

Firm Ecologies: Life Science and Video Game Industries in Liverpool

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for the degree of Doctor in Philosophy by Dane Kevan Anderton.

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Abstract

This research examines the life science and video games industries in Liverpool. Previous research on agglomerations and cities tends to focus on epicentres or high concentration places such as Silicon Valley or global cities such as London and Tokyo, neglecting the northern post-industrial cities such as Liverpool, Leeds or Newcastle. Equally, many studies tend to focus in on one particular industry, whereas this research examines two key knowledge economy sectors in one place. Petilis (2012) argues that the cluster literature has become overemphasised and lacks analytical ability in the investigation of smaller firms and highly diverse concentrations of activity. An alternative ecological perspective is used in this thesis, which is considered more reflexive and flexible to the composition of the agglomerations seen outside the epicentres of the global economy.

Using the heterarchical approach, as outlined by Grabher (2001), this research investigates the emergence and organisation of Liverpool's life science and video game industries. It reveals the changing composition of the industries in Liverpool and how firms are connected into wider production networks beyond Liverpool. Finally, the research analyses how the two industries are situated in the anatomy of the city. The key findings are generated from a mixed methodology utilizing qualitative semi-structure interviews with owner-managers, industry informants and supporting institutions. Secondary quantitative data has been used gathered from annual reports, company websites, industry association and office for national statistics.

Firstly, it is argued that the two industries emerged in Liverpool under different conditions and are on different trajectories, conditioned by local events and global mechanisms in the wider industry. Such trajectories have aided the rise or the fall of various structures and institutions within the city of Liverpool. This has resulted in a life science industry that resembles an institutionally thick anatomy and a video games industry that resembles an institutionally thin anatomy. Secondly, key findings regarding the organisation and connections beyond Liverpool highlight the fact that both industries show a lack of internal connectivity within the ecology and depend significantly on their external connections for inputs in production. For the life sciences this is exacerbated with the high level of product diversity between firms decreasing the likelihood of potential internal connectivity in production or joint resource utilization between firms. Thus firms rely on their external

connections for finance and resources in order to further the production of their products through licensing and merger and acquisition agreements. Thirdly, the video games industry has gained greater autonomy over production analogues to that of the industry norm. For the life sciences, the rigidity in the generic business model is reinforced by the high levels of regulation and intellectual property protections and reduces the ability of some smaller firms to complete a product. Overall, we see two key knowledge economy sectors emerging with changing degrees of functionality as a result of global changes in the industry and the development of institutional infrastructures around these two sectors.

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List of Abbreviations

ABI	Annual Business Inquiry	NHS	National Health Service
API	Active Pharmaceutical Ingredients	NICE	National Institute for Health and Care Excellence
BBC	British Broadcasting Corporation	NWDA	North West Development Agency
Biotech	Biological Technology	NWUA	North West Universities Association
BIS	Department for Business Innovation and Skills	OECD	Organisation for Economic Co-operation and Development
BRIC	Brazil, Russia, India and China	ONS	Office for National Statistics
CFC	chlorofluorocarbon	OTC	Over the Counter
DBF	Dedicated Biotechnology Firm	PC	Personal Computer
EA	Electronic Arts	Pharma	Pharmaceutical
EMA	European Medical Agency	PLC	Publically Limited Company
ERDF	European Regional Development Fund	PPRS	Pharmaceutical Price Regulation Scheme
ESA	Entertainment Software Association	PS1	PlayStation One
EU	European Union	PS2	PlayStation Two
F'cast	Forecast	PS3	PlayStation Three
FDI	Foreign Direct Investment	PS4	PlayStation Four
FDA	Food and Drug Administration	PwC	Pricewaterhouse Coopers
GSK	GlaxoSmithKlien	R&D	Research and Development
HGF	High Growth Firm	RDA	Regional development Agency
HIV	Human Immunodeficiency Virus	RGF	Regional Growth Fund
ICH	International Conference on Harmonisation	ROC	
ICT	Information Communication Technology	SME	Small and Medium Enterprise
Indie	Independent	SCE	Sony Computer Entertainment
iOS	Internetwork Operating System	TIGA	The Independent Game Developers' Association
IP	Intellectual Property	THQ	Toy Head-Quarters
LEP	Local Enterprise Partnership	UK	United Kingdom
MIT	Massachusetts Institute of Technology	USA	United States of America
MNE	Multinational Enterprise	UTC	University Technical collage
MNS	Multinational Studio	VC	Venture Capitalist
NBC	National Biomanufacturing centre		

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Chapter One

1.0 Introduction

This research emerges from two interrelated concerns. First, is the need for further understanding of agglomeration activities by social scientists. Secondly, how key industries in a knowledge based economy are situated within cities. The research will focus on the city of Liverpool, a northern English city. Most of the existing research on agglomerations and cities tends to focus on epicentres or high concentration places such as Silicon Valley (Kleppers, 2010) or global cities such as London and Tokyo (Sassen, 2006a), neglecting the northern post-industrial cities such as Liverpool, Leeds or Newcastle (Southern, 1999). The City of Liverpool has seen a profound transformation in its economy and physical appearance. This thesis will focus on two industries that have historical roots in Liverpool and have been a part of a knowledge economy framework development over the last decade. These will be the Life Science and Video Game industries. Alongside the growth in the agglomeration literature, social scientists have also drawn attention towards both creative and life science industries as archetypes of industries that tend to agglomerate (Scott, 2000; Cooke, 2004a, 2004b; Hartley, 2005; Storper and Venables, 2004; Moodyson *et al*, 2008; Stark, 2009).

Economic geographers and business strategists have particularly focused on the agglomeration of activities and strategic organisation of firms and production respectively (Porter, 1990, Markusen, 1996, Pitelis, 2012). The key questions this research aims to contribute, goes towards understanding why particular industries agglomerate and how they have come to exist in particular places that are not global hubs or nodes in a global economy (Sassen, 2006a; Dicken, 2011). Building on critiques of existing works, there is an area of concern regarding the connectivity of economic activity beyond its local environments. Equally however, there is also a concern with how firms are embedded or situated within the broad context of space and place (Martin and Sunley, 2003). Fundamentally, the research seeks to

answer broader questions on how firms, networks of firms and production systems are organised and integrated into the global economy (Bathelt and Glückler, 2011). There is also much more emphasis on the interdisciplinary cross over between Economic Geography, Strategic Management, Entrepreneurship and International Business. This research aims to explore some of those crossovers through the use of an ecological perspective built upon work in economic geography, entrepreneurship and strategic management.

A traditional starting point into investigating an agglomeration would be to look at cluster approaches as reinvigorated by the work of Porter (1990, 1998, 2000). Work on cluster-type forms is not new, as the work of Alfred Marshall (1920) formally addresses the benefits of the co-location of industries and related industries and the then chosen location of cities having 'something in the air'. Markusen (1996) proposed several industrial district typologies coining the well known phrase 'sticky places in slippery spaces'. Other contributions include Enright (1996), Sabel (1989), Saxenian (1994), Gordon and McCann (2000), Maskell (2001), Bell *et al* (2009) and Matthews (2010). The cluster approach has been widely used in academia but has gained further traction through its adoption by policy-makers as both a theory and method. However, many studies using cluster approaches have been increasingly criticised (Martin & Sunley, 2003; Pitelis, 2012) in particular, for their focus on local connections to the neglect of extra-local networks and their inability to explain and incorporate entrepreneurial activity, particularly small firm start-ups into the cluster processes. Malmberg (2003) and Malmberg and Power (2006) have argued that clusters suffer from conceptual confusion and the notion of geographical elasticity has proven difficult to conceptualise making analytical boundaries fuzzy and blurred. Further Pitelis (2012:1359) argues that the conceptual foundations of clusters has remained weak due to the theoretical perception of absolute advantage rather than a comparison with other forms of governance based frameworks of economic organisation. Overall, the cluster literature has failed to incorporate concepts from strategy and entrepreneurship's disciplines to explain emergence, evolution and co-evolution of clusters (Pitelis, 2012). However, there are new publications on clusters from an evolutionary economic geography

perspective (De Vann *et al*, 2013; Balland *et al*, 2013; Boschma and Hartog, 2014). This work has been predominantly longitudinal and quantitative in approach.

Research on cultural industries has revealed the predication of local clusters on extra-local connections (Coe & Johns, 2004). In the life sciences industry, firms tend to geographically cluster in a minority of locations. They have been argued to be evolutionarily constrained or enhanced by historical, geographical and institutional conditions at multiple scales (Gertler and Vinodrai, 2009, Goddard *et al*, 2012). Although the cluster literature is vast, covering many cities around the world, current research still overlooks many regions of the UK and in particular northern cities such as Liverpool (especially in regards to life sciences). There are still many questions to be asked about how a small northern English city hosts and supports a life science agglomeration and how these firms connect into wider production network. Work on creative industries, beyond the first tier cities such as London and Paris, is increasing with Scott's (2006a, 2006b, 2010) study on the cultural economy in Los Angeles and the Lake District, Coe (2001) and Coe and Johns (2004) work on the film and television industry in Vancouver, and Johns (2004, 2010) investigation into the film and television industry in Manchester. This research will focus on two under researched areas in regards to creative industries and cities. First is the limited study of local video game agglomerations and second is the study of such agglomerations in cities such as Liverpool. However, as the next section will outline, this thesis is using an ecological perspective to analyse the agglomeration of both industries in Liverpool, following the heterarchy framework developed by Grabher (2001).

1.1 Firm Ecologies

An ecological perspective, using a heterarchy framework (Grabher, 2001), is applied in this thesis to overcome many of the issues and critiques levelled at cluster theory and the exclusivity of more recent work on entrepreneurial ecosystems (Mason, 2010, Mason and Brown, 2013). Chapter Two engages in some

of these debates in more depth outlining further critique of cluster literature from above, but also debating the exclusivity of entrepreneurial ecosystems to new start-up firms and high growth firms. The heterarchy outlines five basic features for investigation in firm ecologies: diversity, rivalry, tags, project and reflexivity. All factors are examined further in Chapter Two and applied in Chapters Four and Five. Toulmin (1990:194) effectively summarises the use an ecological perspective stating;

'Once we begin to think in ecological terms, we shall soon learn that every niche or habitat is one of its own kind, and that its demands call for a careful eye to its particular, local, and timely circumstances. The Newtonian view encouraged hierarchy and rigidity, standardisation and uniformity: an ecological perspective emphasises, rather, differentiation and diversity, equity and adaptability'

Tsoukas and Dooley (2011) argue that the post war intellectual, social and technological developments have made it increasingly possible to challenge the reductionism involved in the Newtonian ideal within the study of organisation. Hence, referring back to Toulmin (1990), Tsoukas and Dooley (2011) argue that we can articulate what he calls an 'ecological style' of thinking which embraces complexity and inclusivity by reinstating the importance of the particular, local and the timely. Furthermore, Hayles (1991, 1999) argues that the ecological style includes connectivity, recursive patterns of communication, feedback, non-linearity, emergence, ineffability and becoming.

The ecological perspective is in alignment with the relational approach that forms the basis of the theoretical framework. An ecological perspective argues the need to understand our observations as crucially shaped by initial conditions and path dependent processes (Tsoukas and Dooley, 2011). Two of the three core relational factors are contextuality and path dependence which are both synonymous with ecological investigations of organisations whether they be the individual firm, the place itself and collections of firms in a particular place. Equally valid is the use of

contingency from the relational framework to compliment the fact that outside influences are just as important to the development or emergence of ecological processes.

Therefore, the ecological perspective underpinned with a heterarchy framework has the ability to overcome two key drawbacks in the study of agglomeration and organisations within them. Firstly, cluster theory which neglects the role of smaller firms and start-ups as well as extra-local connectivity. Secondly, entrepreneurial ecosystems theory privileges start up and high growth firms, neglecting any other type of firm that may co-exist in a particular location. This thesis argues that an ecological perspective is holistic in the analysis of an agglomeration of two separate industries in one place with limited existing data suggesting a plethora of organisational forms in existence. The perspective itself is adaptive and embraces the complexity needed with multiple factors and processes in action.

1.2 Liverpool Context

Liverpool is a UK city steeped in over 800 years of history, established as a borough in 1207 by King John. Its role as a port city has been through various stages of fortune, decline and renewal (Kermode *et al*, 2006, Belchem, 2006). Without disregarding its historical context, this thesis will be focusing on the city of Liverpool and in particular, the events of the last decade to varying degrees in relation to the two industries. Between 2000 and 2006 Liverpool city was in receipt of European Union (EU) Objective One funding worth £2 Billion (NWUA, 2013). The objective was titled '*Realising the Knowledge Economy*' which focused EU development funding towards economic regeneration projects and also to aid stimulation of economic growth, labour market development and the regeneration of social areas of greatest need. As part of the strategy towards realising the knowledge economy, the former North West Development Agency (NWDA) local institutions such as the council, chamber of commerce, Liverpool Vision and more recently the Local Enterprise Partnership (LEP) in collaboration with universities and industry

developed a Knowledge Economy Plan focusing on four key sectors in Liverpool (Goddard, 2005; Goddard *et al*, 2011). These are Life Sciences, Advanced Manufacturing, Creative and Digital Industries and Financial and Professional Service (Liverpool LEP, 2014). Each industry is represented not only by firms in the city but by institutions deemed ‘assets’, something that will be discussed in Chapter Six.

Like many cities in the developed world, recent economic development policies in Liverpool have emphasised the importance of industry co-location and as a result, several large-scale infrastructure investments have been made in the city, such as the development of Liverpool Digital for digital industries in the east of the city. For the life sciences a special incubator site located within the University of Liverpool offers a platform for growth and knowledge transfer (Goddard, 2005; Goddard *et al*, 2012). Liverpool’s explicit use of ‘cluster’ theories in economic strategy, despite academic understandings of their limitations, provides foundations for this research to take the pathway that is outline here and in subsequent chapters. The remainder of this section will briefly outline the Life Science and Video Game industries in Liverpool and some of the existing literature.

1.2.1 Life Sciences

Life sciences are a leading sector in the Liverpoolian economy, having developed from the globally renowned innovative and collaborative expertise of the University of Liverpool. The activity base is very diverse, including manufacturing and research and development. Studies of the life sciences industry have highlighted that tacit knowledge plays a large role in the life science industry (Cooke, 2004a, 2004b and Powell, 1996, 2002, 2005). Cooke (2004) identified that the UK life science industry funding is being located in the “Golden Triangle”. This refers to London, Oxford and Cambridge. However, regional development agencies and national policy to aid redistribution of economic activity has led to the North West seizing the opportunities of having a life science cluster. Liverpool has a life science

agglomeration (Wainwright, 2008) but little is known about its composition or organisation types, connectivity and how it's situated in the city of Liverpool. Fundamental to the life science agglomerations is capital (Powell, 1996, 2002, 2005). A strong public capital fund existed in Liverpool providing a structure for knowledge creation, transfer and spill over (Pond *et al*, 2010). Recent changes to the composition and funding mechanisms are explored in more depth in Chapter Four.

1.2.2 Video Games

Liverpool stands out as one of the leading cultural and creative hubs outside of London with a thriving and changing video games industry formerly hosting three multinational studios located in and around the city, as well as a hive of music related activities and festivals, film and television studios and countless other digital, cultural and creative related activities. In addition, the 2008 European Capital of Culture awarded to Liverpool has played a significant role in emphasising the industries in the growth and development of the local economy and also regeneration of Liverpool's docklands and city centre. Within the last 30 years, there has been significant allocation of government funding towards cultural industries (O'Connor, 2005: 47). New labour government championed the development of cultural or creative industries and intervened to make sure the UK had a creative industry base to compete globally (DCMS, 1998). Richards (2007) and Van Heur (2010) argue that the creative industries have a dynamic and entrepreneurial characteristic, which is useful in order to achieve a nation competitive advantage. The video games industry is an understudied sector of the broader creative industry. Current studies tend to focus on the geography and production at an international scale or examine the industry as a whole (Johns, 2006; Cadin and Guerin, 2006; Balland *et al*, 2013; De Vaan *et al*, 2013). As Chapter Five outlines, there are significant gaps in the literature on local agglomerations of video game activities that this thesis addresses. The following section will outline the structure of the proceeding chapters.

1.2.3 Methodology

This research was conducted in the city of Liverpool during August 2011 to August 2012 with two follow up interviews that took place in March 2013 with local institutions. Primary data was collected through 50 qualitative interviews split between firms in both sectors and supporting institutions. Secondary data was collected through annual reports, newspapers and company web sites prior to the primary data collection to help inform the research collection strategy and ensure efficient and effective data collection based on the narrative of the research questions. Throughout the data collection and analysis the aim has been to ensure the validity of the evidence presented and ensure its plausibility, authenticity and ability to stand up to scrutiny.

1.3 Structure of the Thesis

Chapter Two sets out the theoretical framework this thesis uses in order to generate questions upon which the remaining chapter will seek to answer. The chapter outlines the relational economic geography approach to understanding the organisation of firms in particular context (Bathelt and Glückler, 2003, 2011). Relational economic geography consists of three core factors, contextuality, path dependence and contingency. The relational approach has been used in many economic geography research projects and informs a large body of recent literature. As will become apparent in Chapter Two, there are many transferable concepts to this thesis, making it an appropriate theory to generate research questions.

Complementing the three factors of the relational approach, the chapter puts forward an ecological metaphor approach utilising the work of Gernot Grabher (2001, 2004a, 2004b, 2004c) focusing on heterarchies. Heterarchies have multiple features that can help us to understand agglomerations of firms in particular

contexts without privileging the entrepreneurial firm like some of the ecosystems literature, or the multinational firms. This thesis argues that this particular ecological approach is more holistic in understanding a diverse collection of firms of different ages and configurations. Hence, given the nature of the industries in Liverpool that are based initially on local public policy documentation and the fact little is written about them in academic literature, it is then argued that an ecological framework is necessary to capture as much activity as possible and add the contextualisation, path dependent and contingent processes in Liverpool. Equally, the basic factors of the heterarchy are synonymous with, and easily found within wider business literature and allow what is initially a metaphor and abstract approach outlined by Grabher (2001) to be underpinned conceptually. The ecological approach is very much centred on the firm agglomeration and does not fully explore the city of Liverpool, incorporating people and the built infrastructures in which the two industries are situated.

The relational approach stresses the importance of place when investigating firms and agglomerations of activities. Chapter Two presents a framework developed by Cohendet *et al* (2009, 2010) called '*The Anatomy of the City*'. The thesis utilises this framework to compliment the relational approach and also capture a gap in the ecological approach. Florida (2002, 2005, 2007) drew significant attention to the role of people within cities and coined the term the "creative class". Progress has been made in terms of developing and critiquing the role of labour markets within cities, the role of certain types of people in cities and agglomerations. What has been neglected but is admittedly nothing new (see Mumford, 1937) is the built infrastructure of cities and what these do to mediate creative and innovative processes (Cohendet *et al*, 2010). Together the anatomy of the city framework captures both people and place, demonstrating how firms can be situated in broader contexts. Using both an ecological approach and anatomy of the city framework, the thesis over Chapter's Four to Six investigates and analyse the firm and place capturing people, infrastructure and other institutions that contribute to the video games and life science industry development.

Chapter Three covers the methodological approach taken in this thesis. The ontological position of this thesis is one of a social constructionist perspective using predominantly a qualitative approach (Teddlie and Tashakkori, 2011). Data from semi structured interviews formed the bulk of the primary qualitative data collection, whilst newspapers, national statistics and annual reports are part of the secondary qualitative and quantitative data collection (Lincoln *et al*, 2011). The method borrowed data analysis techniques from grounded theory (Glazer and Strauss, 1967, Strauss and Cobin, 1990). In order to improve the validity and rigor in the data analysis, grounded theory techniques have been supplemented with novel techniques to improve and strengthen the qualitative research outcomes. Techniques outlined in the chapter include the use of multiple sources for data collection and using multiple quotes to support arguments, triangulation, and member checks (Barbour, 2001; Byrne, 2001; Coffey and Atkinson, 1996; Doyle, 2007; Guba and Lincoln, 1994). Overall, the chapter presents a robust methodology demonstrating attention to validity, rigor and ability to stand up to scrutiny.

Chapter Four is the first of three empirical chapters. The focus of this chapter is the life sciences industry, examining the wider industry composition, geography, merger and acquisition (M&A) activity and regulation all of which have an impact on the industry at the local scale. Having laid out the wider industry trends and composition, the chapter turns its attention to Liverpool and how an ecology of life science firms has emerged into its current form. We find the roots of the Life Science ecology are firmly in manufacturing of drug compounds in Speke, but more recent policy-led interventions have driven the ecology towards research and development lead firms centring on the strengths of the local universities and other research intensive institutions. However, the primary focus of this chapter is on the firms and industry with Chapter Six taking up the debate surrounding institutions and the city. The ecological approach is used in the later part of the chapter using the framework to examine the composition and connectivity into wider production networks. Evident, is the effects of a diverse range of firms limiting coherence and cognitive proximity. This is dominated by firms working in isolation from the rest of the ecology. At the same time there have been significant changes to the

composition of firms over the last decade and the environment with the scaling back of public funding that has underpinned small firms in Liverpool and nationally.

Chapter Five follows a similar outline to that of Chapter Four but focuses on the video games industry. Again, the chapter look at the wider industry composition, geography, merger and acquisition activity and changes in the nature of production. One of the noticeable differences in the video games industry is the frequency of merger and acquisition activity compared to the life sciences, as well as the broader cyclical nature of the industry based on hardware cycles and the availability of software. The chapter also presents the evolution of the video games industry in Liverpool dating back to a highly successful firm, Bug Byte. The chapter makes use of the ecological approach outlined in Chapter Two to examine the video game industry in Liverpool analogous to the previous chapter. The video games industry in Liverpool has been disrupted with the exiting of three multinational firms. From the rare event several small businesses have emerged and realigned themselves based on their resources to application development over big budget triple A games. Unlike other creative industries described by Scott (2000) the video games firms have inherited practices and routines from their former parent firms working beyond the locale using already established networks in production. Increasingly, firms are seeing greater autonomy over the entire production network rather than a fragmentation generally seen in the wider industry (Johns, 2006, Cadin and Guerin, 2006).

Chapter Six is the final empirical chapter focusing on how the two ecologies are situated within the city. Using the anatomy of the city framework (Cohendet *et al*, 2009, 2010) the focus changes from the ecologies and their composition, to how people, place and institutions have developed and compliment the ecologies. Stemming from Richard Florida's (2002, 2005) work on the creative classes, the anatomy of the city framework goes further to include the physical infrastructures and institutions found within our cities. Combining these concepts is not unheard of (Mumford, 1937), but the framework provides us with a conceptual metaphor and framework in which to unpack the various elements of the city and how ideas from

an underground turn into commercialised products and come in through the upper ground. The middle ground is where the chapter focus most but borrows from the previous two chapters to outline the upper and under grounds. The chapter draws upon institutional thickness concept (Amin and Thrift, 1994, 1995), further developed by Henry and Pinch (2001) to add value to the analysis of the middle ground. What emerges from the examination are the differences between the two industries and institutionally variance of the middle grounds. The life sciences having more visible institutional thickness with further institutionalisation to come, backed predominantly by public grants and European Union development funding, compared with the video game industry that has seen some public money go into creating affordable spaces for creativity but also sees institutional thinness and a drive to self-reinvent and organise with less visible public support.

By way of conclusion, Chapter Seven draws together the key findings of this thesis. Having used an ecological approach to examine the two industries that we knew little about in the same context, the thesis has contributed towards the growing literature on the video game industry and how a diverse life science industry can be studied. The research has answered questions surrounding the composition and emergence of two sectors using a framework that strives to be holistic in approach. This final chapter has sought to position the research into a broader context highlighting areas of future research based upon these findings to give a more complete picture of the state of the two industries in Liverpool, as well as what the case maybe in other similar cities and agglomerations. The chapter suggests the need for a deeper understanding of the growth of new firms in the video game industry, given the findings in Chapter Five, pointing towards the growth literature on fostering ecosystems and self-organisation. In addition, the thesis proposes a continued investigation into the developments of the life sciences, given the long development timelines and particularly with the changes that are on stream regarding the bio-campus, advocating an entrepreneurial ecosystem with comparison to existing work by Vogel (2013).

This thesis aims to take advantage of a theoretical framework that can strive to be holistic in examining an agglomeration of firms across two industries in the same geographical context. In doing so, the research has unveiled the emergence of the two industries including the path dependent processes steeped in the contextuality of Liverpool. In the examination of these industries the research has highlighted how Liverpool is positioned into wider production processes, but also how the city is supporting the two industries through institutionally thick or thin environments. Hence, this thesis will ground existing research based on wider industry trends or areas of higher activity and value in a context of the northern UK city in order to understand how a deprived region can foster and host two advanced knowledge economy industries.

Chapter Two

Theoretical Framework

2.0 Introduction

This chapter provides the theoretical framework used in order to investigate the life science and video game industries in the same geographical context. The primary theoretical lens that will be used is the relational approach (Bathelt and Glückler, 2003, 2011; Bathelt, 2006; Boggs and Rantisi, 2003; Dicken *et al*, 2001; Dicken and Malmberg, 2001; Ettlinger, 2003; Sunley, 2008; Yeung, 2005) which stems from Economic Geography. Relational economic approaches allow this thesis to look at firms in a particular place through three key factors: context, path dependence and contingency. The relational approach informs a large body of literature (Bathelt, 2006; Bathelt *et al*, 2004; Coe *et al*, 2004, 2008; Dicken *et al*, 2001; Dicken, 2005, 2011; Hess and Coe, 2006; Peck and Yeung, 2003). It has become apparent that there are many transferable concepts to this thesis, making it an appropriate theory to generate research questions. In addition, there are two other complimentary theories that will be used to help fulfil the broader concepts of the relational approach. The first of these supporting theories is an ecological perspective, provided by Grabher (2001, 2004b, 2004c) in the form of the heterarchical structure of ecologies. Ecologies are said to be comprised of diversity, rivalry, tags, projects and reflexivity. These will be used to explore firm and industrial ecological structures within Liverpool. The ecological perspective places an emphasis on the firms that compose the ecology and how they may interact with place and vice versa. Heterarchies provide the platform for an interdisciplinary framework between, predominantly, Economic Geography and Strategic Management. Secondly, the anatomy of the city perspective theorised by Cohendet *et al* (2010) will further support the emphasis on place and how the ecologies are situated in the City of Liverpool. Attention will be drawn to the infrastructures of the city and how these facilitate knowledge exploration and exploitation.

The chapter take the firm as a focal point of investigation. This is advocated in the relational approach and through the ecological perspective taken in this thesis. The firm is conceptualised as a collective institution comprising of both human and physical elements, working within a wider network that forms industries and economies; themselves functioning in a global economic system. The structure of this chapter begins with an examination of the firm and its conceptualisation. Secondly, the relational approach will be outlined, examining both structure and agency, the three relational factors being used in this thesis and how place is taken as a key factor in this research. Thirdly, the supporting ecological perspective will be outlined using a heterarchical approach (Grabher, 2001). The five features of a heterarchy will be discussed, followed by a review into the application of this approach in the academic literature. Fourthly, the chapter will unpack the anatomy of the city concept; looking into the three layers of a 'creative' city and how this can be transferred into this thesis. The chapter will then conclude and state the research questions generated from this theoretical framework.

2.1 Conceptualising the Firm

The firm is an economic entity that is part of all capitalist economies and plays a notable role in political, economic, societal and cultural phenomenon. There have been many conceptualisations of the firm across the social sciences, but notably from economics and more recently, sociology (Taylor and Asheim, 2001). Two broad schools of thought have been established surrounding the theory of the firm; the rationalist perspective and socioeconomic perspective. The rationalist views do not fully explore the social conditions and breadth of human involvement in the firm (Ettlinger, 2003; Kantarelis, 2007; Whittington, 2004). Maskell (2001) argues that the behavioural view of the firm did make the first step towards fully appreciating the context that firms conduct their activity, but this was only a partial attempt. Changes in the conceptualisations of the firm are linked to the paradigm shifts that have occurred throughout the social sciences; moving from rationally bounded thinking through to more sociological bounded thinking (Whittington, 2004). More

recent conceptualisations have arrived with the cultural turn. They have an added emphasis on the social dimensions of economic activity and link nicely to the relational approach being taken in this thesis. These are summarised in Table 1.

Table 1 Theories of the Firm

Rationalist Perspectives	Socioeconomic Perspectives
<p>Neoclassical economic</p> <p><i>The firm is a black box. Inputs are turned into outputs. Rational choices are made based upon perfect knowledge of the market.</i></p>	<p>Institutionalist</p> <p><i>The firm is a site of rules and regulations. The firm provides and framework for calculating risk. The firm framework should protect against a highly competitive market (Hodgson, 1988).</i></p>
<p>Transaction cost</p> <p><i>The firm aims to minimise the transaction costs of buying raw materials and producing outputs. Firms face a choice of internalising functions or externalising them to the market.</i></p>	<p>Network perspective</p> <p><i>Firms are enmeshed in loosely coupled networks of reciprocity and interdependence (Grabher, 1993; Taylor, 1995). The firm is embedded in a particular social context that it conducts economic exchange.</i></p>
<p>Behaviourism – Bounded rationality</p> <p><i>Based on bounded rationality, opposing rational choice assumptions in previous theories. The firm is a site of decision making due to imperfect knowledge. Emphasis is placed on decision making processes of individuals and firms.</i></p>	<p>Learning firm</p> <p><i>Firms form intra and inter firm relations based on organisational learning through cooperation. This is linked to the learning regions or clusters literature (Florida, 1995, Porter, 1998, Ennals and Gustavsen, 1999).</i></p>
	<p>Competencies view</p> <p><i>Concerned with factors inside the firm and closely linked to the Resource Base view of the firm (Penrose, 1959 and Barney, 1992) and Dynamic Capabilities</i></p>

	<i>(Teece and Pisano, 1994). Resources move beyond neoclassical classification to those that differentiate the firm.</i>
	Project-based view <i>Stems from a focus on SMEs and portfolio entrepreneurs and the role of teams in business start-ups and spotting opportunities. Emphasis on the temporary nature of these groups of people who create and dissolve as economic, social and political landscapes change.</i>

(Adapted from Taylor and Asheim, 2001)

Pre 1930's the firm was conceptualised as a black box; assumed to behave as a self-interested, utility maximising, economic actor (Kantarelis, 2007). Under this belief, the firm would respond instantaneously to change in the economic environment, putting resources to their best and most efficient use. This rationalist way of thinking was challenged by Coase (1937), who posed the following questions: why do firms exist and what is a firm? Firms are collective actors known also as organisations, they consist of individuals brought together as one actor. Coase (1937) placed emphasis on the relations within the firm but also argued that the boundaries between the firm and the market would become fluid over time. The transaction costs of time and money, explains the existence of a firm and their optimal size (Coase, 1937). Firms can seek advantage by reducing transaction costs through internalising parts of production processes and externalising them depending on the shifts in industry market, technologies and labour relations (Storper and Christopherson, 1987). However, Coase (1937:2) depicted the firm as "an island of co-ordination within a sea of market relations". Dicken and Malmberg (2001) argue that this simply cannot be the case, as firms are essentially networked forms; networks within networks. Dicken *et al* (2001:91) argue 'networks are relational processes that produced observable patterns in a global economy'.

Understanding firms as network allows us to observe patterns of organisational formation, connectivity and positioning with broader networks, that being the global economy. Dicken and Malmberg (2001) argue that every territory has a distinctive firm ecology. They are the primary agents within industrial systems and are inherently linked to the territories that co-ordinate the activity within. Early definitions such as that posed by Coase (1937) and functional perspectives, of which the transaction cost is one, are weak in specifying the role of space and territory. Other definitions within a system's perspective differ in their degree of capturing the complexities of production organisation and the logic of learning and innovation (Dicken and Malmberg, 2001:348). As Taylor (1999) argues, there is no widely accepted definition of the firm. Dicken and Malmberg (2001:350) stress the importance for a need of a definition that delimits the boundaries of the firm, the rationale for firm action, and firm organisation.

The rationalist views have, to some extent, shown the firm as a placeless economic agent that on first glance is autonomous and purely functional. This under-socialized view of the firm has been challenged, pushing forward thinking into a number of new, 'socioeconomic' conceptualizations of the firm (Taylor, 1999, Taylor and Ashiem, 2001). The socioeconomic views have their foundations in the work of Polanyi (1944) and are furthered by Granovetter (1985:459) who argued that all kinds of transactions are 'rife' with social connections. In addition to the social connections in any transaction, we need to consider the context that these connections take place within. The 'cultural turn' across the social sciences, notably in strategic management, economic geography and sociology, gave rise to social-cultural practices embedded in corporate culture and knowledge and learning (Schoenberger, 1994, Yeung, 2001, Whittington, 2004). Again, this was breaking from the dominance of economic and rational practices that have dominated such social scientific disciplines. We see there is no longer a world out there to be rationalised and modelled but one that is more complex and fluid.

Maskell (2001) furthers the socioeconomic conceptualisations of the firm as a historical entity. It has a path dependent (David, 1985) or evolutionary nature,

having to respond to changes in the industrial environment (Porter, 1990). Penrose (1959) argues that firms are heterogeneous assemblies of assets and competencies under a common direction. Firms advertise or parade these assets or competencies in the market in order to link into wider production systems that can generate meaningful economic returns (Taylor, 1999). By law, a firm is defined and bounded to the assets and ownership of property by an individual or individuals, but as Dicken and Malmberg (2001:346) argue, we must recognize firms as institutions with permeable and highly blurred boundaries. Hence, firms can form greater systems and networks beyond their own legal boundaries. These are systems of similar or related firms, also known as the industry, the production chain, the cluster, ecology or ecosystem (Porter, 1990; Dicken and Malmberg, 2001; Grabher, 2001).

'The firm is therefore necessarily a site of power relations and power struggles among actors who may be capitalists, workers, technologists, managers, regulators, analysts, strategists and so on. The firm is a sociospatial construction embedded in broader discourses and practices' (Yeung, 2001: 294)

Through the study of the firm we can see there are many actors collectively brought together. There has been an increasing acceptance that the social and the economic are inextricably intertwined and the firm is therefore a place in which networks and activities are played out (Granovetter and Swedberg, 1992; Granovetter, 1985, 2005; Gertler, 1995 and Thrift and Olds, 1996). However, over the last 25 years, there have been many different conceptualizations and uses of the term network (Glückler, 2007). This thesis understands the firm as a relational network that can organise and retain financial control over resources and employment.

'Firms are ownership based units of decision-making and control, they are clearly central collective actors in the mobilisation, allocation, and use of assets, especially human labour power' (Whitley, 1999: 66)

It is recognised that the firm is not just a legal bounded entity and owner of property assets (Dicken and Malmberg, 2001; Taylor and Asheim, 2001). Adopting a sociological view of the firm means we can ask many more questions and unpack the fluid complexities of everyday economic activity by those who are practicing the activity and those who are involved in making the activity happen (Knights and Morgan, 1991; Whittington, 2004). Within a firm network, there are agents or actors that are linked by ties or connections. Yeung (2001) defines the firm as:

“a constellation of network relations governed by social actors. Instead of being a mechanistic production function or an abstract capitalist imperative, it is a contested site for material and discursive constructions at different organisational and spatial scales. (p.294)

Yeung’s (2001) definition follows the networked view of the firm but overcomes Taylor and Ashiem’s (2001, p.324) critique which states that, all the definitions given in Table One underplay the dynamic role of place, space and spatiality in shaping firms’ operations. Equally the inclusion of place has been underplayed in much of the business and management literature (Cohendet *et al*, 2010). It has been repeatedly mentioned that context is an important factor in the analysis of the firm. Places are not homogenous and can be scaled at the level of the firm through to a continent; making place hard to define (Coe *et al*, 2007). The firms belonging to the life science and video games industries have been identified as the units of analysis. Liverpool is the place where economic, social, cultural and environmental interactions and processes take place for this research (Coe *et al*, 2007). The following section will explore the relational approach and the importance of geography in relation to the firm in this thesis.

2.2 A Relational Approach to Investigating the Firm

There has been a long standing debate in economic geography regarding space and place in relation to the firm and its economic activity. In the last two decades there has been a resurgence of work from across the social sciences that has investigated

how national competitiveness is linked to regions and particular industries (Dicken and Malmberg, 2001; Amin 2002; Coe *et al*, 2004; Ashiem and Martin, 2006; Bell *et al*, 2009). Schoenberger (1999) argues that firms and places develop their own identities, ways of doing things and ways of thinking over time. This is because they 'live in different places and must be confronted and respond to particularities of these places across a whole range of practices and issues' (Schoenberger, 1999: 211).

"Firms, like all other forms of social organisation, are fundamentally and intrinsically spatial and territorial" (Dicken and Malmberg, 2001: 355)

Firms are spatial in that they depend on certain resources that are geographically bound. They are territorial and in this way they are bound to the areas in which they conduct their activities but also conditioned by it. Following from the relational perspective, there are clear links that show how a firm has an impact on the characteristics of the territory or place in which they conduct their economic activity, but also how that place can shape the characteristics of the firm. The development of firms and networks are still influenced by the economic environment in which they are placed (Whitley, 1992, 1996, 1999).

'Even firms operating in highly internationalised sectors still tend to retain distinct organisational forms and practices that largely reflect the regulatory environment of their home country' (Dicken *et al*, 2001:96-97)

Hence, it has been argued, that the firm is not placeless and it does have a significant role in the organisation of firms and industries (Dicken, 2000, Dicken, Forsgren and Malmberg, 1994; Dicken and Thrift, 1992). The relational framework is best placed to generate and answer questions about the geography of the firm, how it organises production across space and the evolution of economic actions (Dicken and Malmberg, 2001; Dicken *et al*, 2001; Bathelt and Glückler, 2011). Increasingly, different forms of knowledge have become an integral part of many products and services (Ashiem and Gertler, 2005). Firms have to generate

knowledge and innovate in order to remain competitive and stay ahead of international competitors in a global economy. Firms have become more specialised as technology advances. However, knowledge is not ubiquitous and is found and embedded into specific places and economic practices (Gibson and Bathelt, 2010). Through the relational approach, using the three factors outlined in more detail later, we can understand the contextual, path dependent and contingent processes of knowledge creation in particular places and the value it adds to the production processes and wider economy. The approach has the flexibility to look at concentrations of firms geographically and also the wider networks which they are situated in.

The concept of 'relational' has a dual meaning, as highlighted by Sunley (2008:4) who states that:

“Relational has a dual meaning, ranging from specific forms of relationships to any exchange, agreement, or interaction between two or more people”

There are two meanings to the term 'relational' stemming from economic sociology and post-structuralist thought. The former refers to the relational as signifying interpersonal and inter-organisational networks and connections (Dyer and Singh 1998; Capello and Faggian 2005; Jones, Hesterly, and Borgatti 1997; Rutten 2004) while the latter refers to all forms of networks and relations between entities (Sunley, 2008). Both definitions of relational pose the problem of where networks start and where they finish. This can be contentious, leading to overly exclusive analysis with highly defined analytical boundaries, selected actors and clarity and overly inclusive analysis that tries to incorporate all forms of actors, making the analysis confusing and lacking focus. Thus, this elasticity is what can lead to networks detailing everything and explaining nothing (Sunley, 2008). Holton (2005, p.215) argues, “network may be a metaphor for our times, but little analytical progress will be made until those who discern networks are clearer about what networks are not as well as what they are.” The relational approach seeks to highlight the dynamic and unfolding processes that characterize connections

between entities rather than seeing them as static and fixed (Emirbayer 1997; Lee 1989; McDowell 2004). For the purposes of this research, relational will refer to inter and intra organisational connections that are established throughout the production processes. In order to investigate those connections, this research will focus on the firms' connections that are necessary in the production of a product or service. These connections are what create value for the firm but also provide support, facilitate knowledge exchange or are a source of advice for firms that are in difficulty or failing. An ecological perspective will be taken in this research to help overcome some of the issues with networks boundaries, yet it will also keep the relational approach focused within two industries. The ecological perspective has five characteristics that can be used to explore particular firms and collections of firms. Such an approach compliments the relational approach by focusing on a particular concentration but also being able to explore connections into wider systems of production.

In the production process relational connections emerge within and outside the firm. Internal connections with colleagues can also permeate the boundary of the firm if those employees then become former employees. It results in once intra-organisational connections becoming an inter-organisational connection. Amin and Cohendet (2004) argue that relational proximity is enabled by close social interaction whether this is within the same workplace or the same geographical context. These connections can then become the source of competitive advantage. For the purpose of this research it should be understood that the cause of some, but not all, inter-organisational connections can be the result of former intra-organisational connections. However, there are some inter-organisational connections that emerge without the former intra-organisational connections.

A relational framework focuses "on the ways in which socio-spatial relations of economic actors are intertwined with broader structures and processes of economic change at various geographical scales" (Yeung, 2005, p.37). The framework overcomes static and isolated perspectives of interactions based on

profit maximisation alone. Firms are evolving and shifting their organization of activity in response to changes in demand and the structure of markets; organizing production into new forms that require specialization of core tasks and an increased outsourcing of such specialized tasks (Boggs and Rantisi, 2003). The boundary of the firm is no longer fixed as activities and interactions can permeate beyond its fixed location into wider activity systems (Dicken and Malberg, 2001; Zott and Amit, 2010). Interactions or transactions between firms can be viewed through a spatial lens given by a relational approach. Massey *et al* (1999:12) argue that “we can understand phenomena only by looking at their links and interactions. Focusing on relational geometries... leads us to appreciate that what were thought to be homogenous units [the firm] are, in fact, internally fractured and heterogeneous”.

2.2.1 Agency, Structure and Institutions

Relational approaches allow the dichotomies of scale to be overcome, moving away from the global–local debates or the macro–micro distinctions that have been widely used in other disciplines such as Economics (Dicken *et al*, 2001). The relational approach accepts that the contemporary capitalist economy has the ability to work across multiple scales, hence none of these scales should be privileged (Jessop, 1999; Amin 1997; Brenner, 1998, 1999; Swyngedouw, 2000). In addition, human actions can have effects on social and economic environments (Granovetter 1985; Hudson, 2004). Unlike neoclassical economic views of the firm, that treated the firm as a “black box”, relational frameworks explicitly acknowledge the role of context, specificity in human actions and how relations between institutions and firms or within a firm themselves can lead to very heterogenic outcomes in different places (Maskell, 2001). Yeung (2005:41) states:

“Instead of conceptualizing economic units as a singular site of relational, (re)productive and progressive imperatives, this ‘decentres’ and ‘destabilises’ the fundamental categories of organising socio-economic life [these being the firm, industry or economy]”

However, this is the first point of contention with the relational approach. Focusing the analysis on individuals can be very difficult in an economic context. Given the size and complex structures that exist within some firms, identifying individuals alone can become a daunting task. Firm and individual are not analogous and yet they are not entirely different. Within economic systems, there are collective actors such as the firm or governments that require consideration. Although their inclusion is not new, the relational approach provides a theoretical approach to view all actors in a system in a way that doesn't privilege any one type of actor. Within the firm are managers, employees and attached to the firm are various stakeholders. Each is engaged in the firm in various ways. Following Giddens' (1984) structuration theory, the firm can be conceptualised as an institution; a collective of individual actors that mediates the structure agency dualism. Setterfield (1993, p756) stated that institutions are the correlated behaviour of agents.

"Institutions are collective in the sense that they include patterns of behaviour that cannot be traced back to individual agents" (Blathelt and Glückler, 2011, p 50).

Economic institutions are understood as stabilised forms of social relations (Blathelt and Glückler, 2003). There can be multiple layers of institutions that can support or work against one another.

"[Individual] actors are not given free reign. They are still viewed as operating within a context of institutions, norms and rules, which condition their choices and relations, i.e. within a broader system which is constituted by both structures and agents." (Boggs and Rantisi, 2003, p.111)

Individuals function across many organisations, of which the firm is one. Others include political, economic, social, education, religious and medical institutions. The firm has been the preferred choice of analysis in economic research as competencies and resources are institutionalised through the firm (Nelson and Winter, 1982; Maskell *et al*, 1998; Taylor and Asheim, 2001). Having reaffirmed the

focus on the firm, the chapter will then move to outline the three key factors that will be taken from the relational framework.

2.2.2 Relational Factors: Contextuality

Within the relational framework there are three factors: contextuality, path-dependence and the contingency of economic actions. These factors allow an understanding of the underlying processes and rationalities of economic action (Bathelt and Glückler, 2003, 2011). Each will be discussed in turn.

Firms are not place-less, their activities have to occur somewhere and they are subsequently structured to operate in and from that place (Martin and Sunley, 2006). The choice of that particular place can be based on a plethora of strategic or historical reasons. If we conceptualise the firm as a socially constructed entity or as networks with permeable boundaries, then the places the firm occupies are being conceptualised as a network of networks (Dicken and Malmberg, 2001). We then have to appreciate the contexts that economic activity is practiced in. This places the firm as the economic actor at the core of this framework and can be seen as a rhizome (Deleuze and Guattari, 1988) that grows its network into the context and also beyond it; illustrating that actions are embedded in social and cultural contexts (Hess, 2004). Dicken and Thrift (1992:287) argue that business organisations are themselves produced through interactions between cognitive, cultural, social, political and economic characteristics of the firm's home territory and even the amongst the firm's operations that are geographically dispersed. The level of embeddedness into a particulate place and how that place affects the firm's performance are important when the firms come to design a business model. There are three categories of embeddedness: societal, network and territorial (Hess, 2004). Societal embeddedness has applicability to this relational factor; considering the background of the actor, where they have come from and how that experience shapes their actions and practice (Hess, 2004). Equally, territorial embeddedness focuses on the extent to which a firm is anchored in a particular place. Network embeddedness explains how the firm is involved in wider networks and the

structures of the relationships among a set of organisations regardless of place (Hess, 2004:177). This can be applied to the wider networks of production that a firm is involved in, for a particular product or service. The relational approach realises that the context has particular effects on networks of production and the institutions that form the fabric of a particular place. This in turn creates the 'institutional thickness' or 'thinness', defined by presence or lack of strong institutions, high interactions and mutual involvement in enterprise (Amin and Thrift, 1994; Henry and Pinch, 2001; Hess, 2004). Equally, firms experiment with their business models to factor in context specific characteristics that can enable or constrain the competitiveness of the firm (Baden-Fuller and Morgan, 2010). Firms and places are intertwined. Later in this chapter, the anatomy of the city concept will support how we can imagine the city of Liverpool as a place of economic interactions.

2.2.3 Relational Factors: Path-Dependence

The notion of path dependence gains much of its prominence in economic theory through the work of Paul David through numerous publications on the economic history of technology (1985; 1986; 1992; 1993; 1994; 2001; 2005). The use of path dependency reflects a growing interest in the historical dynamic of economic activity and landscapes (Martin and Sunley, 2006, 2010). Path dependence considers the actions of the past as enabling or constraining on the actions of today. Following on from contextuality, networked embeddedness focuses on the architecture of relationships among organisations regardless of their geography or scale (Hess, 2004). In regards to firm networks, the focus is on the structure and evolution of these networks and this fits with the path dependent relational factor. The actions of economic agents, whether they are social, technological or institutional can have an effect on today's context and activity.

The concept of path dependence can be applied to the firm and to the location in which a firm is situated. The actions of today will also have an impact of the future

developments of a firm or location (Nelson and Winter, 1982, Nelson, 1995). The evolutionary changes are of great importance when making decisions in the present. Path dependence is synonymous to cumulative causation. This creates unequal propensity for future events (Bathelt and Glückler, 2011). There are links to the ways in which organisations learn from historical events. The knowledge that is gained can have an overwhelming effect on the direction and strategy of the firm. Choices that become part of a firm's business model such as the technology used, assets purchased or specific competencies, are formed from internal and external factors, linking to the place in which the activity occurs. For example, once a particular technology is adopted, a firm can become locked into a trajectory that can lead the firm to make certain decisions and perform actions that differ from others. From those actions, the firm can reflect and change their business models to be competitive in the future. According to Baden-Fuller and Morgan (2010), firms experiment with business models and morph over time. The relational approach provides the path dependent factor to explore these changes and circumstances leading to the ecologies of the firms we see in particular places. The anatomy of the city concept outlined later can benefit from having a path dependent approach incorporated. Therefore, we can see how the infrastructures of the place have been changing in order to facilitate or direct the trajectory of ecologies (Howkin, 2010).

2.2.4 Relational Factors: Contingency

Economic processes are contingent, as agents' actions and strategies may deviate from existing development paths (Bathelt and Glückler, 2011). No one place is the same; therefore we have many different contexts, with many characteristics affecting the actions of agents. There can be knock on effects of territorial embeddedness on a firm's wider network (Grabher, 1993; Scott, 1998). Given a path dependent history of a certain context, economic actions are subject to unforeseeable changes and are therefore fundamentally open ended and cannot be predetermined through spatial laws (Sayer, 2000; Bathelt and Glückler, 2003). An action in a particular context, that may be the process of path dependence in one place, can have unexplained consequences in another. Decisions that are made

within a firm that has multiple locations can lead to unequal enabling or constraining effects across the sites (Dicken and Thrift, 1992). For example, decisions being made in the head-quarters of a multinational firm trickle down to the subsidiaries located across the world. That subsidiary is part of the context and path dependent nature of a particular place. A decision to reorganise production and therefore close that particular subsidiary can have a subsequent positive or negative effect on that particular place and the ecology of the firms located there. Using the heterarchical approach outlined later, these contingent processes can really change the ecological make-up of a heterarchy that, again, link into the context and path dependent nature of a place.

The three relational factors outlined above are highly interrelated. The relational approach is best placed to generate and answer questions regarding a set of industries in a particular place and how each are either enabled or constrained. Equally, there is enough scope in the approach to allow the use of supporting concepts to place a clear analytical lens on the investigation. The following subsection looks at how the relational approach has been applied.

2.2.5 Situating the Relational Approach

There have been a variety of relational frameworks applied in economic geography. Firstly, relational assets in local and regional development are concepts related to agglomeration tendencies. Certain firms, such as those in the creative and high technology industries, have been observed locating in proximity to take advantage of traded and untraded inter-dependencies (Amin, 1999; Asheim, 1996; Cooke and Morgan, 1999; Florida, 1995; Henry and Pinch, 2001; Storper, 1995). These have been termed industrial districts or clusters (Markusen, 1996; Porter, 1990). This literature is focused on the local interactions between firms and the interdependencies that they bring. Secondly, there has been theoretical and empirical work regarding relational embeddedness in networks (Hess, 2004; Powell, 1996), social actors, firms and organizations. This use of the relational approach has examined networks of production across space. Much of the literature here has

focused on Transnational Corporations (TNCs) and the governance structures of the entire production process (Grabher, 2004a, 2004b; Ghoshal and Bartlett, 1990; Owen-Smith and Powell, 2004). Theoretical frameworks such as global commodity chains (GCC) (Appelbaum and Gereffi, 1994; Gereffi and Korzeniewicz, 1994; Gereffi, 1994a; 1994b; 1994c; 1999) and global production networks (GPN) (Coe *et al*, 2004; Henderson *et al*, 2002, Hess and Coe, 2006) have examined the power, value and embeddedness of these networks along with the spatial unevenness of production and allowed a graphical representation of how firms are organising their production across space and the interactions between actors. Thirdly, scale has been examined as a relational construction (Cox 1998a, 1998b; Marston, 2000, 2005; Peck, 2002; Swyngedouw, 1992, 2003). This set of literature has focused mainly on the political, urban governance and the social regulation aspects of scale debates, covering rescaling and reterritorialisation (Brenner, 2003, 2009; Healey, 2004; Jessop, 2002).

The relational approach has sought to overcome the dualism between structure and agency through the use of networks, following Giddens' (1984) structuration theory. Structural perspectives have been focused on general laws, regularities and patterns in order to understand how markets reproduce or stabilise themselves over time (Sayer, 2001; Boggs and Rantisi, 2003). However, actors are still enabled or constrained within a context of an institution's, norms and rules that condition their behaviour (Boggs and Rantisi, 2003). Bathelt and Glückler (2011) argue that there is contingency, in that economic actors participating in a network can still deviate from existing development paths causing disruption.

There are proponents who argue that the relational approach should move towards evolutionary frameworks (Sunley, 2008 Boschma and Martin, 2011). This thesis would disagree with taking an evolutionary approach and favours the relational approach. For the framework that is being developed throughout this chapter, the path dependency element places enough emphasis on the role of historical events and their impact on present events and future events. Evolutionary perspectives take a critical stance towards static analysis seeing the present as a product of past

affairs (Boschma and Franklin, 2006). Following Dosi (1997), evolutionary perspectives want 'the explanation to why something exists intimately rests on how it became what it is' (p. 1531). However, evolutionary perspectives are not the first to acknowledge historical process and their impact upon economic activity. Krugman (1991, 1998) stressed that history does have a role to play and that path dependency can be a factor in actions of economic actors. There are also business historians who have been documenting historical changes in business landscapes, providing an alternative way of understanding firms in particular locations and how path dependent affairs construct present economic environments (Popp and Wilson, 2007; Wilson and Popp, 2009; Popp and Holt, 2013 Colli *et al*, 2013).

The relational approach allows for detailed accounts to be taken of historical processes that can help to understand the types of firms that exist within Liverpool, the connections they have within the production and value creation processes. Having recognised the work that is currently being done under the evolutionary perspective in economic geography, the relational framework has greater applicability to this research and has already been used in both industries under investigation in this research. The following section will move onto the ecological perspective and how we can look at firm ecologies.

2.3 An Ecologies Perspective

Place in the global economy has become widely examined, with some advocating that globalisation is increasing the importance of location (Martin and Sunley, 2003) rather than reducing its significance (O'Brien, 1992; Grey, 1998; Reich, 2001). The agglomeration of economic activity is not a new phenomenon and has been noted as a characteristic of nineteenth century industrialisation across North America, Europe and other places (Asheim *et al*, 2006). More recently, there has been work on clusters in a knowledge-based economy termed the knowledge-based view of spatial clustering (Malmberg and Power, 2005, Bathelt *et al*, 2004). This progressed the arguments further in order to understand knowledge as a resource to the firm

and the socio-economic relationship between knowledge production and consumption (Maskell and Malmberg, 1999a, 1999b). Finally, there has been a move towards conceptualizing the concentrations of firms and the linkages they may have in production as ecologies or ecosystems (Grabher, 2001, 2002, 2004b; Isenberg, 2011a, 2011b, 2013; Mason, 2010; Mason and Brown, 2013). This reflects a move towards project based work and highly specialised flexible firms that are common in creative and digital industries (Grabher, 2002). As the production process is becoming increasingly fragmented across other industries, there are even greater efforts to foster linkages beyond the firm boundaries.

An ecological perspective, using a heterarchy framework (Grabher, 2001), will be used in this thesis to overcome many of the issues and critiques levelled at cluster theory and the exclusivity of more recent work on entrepreneurial ecosystems that focuses on high growth firms and entrepreneurial start-ups only (Mason, 2010, Mason and Brown, 2013). The heterarchy framework outlines five basic features for investigation in firm ecologies: diversity, rivalry, tags, project and reflexivity. Toulmin (1990:194) states:

'Once we begin to think in ecological terms, we shall soon learn that every niche or habitat is one of its own kind, and that its demands call for a careful eye to its particular, local, and timely circumstances. The Newtonian view encouraged hierarchy and rigidity, standardisation and uniformity: an ecological perspective emphasises, rather, differentiation and diversity, equity and adaptability'

In addition, Tsoukas and Dooley (2011) argue that we can articulate what he calls an 'ecological style' of thinking which embraces complexity and inclusivity by reinstating the importance of the particular, local and the timely. Furthermore, Hayles (1991, 1999) argues that the ecological style includes connectivity, recursive patterns of communication, feedback, non-linearity, emergence, ineffability and becoming. An ecological perspective argues the need to understand our observations as crucially shaped by initial conditions and path dependent processes

(Tsoukas and Dooley, 2011). Two of the three core relational factors are contextuality and path dependence. Both are synonymous with the ecological investigations of organisations outlined above, whether they are the individual firm, the place itself and the collections of firms in a particular place. Equally valid, is the use of contingency from the relational framework, in order to compliment the fact that outside influences are just as important to the development or emergence of ecological processes.

Therefore, building onto the relational framework utilising the ecological perspective overcomes two key drawbacks in the study of agglomeration and organisations within them. Firstly, this framework overcomes cluster theory that neglects the role of smaller firms and start-ups as well as extra-local connectivity. Secondly, the framework overcomes entrepreneurial ecosystems theory that privileges start up and high growth firms, neglecting any other type of firm that may co-exist in a particular location. This thesis argues that an ecological perspective is holistic in the analysis of diverse and smaller agglomeration of two knowledge economy industries in one place. The perspective itself is adaptive and embraces the complexity needed with multiple factors and processes in action. The following section will outline the definition of a heterarchy followed by the key features.

2.3.1 Heterarchies

Grabher (2001) applies an ecological perspective to a creative industry agglomeration and focuses his conceptual approach on heterarchies. Heterarchies are closely linked to traditional perspectives on networks, that emphasized strong ties, weak ties, brokerage, emddedness and network position (Granovetter, 1973), but go further into exploring the firm ecology through a heterarchical framework. Grabher (2001: 353) states that:

“...although the conceptual foundations of heterarchies have been laid down in natural sciences... the notion has also been applied in the analysis of large corporations... and regions. By drawing on these organizational

reconceptualisations, heterarchies are conceived here as a form of social organization this is define by five basic features which constitute a fragile balance between integrative and disintegrative processes, between sources of stability and instability”

The focus of this research is to investigate two industries in the same geographical context. The ecological perspective supports such an approach because it is well placed to look at concentrations of firms within a particular place and in a specific industry; especially as the framework has previously been used on a creative sector, as will be done in this thesis (Grabher, 2001, 2004). This is an inclusive and consistent perspective, providing a framework in which to generate questions surrounding the two knowledge economy industries. Additionally, the framework has not been applied to either of the industries under investigation. Previous studies have used other forms of cluster analysis. However, cluster approaches have become increasingly criticised (Martin & Sunley, 2003; Pitelis, 2012). Clusters have been overly focused on local connections to the neglect of extra-local networks, as well as inadequately explaining and incorporating entrepreneurial activity, particularly small firm start-ups into the cluster processes. Malmberg (2003) and Malmberg and Power (2006) have argued that clusters suffer from conceptual confusion and the notion of geographical elasticity has proven difficult to conceptualise, making analytical boundaries fuzzy and blurred. This has resulted in further contestation around the conceptual foundations of clusters. Pitelis (2012:1359) argues the conceptual foundations remain weak due to the theoretical perception of absolute advantage, rather than a comparison with other forms of governance based frameworks of economic organisation. Overall, the cluster literature has failed to incorporate concepts from strategy and entrepreneurship's disciplines to explain emergence, evolution and the co-evolution of clusters (Pitelis, 2012). The advantage of using the heterarchy approach is that it profiles the ecology in a particular location in greater detail as well as looking into the individual firm's operations and how they are connected into wider production networks. Later in the chapter, the focus on the anatomy of the city is particularly relevant

and supportive, as it seeks to investigate what an ecology of related firms need from its location, for the production of knowledge and survival (Howkins, 2010).

Grabher (2001) implicitly suggests an element of change over time through a reflexive process, where firms have to be responsive to stable and unstable economic environments. Through the theorisation of project ecologies, research can move beyond the focus on inter-firm relations and recognize the many different network relations between individuals during a particular project (Johns, 2010:5). Previous studies have looked mainly at strong network ties or just inter-firm relations and their power or influence over the allocation of resources. Application of Granovetter's (1973) work shifted the focus to the benefits that weaker ties yield in social relations between groups of individuals. The weaker ties are argued to be able to generate opportunities and inclusion into other communities, which, in themselves, house opportunities. Burt (2001) introduced the concept of structural holes and the brokerage mechanisms that are needed to bridge these. Institutions and gatekeepers provide these links within a particular place and thus fuel the ecology. Again, this links to the preceding framework and highlights these infrastructures. Hence, project ecologies include all non-firm actors in production and allow us to conceptualize networks across space. There are five features to heterarchies that will be discussed in turn.

2.3.2 Heterarchy Features

Howkins (2010) argues that creative ecologies required diversity, change, learning and adaption in order to flourish in a particular place. Grabher's (2001) use of the heterarchy features in the ecological perspective and includes Howkins (2010) creative ecology factors. There are five features to the heterarchy: diversity, rivalry, tags, projects, and reflexivity. Each will be discussed in turn.

Diversity refers to a mix of organizational types and ownerships. Within a particular place, there should be tolerance for a broad scope of businesses providing many production inputs, varying business models, philosophies and organizational

practices (Grabher, 2001:353). Spin off firms are those firms that identify a gap in the market that can be filled by moving away from an established company and selling the service back to the company and others. This activity thus enlarges the “genetic pool” for the evolution of new organizational and project mutations (Grabher, 2001:363). Increased diversity in the locality, can lead to innovative forms of entrepreneurial activities. It is vital to the evolution and survival of the ecology that there be a diversity of firms and new organisational forms (Cohendet and Simon, 2007; Howkins, 2010; Lewontin, 1982). Within a diverse range of firms and ownerships types, the less efficient or less active firms are in producing value, the more likely the evolution of the ecology will stop. It is advantageous to have a diverse set of economic activities in close proximity. This is given as a strength to a particular location (Hall, 1998; Glaeser *et al*, 1992; Glasmeier, 2000). Likewise, it is argued that too much diversity within an ecology can have adverse effects, again halting the evolution and rivalry within the ecology (Grabher and Stark, 1996). Sabel (2001) argued that the greater the diversity, the more likely it is that firms can reach out to form partnerships that are more effective and broad reaching. Diversity can bring with it benefits and constraints. It is applicable to this research as both industries under investigation have a number of firms operating within them. By implication, of the diversity element of the heterarchy we can begin to unravel if the diversity we observe is a beneficial or constraining one.

Organisations are not fixed in static co-existence and are therefore implicitly or explicitly driven by *rivalry*. The rivalry between firms recreates different ways to organize, interpret and evaluate the same or similar business activities (Grabher, 2001; 2004). Rivalry comes from domestic and foreign firms requiring organizations to reposition themselves in the market over time. This repositioning can be proactive or reactive and can vary in terms of speed linked to responsiveness to market dynamics. Rivalry drives the organisation to think of new ways of conducting business activity and plays a direct role in catalysing innovation and improvements in products and service (Porter, 1990) as well as in business models (Zott *et al*, 2011). Firms can perform competitor analysis in order to understand and predict the rivalry that exists in the market place (Caves, 1984; Porter, 1990; Scherer and

Ross, 1990). Rivalry can be viewed at the industry level through existing frameworks such as Porter's (1990) five forces. The framework lacks an in-depth appreciation of the individual firms that compose an industry, as well as large multinational enterprises (MNE) that coordinate activity across several places (Dunning, 1993, 1998). The five forces framework implicitly assumes that firms have the same internal structures. The empirical work underpinning this framework focuses on either one large market leading firm or firms that are highly successful. This prevents any comparison between industries with different levels of performance (Davies and Ellis, 2000:25). Porter's diamond underestimates the significance of the globalisation processes, neglecting the cross-border linkages in production and markets for the competitive advantage of nations (Dunning, 1993). Additionally, there have been several critiques of the frameworks methodology and conceptual underpinnings, concluding that both have fundamental flaws (Davidson, 1991; Clark, 1991; Davies and Ellis, 2000). The relational and heterarchical approaches are complimentary by allowing rivalry in production to be explored at either the firm level basis or at an industry level, and providing theoretical insight into the examination of agglomerations of particular industries or firms. Looking closely at some of the relations within firms and between them, business models provide a lens and justification as to why some firms use particular connections. All firms employ a business model implicitly and explicitly (Teece, 2010). In terms of rivalry, supporting the relational and ecological approach, understanding a firm's business model can as Zott and Amit (2010) argue uncover;

“The architecture of the firm's activity system – shaped by the choice of activities, how they are linked, and who performs them – captures how the focal firm is embedded in its 'ecology' i.e., in its multiple network of suppliers, partners and customers, as well as defining who are the firm's potential suppliers, partners and customers (and competitors) in the first place” (p.218)

The heterarchy is well placed to elaborate on the wider ecology of firms in a particular geographical location. This can yield a consensus on how firms within a

locational ecology are operating with or without each other. Overall, the business model is used in strategy in order to explain a new network and activity system-based value creation mechanism and sources of competitive advantage (Christensen, 2001; Zott *et al*, 2011).

Tags are the prescribed rules and limits to the heterarchy. Scott (2006a) and Pratt (2006) argue a favourable image creates entry barriers for products from competing places. Molotch (1996) argues there are reputational benefits from being in a place that is linked to your image. This image can be constructed by the people in the locality or by reputation through particular actors' interests and actions. Shared self-understanding is linked to social capital directly, as social capital networks are usually built on shared experiences and a sense of shared outcomes. The *tag* a place carries is aesthetic, as in the case of the advertising industry in London. London is known as a centre for creative buzz, a place of creative stimulation in which the advertising industry is located and benefits greatly from (Grabher, 2001, Bathelt *et al*, 2004). This aspect of the heterarchy is closely related to the preceding theory on the anatomy of the city. It is also the physical infrastructures of the city that can sometimes give a place its tag or reputation (Grandadam *et al*, 2013). However, these are not always a positive and can cause significant harm to a place hosting an ecology of firms. For example poor road infrastructures or airport facilities can have an impact on the perception outside firms have on the city and thus the local firm. Labels used to describe the economic condition of a city, such as deprived, disadvantages, unhealthy can also have unwanted stigma attached (Know and Pinch, 2006). It is also the activities of firms or individual firms who, on a particular product, may generate interest from other firms to locate in their ecology.

Projects have become synonymous with the modern economy and are increasingly deployed as an important form of work organisation (Newell *et al*, 2008). This has been the case more so where innovation and creativity is key to industrial success. Broadly, projects have key defining characteristics. They are like a form of temporary organisation (Grabher, 2002; Grabher and Ibert, 2007; Newall *et al*,

2008) defined by the features shown in Table 2 (Lundin and Soderholm, 1995). Further, Lundin and Soderholm (1995) argue that ‘action’ is the fundamental concept needed when understanding temporary organisation. They outline four key interrelated demarcations of the temporary organisation from the permanent. These are time, task, team and transition. These are discussed in Table 2.

Hence, projects are viewed as being ‘initiated to accomplish pre-specified goals and objectives, within a defined period of time, and in a relatively autonomous way, unencumbered by established organisational routines and practices’ (Newall *et al*, 2008:33). Grabher and Ibert (2007:176) argue further that projects should not be seen as isolated from their history, stripped off their contemporary social and spatial context, and independent of the future. Instead we should be seeing them continually interacting with their wider contexts, hence making them a relational space with elements of contextuality, path dependence and contingency interlinked into their conceptualisation. Projects in this contextualised view connect the personal, organisational, and institutional resources utilised in performing a projects. Graber and Ibert, (2007:176) state ‘the relational space encompasses social layers on multiple scales from the micro level of interpersonal networks to the meso level of intra- and inter-organisational collaboration to the macro level of wider institutional settings’. Therefore the project is not bounded to a local cluster or city and can have geographical reach that extends to distant individuals, organisations or institutions.

Table 2 Demarcation of temporary and permanent organisation

Feature	Temporary	Permanent
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Time	There has to be some conception of time. A limit or boundary that defines the start and termination of the project.	'Planned to exist if not forever, then for the foreseeable future' (Ekstedt <i>et al</i> , 1999:41) and a drive to survive.
Task	These can be specific task that maybe a 'one off' and unique (DeFillippi and Arthur, 1998); or standardised and repetitive.	Permanent organisations are more naturally defined by goals rather than specific goals (Lundin and Soderholm, 1995:439)
Team	Individuals organise around a task in hand for a particular amount of time. Individuals will commit their ability to the different sequences of the project: creation, development and termination.	A holistic working organisation with functional departments.
Transition	Temporary organisations are concerned with progression and achievement or accomplishment. There is the creation of a new setting or arena for action.	Focus on entire production processes and continual development of the organisation.

(Adapted from: Lundin and Soderholm, 1995)

Earlier conceptions of the temporary organisation or project have been associated with 'drafts' or 'proposals' in relation to when architects propose a new building or an investment banker presents a project for new investment opportunities

(Grabher, 2002:207). Modern understandings of the project evolved from US based project management of defence contracts. Grabher (2002:207) argues that 'development processes that earlier were conceived as separate activities were now conceptualised as an integrated entity, called a 'program', 'system' or 'project'. This literature is based upon engineering principles whereby the projects are manageable systems designed to improve efficiency with defined sequences and involved strict planning and control over resources (Lundin and Soderholm, 1995; Grabher, 2002; Turner and Keegan, 2001; Turner and Muller, 2003). This literature is overly focused on the project, neglecting the ties and networks that are formed and maintained through the project or even those ties and networks brought into the project from individual social networks (Gann and Salter, 2000; Grabher, 2002). Equally, projects are embedded in layers of networks based on reputation, localities whereby projects operate in milieus of recurrent collaboration and institutions where 'swift' trust and learning by switching occurs (Grabher, 2001).

Projects provide trading zones for different business models, allowing a firm to choose the best practice or morph their current business model into something different. Projects are temporary social systems (Grabher, 2004a, 2004b, 2004c), however, the time scales can vary considerably from weeks to years, creating trading zones crossing inter and intra firm boundaries (Maskell *et al*, 2006). These new ways of working, allow the firms to challenge their own way of thinking and how the production processes can be carried out. Business models provide a good 'genetic code' for understanding how firms are organising and managing relations in the production process. Baden-Fuller and Morgan (2010) state that the basic and fundamental goal of the business model is to act as a descriptor concentrating on value capture, creation and delivery. They state that not all firms are the same, but equally, they are not all completely different. They argue that there is a generic business model or benchmark within an industry that is then built upon and tailored to a particular firm.

“There are generic kinds of behaviour which are distinctly different. And it is these generic kinds of behaviours – that form the set of known business models at any point in time” (Baden-Fuller and Morgan, 2010:159).

Firms therefore reconfigure the generic business models to current conditions facing that firm and the best ways to create, capture and deliver value (Teece, 2010). This reemphasises the focus on the firm that this thesis takes along with other scholars who have seen business models as firm-centric yet boundary spanning activity systems (Applegate, 2000; Morris *et al*, 2005; Shafer *et al*, 2005; Stewart and Zhao, 2000; Weill and Vitale, 2001; Zott *et al*, 2011). Hence the business model can be seen as “a system that is made up of components, linkages between components and dynamics” (Afuah and Tucci, 2001, p4). Therefore the business model defines the value creation and process (activity system) from the inputs of raw materials through to final consumption. Projects are made up of collectives of individuals within one organisation or several specialised firms working towards a common goal set by an individual or lead firm striving to satisfy self-interest (Field, 2008). There are clear links here to social capital and the use of local buzz and global pipelines in order to bring together specific individuals or firms within or beyond a specific place (Bathelt *et al*, 2004). This concept is highly applicable to the creative sector were the production system can be structured around a project, with firms providing the required inputs to complete the product or service (Ibert, 2004, 2007).

Externalising these elements of the production, that are not as standardised and do not have a large market and require specialised skills and technology, to the market is more productive and efficient. What we have increasingly seen in the disintegration of production systems is networks of flexibly specialised small firms providing inputs to lead firms or organising production through projects. There is criticism levelled at project-based organisation. As Table 2 shows, there is a time limit on projects, meaning that there is less opportunity to build confidence using traditional practices (Lundin and Soderholm, 1995). Additionally, projects lack the institutional safe guards like conventions (Storper, 1997) and normative structures

in order to minimise risk and the prospect of failure (Grabher, 2002). However, given the perceived drawbacks, project organisation is no longer confined to a select few industries such as film and television, construction or shipbuilding (Winch, 1986; Faulkner and Anderson, 1987; DeFillippe and Arthur, 1998). We see project based organisation in industries such as life sciences, chemicals and automobile industries (Todling and Kaufmann, 2001; Grabher, 2002; Lampel and Macmillan, 2008). As part of the heterarchy, we can acknowledge the make-up of the ecology in the diversity section and include many different actors. Even though projects can be a way of organising several firms in production, they also allow an internal analysis of one particular firm and their project(s). Therefore a diverse range of firms and institutions can be analysed with this approach.

Due to the environmental uncertainties that exist, the organization has to be able to reassess its own organizational behaviour and be *reflexive* (Grabher, 2001; Teece, 2010). Reflexivity is like the immune system to the herterarchies. This demonstrates the ability to adapt to the unknown environment and be able to call upon resources. However, Grabher (2001) does not mention failure in stable or unstable environments. Like a human's immune system, a firm's attempt to respond can ultimately lead to failure. The result of the failure can rest in the organizations behaviour or strategic decision-making and the resources the firm has available. Likewise if the firm fails to respond to changes over time, through implementing a new business model, they can see a loss in value and subsequent lower yields (Chesbrough, 2010). If these are inadequate at any point in time, the firm will increase its risk of failure thus damaging and cause a reconfiguring of the ecology. As Amin and Cohendet (2000) argue, learning to adapt can be one of the greatest challenges to a firm overcoming knowledge-based or competence-based learning. This depends on the firm's ability to monitor and negotiate a change in its own governance structure.

The five features of the heterarchy have been outlined above showing the supporting elements towards the relational approach. Both of the theories discussed so far will give this theoretical framework the ability to look at a

geographical place and the firm ecology that exists within it. Heterarchies allow the understanding of economic, social and historical contexts. The approach is also more responsive to change and the need to replicate assemblies of a wide number of actors.

'Rather it is interested in elucidating how these ties are dissolved on one organizational and spatial level just to be reconfigured on another level in order to mobilize basic ingredients for the practice of episodic project collaboration' (Grabher, 2002:246)

Overall, the main focus of the ecological perspectives is that of adaptability, change and growth. Firms, individuals and economic milieu do not stay static; they change over time and space. Adaptability is forward looking, as it seeks to mitigate adverse economic impacts to the organization and look to the future. It is also a statement of the organization's ability to cope with unforeseen circumstances and how it manages its many resources. Project ecologies do not just denote an organization of production but the logics and individual identities, values and loyalties within the ecologies (Grabher 2004).

The ecological approach has been widely used to research the creative sector (Grabher, 2001; 2002; 2004; Grabher and Ibert, 2006; Ibert, 2004 and Johns, 2010) and provides a framework in order to understand the increasingly fragmented production processes that are systemic in this industry. There has been limited application beyond this sector. In management literature there have been papers published on managing firms through project ecologies in biotechnology firms (Lampel *et al*, 2008; Newell *et al*, 2008) but there has not been a focus on the organization of production using an ecological approach within that particular sector. The existing work makes limited use of the heterarchy and the six features outlined here. Although there are papers that discuss certain elements of the heterarchy such as diversity (Lowe and Gertler, 2009) or rivalry (Chen, 1996), but in isolation, rather than together, as this framework intends to do. The framework will give a standardised set of elements to apply to both the life science and video game

industry under investigation in the same geographical context. The following section will move onto the anatomy of cities finalising the theoretical framework.

2.4 The Anatomy of Cities

The previous sections have focused on how we can use the relational approach to place emphasis on firms and place, followed by a supporting ecological perspective which provides a tool to generate questions on the firms. The following section will focus on cities and how they have been established as significant units of analysis. Cities are sites of significant economic activity, yet they are nodes in a highly uneven geographical distribution of economic activity. Secondly, the section will outline Cohendet *et al* (2010) concept of the anatomy of creative cities. All economic activity has to happen somewhere. A place that can have a distinguishing effect on that particular economic activity for good and for bad. This has been a long-standing interest of many economic geographers and increasingly in management and economics. Over the last thirty or so years, interest has been placed at a variety of scales, but most notably, the city and the region (Jacobs 1986). For this research, the focus has been placed on the city of Liverpool and its anatomy. Exploring the anatomy of the city (Cohendet *et al*, 2010), in combination with the relational approach, we can draw an understanding of how the ecologies of both video games and life sciences are situated in the City of Liverpool. It is the aim then of this section to unpack the theoretical approach proposed by Cohendet *et al* (2010) on the anatomy of creative cities and look at its application to both ecologies in this research. The section will also justify why this approach has been taken in this thesis.

2.4.1 Cities

From the historical beginnings of capitalism, cities have functioned in important ways as sites of agglomeration and specialised production activities (Scott, 2000:23). Hall (1998) has documented in great detail the privileged role cities have

played across the world as centres of economic activity. Not only are cities places of economic activity, they are hives for creativity and innovation, hosting a rich diversity of people, especially in western economies (Florida, 1995, 2007; Howkin 2010; Lowe and Gertler, 2005; Scott, 2000; Tay, 2005). Many cities host a variety of actors and institutions that have the capacity to develop and exploit knowledge bases (Asheim and Gertler, 2005; Asheim and Coenen, 2005). However, we have to acknowledge the city is also a site in which there can be deprivation and decline but also renewal (Harvey, 1997). A critique we can raise is that when analysing these sites we are only seeing a cross section through a developmental trajectory, emerging out of a path dependent evolutionary process, structured by phenomena occurring within and beyond the city (Scott, 2000). It is difficult to overcome this without the use of longitudinal studies and a continued empirical investigation. However, using the theoretical framework in Chapter Two and shown in Chapters Four and Five the empirical research has sought to interrogate the path dependent processes and the emergence of particular ecologies, institutions and actors in Liverpool (David, 1985, 1994). So, we have to accept that we are seeing a cross section in time but we are aware that in this chapter and shown in previous chapters that we address, as best practice, the trajectories that have led to current contextual configurations (Bathelt and Glückler, 2011).

Cities can be understood and analysed in relation to their history, culture and economy requiring a multidisciplinary approach, therefore attracting attention from across the special sciences (Harvey, 2006; Jacobs, 1986; Knox and Pinch, 2006). Westernised thinking behind what a city is and what it should look like has changed significantly over time in relation to broader political economy and academic paradigm shifts. To begin, the seminal work of Mumford (1937) titled 'what is a city' has gained significance, particularly in urban geography and planning studies, as a foundation towards more contemporary thinking of the city. Mumford (1937) introduced a social element to the theorisation of the city, moving beyond the fixed measures, reducing cities to population size, density and attributes of the built environment. These were deemed inadequate by Mumford (1937), arguing that cities are social dramas. The metaphor of the theatre is used in his work and this

runs as a narrative in current work on urban settings. For Mumford (1937) cities are the stage in which people play out their social interaction, enriched by diversity in people, education, commerce, art and other institutions found in cities. Understanding the seminal work of Mumford (1937) here underpins the ideas of more recent analysis, proving that new farmworkers are indeed novel yet built on principles set decades before. Hence, cities have long been sites made up of institutions such as government citadels, economic markets but conceptualisations and planning has strongly recognised and included community.

Soja (1980) argued that cities have a socio spatial dialectic, meaning people change the place (the city) as they live and work, yet the place conditions their behaviour. Cities have a dialectic process, where social relations are constituted, constrained and mediated throughout the city. The fundamental link between people and place goes beyond Mumford (1937) and has been taken up by urban geographers such as Harvey (2010), Dear and Wolch (1989) and Knox (1996). This thesis, in its efforts to understand the city, embraces the connection between people and place through the post structuralist lens taken in much of the human geography literature (Knox and Pinch, 2006). The approach strongly opposed the idea that the world, or in this case the city, can be explained through one single hidden underlying structure (Duncan, 1980; Knox and Pinch, 2006). This research suggests that cities have numerous shifting and unstable dimensions that we should understand as evolving and changing. Ingersoll (1992) stated that cities are almost impossible to describe, noting that they are not as they used to be, with physically defined boundaries, (usually a wall) instead their boundaries are increasingly ambiguous with flows of people and capital permeating their geographically defined boundaries. Over the last 30 years there has been significant economy change that has led to urban restructuring and the way in which we can conceptualise our cities (Knox and Pinch, 2006). Economic change has been one of the defining factors in the trajectories of cities, propelling those cities able to capture and nurture high value, creating activities and leaving other cities behind, having to pick up low value activities (Sassen, 2006a). The most significant change has been the shift in cities being dominated by manufacturing activity to being dominated by service sector activity.

In short, the change has been driven by the wider changes, such as political economy in the post Fordism era where mass production fell to more flexible methods of production and organisation (Piore and Sable, 1984). Table 3 summarises the main economic changes and as a result the main characteristics of the city for that era.

Table 3 Changing contexts and cities

Economic context	Main Characteristics
Preindustrial cities	Small Scale waling cities Vertical differentiation based on social divisions Core - elite of the city Periphery – mass of population
Industrial capitalist city	Fordism paradigm Dominated by mass production and consumption Rigid production systems Elite migration to periphery or suburbs Poor/working class occupy inner city
Post Fordism to flexibility	Increasing use of technology in production Flexibility in workforces Deindustrialisation of cities Move towards service based economy New industrial spaces – clusters
Globalisation	Emergence of global cities and global command centres (Sassen, 1991, 2006) Knowledge economies and information cities Intensified social polarisation Increased competition between cities

(Adapted from Knox and Pinch, 2006)

Sassen (2006a) argues that ICT has played a significant role in the development of cities and what we have seen more recently is the emergence of global cities. Global

cities are characterised by social polarisation, the presence of large financial institutions, multinational headquarters, a stratum of well paid workers who in turn demand particular consumer services and provisions such as restaurants and shops and bars that in turn utilise a large number of low paid workers. Hence, there is a cycle in global cities feeding a growing inequality. Sassen (2006a) argued in her work that with increased globalisation and the adoption of ICT the global capital is becoming increasingly reliant on global command centres of the world. These are places where large financial institutions exist such as London, New York and Tokyo. Based on Sassen (2001, 2006a) and Beaverstock *et al's*, (2000) analysis and characteristics of global cities, Liverpool does not represent a high-ranking global city able to call upon the resources of alpha cities such as London or New York. However, Southern (1999:13) argues that the global cities framework does little to explain the roles of those places that cannot call upon the resources, or centralised activities of global command centres. The work that has been done surrounding global cities focuses on focal cities in the global economy, arguing that peripheral cities are left to pick up what is left, such as back office activities that can be done over greater distance (Sassen, 2006a). The framework does not help to explain the precise role of non-global cities but allows us to place the city of Liverpool into a wider context and thus answer the question raised by Southern (1999) as to what the role of northern English cities is, or for this thesis, how can a city such as Liverpool host two innovative and dynamic industries? One of which requiring large amounts of capital not found in the local and both requiring a labour market of highly skilled innovative and creative people that we typically find in global cities (Beaverstock *et al*, 1999; Scott, 2000; Cook *et al*, 2011; Faulconbridge *et al*, 2011).

Knox and Pinch (2006) highlight that many social scientists have used similar metaphors describing the city as a body; a living organism with a system with a hierarchy of cells and circulation through various arteries, often portrayed as sick or unhealthy. Cities have been referred to as networks defined by a conjunction of many overlapping webs of social and economic interaction. More recently ecology has been used as a more holistic and adaptable narrative to capture the functions and environment of cities, as well as the multiple industries and people within it

(Howkin, 2010). However, the use of the ecology metaphor is developmental and is rather abstract with few conceptual or empirical underpinnings, yet it does help us to make sense of how the processes of the city can be imagined. This chapter will use empirical studies to show the interconnectedness between firm ecologies and place, showing how the geographical context city of Liverpool is the place where the ecologies are situated. Following Soja (1980), not only is there a dialectic between people and place but also the industry, as people make up the workforce, firms and institutions found in cities that in turn influence place and are conditioned by place. This requires a framework that does indeed focus on the city, both the people and the physically built environment, but can also be used in order to understand the city in relation to a particular industry.

Howkins (2010) argues that for ecologies to flourish, we need a place that can offer diversity, change, learning and adaption in both scale and scope. Furthermore, these places will have the most people, active markets, an appropriately built environment and a modern infrastructure such as broadband communication. It has been outlined above; that an ecological perspective provides more than what Howkins (2010) initially looked for in terms of conceptual frameworks on composition of ecologies. It is no surprise that cities have been the location offering these traits and why many firms across many different industries locate within them. The creative industries have been noted for their concentrations within cities and for cities becoming beacons of creativity (Howkin, 2010; Scott, 2000). The video games industry falls within the wider creative industries sector. There are several papers looking specifically at video game firms within cities, noting its uniqueness from other actives such as software development for commercial use (Cohendet *et al*, 2010; Cohendet and Simon, 2007; Grandadam *et al*, 2013; Howkins, 2010; Scott, 2000). What are less well documented especially in UK cities, are the concentration of life science based activities and the anatomy of a 'science' city. There is a body of literature that has investigated why we see the concentration of life science firms.

2.4.2 Depicting the Anatomy of the City

One notable body of work by Florida (2002; 2007; Florida *et al*, 2008) is claimed to have set the background for the study of situated creativity within cities. His work on the creative class has focused on who the creative people are and how they can enable an urban renewal within cities. Central to his thesis is the diversity of people within metropolitan areas that he describes as ‘bohemians’. Having such as high concentrations of diversified people can lead to increased economic development. Having a rich diversity of people in such concentrations fosters an environment where ideas are open and dynamic, creating a professional urban environment (Florida, 2007). Furthermore, Florida argues that the focus should be on retaining and attracting such bohemians rather than focusing on singular infrastructure projects in such areas. In his thesis, Florida was not exclusive to particular industries and used a broad approach, signalling out economic activity such as creative, innovative and high technology. Although the work has been well received by policy makers at various scales, academics have taken issues with some of this work in regards to the data used and the methodology (for a full critique see Malenga, 2004; Peck, 2005; Scott, 2006a). More recently the critique this thesis wishes to draw on is from Cohendet *et al* (2010) that argues Florida’s work, although criticised elsewhere, has set an agenda for the anatomy of cities. However, the focus on who these people are is a major pitfall rather than looking at what they really do. Cohendet *et al* (2010:92) state that:

“what Florida suggests is more a necessary condition for having a creative city (by accumulating talents belonging to the creative class), rather than a comprehensive vision of the actual processes that lead an urban milieu to be more creative”

Hence, Florida has argued for the types of people cities need to retain, were as Cohendet *et al* (2010) is arguing for an understanding of place and what roles are performed in these places. Complementing the heterarchy that views the collection of firms within a particular industry as an ecology. Following the features of a heterarchy, this approach can support further the generation of questions to understand what these firms are actually doing and how a particular place is

facilitating their activities. We can explore both the firm and place, as well as their interconnectivity, using the frameworks outlined in this thesis.

The anatomy of the city concept is defined by three parts. These are an upper, middle and lower ground, shown in Figure 1.

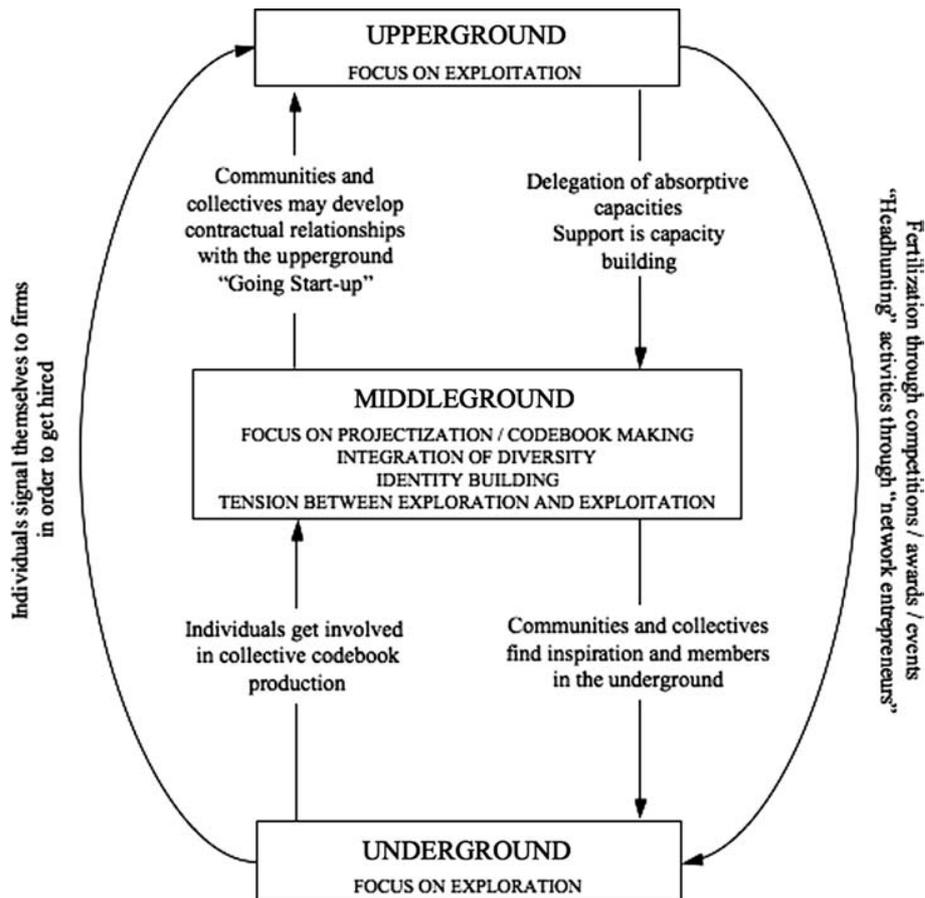


Figure 1 Anatomy of the Creative city (Source: Cohendet *et al*, 2010, figure 1)

Although focused on the creative city, the concept is looking at local ecologies and the production of knowledge. There are other approaches to analysing cities, such as the work produced by Scott (2000) on creative cities, Florida (2008) on the creative classes in cities and Sassen (2006a) global cities framework that tends to focus on nodal cities in the global economy. However, this work does not provide such a clear conceptual framework to apply onto cities such as Liverpool. Additionally, the focus of Scott’s work is solely on creative industries giving less

flexibility for this research to move the focus to life sciences. However, Scott's work is not being ignored; instead it can be used to inform the empirical observations in later chapters. Here, the anatomy conceptualisation has much more flexibility in its approach to investigating ecologies and the knowledge in both industries used in this research. Further, Cohendet *et al* (2010) argue that not all knowledge is scientific or industrial, even more so in the creative industries. Knowledge developed in the creative industries can be highly context specific and variable by location. Although knowledge in the life sciences is by no mean like that of the creative, there are still elements of chance discoveries and innovations that can be highly context specific and vary by location. For example the specialisms of particular scientists, the infrastructures that exist to aid scientific knowledge and the need to facilitate life styles along with the quality of life within a city. Going back to Florida's (2008) argument that cities need to retain highly qualified people, then as Cohendet *et al* (2010) argue; look at what these people do and how context can help facilitate ecologies and knowledge.

2.4.3 Depicting the Anatomy of the City: Upper Ground

The upper ground is the top layer of the city, consisting of firms with various specialisations and institutions both public and private including research laboratories, universities and studios. These firms and institutions are responsible for launching products onto the market (Cohendet *et al*, 2010:95). The upper ground inhabitants have the ability to finance and commercialise knowledge through their business models that connect them into wider production systems and markets. General cluster analysis has tended to focus on the upper ground entities, their production processes and use of externalities between firms. Cohendet *et al* (2010) argue that the creative industries do not have large networks of subsidiaries and vast amounts of capital to put into R&D. Additionally, they cannot tap into global pipelines of knowledge for inspiration in the creative process. Hence, they conclude that none of the classical ways to enhance creativity are available in creative firms (p.95), painting a very localised creative process.

Creativity is thus drawn from the fertile soils of a creative city. It can be argued that this is not always the case in creative industries, and that some are dependent on extra-local connections that extend beyond local milieu. Additionally, high technology industries such as the life sciences have been observed relying on both local buzz and global pipelines for knowledge generation and production. Questions surround how the firm ecologies are situated in the anatomy of the city can be raised.

As previously mentioned in the ecological perspectives, projects are a particular mode of organisation that has grown in prominence in its usage and academic understanding (Grabher and Ibert, 2006). Increasingly innovative and small firms are using projects as a way of organising the firm, unlike larger firms that use more functional departments in order to organise a variety of units within the firm. Cohendet *et al* (2010) state that this project typology of organising involves communities of specialists who provide the various inputs into the creative and production process. The anatomy here of the upper ground can be explored using the ecological approach outlined above. This is a point where we depart somewhat from the analysis provided by Cohendet *et al* (2010) in favour of the previous ecological approach, in order to give a deeper analysis of the upper ground, although retaining the upper ground as part of the anatomy of the city.

2.4.3 Depicting the Anatomy of the City: Under Ground

The underground is an invisible part of the city (Cohendet *et al*, 2010). We can draw upon Florida's (2005, 2008) arguments about retaining or attracting a creative class. This layer of the city is about the groups of people that exist in cities. The upperground can at times look to the underground as a source of labour and new inspiration for creativity and innovation. The primary focus of those who occupy this part of the city is to explore; disconnected from the commercialised world of the upper ground. This is where ideas and novel trends emerge, especially in the creative industries. The weakness of this layer in the concept of the anatomy of the

city, is its transferability to the life sciences for the purpose of this research. We can see an emerging underground in relation to those who are scientifically trained, who leave universities or other formal institutions as graduates. Additionally, what can be drawn from the original concept is the need for a buzz within the local area (Bathelt *et al*, 2004). Markusen (2006) argues that raw agglomerations of related firms or occupations do not ensure that synergies will occur among them, or that the number of those involved in the industry will increase. There needs to be events or gatherings that allow those exploring to meet those who are exploiting (upper ground). Individuals occupying the under ground are deeply embedded within a particular milieu (Cohendet *et al*, 2010; Florida, 2008; Hess, 2004). When and where the events and explorations happen are a significant importance. The city has to be able to facilitate such synergies in exploration. This is where the middle ground comes into the framework.

2.4.3 Depicting the Anatomy of the City: Middle Ground

The middle ground contains the intermediate structures that link the upper and under ground (Grandadam *et al*, 2013). The middle ground has a brokerage position within the anatomy of the city mediating between informal and formal worlds. For there to be a middle ground there has to be communities or organisations to facilitate interactions between the upper and under grounds. Within the city we have geographical proximity; the middle ground can also allow cognitive proximity through the translation and codifying of knowledge, artefacts and trends. This comes back to some of the earlier concepts of diversity and rivalry discussed in the ecological literature (Howkins, 2010; Grabher, 2001). In the diversity of firms within ecologies there has to be cognitive proximity and not just a raw agglomeration of firms (Markusen, 2006). Cohendet *et al* (2010:97) states that this cognitive mechanism has two processes: exploitation and exploration. Both are fulfilled respectively through epistemic communities and communities of practice (Amin and Roberts, 2008). The middle ground facilitates knowledge generation from a bottom up and top down flow. For both ecologies under investigation in this

research, a middle ground for each will have to be teased out to see if and how firms are generating the knowledge needed in their production systems. There are issues with the framework in regards to its focus. The original concept focuses on creativity and the processes of creative knowledge production and diffusion throughout the city. One of the major benefits of this concept is its ability to connect what happens in the cities into wider flows between cities (Castells, 2000; Grandadam *et al*, 2013). It can be the role, not just of the upper ground to exploit and connect into wider production flows, but also the middle ground to support these interactions. Linking back to the ecological approach, the tags that are associated with particular places can owe much of their success to the middle ground, through the building of the physical infrastructure that is found in this layer (Grandadam *et al*, 2013; Grabher, 2001, 2004). For example, concert halls, restaurants, hotels, science parks and incubators.

Together these three layers make up the anatomy of the creative city. The framework has been predominantly focused on the creative process, but has the flexibility to bring in a wealth of literature and generate research questions on the life sciences industry as well. As pointed out, there are aspects of the concept that can be taken across to study high technology cities, which is not well researched. As previous literature has shown on the geography of the life science industry; the literature proposed many different observations as to why related firms in the industry co-locate.

Grandadam *et al* (2013) has added to this concept, recently arguing the importance of the place and space that the firms are located in and how they aid the evolving nature of creativity. Here, we can ask, how is the anatomy of the city aiding the development of the two industries in their current heterarchical form? Amin and Thrift (2002) state that places and space are areas where communities can overlap, allowing members, formally and informally, to gather, meet, share their knowledge and learn from each other. A rich middle ground requires places, defined as the 'realm of near, intimate and bounded relations' (Amin and Cohendet, 2004, p92). These are physical places, buildings that house cafes, museums or art galleries.

These places are areas of cultural or creative consumption and validation. They can be public assets or privately owned places. They circulate knowledge and provide a platform for knowledge exploration. They are grounds to activate linkages between people and build shared understanding. Firms can turn these connections into social capital and build stronger ties in the locale. Also, these places can be the grounds where we find brokers to facilitate access to resources or opportunities in weaker ties.

Space is more cognitive, defined as ‘the realm of far, impersonal and fluid relations’ (Amin and Cohendet, 2004, p92). The cognitive spaces facilitate wider connections enhancing the local buzz using the global pipelines of knowledge (Bathelt *et al*, 2004); maintaining connections from previous employment and managing them through various communication mediums, but also being able to draw on the experiences gained through global pipelines into the locale. This also increases the fertility of a middle ground. If that knowledge is not being shared, due to a lack of places in which to do so, then the middle ground is weakened. Creative shared places lead to influential spaces and a fertile middle ground. The following section will look at the current work on both industries and their tendencies to agglomerate in particular places.

2.5 Firms, Territories and Place

Globalisation has intensified the highly uneven divide of economic activity. It has caused a complex indeterminate set of process operating very unevenly in both time and space (Dicken, 2011:8). Economic activity has become increasingly geographically concentrated with some industries agglomerating in particular places. Particular place do offer firms local externalities such as large markets with economies of scale and scope. Firms can be attracted by these to reduce transaction cost or capture technology spill overs. Firms can also agglomerate because of perceived external economies related to a particular place (Bathelt and Glückler, 2011). External economies are defined by Scitovsky (1954:143) as services and disservices rendered free without compensation by one producer to another.

Other factors such as size and scope or the industry, region or economy also have influence on the intensity and availability of such external economies. As a result location in the global economy has become widely examined, with academics advocating that globalisation is increasing the importance of location rather than reducing it (Martin and Sunley, 2003). Competitive advantage it seems is located locally in the global economy and is exacerbated by the disintegration of the production processes and social division of labour (Porter, 1998). However, agglomeration is not a new phenomenon and has been recently revived through the cluster literature. Both the term agglomeration and cluster have become widely interchangeable. Clusters have been examined for decades most notably starting with Marshall's (1920) analysis of industrial agglomeration of specialised manufacturing industries. Marshall's work has heavily influenced cluster studies that have expanded across multiple disciplines with academics conceptualising and critiquing the phenomena (Bathelt and Glucker, 2011). Some of the claimed advantages of agglomeration include higher innovation, growth, productivity, new firm formation, job growth, increased profitability as a result and increased competitiveness. Once an agglomeration of firms is established they can grow, remain stagnant or decline before their time. Growth is dependent on the place being able to attract additional firms and supporting services causing a self-reinforcing accumulation (Dicken, 2011). Further processes of widening and deepening the labour pool, thickening local institutions and enhancing the physical infrastructure come with continued development of the agglomeration. It is argued that these processes of agglomeration are highly path dependent and set a place on a trajectory influenced by its history.

However, the advantages and trajectory tend to rely heavily on local interaction. The relational approach outlined above goes beyond the issues of local externalities and investigates network externalities and influences beyond the locale (Bathelt and Glückler, 2003, 2011). To understand further the connections between places and why particular firms may look beyond their locale, an understanding of the production network is needed. These are organisational networks that can span

geographical space or in some instances be concentrated in particular place (Dicken 2005; Glückler, 2007). The production of many commodities both manufacturing and services, involve networks of individual activities and transactions performed across time and space (Dicken 2011). Dicken (2011:72) defines the production network as 'the nexus of interconnected functions and operations through which goods and services are produced and distributed'. Hence understanding the production networks and the inputs and activities involved within it, we can begin to see where those inputs and functions are geographically situated. The geography of the production network can be linked to agglomerations of particular inputs as firms seek out potential local and external economies, specific to their function in the production network.

2.5.1 Geographies of the Life Science Industry

There are tendencies for firms in the life science industries to agglomerate at certain points along the production network. Firms involved in the exploration stages tend to be highly concentrated together, involving connections between public and private organisations in the basic research of new discoveries (Powell, 1996, 2002; Cooke 2001, 2004a, 2004b, 2004c, 2005; Gertler and Vinadrai, 2009; Nilsson, 2001, Moodysson *et al*, 2008). In the exploration stages of production, clinical trial companies tend to be less geographically attached to geographical concentrations of life science activity (Cooke, 2005). Clinical trials require patients from rare or selective demographic backgrounds, which are not always found in the location of life science clusters. Hence, they are usually dispersed across many locations in order to access different samples of the population. The manufacturing stage is also argued to be less likely to locate in life science clusters. Cooke (2005) argues that the location of manufacturing tends to be in former sites of bulk chemical production. Henderson and Reavis (2008) states that sites in emerging economies, such as India and China are cost effective places to move manufacturing production.

Marketing and sales functions in the life science production network are less well documented. This is mostly a footloose part of the production network (Cooke, 2005). However the latter stages of the production network are very geographically dispersed, with hospitals and general practitioners surgeries and clinics located in many major urban locations. However, in some cases, hospitals do become part of life science clusters at multiple scales as they provide patient databases and access to samples of the population. There have been a number of empirical observations to explain the emergence of a concentration of life science firms in particular places, such as USA, UK and Scandinavia (Powell, 1996, 2002; Cooke 2001, 2004a, 2004b, 2004c, 2004d, 2005; Nilsson, 2001, Moodysson *et al*, 2008). Thus far, there are five clear observations outlined below that can be useful to this research when using a relational and heterarchical approach.

Cooke (2004a, 2004b, 2005) has used cluster analysis in regards to the Cambridge life science agglomeration. Cooke (2004a) states that the formation of life science clusters is due to the presence of science based infrastructure, such as research and development intensive universities or government laboratories. Such actors are known as public research organisations (PROs). Universities are said to act as magnets to firms and draw them to locate within close proximity to benefit from knowledge inputs and outputs. Here institutions in the public sector play a significant role in the development of the cluster. The publically funded institutions have thus attracted further private investment into the science base infrastructure through the emergence of privately funded firms and collaborations between private and public sector organisations. Amin and Thrift (1994, 1995) have argued that institutionally 'thick' regions or places help promote and support the growth of particular industrial agglomerations. Henry and Pinch (2001) have argued that the opposite can also be true, that institutionally 'thin' regions or places are also effective promoting a process of firms self-organising.

Secondly, rather than suggesting a magnetic pulling force, Feldman and Francis' (2003) suggest that a number of key triggers within the local economy spark cluster emergence. This links to relational approach that advocates the importance of path

dependence processes in the emergence and trajectory of particular agglomerations. Understanding what came before and the key trigger points allows us to trace a history of events towards the current day. Feldman and Francis (2003) argue in the case of Washington (USA), the downsizing and closure of public laboratories triggered investment in the region to reinvigorate these once public assets. Whereas Cooke (2005) stressed the importance of PRO's and publically funded institutions and organisations as a cause of cluster formation, here we see a public policy dichotomy at a national level and a regional level.

Thirdly, the geography of highly regarded scientists is uneven, as universities with global reputations in particular scientific disciplines tend to attract such talent. From Zucker and Darby's (1998) observed a co-location benefit between "star scientists" and start-up firms. Collaborative relations form between public and private sectors emerge (Feldman *et al* 2005) and a local buzz is created through networking events and social interactions between scientists and entrepreneurs. Maskell (2001) makes the link between innovation and clusters, taking the view that cooperation between actors in the cluster can lead to activities of innovative learning. Actors in cooperation include user-producer relationships, formal – informal collaborations, inter-firm mobility of skilled workers and spin offs of new firms from existing firms, universities and public research institutions (Rosiello and Orsenigo, 2008). The local milieu is characterised by social interaction on a formal and informal basis with actors (from firms to individuals) being able to embed themselves in deep social networks. These networks thus facilitate knowledge sharing, spill over, face to face interaction and direct exposure to the practise and expertise within (Rosiello and Orsenigo, 2008).

The previous three observations tend to focus on place-bounded factors. However, research by Owen-Smith and Powell (2004) suggests that non-local knowledge absorption through scientists who participate in international networks act as conduits, bringing knowledge back to the local cluster. A relational process that brings complementary knowledge from multiple places together in one place accelerates innovation. Co-authored publications are another way of illustrating

collaboration between actors in different places. Coenen *et al* (2004) demonstrated this using Medicon Valley, which is located between Sweden and Denmark. Strong evidence suggested that scientists in Medicon Valley collaborated on publications with European and USA colleagues. Hence, as well as a local buzz from local networking there are “global pipelines” that facilitate non local networking knowledge transfer (Bathelt *et al*, 2002).

Kasabov and Delbridge (2008) have augured further that a life science agglomerations success and development is based on a number of traded and “soft” interdependencies. Traded interdependencies are globally active research institutions such as universities and government research laboratories; and commercial prowess based on the reputation of a selected number of firms located within the clusters. Access to start-up capital is a vital component of any new and existing business. Areas that are well served by venture capitalists or business angels tend to foster more start-ups. Management capabilities are essential in running a business. The firm has to be able to recruit locally or be able to attract high quality managers who understand and can demonstrate the ability to drive the firm. Firms rely on a readymade pool of scientifically educated labour, without which, would make the firms operations difficult as they would have to look beyond their locality for employees.

Soft interdependencies refer to the facilities that generate knowledge transfers and the diffusion of tacit uncodified knowledge. These include networking events, forums and trade fairs. Rosiello and Orsenigo (2008) state that proximity can help to develop local life science markets. Bio-knowledge generated by the local public research organisations can be exploited or licensed to private companies in which scientists or entrepreneurs can own shares, occupy managerial positions and sit on advisory boards. The space in-between the transactions is filled by public policy and related services such as lawyers, brokers and venture capitalist (Powell *et al*, 2002). Public policy can play a role in the cluster by creating spaces for such interactions, providing protection for smaller firms and directing public research organisation’s

research strategies by making public funds available for specialised research projects. All this is prevalently local activity (Rosiello and Orsenigo, 2008).

The observations outlined above, with the exception of Owen-smith and Powell (2004), tend to focus on local externalities. For this research, it is important to keep in mind the locality and what it has to offer, however, the gap emerges in the investigation of the locality using the theoretical framework presented here. The framework allows the articulation of local and non-local connections in production. Additionally, Cooke (2004a, 2004b) based his research on the Cambridge Life Science cluster which has a very long tradition of scientific success and is very much identified with the UK life science industry. What are less well documented are other regions of England that have seen a concentration of life science activities emerge like in Liverpool. Emerging from this are questions of what firms exist in Liverpool? And how they are connected beyond Liverpool? Following Owen-Smith and Powell (2004) and the critique levelled at cluster analysis (Martin and Sunley, 2003), further investigation is warranted in the context of Liverpool into the extra-local connections in production.

2.5.2 Geographies of the Video Games Industry

There is huge potential to contribute in many ways to the analysis of the video games industry. The sector is vibrant and undergoing many changes with the onset of digital technologies and digital service provision. This is having wider impacts on the broader structures in production and organisation for firm activity around the world. Current academic literature focusing specifically on the video games sector has so far produced research on the sectors development up until 2007 (Aoyama and Izushi, 2003; De Vaan *et al*, 2013; Poole, 2000; Balland *et al*, 2013; Johns, 2006). In particular, research on entrepreneurial activity and how small businesses are connected into wider production networks, lags behind existing research on the larger video game firms such as Sony and Microsoft (Cadin and Guérin, 2006; Cohendet *et al*, 2010; Gaume, 2006; Johns, 2006; Marks and Scholarios, 2007).

There is a large amount of research that exists on other creative industries, such as software development and film and television. The most recent publications specifically on the video game industry draw on empirical studies from other creative sectors and industry media articles (De Vaan *et al*, 2013, Balland *et al*, 2013). Hence, there is a body of literature slowly developing both theoretically and empirically tailored to the video game sector, at the same time the industry is seeing significant growth in revenues and its user base. As Poole (2000: 24) argues:

'Videogames are not going to go away. You can't hide under the stairs. Resistance is futile. Any industry with such a vast amount of money sloshing around in it is by that token alone worthy of investigation'

Aoyama and Izushi (2003) have highlighted, through the complex trajectory of the Japanese video game industry, an interplay between hardware devices (consoles) and software (video game) from its conception. The industry is cyclical in that new hardware with advanced technology emerges every four to six years. Johns (2006) argued that the hardware suppliers are dependent on the supply of software for their platforms in order to create an ecosystem with critical mass. Although the hardware manufactures develop software for their consoles, there are also third party publishers in the industry who focus on publishing and development across a number of hardware devices. If new hardware is to be successful, manufactures need to have close coordination with publishers and developers of software in order to give a critical mass of hit titles upon its launch (Aoyama and Izushi, 2003; Cadin and Guérin, 2006). Hence, hardware sales increase as more games are available (Johns, 2006).

Balland *et al* (2013) argue the effects of geographical proximity, indicating an increased likelihood of inter-firm collaboration. The flexible and project-based way of working, that is characteristic in the video game industry, means that it is less likely to be able to codify and standardise practises even in close proximity. Sorenson *et al*, (2006) argue that with the increase, complexities of knowledge and technology in the video games industry are driving firms to towards inter-firm

collaboration at shorter distances. Together, Balland *et al* (2013:761) argue that as the industry has evolved over time, geographical proximity has become more important, but the effect of institutional proximity at the national level has decreased and even lost significance. Furthermore, latter generation firm networks are found to have cognitive proximity driven by similarity in the firm portfolios. Following on from Sorenson *et al's* (2006) argument, the complexities in the knowledge and technology requires more cognitive proximity. Balland *et al* (2012) state this is due to the boundaries between video game firms and other creative industries that has become more defined and specialised over time.

De Vaan *et al* (2013) argue that in the video game industry, having a large number of competitors in a particular place lowers the firm's performance. However, firms that spin off from parent organisations take with them routine experiences and personal networks that benefit the new organisation. This positive effect is argued to outweigh the negative effects of too much completion in one place. However, one of the drawback to this study was the lack of data on the freelance individuals or micro firms that are involved in video game development. However, the study was covering the entire global industry. This thesis will be focusing on a particular place and will therefore be able to look at the networks of firms in more detail.

Although there is a move to increase the literature on the video game industry, the majority of literature has taken a global outlook on the industry. The limitations regarding the inclusion of individuals and micro firms have been noted in large quantitative studies and the academic literature has not investigated the last six years of the industry. Given the industries cyclical nature, there is scope to look at any of the industrial changes that have occurred post 2007 and how these have impacted Liverpool's industry. Balland *et al* (2013) argue that there is still more to do in this industry especially through qualitative analysis. The relational approach is well placed in order to generate and answer research questions around this issue. Additionally, the business model's literature also provides a lens into how firms construct and change their business models over time; responding to changes in their economic environments. Liverpool has been noted for having a strong

historical background in video game production, hosting three large multinational studies at one point. Few have specifically looked at video games in the UK or in particular places within the UK.

2.6 Conclusion

This chapter has built a theoretical framework based on the relational approach and is supported by other theories that provide this thesis with a clear tool for analysis and the generation of research questions. The research focuses on the firm and place using relational elements of contextuality, path dependence and contingency; supported by the heterarchical and anatomy of the city concepts (Grabher, 2001; Bathelt and Glückler, 2003, 2011; Cohendet *et al*, 2010). It has been argued, that the relational approach and the heterarchical approach provide a theoretical lens which helps us to examine the ecological composition of the two industries. It lends flexibility to the city of Liverpool, where limited information on the pre-existing firms and institutions exists. In order to understand the city better in relation to two unrelated industries, the anatomy of the city concept, allows further examination of the place and its ability to host the two firm ecologies. Throughout the chapter there have been several links made between the relational approach and the supporting theory. Most of all the theories use, in various ways, the three factors of the relational approach that underpinned many of the arguments and theoretical perspectives used in this research.

It has been argued that the firm will be the focal point of this research. The theories that are used to build this theoretical framework all take the firm as their point of entry into the field. All theoretical perspectives have dealt with agglomeration of economic activity and add different theoretical lenses to the framework. It is worth pointing out that the heterarchical approach does lack a clear path dependent aspect that can fully explore historical events and their influence on the present ecology (Martin and Sunley, 2006). However, the relational approach, in its broader remit, encompasses this and allows for its inclusion as well as adding contingency. However, the ecological perspective is key in its ability to treat every milieu as one

of its own kind (Toulim, 1990). Cohendet *et al's* (2010) anatomy of the city perspective has provided a tool for deepening the understanding of contextuality in the relational approach and furthers the ability to unpack cities and ecologies together clearly and consistently rather than individually. Again, this reinforces the individuality, diversity and adaptability of different places. Equally, the research will investigate two unrelated industries in the same place. Therefore, this framework has chosen the approach which best suits an investigation into the video games and life sciences industries in Liverpool. So, from this theoretical framework, the following research questions have been generated:

1. How have the industry ecologies of the life science and video game industries in Liverpool emerged?
2. How are the ecologies organised and connected beyond Liverpool?
3. How are the two ecologies situated in the anatomy of the city?

Methodology

3.0 Introduction

In order to further develop and understand the theoretical arguments presented in Chapter Two, it is necessary to relay the research onto a specific case. Liverpool is the site in which primary research is based, investigating two key sectors of the city's knowledge economy. The life science and creative industries form two of the four knowledge economy cornerstones. This research is part of an ESRC CASE studentship with the economic development agency Liverpool Vision. This chapter will outline why Liverpool and the two industries have been chosen for this study, the research paradigm and the methodological approach and processes that underpins this thesis. Examining two industries in the same geographical context requires a methodology can that get the first hand experiences of particular actors and their situated knowledge in order to uncover various nuances in the way each is situated within the city.

The methodology underpinning this research is predominantly qualitative with secondary information used to contextualise and inform the empirical data collection strategy and findings. The primary justification for the use of a purely qualitative methodology is their effectiveness to understand phenomena from the point of view of participants and appreciate their perception and understanding of particular events (Berg, 2007:97). To answer the research questions posed it is the practitioners themselves who can provide the best understanding into their environment and what it feels like to be situated within the two industries in the same geographical context. Interviews enable participants to provide the historical, social and economic accounts and focus upon what is significant to them. The use of a predominantly qualitative method will be reinforced through the remainder of this chapter.

3.1 The Site and CASE Partner

Liverpool is certainly a city that has gained attention through the number of prestige development and regeneration initiatives (Campbell, 2011). It is a city that has seen enormous change in its most recent history (Southern, 2013). The path towards a knowledge economy has not been so straight forward for the majority of Liverpool and its city region. Liverpool's difficulties are predicated on path dependent issues embedded in its turbulent history in the 20th century. The trajectory of the current knowledge economy can be further understood through a reflection on the preceding events. As mentioned above, the more recent history of the 1990's until now has seen European Union and regional interventions acting as catalyst for the knowledge economy. However, this would not have been the case if Liverpool had not been affected by post-industrial restructuring and deprivation.

Southern (2014) notes that Liverpool had a very different industrial structure to most northern cities in England. Before, and at the beginning of, the 20th century Liverpool was shaped by the shipping trade between the UK and rest of the British Empire (Lane, 1986). In comparison, other northern cities were dominated by manufacturing activities. This would inevitably affect the way in which Liverpool reacted to industrial restructuring that was to come in the 1980's. However, in the post war era (post 1945) dominated by mass production and consumption, industrial policy took hold leading to a number of branch plant economies emerging in UK cities and regions throughout the 50's and 60's (Meegan, 2003). These tended to be manufacturing activities such as automobile production, textile and food processing. As will also be mentioned in Chapter Four, pharmaceutical manufacturing was also prevalent in Liverpool throughout the post war era, developing through acquisitions of former government drug grinding factories in Speke into predominantly flu vaccine manufacturing today.

Yet, another pivotal turning point in Liverpool's history came in the 1970's through Britain's membership of the European Economic Community or now EU. This brought about two significant changes in the Liverpool economy: Firstly, it shifted

the shipping trade from the Commonwealth Nations and North America to Europe, which was served by Southern and Eastern ports of England; Secondly, the new economic community coupled with globalisation made national boundaries more porous, allowing Multi-National Enterprise activity to become increasingly mobile. This signalled the decline in competitiveness of the branch plant economy in Liverpool. This phenomena lead to the closure of many branch plants and other industries much earlier than in other northern cities (Southern, 2014). By the 1980's Liverpool was hampered with escalating unemployment rates and population decline, catalysed by the erosion of the ports and branch plants. This also left supporting service based activities in decline, where other regions and cities where seeing modest growth in the service sector (Allen and Massey, 1988).

The very infrastructure that kept Liverpool at the heart of the British Empire had almost collapsed by the end of the 1980's along with the post war industrial structures. Furthermore, enterprise in the city was increasingly squeezed out by larger corporations, furthering the decline of the city (Southern, 2014). Large manufacturers that relied on the port also closed their operations. However, pharmaceutical manufacturing did continue in Speke. The industry was not reliant on the ports and could readily draw from the unskilled or semi-skilled labour markets at this time. At this time video game production was in its infancy not requiring the levels of skill and development needed today. However, both industries where underdeveloped in Liverpool, at this time, and the city faced further fiscal crisis as the economy shrank further throughout the 1980's. Frost and North (2013) have argued that the then Labour council began to fight against the decline marking a starting point of renewal for the city.

It was from the late 1980's and the beginning of the 1990's that local development agencies where formed such as The Mersey Partnership, Liverpool Vision (the first Urban Regeneration Company) and Government Office for Merseyside. Through these agencies the city entered a stage of regeneration of its docklands and ports through the establishment of enterprise zones. This was followed on by the European Structural Objective One funds that provided £700 million of public sector

funding to attract matched funding and further private sector investment for ten years from 1993. This significant initiative sparked interest in both life science and creative industries. Both the life science and creative industries were highlighted as key drivers to transform the city under Objective One. Both industries were seen as the big winners from Objective One funding (Liverpool, Echo, 2004). Following on from the EU Objective One with continued efforts to regenerate the entire city and the city region; Liverpool's local council, LEP and the broader regional development NWDA over the last decade have formulated a knowledge economy strategy. The strategy consists of four sector drivers of which two have been selected in this research:

- Life sciences
- Advanced manufacturing
- Creative and digital industries
- Financial and professional services

(Liverpool LEP, 2013)

These sectors are expected to generate around 60,000 new jobs by 2020 in a city that has been in economic and social distress (Liverpool LEP, 2013). Together this makes the case for Liverpool a particularly interesting one. As will be discussed in Chapter Six there are many organisations and institutions that have come along with the EU funding to support the growth and development of these two industries. The knowledge economy context in Liverpool reflects the national knowledge economy strategy, highlighting life sciences and creative as two key industries where vast amounts of attention and subsequent funding have been received and allocated.

Adding to the case for Liverpool, in the previous chapter it was shown that most existing research centres on significant concentration of life science and creative activities. These concentrations tend to be in major cities around the world where we see large critical masses of firms, institutions and people (Florida, 2008; Scott, 2000, 2006). These studies tend to focus on one particular industry either in one

city or in multiple locations. Missing from much of the literature is an approach to understanding multiple sector situated in the same city. Equally there are few studies that place two highly distinctive industries under investigation in a northern English city. The focus here then is to explore how two championed industries have emerged within the city and what state they have manifested themselves into today. This will come from first-hand accounts by those who have been a part of this transformation and are themselves the transformation. Cities have long been the sites where most of our economic activity has taken place. By studying these issues at the geographical level of the city, a useful insight can be gained into abilities of firms and institutions related to the two industries to foster a knowledge economy and create an ecology suitable for their continued development and growth.

It has been argued above that Liverpool is indeed an interesting city to situate this research and has a just cause. However, there is one other fact to note about the nature of this research. The research is funded by the Economic and Social Research Council CASE student ship scheme. This scheme is designed to integrate both theory and practice together for greater impact in research. As part of this research Liverpool Vision was the CASE partner. They are a local economic development agency with a broad remit covering inward investment, regeneration, business support and international marketing of the city. Throughout the duration of this research Liverpool Vision have been undergoing changes as a result of government austerity measures and a rolling back of the state. Liverpool Vision was a public and private organisation but is now fully incorporated into the Mayor of Liverpool's office making it a fully publicly run organisation. This has resulted in a number of key individuals leaving the organisation and its remit changing to one that is focus more on business support as a key to economic development. This aside, the organisations involvement in this research has been minimal, reduced to only a few exchanges initiated by myself throughout the completion of the work. The exchanges involved requests for information and participation in data collection via interviews with selected individuals. However, due to the nature and timing of the

changes driven by austerity, Liverpool Vision has allowed the research to be driven by myself under the direction of the supervisor team.

3.2 Research Paradigm

Method is argued to be secondary to that of the research paradigm (Lincoln *et al*, 2011). The research paradigm is viewed as a set of basic beliefs that present a view that defines the nature of the world, the individuals in it and the range of possible relationships to the world and its parts (Guba, 1990; Guba and Lincoln, 1994; Lincoln *et al*, 2011). It is the paradigm that guides any investigator in their choice of method as well as ontology and epistemology. These beliefs that one investigator may hold are basic in the sense that they must be accepted simply on faith, however well argued; as there is no way of establishing their ultimate truthfulness (Guba and Lincoln, 1994:107). It has been stated from the onset that this research relies predominantly on qualitative methodology. In order to arrive at the use of qualitative methodology we must examine the paradigms underpinning the use of such techniques for inductive enquiry into social and economic phenomena.

The world is increasingly complex and ambiguous, constantly changing and most certainly fluid. Where this leads to is a set of assumptions that lie behind any method and research strategy used in research (Corbin and Strauss, 2008). Strauss (1993:19) neatly expresses this as;

'We are confronting a universe marked by tremendous fluidity; it won't and can't stand still. It is a universe where fragmentation, splintering and disappearance are the mirror image of appearance, emergence and coalescence. This is a universe where nothing is strictly determined.'

Put simply there are no simple explanations behind many of the things that happen within society or economy. Events or phenomena are the result of many different factors interacting and coming together at various times and in various places

(Corbin and Strauss, 2008). It is the belief of this research that we have to capture as much of this complexity as possible in order to contribute towards the volumes of knowledge we have about our universe. To do this the researcher must first set out the ontological, epistemological beliefs that inform the construction of knowledge in this thesis. This thesis adopts a social constructionist perspective. This thesis agrees with constructionist that concepts and theories are constructed by the researchers out of narratives from participants in such research. Schawndt (1998:237) argues that concepts and ideas are invented rather than discovered, yet these concepts and ideas correspond to something in the real world. Therefore, there is no one true reality to be discovered for all (Geertz, 1973; Preissle, 2006), but many different realities based upon the constructed knowledge of those practicing and experiencing everyday life.

Guba and Lincoln (1994) distinguish four broad beliefs of alternative inquiry paradigms (see Table 4);

- Positivism
- Postpositivism
- Critical theory
- Constructivism

Each of these paradigms has various ontological, epistemological and methodological beliefs that are neatly intertwined. Denzin and Lincoln (2011) argue that the most logical starting point is with the ontology. This then constrains the answer to the epistemology, which in turn constrains the methodology.

Table 4 Basic Beliefs of Alternative Inquiry Paradigms

Item	Positivism	Postpositivism	Critical theory and others	Constructivism
Ontology	Naïve realism – ‘real’ reality but apprehendable	Critical realism – ‘real’ reality but only imperfectly and probabilistically apprehendable	Historical realism – virtual reality shaped by social, political, cultural, economic, ethnic and gender values; crystallised over time.	Relativism – local and specific constructed realities
Epistemology	Dualist/objectivist; findings are true	Modified dualist/objectivist; critical tradition/community; findings probably true	Transactional/subjectivist; value-mediated findings	Transactional/subjectivist; created findings
Methodology	Experimental/manipulative; verification of hypotheses; chiefly quantitative methods	Modified experimental/manipulative critical multiplism; falsification of hypotheses; may include qualitative methods	Dialogic/dialectical	Hermeneutical/dialectical

(Source: Guba and Lincoln, 1994, Table 6.1)

This thesis positions itself in the latter column of Table 4, taking the constructivist views on ontology, epistemology and methodology. The aim of this research is understanding and reconstruction of the constructions that people including myself initially hold (Guba and Lincoln, 1994). The end goal is to aim for consensus yet still have room for interpretation over any findings as information and sophistication evolve over time. Hence the epistemological stance is to create a consensus or move towards one in the empirical findings of this research.

In Chapter Two it was stated that the firm and institutions are the units of analysis in this research. Hence when studying this aspect of the economic landscape, this thesis argues that there are multiple realities that are constructed through each individuals own experience and co-created with the investigator (Graham, 2005;

Denzin and Lincoln, 2011). Knowledge accumulates in a relative sense through more informed and sophisticated constructions using the hermeneutical and dialectical processes. To clarify, the epistemological stance in this thesis is a relativist social constructionist. Social constructionism has its foundations in phenomenology and has been recently associated with postmodernism. Lincoln *et al* (2011, p.103) define a social constructionist epistemology as:

“The philosophical belief that people construct their own understanding of reality; we construct [and attach significant] meaning based on our interactions with our surroundings”

It has been seen as an alternative to positivism and critical realism because, for social constructionism:

“... reality – or at least selected parts thereof – is not something naturally given. The study of how reality is socially constructed therefore becomes crucial for social constructionists” (Alvesson and Sköldbberg, 2009: p. 23)

Given the many different types of firms that exist, researching such actors presents a unique problem. This is only understandable and resolvable by reflecting on the knowledge and experience gathered during the course of research and validated through a consensus of reality (Lincoln *et al*, 2011; Jonker and Pennink, 2010). We can argue that to construct a theory that is representable of those involved we must examine the situation, together with participants to generate knowledge and subsequently theory. The criteria used to judge the worthiness and quality of the data is the trustworthiness and authenticity of such knowledge to form the constructions (Guba, 1981, Lincoln *et al*, 2011). Technical methods of data verification are outlined below. However, any research in social sciences can only deal in partial or incomplete truth, because what we see when conducting research is a snapshot of a particular time or event that requires more informed and sophisticated inquiry over time (Lincoln and Guba, 2000, Lincoln *et al*, 2011). This snapshot of time or particular event is still significant in documenting phenomena that can to some extent be generalised and used to predict or apply elsewhere. This

opens up the possibilities beyond this research to build a longitudinal qualitative empirical examination into particular phenomena.

The ontological and epistemological beliefs outlined above have set a trajectory towards a prominently qualitative methodology to answer the research questions posed. It is the hermeneutics approach that rely heavily on the use of naturalistic method such as interviewing or observation (Angen, 2000). Qualitative methods have been primarily used in this research because there is limited existing data on the firms involved in this research.

Denzin and Lincoln (2011) define qualitative research as:

“... research [that] involves the studied use and collection of a variety of empirical materials – case study, personal experiences, introspection, life story, interviews, artefacts, and cultural texts and productions, along with observational, historical, interactional, and visual texts that describe routine and problematic moments and meanings in individuals’ lives.”

Aliaga and Gunderson (2000) define quantitative research methods as:

“Quantitative research is ‘explaining phenomena by collecting numerical data that are analysed using mathematically based methods (in particular statistics)’”

Qualitative methods ensure adequate dialogue between both the researcher and research participant in order to collaboratively construct a meaningful reality (Angen, 2000). Hence, qualitative research has the ability to investigate, the context that firms are functioning, relying on experience-based exploration. Linking this approach to the research questions, qualitative data is required to understand the many different types of firms and how they have come to exist in Liverpool as well as how each individual firm is connected beyond Liverpool. In order to understand the connections these firms have, and compare the industries, qualitative methods allow for more flexibility when entering into discussions with each participating firm. The research will strive to understand the social context in which the data is

produced in order to reflect accurately what the data actually means to the study (Lincoln *et al*, 2011:113).

Qualitative methods have a long and distinguished history in the social sciences (Van Maanen, 2002). In management research the case study approach was widely used up until the mid-1960's with notable examples including Fredrick Taylor's (1914) anthropological work on shop floor worker behaviour. Studies in management have been concerned with improving the performance of the firm (Gummesson, 2000) and the post 1960's saw a rapid increase in the use of quantitative methods on the subject. However, qualitative methods have become highly employed across many parts of management research. In small business research Blackburn and Kovalainen (2009) have stimulated debate surrounding the increased use of qualitative research to understanding small business phenomena, notably the socio-cultural aspects involved with starting the maintaining a small business. Further, Blackburn and Smallbone (2008) argue that the researching of small businesses and entrepreneurs will benefit from further use of qualitative data, enriching the methodological diversity of the discipline.

Within strategic management, Whittington (2004) argued that the discipline needed to move beyond rational analysis of economic analysis in the study of firm organisation and move towards incorporating more sociological understanding of how firms organise themselves and are competitive. Whittington (2004) states that the field of business research has been dominated by structured questionnaires and quantitative analysis, producing large data sets and modelling data. The work of Porter (1990, 1998) typifies this type of analysis. There have been other theories that have looked into the competitiveness of firms such as resource-based theory of the firm (Penrose, 1959, Barney, 1991) and dynamic capabilities (Teece & Pisano, 1994). It has been argued that these theories will benefit from increased use of mix methods rather than relying on quantitative methods alone (Molina-Azorin, 2007).

This move towards increased use of qualitative methods is echoed in economic geography with the cultural turn and a wider acceptance of the socio-economic views of the firm (Taylor and Asheim, 2001). Goulding (2002) states that quantitative research was more about testing theory or hypothesis and provides inflexibility, factoring in controls and constants. Any environment involving human behaviour cannot be totally rationalised, leaving quantitative analysis embracing a 'minimal reality' (Goulding, 2002:13). As mentioned above, there have been several proponents from across the social sciences and in particular economic geography and organisation studies for a turn to qualitative methodologies that seek to add a contextualised, path dependent and contingent approach to the study of the firm and institutions in particular places (Guba and Lincoln, 1994; Strauss and Corbin, 1990; Bathelt and Glückler, 2011). Therefore, this research strategy will use a qualitative method for the primary data collection allowing an investigation of firms within two distinct sectors located within Liverpool to be examined. The design will seek out information guided by the research questions generated by the theoretical framework.

3.4 Qualitative Methodology

Liverpool's video game and life science industries have been highlighted as key growth sectors for Liverpool's knowledge economy. The transformations that have occurred over the last ten years have been documented in a limited number of consultancy reports (Wainwright, 2008; Knowledge Economy 2008). The depth and level of analysis of the two industries in Liverpool is still somewhat limited and potentially up for debate. Academic research on these two sectors in the context of Liverpool has been limited, given the adoption of Porter's (1998) cluster concept by many of the regional and local development agencies. This research will be investigating the types of firms that are located in Liverpool and how the firms are situated and connected beyond the city. In addition to this, previous research on industrial districts tends to look at locations that have a very intense and dense

concentration of related and similar firms, such as Silicon Valley or Medicon Valley (Ferray and Granovetter, 2009; Moodyson *et al*, 2008). Hence, the research questions will consider the context of Liverpool and the firms that operate with this location. As no previous studies have been conducted involving both industries in the city, qualitative research facilitates a rich contextualised source of data to be produced. This constructs a collaborative reality between both the researcher and the participants in order to create a validated and trustworthy account of the reality in which firms are organised within.

Although quantitative and qualitative data are different in many ways, the last 20 years in social sciences has acknowledged the continuum between the two (Teddlie and Tashakkori (2003). The use of qualitative methods within the social sciences is certainly present in modern literature. The debates surrounding the paradigm shifts and the use of quantitative or qualitative methods have not been settle as such but have become well documented and since enhanced our understanding (Guba, 1990; Teddlie and Tashakkori, 2003 Dezin and Lincoln, 2011). Qualitative research has become well practiced and in doing so the methods of data verification and reliability have thus improved. However, by choosing a qualitative methodology does not mean embracing a complete ignorance to quantitative data. Although this thesis is not mixed methods and does not wish to enter the debates around '*paradigm purity*' (Teddlie and Tashakkori, 2003:7), it does have to acknowledge the use of some quantitative data. A relatively small amount of quantitative data has been used to inform this research of the life science and video game industries at a global scale, by taking financial data from annual reports and using company web sites. Considering there are several multinational companies operating within Liverpool, and their influence over each of the sectors, it is vital to understand their positioning within the global economy. This data will contribute to the first and second research questions by providing context and explanation to the connections and positions of Liverpool based firms in wider production systems. This data can form an understanding of the global organisation of these larger firms, in line with how local firms connect into wider production systems.

However, the data that I needed regarding Liverpool based firms in both industries, does not currently exist and the nature of the research questions dictates the use of qualitative methods. Most large or multinational firms operating in the UK are required to publish certain data for corporate investors and stakeholders. In addition they may publish information about the firm's activities. Given the diversity of firms that were discovered in Liverpool for both sectors, the ability to gather the same data from company documents or web sites was restricted. Hence, the research questions are investigating who these firms are, what they do, how they do it and how the firms are connected within and beyond Liverpool. Firms do not explicitly publish this data in company reports or on web sites. Given the diversity of firms and the type of enquiry needed into the firms' position and connections, a qualitative approach was favoured and considered best practice.

Previous studies have utilised qualitative methods, (predominantly interview data) to investigate the phenomena of firm colocation and the connections between firms (Grabher, 2001, 2004; Grabher and Ibert, 2007, Johns, 2010). Ecological approaches look at multiple firms who may or may not be connected in the same production process, but share a common location and economic externalities. In this research an ecological perspective, using a heterarchy framework (Grabher, 2001), is applied in this thesis to overcome many of the issues and critiques level at cluster theory and the exclusivity of more recent work on entrepreneurial ecosystems discussed in Chapter Two (Mason, 2010, Mason and Brown, 2013).

Qualitative approaches allow a disconnection from the standardised and uniformity of previous cluster studies and compliments the relational and ecological approaches that remove hierarchy and rigidity in analysis. We can form an understanding of what it is that firms benefit from and how they have come to exploit this, by being in the same industrial district and through learning about the connections they are maintaining locally and over many distances. The diversity of

firms and institutions involved in this research, and the different meanings and representations each firm will assign to themselves, qualitative methods are seen as the best practice to gathering this information and exploring multiple avenues in a semi-structured practice.

Research in the creative sector has been predominantly qualitative, due to the nature of the firms, freelancers and people involved in this sector (Bathelt, 2004; Coe and Johns, 2004; Cohendet *et al*, 2010; DeFillippi *et al*, 2007; Leyshon, 2001, 2009; Pratt, 2006, Johns, 2006; Yoon & Malecki, 2010). Previous studies have highlighted that there are a lot of freelance workers and multiple firm start-ups and closures. Statistical data would either be out of date or not able to capture many of those involved. Using qualitative approaches such as snowballing, these individuals and firms can be found and more accuracy can be established. Snowballing is the method of asking a participant if they know of others who meet the research criteria and may be able to participate in the research (Given, 2008). Additionally, individuals that have set up multiple firms can have the ability to talk about those experiences through the use of qualitative methods, enriching the depth and meaning in the data. Organisation of production over space has used qualitative methods due to the nature of the work and number of freelance agents involved. The use of quantitative data here runs the risk of leaving too many actors out of the sectors, and many of them being undiscoverable.

There has been limited qualitative work surrounding the life sciences. Most of the research has used quantitative data, secondary analysis, or in management literature, ethnography (Cooke, 2001, 2004, 2005; Gilding, 2008; Liu and Schmid, 2009; Mitra, 2007). There are a limited number of studies within economic geography and entrepreneurship that have dealt with such a wide variety of firms using predominantly interview data. Additionally, the studies that do exist are focused on conceptualisations of innovation across the whole product life cycle. This research investigates the firm's connection into wider production systems and

how these predicate their survival. The starting point in the data collection process was secondary data using collections of annual reports, newspapers and web based sources. The following section will outline the use of secondary data in this thesis.

3.4.1 Secondary Data Collection

Clark (2005) states that secondary data refers to information that has already been collected by someone else, which is then made available to you. This information can be used to inform the primary data collection and help the researcher create a context in which they can situate their research. There are many reliable sources of secondary data but we have to note that some of the data has been interpreted by its original author and then by the reader. Secondary research here plays an informing role for this research. It has been vital in providing the researcher with information about two industries of which there is not first-hand lived experiences. Secondary information has helped to construct context and also add to the research by providing reliable and validated data to inform further data collection and analysis. The following sections will provide an overview of the secondary data collected for this research.

3.4.2 Annual Reports, Company Websites and Newspapers

Annual reports have been used in this research in order to rank the top 10 life science and video game studios globally. Data was collected on sales, profitability, transnationality and geographical coverage. Transnationality here refers to firm overseas operations and revenue as a percentage of the total sales. This data highlights the breadth and dependence on non-domestic revenues for multinational firms. Liverpool is host to several multinationals in the two industries and they play a vital role in production. Previous research has emphasised the key role these multinationals have in funding smaller business and entire production networks

(Cooke, 2004, PWC, 2011). This data has supplemented the contextual data on the two industries; overcoming an overemphasis on the local. One advantage of annual reports is that they have historical records available online. Data was collected on these top ten firms dating back to 2000. This data has allowed a 12-year period in both industries to be analysed, including the major financial shock of 2008 and the links to be made to the local sectors.

Annual reports and company web sites have also been used, when available, for the firms operating in Liverpool. However, small and medium sized firms do not have such information published or available to the public. This exploratory work using a mixture of annual reports and company web sites helped to define the interview questions. Reiterating Strauss and Corbin (1990), the researcher should have a general idea of where to begin and be able make use of some structured questions. Identifying as much descriptive factual information before entering the interview with a participant can speed up the process and create more value from the interview. The majority of secondary data collection occurred before the interviews took place. This gave me the ability to talk about the firm knowledgably to the owner-manager or managing director and reduces the interview time spent on understanding fundamental issues the firm maybe dealing with. In addition, knowing the firm before interview allows an element of respect to be established between interviewer and interviewee.

The final source of secondary data came from newspapers and online news providers such as the BBC. The Liverpool Daily Post was a good source of local information. The paper reported several articles relating the gaming industry and life sciences industry in Liverpool. Again, this informed the interview process and also gave insights into phenomena that the firms themselves may not divulge openly. Again, this added to the knowledge acquired by myself about both sectors and also the local development agencies' role in regards to the two sectors. Given the increased use of qualitative methods in the social sciences, along with the

limited amount of existing qualitative data on the sectors, I needed to make sure the questions and procedures will work. In order to extract the best possible data from this research a pilot project has been used. The next section will outline the pilot project and what was gain from establishing such a procedure.

3.4.3 Pilot Project

Pilot projects are an effective way of incorporating a reflexive methodology in qualitative research (Sampson, 2004). Sampson (2004) argues that the pilot project before emersion into the field is not a new technique but one that is under-utilised in qualitative research. A pilot project can be used to refine interview questions and trial them with carefully selected participant's. Participants had to be selected on the basis of continued access beyond a pilot. Bryman (1988), Cassell, (1988) and Hartley (1994) have stressed the importance of maintaining access to participants, especially when researching organisations. For the researcher a pilot project is a good way of engaging with industry specific terminology that may not have been pre-empted. It is acknowledged that verification strategies may be problematic in pilot studies where data are thin. However, the purpose of pilot studies, when used in qualitative inquiry, is to refine data collection strategies rather than to formulate an analytic scheme or develop theory (Morse *et al*, 2008:20). In the case of this research, prior to the interviews taking place with the firms, five exploratory interviews were conducted with industry informants as a pilot project. These participants are also known as gatekeepers. Gatekeepers are actors who control avenues of opportunity (Trinch, 2001) and are usually in a position of authority having gained experience through interaction with the sector. Rossmann and Rollis (2003) state that almost anyone in an organisation can be a gatekeeper to further information and connections to other potential participants. Likewise, the gatekeepers can also be a source of exploratory knowledge that can inform the interview process and validate the data collection process. However, this knowledge and access is not just a given and requires a level of appreciation and common belief in the cause of the research. Gatekeepers used in the initial enquiry

for this research were identified through informal conversations between the CASE partner Liverpool Vision and myself. In addition to formal gatekeepers, the University of Liverpool Management School was a good source of industry connections to Liverpool based firms. Three members of the school were informally approached as gatekeepers, aiding in the approach of research participants and knowledge generation. In total eight gatekeepers were used to access participants.

Strauss and Corbin (1990) argued that the researcher should have a general idea of where to begin and how to go about drawing the data out of the field. This was done in two stages. First, the eight gatekeepers were used in a pilot project to test some of the interview category questions. By testing the category questions for the semi-structured interviews, I could see where the conversations would potentially lead and how the narration of the questions fared under interview conditions. Posing the wrong types of questions, or having a poorly worded question, can lead to less valuable data being collected (Robson, 2005). The interview questions did change based on the evaluation from the pilot project. Certain questions were removed and others changed for clarification in forthcoming interviews. The pilot project also gave me time to reflect on the nature of the terminology used with particular industries. This was particularly the case within the life science industry where acronyms and medical jargon is used. Overall, the pilot project was an effective way of testing out my interview topic areas and my own etiquette in the procedure. In addition, the pilot project allowed me to establish a network of contacts through which other contacts could be approached in the actual research process.

Second, using the secondary data from annual reports and company web sites, plus information gained during the pilot project, I composed a list of firms that were located in the Liverpool city boundary. Life science firms were taken from the 'Bionow Directory 2011'. Bionow are a spinoff organisation from the former North

West Development Agency. The organisation kindly provided a free copy of the directory via post. This was cross-referenced with a document produced by Wainwright (2008) 'Liverpool's Health and Life Sciences Offer' and an Internet based search for firms using key words such as diagnostic, pharmaceutical, medical device, health services firms. The information in both documents was not completely accurate with several firms still listed no longer active or relocated. This was verified using Companies House web site and the company's web sites. For the video games sector no such directories existed. To compile the list of firms I relied on Internet based searches to begin. Following the closure of the multinational studios in Liverpool (discussed in Chapter 5) there were many press releases following new firm start-ups in Liverpool. This was echoed in the main stream gaming magazine journals. Although the information wasn't by any means centralised, I was able to use similar techniques mentioned above to verify the existence and status of the firms. The list at this point was short and only had firms from the Internet search or those gained from the newspaper and magazine journals with recent success or exposure. The list grew significantly using the snowballing technique. One noticeable contribution came from a participant who had organised 'The Indie Showcase' aimed at gathering local independent developers and video game related service providers to a small conference. The document had a list of firms within Liverpool of freelancers and firms. Unlike the life sciences listing of firms, the video game industry list emerged over time and with the help of one significant gatekeeper passing on their list. Again, once both list were compiled and all firms verified as 'active'¹ the industries could be mapped out with the scale and scope of activities.

3.4.4 Researching Firms and Institutions

Primary qualitative interview data has been supplemented with further primary qualitative data, notably, participant observation and engagement from attendance

¹ Active firms are firms that are legally in business and filing tax returns to Her Majesties Revenue and Customs

at conferences and industry specialists respectively. Secondary qualitative data has also been collected from selected newspapers and company reports for publically traded firms. Flick (2002, p. 226) argues that qualitative research is inherently multi-method in focus. Using the stated qualitative methods the research aimed to gather an experience based first hand understanding of the types of firms located in Liverpool and how they themselves fit into the wider production systems. The primary method for extracting such data will be interview. Interviews typically involve the researcher asking questions and hopefully receiving answers from the informed participant (Robson, 2005). This method has been widely used in the social sciences (Atkinson and Silverman, 1997) and has three broad typologies: structure, semi-structured and unstructured. This research has used semi-structured interviews, that had predetermined topic areas, but the order and depth of discussion was modified on individual basis, based upon my own perception of what seemed appropriate and what the participant wanted to emphasises (Robson, 2005). Interviews were chosen because they encourage immersion in the field, in order to interact with social actors as a vital data source (Phillips and Johns, 2012). The aim is not to be representative of a population, rather, it is to gain an understanding of actors lived experiences and the meanings they subscribe to actions within contexts (Valentine, 2005). The interview provides an effective means to understand particular phenomena from the view point of the participant, and to then grasp their perception and understanding of such events (Berg, 2007:97). Interviews can take place in a variety of locations negotiated or dictated by researcher or participant (Silverman, 2004). During this research the interviews took place in a location dictated by the participant. The most frequently used location was the firms' premises. Caf  s and the University of Liverpool Management School were also used in a small number of interviews. All the interviews were recorded on a digital voice recorder and anonymized for use in this thesis. Permission was gained from participants upon my arrival to interview. This enabled the data to be stored and transcribed in verbatim after the interview process. Having a recording and transcription of the interviews aided the preceding analysis.

Semi structured interviews provided this flexibility needed in the context of Liverpool. This was because of the nature and type of firms under investigation. Given the nature of the topics and the language being used, interviews also allowed a more sophisticated level of knowledge to be generated surrounding the research questions. This could have been done via an open ended questionnaire but this would have limited the level of explanation I can retrieve from the participants as to why they feel a particular way about the economic support they have received or provided. The qualitative aspect of this research has served to provide a contextualised and path dependent explanation of firms located in Liverpool, the connections they have and how development agencies have supported them. If a survey were favoured here, I as the researcher would have to generate responses for participants to choose from. The responses may not be suitable or cover the entire context, path dependency and contingency of the firms behaviour and organisation, thus, creating a very abstract narrative. Hence it is the practitioners own understanding of his or her situation within the selected industries and the city of Liverpool that such a qualitative approach seeks to draw out. Interviews are deemed the most appropriate method for extracting this type of data from participants.

A case study approach involves empirical enquiry of a phenomena in a real world context (Robson, 2005; Flyvbjerg, 2011). It has been widely used in management research for a considerable amount of time. Case studies focus on an individual unit in a certain context. This links the unit of analysis and development factors to the environment over time (Flyvbjerg, 2011). This research looks at two industries, digital and life sciences, in the same geographical context, Liverpool. The relational approach outlined in the previous chapter suits the case study approach well as it provides the framework to explore contextuality, path dependence and contingency. For presenting the data, a case study approach will be utilised and constructed through the data, collected using the grounded theory method. Case studies give depth, high conceptual validity, understanding of context and process and what causes a phenomenon, linking causes and outcomes (Flyvbjerg, 2011, p.

314). Overall, this research justifies the use of qualitative methods to understand how the development of these sectors and the connections that predicted its existence, has come about.

Further to this, secondary quantitative data from annual reports found on company web sites has been collected to inform the data collection and analysis. Quantitative data was collected during the interviews process on employment numbers, years in operation and the numbers of connections firms have before interrogating these further in the qualitative interview. Combined, this produced a multi-method approach that has aided triangulation and verification of the data. This data will inform two sector-based chapters, which can be analysed individually and analysed as two sectors situated in the same geographical context. The data also provides an outlook on the current wider industry context and trends. Given the dominance of the large multinational firms in both sectors, it is important to have data on these firms and their positions in production systems. As mentioned previously the larger multinational companies tend to publish more information on company web sites and in corporate documents.

3.5 Primary Data Collection Method

As previously mentioned, there are two industries under investigation for this research: video games and life sciences. Institutions (including development agencies and universities) make a second category in the interview process. This makes two categories, firms and institutions. Each of the two categories has a different number of actors operating within them. Similar semi-structured questioned were posed to the firms in the video games and life sciences industries. For the institutions, the line of questioning changed considerably, although the format of semi-structured interviewing stayed the same. The following section will outline the use of gatekeepers and the approaches taken in the two sectors and for the development agency.

3.5.1 Video Games

The data collection process started in August 2011 and ran until January 2012 for the video games. Firstly, an initial list of firms was drawn up from basic web searches on incubator and business park web sites. During this research, there were approximately 30 firms that fitted the definition of a video games firm, within the Liverpool city region. All of these firms were contacted via email that contained an approach letter and information sheet. Email was the preferred choice for this sector as many of the firms did not display postal addresses and constructed their websites to direct enquiry traffic to an email domain. Of the 30 firms 21 responded and participated in the research. Of the 30 firms in the Liverpool city region, 21 were located within the City of Liverpool. Of the 21 interviewed, two were located in the city region rather than the City of Liverpool. Interviews were conducted with the managing directors and owner-managers of firms that ranged in size, from a single employee to 150 employees. The latter being the one multinational studio; located in Liverpool at the time of this research. The majority of the firms are micro enterprises, small and medium sized firms shown in Table 5 with the number of firms interviewed in brackets. Each interview lasted approximately 60 to 90 minutes and was recorded via digital voice recorder.

Table 5 Video game activity in Liverpool

Firm Activity	Number of Firms	Micro	Small	Medium	Large	Number Interviewed
Developer	25	4(4)	20(11)	1(1)	0	16
Online Publisher	1	0	1(1)	0	0	1
Sound	1	1(1)	0	0	0	1
Visual art and graphic	1	0	1(1)	0	0	1
Outsourcing	1	0	1(1)	0	0	1
Multinational Studio	1	0	0	0	1(1)	1
Total	30	5	23	1	1	21

The interview process provides data for all three research questions. Research question one in particular, inquire into the firm's past, notably, how and why it was set up in Liverpool. Quantitative analyses, would not be able to fully explore the details and experiences each firm went through and the reasoning behind its start-up and choice of location. Hence, the grounded theory approach, allows the participant to explain in their own way, the history and reasoning behind their firm's behaviour. Similarly for research question two, the nature and maintenance of a connection was explored in more depth, rather than simply traced.

The interview process was also used to collect some quantitative data on the firms themselves. Quantitative data included employment numbers, the number of production based connections the firm maintained and financial data, when available, on investments into the business and turnover. Again this does not substantiate a mixed method approach but places quantitative data into the context building surround the firms. Not all firms would freely state their financial data, but the majority, though the qualitative part of the interview, explain how they have funded and started their businesses in Liverpool. Although the financial

data does not fully contribute to any comparison of competitiveness, it does help when profiling the firm. This data was asked for, but not aggressively, and sought to help maintain a level of mutual trust and reciprocity in the interview process.

Finally, in regards to the interview process was the inclusion and construction of a holistic production network diagram. Before the interview process commenced, Johns (2006) created a production network diagram for the video games sector, based on data from the top global video game publishing houses. This diagram was taken into the interview process as a way of talking about the connections these firms had. There were two reasons for this. Firstly, it made the illustration and articulation of the connections much easier to talk about. Secondly, it tested the applicability of this model to smaller businesses that dominated the sector in Liverpool and allowed them to reconstruct how it looks to them. From this process the production network has since been modified and is included in the following chapters.

3.5.2 Life Sciences Sector

The same research questions apply to the life sciences sector and a similar data collection strategy has been utilised to the one outlined above for the video games sector. A list of firms in this sector already existed in a consultancy document that was passed onto me via Liverpool Vision. It should be noted that the list of firms at the time was 3 years old and contained firms that no longer existed. However, it was a very useful entry point. This part of the research took place between March 2012 and August 2012. Unlike the video game sector, emails were not the preferred intermediate for approaching all life science firms. Instead, an approach letter and information sheet was sent via the post and was followed by a phone call. A postal strategy was chosen for this sector due to the nature of the web sites design that was explicitly directing predominantly sales traffic via e-mail. Additionally, given the larger size of many of the firms and the formal structures

that were in place, such as executive boards, a postal strategy would allow the approach letter and information sheet to be delivered directly to the targeted respondent. However, some firms were contacted via e-mail when a direct e-mail address was available. This was due to the life science industry having a very diverse range of firms from large multinationals to micro-enterprises. In order to target the correct person within the larger firms, a letter was preferred followed by a phone call. For some of the smaller firms an e-mail did prove to be an effective way of establishing contact. However, some firms only provided an 'info@company.com' email address. These e-mail addresses did not prove to be as effective as a letter targeted at a specific person via their name or job role. After the letter was sent and a phone call arranged, some respondents requested I send them an e-mail to arrange further a time and date for participation.

During the research, there were 53 active companies in the life science sector in Liverpool City Region. Of these, 25 have been interviewed. In all but the medical devices sector, approximately half of firms were interviewed. The medical devices firms in Liverpool were very small operations and seemed to be very apprehensive about participating in the research. It was later noted from secondary research, that many of the medical device firms operated only as wholesale suppliers with a registered address in Liverpool. Others refused to participate without financial incentive. This explains why just short of half the total identified population of life science firms have been interviewed. Compared to the video games sector the life science prove to be a less accessible group, especially the larger the organisation became. Response times were also an issue when trying moving the research along. To overcome the access issues faced with several firms, I had to use established networks in order to get my research approach letters in front of the desired participant. Other strategies such as follow up telephone calls were used to negotiate access to participants. Not all were successful as reflected in the number of interview conducted. In many cases of qualitative interview based methods the research is in a position of a relative lack of 'power'. The participant takes the role of the expert informant in the cases noted here.

Interviews lasted approximately 60 to 90 minutes with participants. The life science sector can be broken down into several different sub-sectors in order to make the sector easier to understand. Table 6 represents the number of firms and the number of interviews conducted in each sub sector. Table 7 shows a further breakdown into the size of firms and how many of each size were interviewed in brackets.

Table 6 Life science activity in Liverpool

Activity	Number of Firms	Interviewed
Consultancy	7	4
Diagnostic	7	4
Discovery	13	6
Drug Manufactures	9	6
Medical Devices	8	1
Other	9	4
Total	53	25

The life science sector differed considerably to the video games sector in terms of the size and age of firms. The life science sector had considerably more multinational and medium to large sized firms, compared to the dominance of small and micro enterprises in the digital sector (See Table 7). Firms in the life science sector had also been operating in Liverpool for a considerably longer amount of time.

Table 7 Composition of the Industry

Activity	Number of Firms	MNE	Medium	Small	Micro
Consultancy	7	0	0	3(2)	4(2)
Diagnostic	7	2(1)	1(1)	2(1)	2(1)
Discovery	13	3(1)	2(1)	7(3)	1(1)
Drug Manufactures	9	4(4)	2(1)	3(1)	0
Medical Devices	8	1	1(1)	4	2
Other	9	1	1	7(4)	0
Total	53	11	7	26	9

For the life sciences sector, contextual industry data was collected and verified from four conferences and networking events at a local and national scale. In Liverpool, two events were attended that had been arranged by two local firms. These events were used to gain background information on the sector as well as access to guest lists and an opportunity to approach people and invite them to participate in the research. It was an opportunity for them to meet me and place a face on the approach letter that was sent previously. This did help to ease the access issues that I was facing in this sector. Welch *et al* (2002) argued that business elites do have the power and influence to be invisible inside and outside the organisation. This was particularly true for the larger firms in the sector. A further two conferences were attended in London, hosted by The Department for Business Innovation and Skills, specifically for the UK life sciences sector. These conferences differed considerably from the local events, as no firms were present from Liverpool. However, these conferences added to the national context that Liverpool firms are working within, but also how firms are competing internationally. This supplemented the secondary quantitative data that has been collected and discussed below.

3.6 Data Analysis

The transcriptions were completed in three stages. The data from the video games sector was collected and then transcribed, followed by the life science sector and then finally the development agencies. This order was adopted to enable a full immersion into each industry rather than switching between the two during data collection. After each section was transcribed, the data was then anonymised and then coded for the first time (Plummer, 2001; Merrill and West, 2009). Merrill and West (2009:132) state that 'coding involves identifying concepts and themes as you read the interviews'. The coding process was supported by the fact each interview was transcribed by the researcher allowing a closer attachment to the data helping to extract coherent and unified themes (Bernard, 1994). The coding of the data produced a number of categories from which an initial findings report was produced. The data is not treated as thematic document analysis to relate the

findings directly to the research question, but to allow for the identification of common or recurring themes or narratives. The broad themes were the same for both sectors:

- Experiences of starting or operating a firm in the industries
- Location in the city of Liverpool
- Production processes
- Local and global connections
- Institutions and their role

This was done for both sectors with interviews from supporting institutions complimenting this data. The coding process involved splitting the interview data into categories. This is described as 'reading the themes' by Glaser and Strauss (1967). Once the categories have been derived, they are then saturated with examples from the interview data. Within the interview texts, different parts were highlighted and marked relating to the category that they fit. These key themes reflected in the initial findings reports for the two sectors. This intermediate process is called memo writing (Strauss and Corbin, 1990; 1998). These categories have been further saturated with an in-depth analysis of the data and triangulation as a method of validation (further discussion below). These categories have guided the rest of the writing of this thesis. Although the data coding has sought to extrapolate common themes or narratives, further in-depth analysis has also looked at the difference between participants responses. Examining further how different realities have been constructed. These commonalities and differences are what provide and analytical structure to the proceeding chapters.

Yeung (1997, p.63) states that the process of data analysis that leads onto the development of theory should consider an interactive process of abstracting theories based on immanent critique and the grounding of abstractions in concrete data. Other methods, such as grounded theory, are just as useful when trying to abstract theory from empirical data. Abduction is used to discover why actors do

what they do by uncovering tacit, mutual knowledge and the symbolic meanings, motives and rules that provide the orientations towards certain actions (Lewis-Beck *et al*, 2004). Abduction is used where case studies are utilised, focusing on underlying patterns in order to understand a phenomenon beyond that of induction or deduction (Alvesson and Sköldberg, 2009).

3.6.1 Validation

When using qualitative data, it is important to validate the research findings in a rigorous way. The aim is to establish credibility in the research findings. There are numerous ways that rigour can be instilled into qualitative research. In particular, this research used triangulation (Webb *et al*, 1966; Denzin, 1978), whereby multiple quotes were selected from more than one participant to reinforce an argument being made (Baxter and Eyles, 1997). Following in line with the grounded theory approach, the production of categories and then memo-ing before writing the initial findings, the process of triangulation is occurring throughout the analysis of the data. Yeung (1997) argued triangulation should be used in conjunction with the grounded theory approach. By collecting different types of data, they can complement each other and give insight into the phenomena. Baxter and Eyles (1997) state that it is important to use participant direct quotations for revealing how meanings and experiences are expressed in their own words. However, I have been careful that these quotations have not been selectively picked to suit a preconceived outcome, following the best practice of grounded theory (Glaser and Strauss, 1967).

In addition to the above triangulation method, information was also validated from multiple sources. Data collected from the digital and life sciences sector was triangulated with data from informants and observations. This is known as data triangulation (Olsen, 2004). As outlined above, the research started by gaining insights into both industries and the workings of the development agencies from

informants or gatekeepers. The data provided here was then compared with data collected from the firms operating in this industry and the development agencies assisting them. Additionally, the views of other institutions were also compared with the view firms had of them. This grounded the institutions' claims about their role in the industries.

Member checking was used during the recorded interview processes. Member checking is an important quality control mechanism in qualitative research for maintaining accuracy, credibility and validity during a research interview (Barbour, 2001; Byrne, 2001; Coffey and Atkinson, 1996; Doyle, 2007; Lincoln and Guba, 1985). Throughout the interviews I would summarise key points, based on the information obtained and asked if the participant agreed with what I had noted from his/her answers/conversations (Creswell, 2007; Harper and Cole, 2012). Lincoln and Guba (1985) have suggested that the researcher offer access to the information collected from each participant. This will allow participants to review the data and confirms its authenticity. I offered every participant the choice to review the data collected from him or her. Uptake on this was low resulting in only three participants asking to see the transcripts but providing positive feedback and suggesting nothing to be change. A low uptake could reflect the busy nature of these firms but also the confidence they had in the information they had supplied during the interview, given the methods used to verify and clarify understanding through the process. Member checking serves to reduce the risk, when the moment is 'fresh' in the researchers mind of incorrect data or the misinterpretation of the data.

In qualitative research the setting in which the data is collected is less well-documented, yet it can have a detrimental impact on the quality and clarity of the data. Whenever possible, I would travel to the participant's chosen place in order to allow them to feel more at ease and create an environment that was open and trustworthy. Phillips and Johns (2012) draw attention to the issues of location when

conducting interviews. Location can be important as a poor choice such as a busy café can lead to lots of distractions and a poor quality recording. Linking this to how this research was conducted, doing the interviews on the site of the firm allowed the participants to show me around their firm. This clarifies my understanding of the production process but also the reality that these firms operate in. All participants were given the choice of location in the end. Most chose their offices or place of work, where it could be assumed they felt most comfortable at the time. However, it can be acknowledged that interviewees may be more candid outside the office environment away from the formality or panoptical effect (Foucault, 1979).

During the interview process, power relations are negotiated and constructed between researcher and participant (Thornborrow, 2002). Power in an interview can be built up and determined by a number of factors including, socioeconomic status, educational and professional background, or the gender and ethnic identity of the researcher and participant (Anyan, 2013). Additionally, in this research power was given to the participants to end the interview at any time and also to remain anonymous. During the interviews, there was one participant who was very reluctant to respond to questions. This is typical of Lukes (1974) power dimension involving uneven direct confrontations where, in this case, the participant explicitly displays control and power by not responding or providing partial responses. Throughout the entire interview the power over the agenda and what was being asked lay firmly with myself, the researcher. However, as Lukes (1974) points out, there is power in the interviewee's hands to rebuff any line of questioning in a particular category. This is known as deterrence power (Anyan, 2013). In this research, some firms became very uneasy when questions about the firm's financial position or business development grants were posed. In all of the interviews, the participant has taken the role of the expert informant basing his or her answers on lived experience within the firm situated within Liverpool. In every instance as the researcher I would be in a position with a lack of power as participants had the option to withdraw at any given moment and refuse to answer any question.

Hence, my intention was always to create an environment whereby information can be gained that is creditable and useful to this research, whereby the participant is comfortable and responsive. As Odendahl and Shaw (2002:306) noted 'access to elites can be difficult to obtain and typically requires extensive preparation, homework, creativity pm the part of the researcher, as well as the right credentials and contacts.

3.6.2 Positionality

Social science research should aim for a kind of reflexivity that ideally, fully understands the researcher, the researched and the research context (Rose, 1997). Becker (1967) highlighted that no research in the social sciences can be value free and we should acknowledge subjectivities that enter the data collection and interpretation. Emerging from my research philosophy, I believe that knowledge is situated and therefore influenced by the context, in which it is being produced, as well as my own story and that of the participants. This applies to both the researcher and participants. To deny this, is to make false claims to universal applicable knowledge (Rose, 1997). This section will look at positionality in two ways. Firstly, how my positionality affected the data collection. Secondly, how it influenced the data collected and analysis.

McDowell (1992) argues that we must recognise our own positionality, as well as that of the researched. This is done in order to inform likely readers of our work, of the relations and stories a research has before and during their time in the field. This is a quality of qualitative research. Although this research does not hinge on the nature of demographic traits such as age, religion or ethnicity, it would be ignorant to ignore particular issues in this research. As a white, university educated male I accessed the field with varying levels of ease. This research involved interviewing many different types of individuals from firms and institutions. The participants who have contributed to this research have been in public and private

organisations and can be said to be public elites or business elites (Rice, 2010). Elites are hard to define as well as access (Sabot, 1999, Mikecz, 2012). A business elite can be thought of as someone who is in a management position usually located in headquarters or at a senior level of a subsidiary (Welch *et al*, 2002). They are a “group in society that are considered to be superior because of the power, talent and privilege of its members” (Hornby, Cowie and Gimson, 1983, p.280). It has been noted in international business, economic or political geography and sociology that interviewing elites has received little attention (Mikecz, 2012; Rice; 2010; Welch *et al*, 2002).

During the interview process, I felt I had to slightly vary how I presented myself to the interviewee. There was a clear divide between the two industries under investigation. The video games industry tended to be more informal in terms of manner and dress, whereas the life sciences industry was more formal and corporate in appearance and conduct. This was also reflected in the work places of the firms in the industries. Other institutions were similar to the life sciences firms, requiring more formality and structure in conduct and appearance. The impact on the data collection could have been serious in these cases. Appearing less formal and less knowledgeable about particular firms and institutions could give the interviewee the perception that I was not making the effort or that I was not taking the research seriously and lacked credibility. This could result in the interviewee feeling annoyed by having to explain, to them, what maybe basic concepts and this might also make them less engaged in the interview.

With the video game firms, I felt I could be more relaxed in attitude and in how I presented myself as I entered their studio spaces. Most were keen to show off previous achievements, but as a non-gamer myself I did feel a little uncomfortable when asked did I know or have I played this game? I questioned my legitimacy to ask questions with a participant who is passionate for making and playing games. However, I felt the conduct of the interview changed when my previous background

research of the participant and the firm came through. For the first few interview I arrived smartly dressed but not in a full suit. However, I immediately felt overdressed and that, as a result, I had erected a boundary between myself and the participant. For the remainder of the interviews in this sector, I adopted a smart casual look fitting the industry, which also helps to reduce any perceptions that the participant may have.

When interviewing the life sciences firms I felt a different approach was needed. This sector was much more formal and fitting of the businesses elites definition given by Hornby *et al* (1983). Access was particularly difficult in this sector given the number of larger firms operating within it and the layers of administration to cut through to find the right person. For these interviews, I again travelled to the participants preferred location, most of which were their places of work. I felt that after the first few interviews, I had to be much more prepared in terms of my background research of the firm and its focus, in order to keep up with the business terminology. It was more appropriate for these interviews to wear a suit and give a more formal image. This, I felt, gave gravity to the research and my person, so that the participants were not under any illusion that the research was a waste of their time. For each sector, the more people I met, the more I reflected on how I would position myself and how to arrive to the interviews. This is in line with most qualitative research, especially when interviewing elites (Mikecz, 2012).

“Positionality is based on the notion that the researchers characteristics vis-à-vis the respondents can influence the data that are produced.” (Teye, 2012, p. 387)

Having reflected on my positionality in the field, there needs to be an acknowledgment of my positionality across the entire research in regards to the data collected. I recognise that the emergent themes outlined above do reflect and represent both the participants and my own interpretation. This subjectivity can be addressed by approaching the field as a group, using co-authors to identify emerging codes and themes to reach overall agreement (Anderson *et al.*, 2010).

However, this was not achievable given the nature of this research, being a submission for PhD. My background as a white, university educated, male from the North West but also who has live in Liverpool throughout my university career does have relevance to this research. From the onset I had no experience in either of the two industries under investigation, basing most of my knowledge on secondary research and face to face interactions with informants. These prior engagements did help me construct two views and build a knowledge base on which to enter interview confidently. Firstly, the video game industry came across as vibrant, dynamic and open industry to be in. I have not play video games for over 10 years myself but appreciate their use in entertainment. I also had a natural curiosity in regards to this industry as to how things work and how we get to the end product. Secondly, the life science industry was a much more formal and elite profession requiring very high level knowledge making it the least accessible to many. I would not go as far to say I envisioned lots of individuals in white coats and test tubes, but I felt as if this industry was old yet ultramodern and vital to our futures as human beings.

The only common denominator between myself and many of the respondents in this research was place, that being Liverpool. Many of the participants in this research where like myself, not from Liverpool but had an affinity for the city that had gone beyond just a location of a job. In the video games industry many were drawn to Liverpool or hire to work here by one of the three big publisher studios before their demise. In the life sciences many of the individuals working in this sector are drawn or hired to work based on their specific expertise in relation to the product or service and related infrastructures. The affinity for Liverpool did not come through as strong with the life science industry. By not having such an emotive attachment to place drew out the more strategic reasoning for the firm location and positioning. However, it was my aim to enter the field with as few prior assumptions as possible about whom these individual are or place any greater or lesser value on what they do. Again, when researching two different industries it became apparent that each had their own perspective and placed greater emphasis

on particular issues over other. By using the techniques above, through finding consensus yet looking at differences, the research has sought to find and provide authentic and valid accounts. As follows in the findings section, quotes are used from the participants to tell their experiences and perceptions in their words, to provide authenticity to my account of their experiences.

Overall, my positionality has had both positive and negative effects on the research. This research is framed as an outsider's perspective, interpreting an expert informant's perspective, but validated and authentic using the techniques above. A poignant moment to reflect upon was in regards to one firm's limited responses. Given my relatively young age and background as a postgraduate researcher, the participant was either suspicious of my motives or simply did not take the research and researcher seriously. The participant would answer in very short sentences or with a simple yes and no answer, shutting down many avenues for further discussion. In the end, the participant ended the interview asking 'are we done I have other things to do today'. A positive indicator that I can take from the research relates to the recording of the interviews. Most participants agreed to this, giving an impression of trust and appreciation for the research. Overall, the research process was positive, as I was able to respond and learn quickly as the data collection process unfolded. Having discussed the validity and positionality of the research strategy, the following section will discuss the ethical considerations surround this research.

3.6.3 Ethical Considerations

Research ethics are a part of all research conducted within academia. Research ethics are the moral principles that guide the conduct, data collection, storage and publication of the information taken from participants. There are certain rules and regulations that must be adhered to before and during the research process. As an ESRC CASE studentship, this thesis has adhered to the ESRC Framework for

Research Ethics (2010) and complied with the University of Liverpool research ethics. This research maintained a high ethical standard throughout by following the steps below:

1. All participants were provided an information sheet with their approach letter, to inform them in lay terms what the research requires of them.
2. If the participants accepted an invitation to participate, they were required to sign two copies of a consent form, outlining their right to withdraw at any time and that the information they provide is protected and confidential.

The approach letter, information sheet and consent form included the statement that participation is voluntary, confidential and they had the ability to withdraw at any time. Upon arrival to any firm participating in the research, I always carried a copy of the information just to reiterate the key aims of the research and the rights the participant had. One key issue that was not mentioned in any of the research documents mentioned above was the use of a digital recorder. Digital recorders are effective ways to capture and store the majority of the verbal data (Phillips and Johns, 2012). It has been argued that notebooks can cause suspicion from the participant and are not as effective in recording all the data (Holmes, 1998). In most cases for this research, upon arrival verbal consent was gained from the participant to record the conversation we had. It was clearly explained that they could refuse this recording. In the two incidents this occurred, I asked the participants could I make notes, and left the notebook clearly visible for them to see. Overall, it is impossible to fully predict the risks that maybe involved in any research. However, this research has outlined the process and adherence to both the ESRC FRE and University of Liverpool Research Ethics.

3.7 Chapter Summary

This chapter has outlined and justified the research strategy used in this thesis. It has made the case for investigating two industries in Liverpool and why those two industries are particularly useful in constructing two case studies. The method

presented here has acknowledged and provided a strategy to examine the topics outlined in Chapter Two. It has successfully generated data and provided answers to the research questions posed in the previous chapter. The social constructionist ontology was outlined as the research paradigm that informs and then conditioned the way in which this research has been conducted. This dictated the use of a predominantly qualitative research methodology. In justifying the use of qualitative methods the chapter outlined previous studies that have used a qualitative approach and its fitting within the theoretical approaches outlined in the previous chapter.

The use of qualitative methods required an element of reflexivity. This was built into the methodology through a pilot project and personal reflection in terms of positionality. Having never been engaged in either of the sectors under investigation and only sharing the common denominator of place, that being Liverpool, secondary data was collected and was continued to be collected throughout the research process. This informed the nature of the pilot project through which several topic areas were tested to see what the outcomes and any potential drawbacks were of the interview questions. Sampson (2004) argued that pilot projects are an effective way of incorporating reflexivity into qualitative research yet the technique was underutilised or documented. By employing a qualitative methodology, data has been created, with the semi-structured interview data providing an expert informed insight into the industrial landscape in Liverpool, the connections that predicate its existence and how public organisations have and can contribute to a stronger infrastructure for both sectors to survive.

Overall, this methodology has been successful in producing data in order to answer the research questions posed in this research. There have been challenges, as outlined in the chapter where my positionality affected the data collection but there have been processes in place to be reflexive and also in this chapter document that reflexivity. The data collection process was intended to provide expert testimony that

is authentic and valid from those who are positioned within the two industries and supporting institutions. The next two chapters examine the life science and video game industry in turn, providing a thorough examination of the secondary and primary data collected in Liverpool from firms and institutions.

Chapter Four

Liverpool's Life Sciences Ecology

4.0 Introduction

Pharmaceuticals are an integral part of modern society. Their aim is to lead to the overall improvement of health and wellbeing. The origin of the Pharmaceutical industry can be traced back to the Middle Ages, but it was in the early 20th century when developed economies began to see the emergence of the pharmaceutical firms that we know today (Dutfield, 2003). In the 1920's and 30's major discoveries emerged such as insulin and penicillin. More recently, life science agglomerations in the UK are a phenomenon emerging from a mixture of multiple factors acting at different scales. Governments at all levels have seen the potential economic and social benefits that a strong life science industry can yield (Webster, 1994). The life science sector today consists of three core sectors: pharmaceuticals, biotechnology and medical technology (Deloitte, 2014, Schweitzer, 2007).

In the UK the life sciences sector has been highlighted as a key sector for growth (OLS, 2010). The industry was included in the Liverpool Knowledge Economy Framework and it also makes up one of the four cornerstones of the future economic development for the city. Liverpool has received limited academic attention in regards to its life science ecology. On the international stage, Liverpool is less well known for its life science concentration and is usually dwarfed by larger mega-centres (Cooke, 2004) such as Cambridge or Medicon Valley (Henderson and Reavis, 2008; Moodyson *et al*, 2008). This chapter seeks to address this imbalance and will answer research questions one and two in relation to the life science ecology in Liverpool:

1. How have the industry ecologies of the life science and video game industries in Liverpool emerged?
2. How are the ecologies organised and connected beyond Liverpool?

The chapter is structured into three broad sections. Firstly, the chapter will profile the wider life science industry covering the size and scope of the industry, key players and driving forces, merger and investment activity at an international scale and in Liverpool and the geography of the wider industry. Secondly, the chapter will look at the evolution of life science activity within Liverpool. Thirdly, the chapter will use the heterarchy concept to profile and examine the Liverpool life science ecology.

4.1 Profiling the Life Science Industry

When examining any sector in the economy, we need to firstly define what activities should and shouldn't be included. There are many definitions that could be listed here that capture what a life sciences industry looks like. Firstly, the OECD definition will be outlined as a widely accepted but broad international definition. Secondly, more specific definitions that emphasize the scope and scale of the sector will be put forward. Academic literature is abundant with life science definitions but most tend to overlap and be specific to the location under investigation.

OECD (2009:1) defines life sciences as:

“the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services”

The OECD definition serves as a widely accepted definition amongst its members. As an institution, the OECD serves to promote policy that is beneficial to the economic and social well-being of people all over the world (OECD, 2014). Hence the definition is one that encompasses a collaborative acceptance by member nations. However, the definition is broad in scope and needs further elaboration. Given the context of this research it is justified to look to the UK government

definition of a life sciences industry. The Department for Business Innovation and Skills (BIS) states that a life science industry:

“Comprises [of] three sectors – pharmaceuticals, medical technology and medical biotechnology – which together develop new innovative products and technologies with commercial applications in a wide-ranging number of end-user markets. These include healthcare, food and agriculture, environmental goods and services, and chemicals.” (BIS, 2010a, p. vii)

There are similarities to the OECD definition. The inclusion of innovation and knowledge production from these activities appears to be important in defining such a sector. BIS furthers the definition in a UK context by outlining three key activities: pharmaceuticals, medical technology and medical biotechnology. This chapter takes these three core activities as central to any definition of a life science industry. More specific to Liverpool, Wainwright (2008:1) defines the life sciences in Liverpool as:

“...activities that have a target application that impacts upon (i) furthering understanding of biology and biological processes, or (ii) development of new technologies, products or approaches to improving healthcare”

Again what are key to a life science industry are pharmaceuticals, medical technology and medical biotechnology and the ability to innovate and generate new knowledge in relation to productions and applications towards healthcare. Hence, there is an agreed general overlap between institutional definitions of what a life science industry constitutes and they carry relative merit within the industry. However, the various definitions do not point out specific activities but they can be used to build a network of activity which contributes to a life science industry according to the defining principles set out above. The types of companies involved include:

“... companies in the fields of biotechnology, pharmaceuticals, biomedical technologies, life systems technologies, nutraceuticals, food processing, environmental, biomedical devices, and organizations which are involved in the various stages of research, development, technology transfer and commercialization.” (Infoport.ca, 2010)

Following Kasabov and Delbridge (2008) there is a justification for the inclusion of organisations that are involved at the various stages of research, development, technology transfer and commercialisation. In addition to these science and business services there is a need for institutions or organisations that can provide capital (Powell *et al*, 2002; Gertler and Vinodrai, 2009). Belussi *et al* (2008:666) provide a definition that broadens the scope of the life sciences sector. They opt for a definition that:

“includes firms specialised in medical machinery, appliances, pharmaceuticals, and biotechnology, together with research groups specialized in biomedical and biotechnology research in PROs [public research organisations], namely universities and interdisciplinary centres of several faculties (Biology, Chemistry, Molecular Biology, Pharmacy, Physics, Engineering, Medicine, Veterinary, Pathology, and Biomedical Science).”

Belussi *et al* (2008) applied this definition to the Emilia Romagna life science cluster and captured a diverse set of firms enabling innovation and knowledge generation. What emerged from the literature are definitions that vary depending on the context being examined. The UK is different from other contexts in that it has a National Health Service (NHS) which pre-1989 conducted research activities. Since the move away from NHS research, the sector has evolved with private firms taking up more active research roles, but if you were to include the NHS within the definition of life sciences then the definition scope increases. Unlike the USA and some European countries, the public sector has played a fundamental role in the development of life sciences through the NHS and regional development agencies (Sainsbury, 1999; BIGT, 2004).

Consensus can be taken here that there are three core activities to a life science sector: pharmaceuticals, biotechnology and medical technology. This is in line with national and international definitions and covers many of the sub-sectors covered in academic literature. It can also be agreed that a life science industry is one that is based on innovation and knowledge generation in the areas of biological processes for the improvement of human healthcare. Hence, this chapter will focus on life sciences firms involved with the production of innovative products and knowledge generation for human healthcare needs, following closely the definition offered by Belussi *et al* (2008).

Deloitte estimate that the global life science industry to be worth over \$1.5 trillion in 2012 (Deloitte, 2014). This can be broken down into revenues from the three core sectors as follows: Pharmaceutical \$959 billion, Biotechnology \$232.5 billion and Medical Technology \$349 billion. Numerous reports and academic literature point to two key drivers in the continued increase in revenues for this sector. These are increases in health care spending (set to be on average of 5.3%) and demographic changes with a predicted global life expectancy of 65 years (Deloitte, 2014, PwC, 2007, Wield 2013).

Table 8 shows the top ten firms in the global life science industry in 2012 with the industry total and percentage share these top ten firms occupy. The top ten firms have been defined in this research as those with the greatest sales revenue in their industry. Data has been collected from annual reports and industry specialist web sites. In the life sciences the data excludes any commercial products such as food and drinks. For example Johnson & Johnson would rank first year on year on their combined revenue due to a vast proportion of their revenue coming from health care consumables. These revenues have been removed, pitting each firms core life science related revenues against each other. In the life sciences sector, the top ten is dominated by pharmaceutical firms whose success is based on the development of blockbuster drugs; those drugs that generate revenues in excess of \$1bn.

Table 8 Top ten firms in life science industry 2012

2012	Firm	Origin	Total Revenue (\$Bn)
1	Pfizer	USA	47.40
2	Novartis	Switzerland	45.42
3	Merck	USA	41.14
4	Sanofi-Aventis	France	38.37
5	Roche	Switzerland	37.54
6	GlaxoSmithKline	UK	33.12
7	AstraZeneca	UK	27.06
8	Johnson & Johnson	USA	23.49
9	Abbott Labs	USA	23.12
10	Eli Lilly	USA	18.51
		Total	335.17
		Industry	
		Total	1540.5
		Percentage	
		of Industry	21.8

Within the top ten rankings there have been some minor changes over time. Most of the change has occurred among the bottom five firms. Although in the last ten years the rankings have remained pretty stable. Table 8 shows that the top ten firms control over a fifth of the overall life science industry sales, translating into a large influence over the overall sector. If the table was expanded to include the top 50 firms in the sector, most of which originate from a triad of regions (North America, Europe and Japan), the percentage of sales controlled by firms in these regions increase to 38% of the global industry. This strengthens the significant influence of the top ten firms in the life science industry. Table 9 shows a breakdown by region of firms ranking in the top 50 globally. These firms had a minimum of \$1bn sales for this year.

Table 9 Top 50 firms by region

Region	Number of Firms
Europe ¹	19
USA	18
Japan	9
South Africa	1
Israel	1
Canada	1
Australia	1

¹ Countries included UK, Switzerland, Belgium, Denmark, France, Italy, Germany, Spain and Ireland.

Beyond the top 50 firms there are many other large, medium and small firms whose sales do not exceed \$1bn (Pharmaexec, 2013). Cooke (2004) argued that small firms are important innovators within the life science industry and are usually labelled dedicated biotechnology firms (DBFs). DBFs are noted as having the flexibility and innovative capabilities that some larger firms lack. As will be shown in Table 10, there have been several merger and acquisitions of smaller discovery firms as well as larger firms. However, as will become apparent later in this chapter, smaller firms lack the financial capabilities of larger firms, thus creating interdependence on one another in the process of innovation and knowledge generation.

Since 2005 there has been a steady increase in sales as shown in Figure 1. The revenue growth for the life science industry has been increasing with the exception of 2012. As mentioned above, the two key drivers of the increase in sales have been attributed to increases in health spending by advanced and emerging economies and the increase in average global life expectancy (Deliottes, 2014). The recent fall in revenues has been attributed to a number of blockbuster drugs coming off patent for the major producers, leading to a number of competitors being able to produce the drugs, thus increasing competition (Annual reports 2012, Pharmaexec, 2012).

Top 10 Firms Annual Revenue by Year

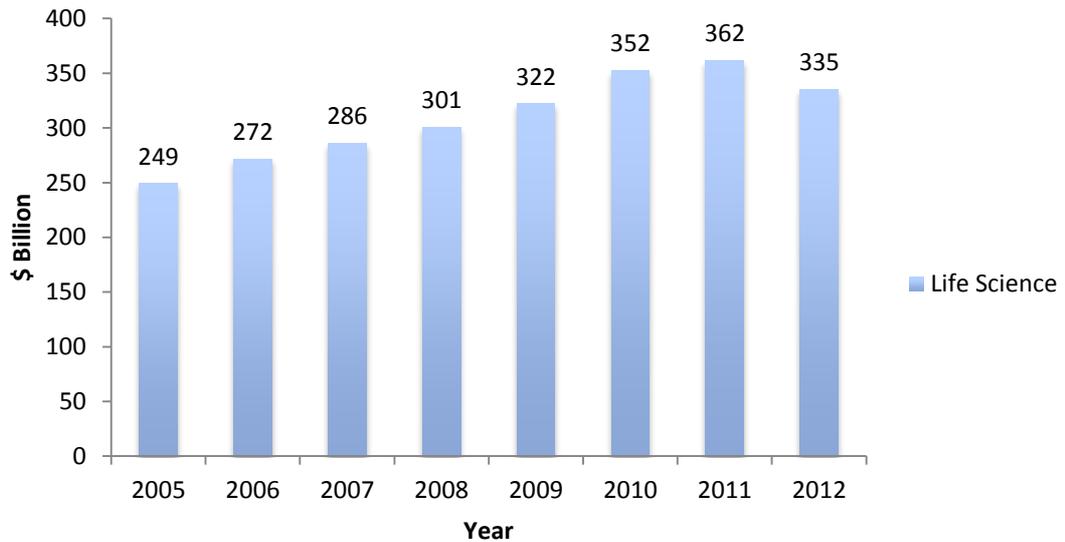


Figure 2 Top 10 firms combine revenue by industry (Source: Company Annual Reports)

Between the top five firms there is less difference in terms of revenue share, compared to the bottom five firms making up the top ten. On the whole, revenue share for life sciences remain steady amongst the top ten firms with only minor fluctuations in the bottom two firms. It would seem that the industry demonstrates only minor movement between the key dominant players. However, as will become apparent below, most of these firms have managed to dominate the industry and retain their place through merger and acquisition activity that occurred in the late 1990's and early 2000's.

Following on, Figure 3 shows the total revenue of the top ten firms combined with the country of origin where we see a triad of regions emerge. This data is not suggesting that these are the only regions where life science activities are found. However, it does suggest, given the dominance of major players within each industry that influence is concentrated (WHO, 2004). In the life science industries, most of the firms are US based and constitute a significant amount of the total revenues year on year. The US is one of the world's biggest markets for pharmaceutical products (Schweitzer, 2007; Pharmaexec, 2012). The US shows the

largest growth in demand for health care products is linked to the changes in population demographics. The increasing longevity of US citizens, increase occurrence of known and unknown chronic diseases drive innovation and continued growth in the amount of GDP being spent on healthcare (Deloitte, 2014). Additionally, being one of the most advanced and largest economies in the world, coupled with the increasing demand for such products and services, it is of no surprise that the USA holds the lead in innovation and dominance of this industry. There are many studies of life science agglomerations in the US (Kasabov and Delbridge, 2008; Zucker and Darby, 1998; Rosiello and Orsenigo, 2008; Owen-Smith and Powell, 2004), which suggests that many factors contribute to the rise of such centre of excellence or mega-centres (Cooke, 2005). Two other observations that are significant from Figure 3 are the decline in the UK share of the total revenue and the increase in share from Switzerland. This is reflected in the growth of Swiss firms, notably Novartis and Roche and the slower growth of UK based firms GSK and stagnated growth of AstraZeneca (BBC, 2011). Deloitte (2014) also point to the deficit reduction measures in the UK and rise in unemployment as contributors towards to slower growth of the UK science base.

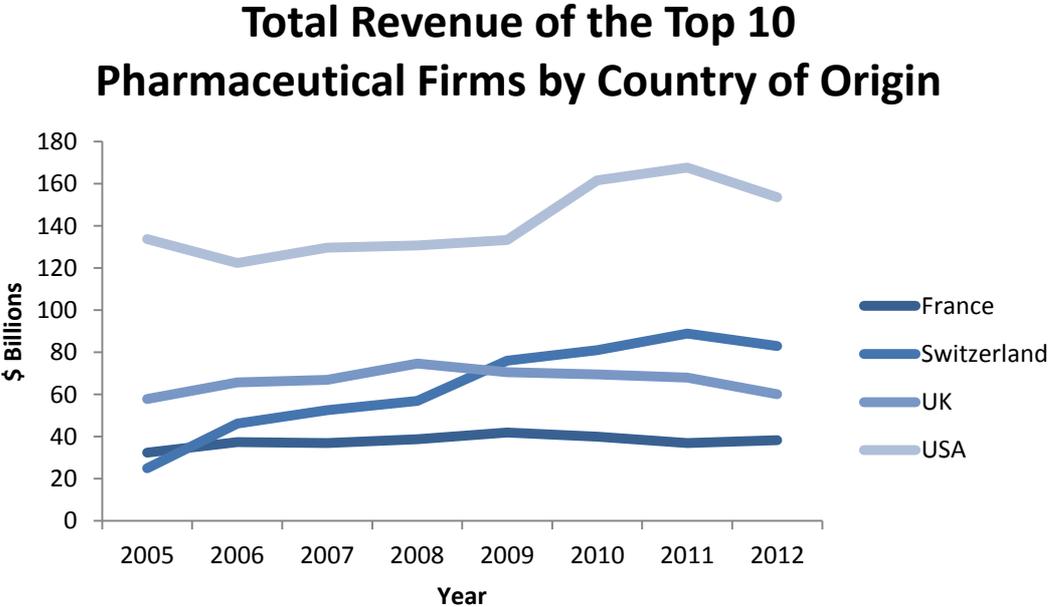


Figure 3 Life science top ten revenue by country (Source: Company Annual Reports)

4.1.1 Mergers and Acquisitions

Over the last ten years there have been a series of large, high profile merger and acquisitions involving the firms in the top ten of the industry. Total merger and acquisition value between 2000 and 2009 can be seen in Table 10. The size and scope of the activity is significant given the value that is attributed to these firms. Given that newly patented products are free from competition or replication and the returns can be high if adopted in western economies, firms merge or become acquired to strengthen their development pipelines.

Table 10 Pharmaceutical Mergers and Acquisitions, 2000 to 2009

Year	Total Value (\$Billion)	Number of Deals
2009	147.2	140
2008	40.6	140
2007	71.6	180
2006	74.8	138
2005	46.6	128
2004	95.2	171
2003	23.6	173
2002	66	147
2001	27.7	87
2000	97.4	41
Total	690.9	1345

(Source: Adapted from Irvin Levin Associates, 2014)

As Table 10 captures overall merger and acquisition activity, Table 11 shows the significant merger and acquisitions over the past 20 years. It's this activity that has spawned the majority of the major players ranking in the top ten globally today.

Table 11 Major global firm merger and acquisition activity

Lead Firm	Origin	Acquired	Origin	New Firm	Size (\$Billions)	Year
GSK	UK	Laboratorios Phoenix	Argentina	GSK	0.25	2010
Sanofi- Aventis	France	Laboratoire Oenobiol	France	Sanofi- Aventis	0.37	2009
Sanofi- Aventis	France	Zentiva	Czech Republic	Sanofi- Aventis	2.6	2009
Pfizer	US	Serenex Inc	US	Pfizer	Undisclosed	2008
Pfizer	US	CovX	US	Pfizer	0.15	2008
Pfizer	US	BioRexis Pharmaceutica I	US	Pfizer	Undisclosed	2007
AstraZene ca	UK	MedImmune	US	MedImm une	15.6	2007
GSK	UK	Sankyo Lifetech Co.	Japan	GSK		2006
GSK	UK	NeuTec Pharma plc,	US	GSK	0.61	2006
AstraZene ca	UK	Cambridge Antibody Technology Group plc	UK	AstraZen eca	0.70	2006
GSK	UK	Corixa Corporation	US	GSK	0.23	2005
GSK	UK	ID Biomedical	Canada	GSK	1.4	2005
Pfizer	US	Idun Pharmaceutica Is Inc	US	Pfizer	0.2	2005
Pfizer	US	Vicuron Pharmaceutica Is Inc.	US	Pfizer	1.9	2005
Sanofi	France	Aventis	Germany	Sanofi- Aventis	65.5	2004
Pfizer	US	Pharmacia	US	Pfizer	60	2003
GSK	UK	Block Drug	US	GSK	1.24	2001
Glaxo Wellcome	UK	SmithKline Beecham	UK	GSK	74	2000
Pfizer	US	Warner Lambert	US	Pfizer	114	1999
Rhone Poulenc	France	Hoechst	Germany	Aventis	26	1999

Astra	UK	Zeneca	UK	AstraZeneca	36	1999
Roche	Swiss	Boehringer Mannheim	Swiss	Roche	11	1998
Ciba Giegy	Swiss	Sonoz	Swiss	Novartis	36	1996
Glaxo Holdings	UK	Wellcome	UK	Glaxo Wellcome	14.2	1995
Hoechst	Germany	Marion Merrell	US	Hoechst	7.1	1995

(Source: Frost, 2004, Mitra, 2007, Schweiter, 2007, Economist, 2004 and IMS Health, 2001)

We can see Sanofi-Aventis who ranked fourth in 2012 being the third biggest merger of the last decade. Initially Novartis wanted to acquire Aventis in 2004 but due to strong opposition from the French Government and their desire to create a strong national champion for their science base Sanofi and Aventis were pressured to merge (The Economist, 2004). In addition, Sanofi was undergoing a legal challenge to one of its blockbuster drugs due to come off patent in 2011 making the merger appear to be in the interest of both party's and the government. GlaxoSmithKlien rank sixth globally in 2012 and was the second large merger in Table 11. The motivations behind the merger in 2000 were to bring together two strong drug pipelines and to create, at the time, the largest pharmaceutical group in the world (BBC, 2000). To the firms this would strengthen the both parties positions in the UK and globally, combining financial and scientific assets for the future. Pfizer is one of the most active firms in Table 11 closing one of the largest mergers of the last decade worth over \$114 billion. Pfizer merged with Warner Lambert in 1999 to acquire new product lines and grow its influence; globally becoming one of the world's most valuable and fastest growing companies (Pfizer, 2014). Pfizer has held the number one ranking globally consistently since 2000 placing it as the most powerful player in this industry. There have also been significant investments made in various forms into Liverpool's life science ecology. Some investments have been by the larger multinational and other sources. The main key motivation behind many of the mergers and acquisitions shown in Table 11 is to acquire existing or new products that are on patent. Patents protections are very generous for life science firms given the amount of money and time invested into them. Therefore,

one legitimate strategic way of acquiring the technology and knowledge whilst the patent is in place, is for a firm to merge with or be acquired by another.

Multinational pharmaceutical firms ranking in the global top 50 own four manufacturing sites in Liverpool. Of these four MNE manufacturers, two are primarily focused on flu vaccines, one focuses on animal and human Active Pharmaceutical Ingredient (API) manufacturing and one focuses primarily on API manufacturing. The two non-multinational, independently owned manufacturers interviewed are contract manufacturers. All of the current manufacturers acquired sites that already existed in Liverpool with the exception of one Greenfield investment. These were bought outright and invested in by the acquiring company. Those who worked in these sites at a senior level had been working for the same company for several years. Table 12 breaks down the investment data for firms acquired in the Liverpool ecology.

Table 12 Investment Activity in Liverpool

Company	Investment (£ millions)	Date	Country of Origin	Source of Capital	Firm Size	Jobs (estimates)
Eli & Lilly	19	2003	USA	Internal	MNE	25
Novartis	42	2004	Swiss	Internal	MNE	100
Baxter	2.2	2008	USA	Internal	MNE	6
Eden Biodesign	15	2010	UK	Acquisition by Watson Pharma USA	SME	145
Auralis	14.5	2010	UK	Acquisition by Viropharma USA	SME	-10
RedX Pharma	10.8	2012	UK	RGF and VC Acceleris Corporate Finance	SME	119

(Source: Financial Time FDI Tracker and Company Web sites)

The investments have brought significant employment boosts for the Liverpool ecology, showing an overall positive impact on job creation. However, one acquisition by Viropharma led to a reduction in jobs in the Liverpool ecology. Auralis was a small discovery firm focused on developing children's medicine. When the firm was acquired for its existing products the acquiring firm closed down the Liverpool base and moved all assets to its US research and development facilities. Additionally, in 2010 Novartis moved 190 jobs relating to the packaging and distribution of flu vaccines from its Liverpool facility to its Italian factory (Liverpool Echo, 2010). This demonstrates that the Liverpool ecology is not immune to the possibility of larger firms acquiring and removing assets as demonstrated by other large multinational pharmaceutical firms (BBC, 2011).

4.1.2 Geography of the Life Science Industry

The global distribution of production and sales in life sciences varies considerably, but there are three specific areas of the world where we can see vast proportions of life science activity relative to other parts of the world. Research and development activities are concentrated predominantly in the wealthy, advanced countries of North America, Europe and Japan (Schweiter, 2005, 2007). The major innovations of the last 20 years have come from these areas of the world. The manufacturing of new drugs and technologies are then exported around the world through vast production networks. Increasingly, in the 21st century, some emerging economies such as India, Brazil and South Africa, have become integral contributors to the production and development of new drugs and technology. However, the level of research and development coming from these areas is relatively small or non-existent. What they have excelled at is replicating existing off patent drugs and selling them to emerging and developing countries where governments and populations have constrained health budgets. It should be noted that there is not a developed developing nation divide in regards to R&D and manufacturing. Most firms in western nations produce the majority of on patent drugs within the triad of regions mentioned above. The same can be said in regards to sales in the life science industry, there tends to be an imbalance of production and consumption

between developed and developing parts of the world. The triad of regions consume far more products than any other parts of the world, but demand is increasing from other parts of the world, especially BRIC² countries (Schweiter, 2007; Deloitte, 2014). As mentioned earlier, demand is driven by the advanced western nations health care systems in response aging populations and the rise in known and unknown chronic diseases.

As previously mentioned, there are a triad of regions where life science activity tends to concentrate. Predominantly life science activity is located within western developed nations. The US alone has several large agglomerations of such activities ranging from discovery firms, drug manufacturers and health care providers. Table 13 outlines the key concentration of activity within the triad of regions based on a number of factors such as size and type of firms, number of firms and supporting institutions, levels of venture capital investment and so on³. It is clear from Table 13, supported by the analysis above, that the strength of the US in the life sciences is overwhelming given its geography, demographic and health care industry composition compared to smaller countries such as UK or Switzerland.

² BRIC countries are Brazil, Russia, India and China

³ For a full list of criteria see Jones Lang LaSalle, 2011

Table 13 Life science regional agglomerations

Americas	Europe	Asia
Bay Area	Paris	Shanghai
Boston	Rhone- Alpes	Beijing
Los Angeles	Munich	Tianjin
New York/ New Jersey	Berlin	Guangzhou
Philadelphia	Rhine Neckar	Hebei
Raleigh-Durham	Ruhr	Shandong
San Diego	Basel	Jiangsu
Seattle	Zurich	Zhejiang
Washington DC	Geneva	Guangdon
Atlanta	Cambridge	Maharashtra
Chicago	London	Andhra Pradesh
Denver	South East England	Gujarat
Florida	Liverpool	Goa
Houston	Manchester	Karnataka
Indianapolis	Scotland	Java
Minneapolis		Singapore
Ontario		
Quebec		
British Columbia		
Brazil		
Puerto Rico		

(Adapted from: Jones Lang LaSalle, 2011)

It is also worth noting from Table 13, the emergence of Asian countries such as China and India. The preferred choice of many larger pharmaceutical companies has been western economies for drug discovery, as they offer the most protection over intellectual property (IP). However, China, India and Brazil have emerged as relatively cost effective destinations for manufacturing through wholly own operations, joint ventures, collaborations or outsourcing (Lalkaka, 2002). Lees and Khatri (2010) have argued that there have been smaller than expected cost savings

by outsourcing to China and India linked to cross-cultural disconnections in doing business.

So at the broad industry level, we can see concentrations of life science activities emerging in western developed nations. Given the nature of this research, focusing on Liverpool's life science ecology, it would make sense to unpack the UK life science industry briefly. Within the UK there are various concentrations of life science activity. Table 14 shows data from the office of national statistics Annual Business Inquiry of 2008.

Table 14 Life Science Establishments and Employment

Region	Establishments	Employment	%		Average
			Establishments	% Employment	
North West	580	17800	10	11	31
North East	190	7500	3	5	39
Yorkshire and Humber	450	10800	8	7	24
West Midlands	420	5200	8	3	12
East Midlands	390	8700	7	5	22
South West	570	15500	10	9	27
South East	1270	49300	23	30	39
London	830	20500	15	12	25
East of England	900	30500	16	18	34
Northern Island	140	3100	2	2	22
Scotland	490	14400	8	8	29
Wales	270	7600	4	4	28
England	5600	165800	86	87	30
UK	6500	190900	100	100	27

(Authors calculations based on data from ONS ABI 2008)

During the last 20 years there has been growth beyond the south east and south west of the UK in regards to life science activity and related or supporting activities. Sainsbury (1999) estimated that the North West had approximately 25 to 30 biotechnology companies, compared with locations such as Cambridge, Oxford and

London, all of which had from between two to five times the number of biotechnology companies in 1999. From Table 14 we can see that there are various concentrations of life science activity across the UK but within England the North West has the largest concentration in terms of employment and number of firms outside the London and South East regions. There is already academic literature on the Cambridge and Scottish life science agglomeration activities (Cooke, 2004, Birch, 2011) but the North West and in particular Liverpool has been underrepresented as an area in which life science activity occurs. Later in this chapter the Liverpool life science ecology will be investigated providing empirical data in order to answer research questions one and two. Before this, the next section will turn towards regulation in the life sciences industry.

4.1.3 Changes in the Nature of Production

Baden-Fuller and Morgan (2010) argued that most industries have generic business models. These generic business models provide the basis on which firms set out to produce and deliver products or services. Magretta (2002) and Teece (2010) have stated that business models do change over time in response to changes in economic environments and business circumstances. The same can be said about the production network. It is sensitive to changes within the local and wider industry. Also, most firms are connected into production networks in different ways. The changes can be driven by the wider industry or through internal innovations from within the firm. Figure 4 shows the life science production network from discovery through to consumption. Although there are slight variations depending on whether you are looking at a pharmaceutical drug or diagnostic device or medical device, the general process from conception to consumption are the same.

A traditional production network tended to keep everything in-house as a vertically integrated firm (Cockburn, 2004). These firms tend to be large multinational firms with the resources and infrastructure to carry out a full commercialisation of a new product. However, internally to most multinational pharmaceutical firms,

manufacturing operates in isolation from the rest of the production network. So, R&D would have little or no interaction with the manufacturing of products. Manufacturing would have little or no direct involvement with sales and distribution, except when discussing the volumes to produce. However, this would typically come from a regional or global HQ. Hence, the life science sector has been internally fragmented with clear roles along the production network (Cooke, 2004a, 2005).

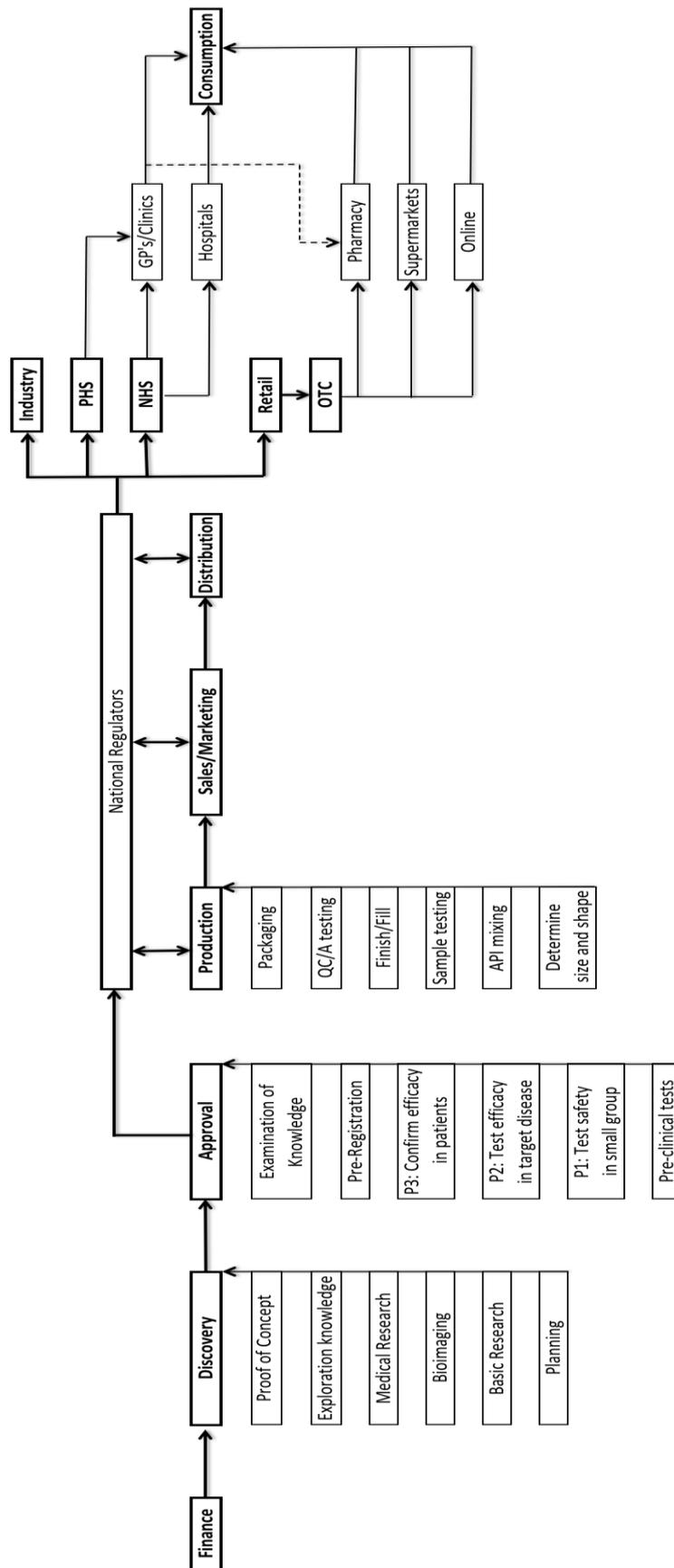


Figure 4 Life science production network

The generic business model used in life science industry has been undergoing significant changes over the last 30 years. Many firms and industry specialists involved in this research claimed that at the wider industry level the current business model is broken. To support this, there are numerous consultancy agencies analysing the sector and proposing new business model structures for the future that support the fragmentation of production among a number of firms rather than relying on larger vertically integrated firms (PwC, 2011). Despite this, the process of producing a new drug or diagnostic device has, by and large, stayed the same. There has been an increase in the regulatory criteria that firms need to overcome, in regards to patient safety. As a result this has lengthened the life cycle of new drug development. A new drug concept can now take up to 15 years to reach the patient/consumer compared to 10 years a decade or so ago. The same can be said for the diagnostic sector that has timelines from two to five years depending on the product's targeted application. As innovations become more complex and advanced to tackle known and unknown life threatening diseases, the regulatory processes lengthens the time taken to get a concept through production and to the consumer.

The most significant driver of change and challenge facing the big pharmaceutical firms is the lack of "blockbuster" drugs in their pipelines (PwC, 2014). These are defined as drugs that will earn a company at least \$1bn in sales. Linked to this is a shift towards tailored therapeutics that are more effective in different populations of people (InsidePharma, 2011). This is leading to more complex production methods that the big pharmaceutical firms don't see as viable to carry out in-house. Therefore, there has been an increase in contract manufacturing of these complicated products. The scale of the outsourcing is still relatively small compared to the in-house manufacturing done by the big pharmaceutical firms (Lees and Khatri, 2010). An independent pharmaceutical manufacturer in Liverpool is one such firm taking on new facilities to deal with the increase in manufacturing outsourcing of complex products. The business is changing to adapt to the wider industry production challenges, but as mentioned above, the contract work comes

from outside the Liverpool ecology and leaves little room for local collaboration or such contracts.

With many blockbuster drugs coming off patent in the next few years (Deloitte, 2014), big pharmaceutical firms have been looking to SME's to help fill this gap in their pipelines. Traditionally most R&D was done in house by large pharmaceutical firms, who with the money from blockbuster drugs sales could plough revenue back into R&D in the hope of finding the next big innovation in the life sciences. Alternatively, big pharmaceutical firms would scout the markets for SME's with drugs that have been taken through to phase two approval and had a very strong proof of concept and efficacy rates, before buying or agreeing a licence for the production of the drug. For some this has worked but across the industry it has left some pipelines dry, like that of Astrazeneca (BBC, 2011). As a result, many of the big pharmaceutical firms are looking to SME's much earlier in the production network to acquire their projects. Some firms involved with the research had been approached after phase one with the offer of assistance from a larger pharmaceutical company. Today we are seeing not just an internal fragmentation of the whole production process but a wider trend towards outsourcing, causing further fragmentation internally and externally. Each section of the production process is becoming a project in itself with specific goals and objectives linked to a certain time scale (Newell *et al*, 2008).

4.1.4 Regulation

The pharmaceutical industry is one of the most heavily regulated markets in the world (Vogel, 1998, Schweitzer, 2007, Vernon, 2005). Regulation varies across the world with developed economies seeing some of the highest levels of regulation due to the concentration of the industry activity in these parts. The objective of such regulation is to protect the general population's health, guarantee access to safe and effective medicines and constrain pharmaceutical expenditure (Mossialos and Oliver, 2005). One of the most influential objectives of the last 20 years is cost containment relating to the control of prices and the volume of products produced.

Regulation tends to be either on the supply or demand side of the market. Mossialos and Oliver (2005) argue that the supply side measures affect the price of the pharmaceutical products, which in turn can also affect volume; whilst demand side measures use financial and non-financial incentives that target volume in regards to physicians, pharmacists and patients. Pharmaceutical regulation has been evolving significantly over the last 20 years in a dense inter-relational set of policies at multiple scales, but the most comprehensive frameworks exist on a national level. The national regulatory frameworks safeguard the general population and are accountable for the introduction of new products to the health care market. In addition, there are multiple institutional actors involved across many different economic environments and at multiple scales. This makes the regulatory framework vast and toilsome to comprehend fully as well as to pinpoint the actual impact of individual regulations. This section will cover three broad levels of regulation, these being supra regional efforts, EU and the UK. Each will be discussed in turn given their impact on the context in question for this research. It should be noted here that this section will not be listing nor analysing each individual regulation but will give an overview of the institutions and specific regulations or policy that have impacted on firms in the Liverpool Ecology.

Supra-Regional Regulatory Environments

Since 1997 the OECD has been concerned with the pricing of drugs, intellectual property and stimulating innovative drug design. The reports "*Pharmaceutical Policies in OECD Countries (2000)*" and "*Pharmaceutical Price Controls in OECD Countries (2004)*" both consider these issues. The pricing of drugs has been fixed in many OECD member countries. This has acted as a stimulus for the reinvestment in innovative drug design. Additionally, strong national intellectual property rights have assisted the ability to secure the investment made in the drug (Jacobzone, 2000). Price controls can also be used to limit the profits of pharmaceutical companies and increase patient access to drugs. This is apparent in countries where public health services are the main consumers of drugs (US Department of

Commerce, 2004). Pricing policy stops pharmaceutical companies making large inflated profits from organisations such as the UK National Health Service (NHS).

However, the OECD stresses that competition from developing economies where manufacturing costs are lower and IP is weak could drive the market price of non-patented drugs down. Recent deregulation on price fixing in the US could in the long-term fuel a decrease in returns on drug related products (Jacobzone, 2000 and US Department of Commerce, 2004). The suggestion is that:

“Reforms of pharmaceutical policies need to foster efficiency and preserve equity. This can be realised through increased market pressure to obtain competitive prices for non-patented drugs while allowing higher prices for those still on patent.” (Jacobzone, 2000, p30)

At a global scale there have been efforts to bring some level of homogenisation to the regulation of new drug development and market authorization. Again there are well-documented efforts (see Vogel, 1998) but the most significant institution that has been created brings together only the triad regions consisting of North America, EU and Japan (Ohmae, 1995). The International Conference on Harmonisation of Technical Requirements for the Registration of Pharmaceuticals for Human Use (ICH) was established in 1990.

‘ICH is a unique undertaking that brings together the drug regulatory authorities and the pharmaceutical industry of Europe, Japan and the United States. ICH’s mission is to make recommendations towards achieving greater harmonisation in the interpretation and application of technical guidelines and requirements for pharmaceutical product registration, thereby reducing or obviating duplication of testing carried out during the research and development of new human medicines.’ (ICH, 2014)

Inclusion of only three regions of the world does not warrant a global consensus. It can be argued that the efforts fall short of being a ‘global’ initiative or institutional

effort (Dicken, 2001), however, the triad regions that are represented do have the disproportionately larger concentrations of global life science activity than anywhere else as demonstrated in previous sections. Furthermore, the World Health Organisation (WHO) published a report in 2004 stating:

'Medicine production is highly concentrated in the industrialized countries, where just five countries - the USA, Japan, Germany, France and the UK - account for two-thirds of the value of all medicines produced.' (WHO, 2004: 3)

A further report published in 2008 'WHO Medicine Strategy 2008-2013' continues to support the statement above highlighting the dominance of a triad of regions in this industry. In addition, these regions accounted for 90% of all research and development activity during the late 90's (Vogel, 1998) but figures today are showing a small shift towards South East Asian regions, although the shift remains small, the three dominant regions play a significant role given their role in the industry and their availability of capital to reinvest into research and development (Wield, 2013). Hence these regions have had the largest influence on the suggested outputs from the ICH and have been able to adapt relatively easily to the frameworks as they overlap with existing nation and superregional environments (Vogel, 1998).

EU regulatory Environments

Vogel (1998) and Permanand (2006) argued that there has been too much emphasis on the national regulatory systems, creating an incoherence and added bureaucracy for many life science firms who wish to bring new innovations to the market. The EU has been pushing for a more coherent regulatory environment but still this is not a reality, with many companies having to still focus on the individual member states own regulatory environments. Efforts to reduce the disparity between EU member states regulatory environments began in 1963 (Oraz *et al*, 1992). It was in 1965 that the EU moved to commission a baseline criterion for safety, quality and efficacy as

preconditions for marketing authorised drugs (Vogel, 1998: 3). Up until present day, there have been numerous attempts to ratify an untied agreement at EU level on drug approval and development. There was a breakthrough moment in 1992 with the Maastricht Treaty on European Union (1992), leading to the creation of the European Medicines Evaluation Agency (EMEA) (Kingham *et al*, 1994). The institution now operates under the name of the European Medicines Agency (EMA) and has been established since 1995. The institution is summarised as having two key objectives, these are the marketing authorisation of new drugs and to promote more Europe wide drug research (EMA, 2014, Permanand, 2006). Innovation in drug development in the EU has been relatively low in comparison to the US, with the number of patents being submitted by firms in the EU being a quarter of those compared with the USA (Rawlins, 2004; Vogel, 1998). Europe had a public policy void in relation to innovation and support for science (Etzkowitz, 2002). Europe produced excellent research outputs but lacked the necessary systems in the market to take the output and make it commercially viable. This failure was accountable to (i) market failure to recognise intangible knowledge transfer and (ii) low connectivity between universities and industry (Rosiello and Orsenigo, 2008). To rectify this, Europe adopted the American model but ran local and regional level policy parallel. Local and regional policy was aimed at increasing knowledge transfer and exchange and also to adopt a proactive approach to interaction between various actors in regional and national innovations systems (Rosiello and Orsenigo, 2008).

Alongside these two key objectives the agency is a networking hub for EU nations responsible for implementing telematics or information exchange, inspections regarding market authorisation of manufacturing processes and development and referrals based on safety and risk to patients. The EMA has aimed to create a homogenised EU environment on drug regulation and development. One key initiative that has stood out in this research in regards to policy and regulation is the development and support for children's medicine. One firm has been successful with the help of the EMA in developing new patented drugs in children's medicine and successfully sold the licencing agreement to a larger multinational firm.

'So what happens in then healthcare providers take adult medicines and they dilute them down, cut them up, do, you know, modify them to give to the child, but not based on any data. So there's an incentive in Europe that if you're willing to do the work to bridge that gap in children's medicine, you get a 10 year data protection on what you, on your, what you've developed. So that is what we're exploiting, it's called the paediatric use, so that's our focus.' (Interview Discovery firm 4, 12/10/12)

The firm quoted above is one example of the direct impact of particular regulation regarding the life sciences industry from an EU to ecology level. This incentive based regulation has impacted on a firm in the Liverpool ecology. Hence, despite the complexity of the regulatory environment and the procedures firms adhere to in order to gain market authorisation, this research has managed to uncover a particular example of regulatory impact on the Liverpool ecology.

The EU has been one of the most ambitious organisations in creating a pharmaceutical regulatory environment and has come some way towards creating a homogenised market place (Vogel, 1998). However, individual nation states still have an overall authority in drug authorization within their territories, but cannot disregard the input of the EMA. In summary, the EU is involved in strategic policy making unlike the OECD. The EU is a driver and supporter of coordinated policies that affect and can sometimes shape member states' individual strategic policies. In addition, the EU provides a platform for cooperation and wider economic, social and political gains in regards to life sciences.

UK Regulatory Environment

In the UK cost is regulated through a structure system of co-payment. All drugs have the same level of co-payment regardless of the actual cost of the product. This is known as a prescription charge. Various exemptions exist for selected segments in the population, placing the cost on the existing NHS budgets. However, given the

high number of exceptions and prescriptions of medicines through hospitals where there is no charge, the overall number percentage of people paying for a prescription is relatively low compared to other European systems. It has been argued that although an increase in the cost of prescriptions does increase revenue expenditure (Hitiris, 2000), the increase is negligible (Mossialos and Oliver, 2005).

In the England and Wales the National Institute for Clinical Excellence (NICE) has the most influential role within the sector in terms of what products can enter the market and be used in the NHS, based on the best allocation of available resources. When NICE was established as an institution, it was seen by the industry as a barrier to new and more expensive innovations in health care. However, the opposite has been true and it is in fact the NHS managers with constrained budgets who have seen the cost rise due to the role of NICE deeming what is acceptable and what is not in NHS hospitals in England and Wales.

Interestingly, in the production network, pharmacists exercise significant power in the policy making process and over the cost and distribution of products. Pharmacists have the ability to shop around different wholesalers for stock, especially over the counter (OTC) drugs. Attempts to ease the restrictions on market entry have been blocked making distribution a very protected part of the value chain in the UK. Mossialos and Oliver (2005) argue that change has been much slower in this part of the value chain. More recently in the UK, pharmacists are seeing an expansion of their role in the National Health Service providing consultations and prescribing treatments for minor ailments. However, most of the drug expenditure comes from the NHS hospitals.

A key piece of policy in the UK framework is the Pharmaceutical Price Regulation Scheme (PPRS). As part of the voluntary scheme there are five principle objectives, these are:

- Provide stability and predictability to the Government and the industry
- Support the NHS by ensuring that the branded medicines bill stays within affordable limits

- Improve access to innovative medicines, commensurate with the outcomes they offer patients by ensuring that medicines approved by NICE are available widely in the NHS
- Reduce bureaucracy and duplication
- Support the Government's growth and innovation agenda for life sciences.

The aim of the regulation is to make drugs affordable for the NHS but also to ensure competition in the markets. The regulation does go into much more depth on the tolerance over returns on capital and states that:

'8.14. The allowable ROC [return on capital] that may be earned by individual scheme members from home sales of NHS medicines will be based on the historical value of average capital employed. This target will be 21% a year' (PPRS, 2014:52)

The UK market is very much regulated under a pricing mechanism to benefit the patient and the NHS, whilst maintaining competitiveness in the market. If any company has returns on their sales above the stated amount (21%) then they must take immediate action in the form of price reductions, paying the excess to the state or delaying future expected price rises. The actual effectiveness of this policy is undetermined and would require extensive modelling. Despite the regulation aimed at reducing or making the purchasing of drugs more cost effective, there have been and continues to be increases in the expenditure of the NHS on drugs and other medical products. Mossialos and Oliver (2005) argued that successive PPRS regulatory frameworks have been useful in attracting investment; demonstrating to investors the stable and predictable nature of the UK market. Equally the UK offers firms higher than worldwide average research and development expenditure.

'8.28. The Department confirms its commitment to recognising the cost of R&D within the prices paid for NHS medicines. The amount allowed reflects both a contribution to the worldwide cost of R&D undertaken by companies

developing human medicines and a desire to reward and provide an incentive for success in R&D. The Department expects this allowance to contribute towards the R&D of new and improved medicines.

8.29. The maximum R&D allowance is 22% of NHS home sales for assessing price increases (level 1) and 30% of NHS home sales for assessing AFRs (level 2).’ (PPRS, 2014:54)

The policy does have its drawbacks in that the true extent to which it promotes efficiency is debatable given the relative ease in which firms can apply for price increases on particular drugs; especially those that do not meet the 21% return on capital limit. Further Mossialos and Oliver (2005:302) argue:

‘That returns are calculated as a percentage allowance on the capital invested, the company may over-invest in capital equipment or artificially inflate its asset base.’

One direct policy initiative that has helped the ecology that has national sponsorship has been the Regional growth Fund (RGF). Although this is not part of the regulatory environment in which the ecology is situated, we cannot ignore the significance of the RGF especially on one particular firm.

“if there was any policy that was enabling to the north west it was the level of funding available... its help so many businesses grow and increase the profile of the north west” (Public Organisation 2, 05/08/10).

‘Redx Pharma has a conditional offer of £4.7 million to help fund an initial two-year pre-clinical phase of a five year research and development project. The project will deliver new treatments for microbial infection as well as anti-viral therapies for conditions such as influenza, hepatitis C and HIV for progression to human clinical trials. The research will create 119 skilled jobs directly at the company within chemistry, biochemistry and analytical testing

and a further 28 specialist jobs within the wider supply chain over its lifetime.’ (BIS, 2012)

As part of the successful bid, the company has raised a further £6.1 million in private funds to develop a new research and development facility. However, this facility will not be located in Liverpool and has been moved to Alderly Park in Cheshire. Other firms in the ecology have acknowledged the complexity of the UK and EU regulatory and policy mechanisms. When participants were asked about specific regulations, whether they are enabling or constraining to the business, they again were unable to provide examples of specific regulations. This further emphasises the nature of the life science regulatory environments being heavily interconnected and complex when trying to show the effects of individual regulation.

However, it has been argued that firms stand to gain from a harmonisation of global regulatory frameworks in the life science sector, but it is the governments that pose the greatest challenge to the realisation of global consensus or cooperation (Schweitzer, 2007, Vogel, 1998). This has come down to the national regulatory bodies’ unwillingness to surrender their own abilities to regulate the national market as ultimate responsibility for an unsafe drug entering would rest with them.

4.2 Life Sciences in Liverpool

There is a diverse range of life science firm activity in Liverpool. These can be broken down into the following activities shown in Table 15 along with the population of each activity and the range of employees on site. In September 2012, there were 53 firms active in the life science ecology in Liverpool. Previous consultancy lead analysis on the sector put number of firms active much higher (Wainright, 2008). However, these figures were compiled in 2008 and primarily used standard industry classification codes. Since then, there have been a number of changes in the ecology. Several firms have been dissolved or acquired and stripped of their assets. However, despite these changes, the most current

directory compiled by a leading consultancy group for the industry in the North West, still lists many of these firms as active in the Liverpool ecology (Bionow, 2013).

Table 15 Life science firms by activity in Liverpool

Activity	Number of Firms	No of Employees on site (Range approx.)
<i>Consultancy – provide industry specific advice and guidance relating to commercialisation of IP, funding or general business advice.</i>	7	1-10
<i>Diagnostic – R&D and manufacturing of devices used in medical diagnostics.</i>	7	2-100
<i>Discovery – R&D into new drugs and drug applications.</i>	13	3-130
<i>Drug Manufacturers – Manufacture medicines in various forms.</i>	9	50-1000
<i>Medical Devices – Produce and sell products that are used for medical purposes such as surgery or in diagnostics.</i>	8	5-30
<i>Other – firms that have related life science activity but do not fall under the above categories.</i>	9	1-30
Total	53	

The majority of firms were registered in designated science or innovation park developments around the Liverpool City Region. The main centres of activity can be seen in Figure 5 and are:

- Mersey Bio Incubator
- Liverpool Science Park Innovation Centre (IC) 1, 2 and 3
- Speke Estuary Commerce Park – National Bio-manufacturing Centre (NBC)

- Innovation Park/ Wavertree Technology Park
- Daresbury Innovation/Science Park
- The Heath – Runcorn
- Wirral – Bromborough Industrial Park

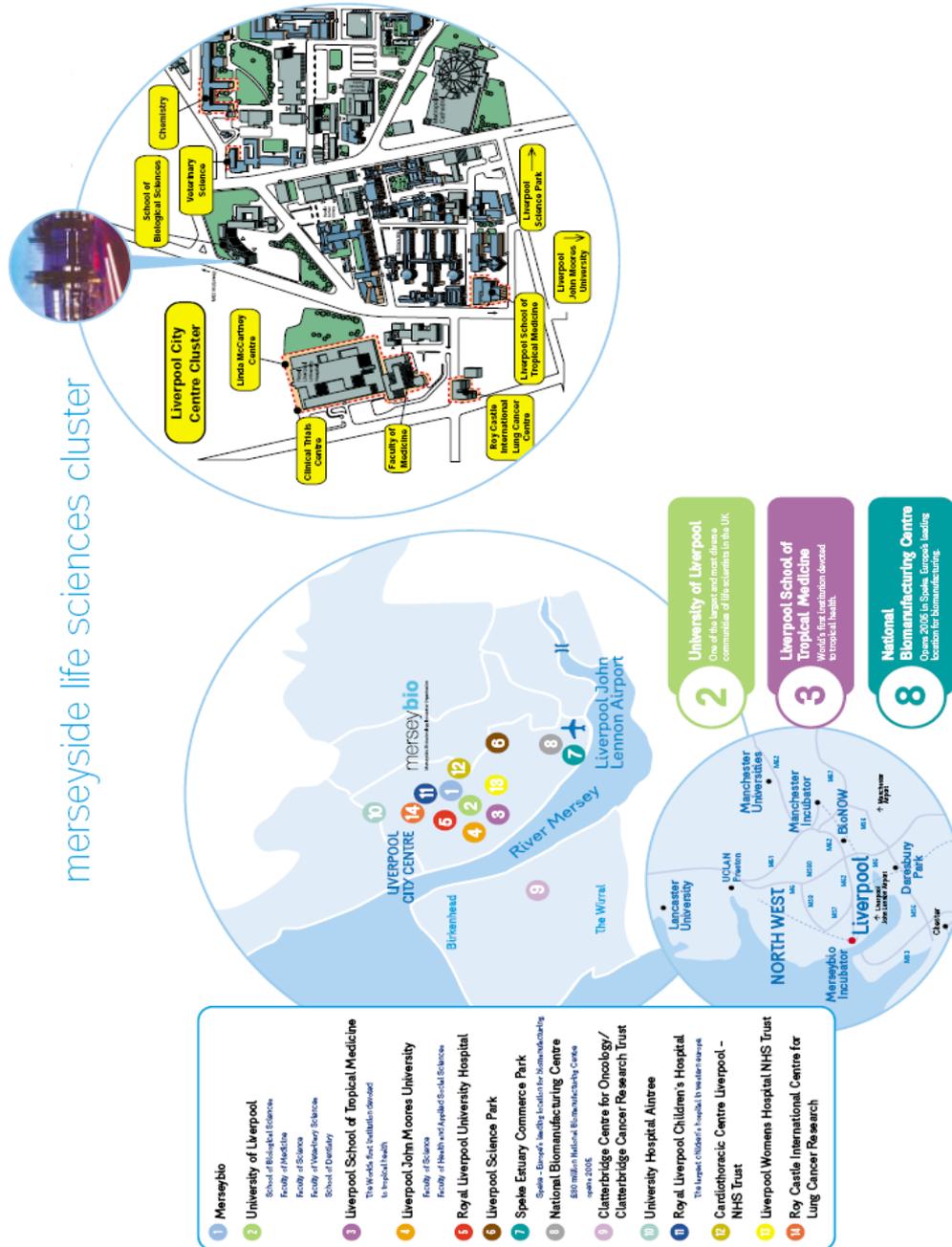


Figure 5 Map of Life Science Assets

These areas have come about through historical links and economic development led initiatives. Alongside the life science firms are a set of organisations that are considered assets to the industry. These assets have been included in many regional and local policy documents. They have been deemed assets based a triple helix model adopted by policy makers seen in Figure 6. The Triple helix was taken from the US as it demonstrated the strongest industrial policy in the world (Etzkowitz, 2002).

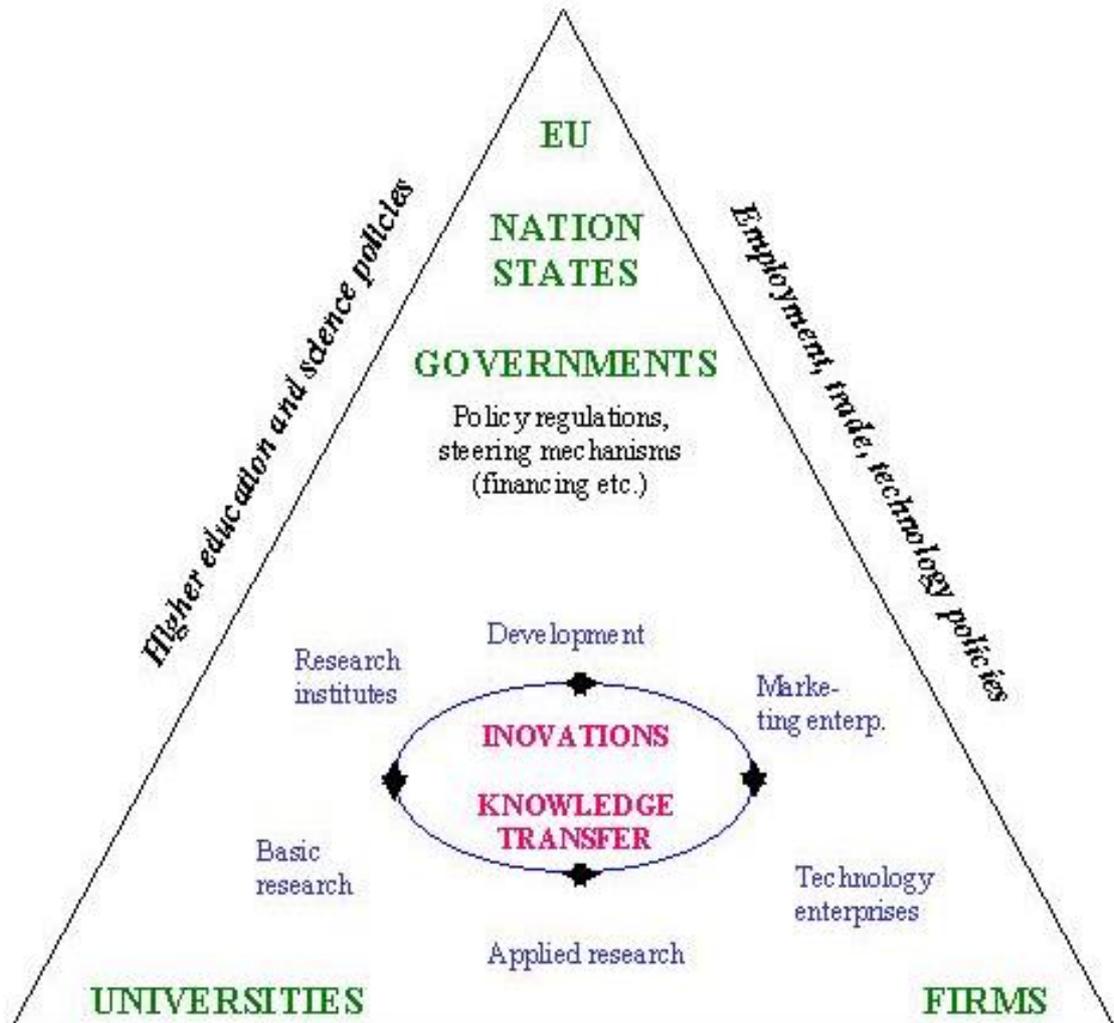


Figure 6 Triple helix (Etzkowitz and Leydesdorff, 1995)

Life sciences sectors are dependent on university-industry-government relationships (Cooke and Morgan, 1999, Shearmer, 2011). Hence the triple helix captures these relationships and how they are processed. The EU recognised that a top-down approach would not yield effective growth in the knowledge economy

(Soriano and Mulatero, 2009). Like the US, the EU adopted bottom-up, sideways, criss-cross as well as the top-down approach for policy. This is linked to the recognition that the innovation process is not linear and involved a systematic process of different actors working together (Soriano and Mulatero, 2009; Veltri *et al*, 2009).

“A mere increase in financial resources devoted to R&D, for example, would do little in the absence of an increase in the level and quality of education of the population and in the use of research output by innovators.” (Soriano and Mulatero, 2009, p.2).

Hence, the Lisbon Strategy is broad in focus and reaches beyond R&D investment to recognise the roles of other institutions and national governments. Hence, the assets deemed important under the criteria of the Lisbon Strategy by the then North West development Agency (NWDA), local council and economic development agency Liverpool Vision for Liverpool’s life science ecology include:

- University of Liverpool
- Liverpool John Moore’s University
- Mersey Bio Incubator
- School of Tropical Medicine
- Speke Estuary Commerce Park – National Biomanufacturing Centre (NBC)
- Royal Liverpool University Hospital

Of all the life science activities listed in Table 15 the oldest activity is pharmaceutical manufacturing. This activity goes back to 1941 with the establishment of a drug grinding mill in Speke owned and operated by Evans Medical producing drugs for injections and compressed tablet form (Richmond *et al*, 2003). The firm was bought out and stripped of its research and development leaving only manufacturing at the site in 1961 by Glaxo Group Ltd. The firm changed ownership again in 1990 and was bought by Medeva PLC who changed the operation to the manufacturing of vaccines (Richmond *et al*, 2003). In 2008 the site was sold again to Medimmune where it now produces flu vaccines (Medimmune, 2014). In 1942 another factory

opened along side Evans Medical operated by an agency factory on behalf of the British Ministry of Supplies during the war period to produce penicillin. Distillers Biochemical, following the end of World War Two, acquired the factory (Richmond *et al*, 2003). Again the factory was sold on to Eli Lilly in 1963 who are still the current occupiers of the site (Eli Lilly, 2014). Today there are four large multinational pharmaceutical firms with manufacturing operations in the Speke area. These two factories can be seen as the nodes in the evolution of the life sciences in Liverpool. Since then, there have been a number of large pharmaceutical companies located within Speke; these can be seen in Table 16.

Table 16 Multinational firms

Company	Country of Ownership	Employment	Date Established	Formally	Specialism
Eli Lilly	Subsidiary (USA)	1000	1963	Distillers Biochemical	API, TB, Diabetes and animal health
Novartis	Subsidiary (Switzerland)	500	2005	Chiron Corp	Flu Vaccine
Medimmune	Subsidiary of AstraZeneca (UK)	450	2008	Medeva Pharma Ltd	Flu Vaccine
Eden Biodesign	Subsidiary of Watson Pharmaceutical (USA)	145	2000	Greenfield investment	Biosimilars ⁴

(Source: Interview data and company web sites)

Prior to the multinational pharmaceutical firms moving in to acquire the previous firms, there was R&D activity in this area through Evens Medical. This activity was later absorbed into Glaxco Group Ltd and moved away from the site. All

⁴ Biosimilars are a biotherapeutic product which is similar in terms of quality, safety and efficacy to an already licensed reference biotherapeutic product.

pharmaceutical R&D activity has been stripped from these sites making them solely manufacturing outfits. This has led to no R&D activity in the area by a large pharmaceutical company since Evans Medical owned the site, up until 2000.

Since 2005 the Speke site has been known as the National Biomanufacturing Centre (NBC), costing £34 million to provide state of the art facilities and infrastructure for any life science related firm. The site is hosting the largest concentration of pharmaceutical manufactures in Europe (Bionow, 2013). There is one multinational drug manufacturer, Baxter Healthcare that is not located in the NBC along with four independent drug manufactures. With the exception of the Baxter Healthcare, the four independent manufacturers acquired sites already equipped with manufacturing capabilities relating to the life science industry. Their motivations to acquire such sites were in response to rising demands on their existing operations requiring further asset purchases in order to increase their internal capabilities and broaden their manufacturing or business scope. As one manufacturer states:

'We acquired it in 2007... contract manufacturing of aerosols is rare because a lot of it is done internally, people like GSK, Sanofi-Aventis will do their own in house. And there was an opportunity here, because the development side helped move metre dose inhalers from CFC propellants to non CFC propellants, so they had development capabilities here, that's basically, it was a neat fit with what we had already, plus it gave us a development arm at the same time' (Interview Drug Manufacturer 1, 16/08/12)

During the last ten years, it has been observed that the life science sector in Liverpool has been dominated by large-scale manufacturing. The NWDA, Liverpool local council and Liverpool Vision saw the push towards developing a life science industry from the national government as part of a broader knowledge economy framework. In line with the Lisbon Strategy and following a triple helix based model, a strategy was put in place to move towards diversifying the industry to high value creation and capture activities.

'So the Government a few years ago decided they were going to invest in bio manufacturing, high tech manufacturing, for the life science industry. And I think Liverpool more closely represents an area like that than it does say a Cambridge or a Manchester or you know Cambridge Massachusetts. The National Biomanufacturing Centre became a 40 million investment in Liverpool.' (Interview Consultancy Firm 3, 09/05/12)

Although there have been more investments and drivers towards an advanced manufacturing base, spin out R&D led activity from universities and firms began to occur as early as 1995. The most significant intervention came through the development of Mersey Bio incubator in 2001. The purpose of this was to help strengthen the research and development capabilities in the life science sector. This would then link to economic growth for the city and attract or encourage other firms and scientists to do the same. In the early days of the incubator, there were three problems to overcome when trying to diversify the industry into R&D.

Firstly, the local universities were not commercialising enough of their intellectual property and turning them into firms. This was for two reasons. Firstly, scientists did not want to spin out of the university and form a company with their concept and IP because they are not business people and saw it as a risk. Secondly, the universities lacked the infrastructure to help smooth the spin out process and had problems with allowing the IP to be commercialised and invested in. This was primarily a problem with control and ownership.

"This idea of spin outs or doing something with your IP was something that sat there and you know people had it in documents but it was never, ever taken seriously. I think that was part of the problem." (Interview Consultancy Firm 3, 09/05/12)

Secondly, Liverpool has not been well served by venture capitalists or business angel funds specialised in this industry. The majority of the funding has come from outside of the area or from national, regional and local government grants and

organisations. Kleppers (2010) argued that an area serviced well by venture capitalists and/or business angels tend to foster more entrepreneurial activity. Given the length timescales that exist in the commercialisation of new technologies in this industry, there are many gaps that exist in the funding models (Festel, 2011). Life science firms in USA and in Europe have noted that business angels are significant players in bridging the gaps between early start ups and raising the levels of capital needed to sustain a venture. Chantelot and Suojanen (2010) and Birch (2011) further argue that less favoured regions tend to suffer from a lack of institutional and venture capital in order to service innovations through to commercialisation.

“So people have to find it somewhere. In the past people would look at a mixture, so it would be their own money, plus grants, plus some VC money. I don’t think the VC money’s been particularly good for life sciences in the North West.” (Interview Consultancy Firm 1 26/06/12)

“One of the fabulously successful initiatives in the previous RDA, the North West Development Agency, was a group called Bio Now, and Bio Now created huge amounts of opportunities for both the business community, pharmaceutical firms and small fledgling business or folks with an interest in creating them to come together, and that was a hugely successful undertaking led by an ex industry professional” (Interview Drug Manufacturer 5 10/09/12)

Many respondents highlighted that the problem with government funds is that they have lots of strict criteria governing the allocation of funds.

‘Liverpool Seed Fund demanded a Merseyside location.’ (Interview Diagnostic Firm 2, 31/7/12)

Additionally, the bidding process that firms must go through in order to be successful is extremely long. For firms this can mean wasting valuable time and

resources pursuing governmental money due to the lack of venture capital and other funding streams. Thirdly, there can sometimes be a miss alignment between the quality of research and the level of funding available. As one participant commented:

“the science is normally terrific, the enthusiasm is unmatched, but it’s matching money with the damp and hard edged enthusiasm of business, which is the hardest piece.” (Interview Discovery Firm 5 15/08/12)

Liverpool’s life science ecology has been responding and adapting to many of the challenges it originally faced. The section has outlined what the Liverpool life science ecology broadly consists of and some of the challenges it has faced through its evolution. The following section will apply the heterarchies framework to further the understanding of the dynamics of the ecology and how the ecology is connected into broader production systems.

4.3 Liverpool Life Science Ecology

The five basic features of the heterarchy, outlined by Grabher (2001) will be used as a conceptual tool for investigating the organisation of the life science ecology in Liverpool, its emergence and how the ecology is organised and integrated into wider production networks. The framework provides an evolutionary economic perspective on the life science ecology in Liverpool generating answers to research questions one and two. Grabher (2001) argued that the heterarchy approach is regarded as a more promising conceptual tool in order to analyse region or the firm in relation to adaptability, trust in relationships and spatial proximity.

4.3.1 Diversity

The preceding section outlined the diverse range of activities in the ecology, however, the ownership forms are quite limited. Firms tend to be independent establishments or a subsidiary of another firm located elsewhere. The larger the

firm the more likely it is to be a subsidiary of another company in the Liverpool ecology. Likewise, the smaller the firm the more likely it is to be independent and originate within the ecology. Each activity also has different requirements as a business. The key points have been summarised in Table 17.

Table 17 Summary of ownership types and key characteristics

Type of Firm	Ownership and Start up Forms
Consultancy	<ul style="list-style-type: none"> • small firms employing 1 to 10 people • employees have experience in large pharmaceutical firms • founders of these firms had worked together in previous firms • either been made redundant or left the business to start their own venture • Overheads can be kept low due to flexible working practice. Able to work from home • Work is gained through recommendation not marketing • Used existing contacts to gain work
Diagnostic	<ul style="list-style-type: none"> • mixture of small and medium sized businesses • Employment ranged from 2 to 100 employees • Contains the two longest surviving independent firms (21 and 55 years old) • All other firms less than 10 years old • Older firms used bank loans and organic growth to start up • New firms relying on government grants
Discovery	<ul style="list-style-type: none"> • Founders came from both industry and academia • Relatively young firms dominate this subsector • Funded by venture capital, seed funding and government grants • Only one firm used personal capital • Two firms are active but have no funding to move forward • Two of the 13 firms have been acquired by MNE in last 5 years • Three firms have moved away from the ecology in the last 10 years

Drug Manufacturing	<ul style="list-style-type: none"> • Ecology hosts four multinational firms • Focused on flu vaccine manufacturing or active pharmaceutical ingredient manufacturing • Independent firms are contract manufacturers only with no R&D elsewhere • Manufacturing tends to be seasonal with flexible work forces to meet demand
Medical Devices	<ul style="list-style-type: none"> • Mostly suppliers of basic medical equipment and manufacturing equipment • Only one firm is own by a USA firm and only produces one product in Liverpool to compliment other product lines • Initial start-up funding varied with firms using personal capital and relying on MNE investment
Other	<ul style="list-style-type: none"> • Include OTC suppliers, laboratory services and training facilities • Seen as supporting services • Tend to be subsidiaries of larger national or international firms • Limited engagement with the broader ecology

The common factor amongst the firms was their experience in the sector and how closely it related to their current activity. As for funding, there are a variety of different funding paths being taken by firms depending on their activity. Due to the limited availability of venture capital and private funding in this sector, coupled with the high start-up costs and long product life cycles, many firms have relied on government supported funding through organisations such as the regional development agencies and national bodies such as the Technology Strategy Board (TSB).

The ecology resembles that of a cumulative learning project ecology (Grabher, 2004). The epistemic community is relatively static, with firms being product-centred and retaining competency skills within the firm. The firms are very much based upon know-how and experience. There is less scope for new organisational

forms or mutations given the levels of funding required to start a dedicated life science firm, multiple layers of regulation, complexity in knowledge commercialisation and compliance to national life science environmental regimes. Most firms also have formal structures comprising of the board of executives given the size of the investment required from start-up through to completion of a final product. This adds to the expense and viability of generating new organisational forms. Although there are not many different organisational forms within the ecology, there are institutions that can add to the life science ecology. These have been outlined above as universities and research lead hospitals. Aldrich (1999) argued that the more diversity you have in organisational forms the more scope there is for entrepreneurial activity. As can be seen in Table 17, the discovery firms are the most entrepreneurial firms, showing their origins in both academic institutions as well as private firms. There is some level of diversity in organisational forms but it would seem the process of production dictates a generic organisational form post establishment. This shows resemblance to an epistemic community that is based on cumulative learning where processes and organisational forms are reproduced based on repetition.

The Liverpool ecology does have diversity in relation to the activities of firms, but lacks diversity in organisational forms through different business models and philosophies due to the rigid nature of the life science industry. Grabher (2001) argued that the wider industry trends are apparent in the adaptability of ecologies and the local decision making processes. Given that many firms in the Liverpool ecology cannot deviate from the generic business model in terms of process, they can respond to the changes that are occurring. Again, the industry is largely influenced by the long production cycles that are increasing, resulting in change becoming increasingly reactive and inherently slow. Hence, a high level of product diversity and low level of diversity in organisational forms reduces the genetic pool in which rivalry can take place to drive the creation of new organisational forms.

4.3.2 Rivalry

Weild (2013), PwC (2007) and Deloitte (2014) argue that in the life science industry the global giants are most competent to commercialise new drugs. These firms include Pfizer, GlaxoSmithKline, Roche, Sanofi-Aventis and Novartis to name but a few. For decades they have been the firms producing the big blockbuster drugs for the market and dominate the industry in terms of sales and R&D expenditure. Today this is still true but it is increasingly becoming unsustainable and unreliable. One example is Astrazeneca, who are at the moment struggling to fill their future pipelines with new innovations (BBC News, 2012). Increasingly we can see the life sciences industry is becoming more characterised by “open” innovation where by firms look to other firms for new ideas, utilising various strategies such as mergers, collaborations or alliances to exchange or acquire knowledge (Cooke, 2005 and Moodysson *et al*, 2008). Chesbrough (2003) argues that firms cannot rely solely on their internal research and developmental capabilities in order to produce the levels of innovative knowledge needed to sustain a competitive advantage. The cost ratio could be too high for some firms to maintain. Hence, in a world that has increased communication technologies and rapid knowledge flows, it makes sense for firms to source knowledge from within and beyond the ecology.

Firms in the Liverpool ecology compete within their own organisations or outside the ecology for production rather than within. All drug manufacturers are disconnected from production within the ecology and compete outside the Liverpool ecology for contractual work on the market or within their parent organisation. The size and composition of other firms in the ecology means that pharmaceutical manufacturing is not required as part of their business models, showing a disconnect in the ecology that is best shown through projects. Here projects are unable to provide the trading zones within the ecology. This relates to the broader cumulative learning typology in regards to project ecologies (Grabher, 2004). Production is fragmented or modular in nature, meaning firms tend to operate on their specialism in various parts of the production network. For diagnostic firms and the discovery firms, they maintain connections beyond the

Liverpool ecology in order to transfer and acquire knowledge and production inputs. The majority of these connections stem to locations in the USA and less so to Europe, more specifically Germany and Switzerland. Following arguments above, life science activity is heavily skewed towards to US, especially in regards to high value activity such as R&D.

R&D firms in the ecology are extremely concentrated on their own intellectual property and attempting to commercialise IP. Firms have become so specialised that rivalry suffers as a consequence of this. Firms are unable to create a typical Marshallian industrial district typology where industry buzz and 'gossip' circulate to create a unique environment or as Marshall (1920) states 'something in the air'. Instead the life science ecology has a dampened level of industry gossip or buzz (Bathelt *et al*, 2004). Instead the firms are predominantly dependent on the global pipelines of knowledge and industry know-how that they manage and maintain over time. Firms do not compete against one another based on similar products but do so for funding and grants that may be available. There is some rivalry on shared organisational requirements; the most notable in the ecology is the need to secure finance to support the development of innovations. As one participant says:

'the bottom line is that we set out with the technology these guys started the company with and we're busy trying to exploit that, so there's not a lot of reason to be honest to stretch out to others at the moment, we don't have a need.' (Interview Diagnostic Firm 2, 31/7/12)

The highly specialised nature of the firms in the discovery actives makes it unlikely, given the population of this type of firm in the ecology that a firm will find itself competing for or requiring the same production inputs other than finance. There is too much product diversification, linked with the extremely long commercialisation timelines, added protection over intellectual property for this industry and the lack of localised knowledge specific to each firm for there to be the sorts of rivalry Grabher (2001) outlines for science based ecologies.

This lack of rivalry is exemplified by larger firms in the manufacturing and diagnostic sector that have well-established internal production and distribution channels, given the lack of supporting firms and their length of time in operation. These activities also had little to no research and development on the Liverpool sites. Discovery firms and those diagnostic firms currently undergoing research and development were much more focused on the commercialisation of their current IP and therefore did not want to actively seek any collaboration into new product concepts within the ecology or beyond. Grabher (2001) argued that firms need to be organising, interpreting and evaluating their activities in order to mutate into new organisational forms. What is not explored in Grabher's (2001) conceptualisation is the presence of firms who are not actively doing this. In the Liverpool ecology there are several small firms who by definition are active according to the Government, i.e. they submit tax returns yearly and are considered to be functioning businesses. It was the case that these firms were in fact not furthering the commercialisation of any products. This reduced the number of projects in the ecology and the possibility of increased diversity and rivalry, dampening the cycles of the evolution of new organisational forms or mutations.

Moodysson *et al* (2008) argue that the accessibility or flows of knowledge between firms using open innovation are asymmetrical. Size of firm, power and intellectual property rights have been highlighted as major causes of the asymmetry. Hence, firms with larger R&D expenditures and turnover are able to access innovation more easily and can force smaller firms out of the process. Additionally, smaller firms who don't have the capital to invest in expertise and resources, yet have an idea to develop, can lose out by licensing or under selling ideas. What seemed to be the case in many of the new discovery firms was that they knew they could not commercialise a new product completely. Following the generic industry business model, firms had the goal of getting their products up to phase two of the approval process. This is a widely accept model for smaller firms in life sciences, that when a product reaches phase two approval there is enough evidence to start looking for a potential licensee or buyer for the IP. These tend to be the big pharma companies outlined in the previous section. Firms in Liverpool are conforming to a global trend

towards DFB's that are later acquired by larger industry giants. This shared industry belief and norm has created a stasis in the diversity of firms, with many using a best practice cumulative learning model based on economies of repetition and recombination (Grabher, 2004, Ibert, 2004).

Consultancy firms compete with their reputations but again they tend to carry a certain set of resources relating to knowledge that is only applicable to certain firms. The highly specialised nature of this industry has reduced inter-firm rivalry in the Liverpool ecology. Hence, rivalry is not enriching the genetic pool in the Liverpool ecology through mutations and new organisational forms. Insufficient synergies and rivalry due to high diversity create stagnation in the ecological evolution or growth. There are many other mega-centres (Cooke, 2004) around the world that are attractive for carrying out life science activity, and several firms have left the Liverpool ecology over the last ten years to move to Cambridge in the South East of England. Overall rivalry is dampened in the life science ecology due to the low levels of diversity in organisational forms, combined with industry wide and national regulatory environments constraining but also protecting the work of these firms. Science based ecologies need a different approach in regards to rivalry based within the broader ecology.

4.3.3 Tags

Liverpool is known worldwide for two things: The Beatles and football. It is less well known for its concentration of life science related activities unless you work within the industry. Even then, Liverpool or even the North West comes second to the South East and Cambridge for life sciences. Place does matter for the outside perception of the firm, with several firms highlighting Liverpool as a strategic place for their firms to locate. For them, being in an ecology that had a reputation as a place where life sciences 'happened' was important. This serves a double purpose, firms are being attracted by the fact that life science happens in Liverpool and the firms can also boost their reputations by being registered as active in the Liverpool

ecology, demonstrating geographical proximity with firms that are in the same or similar business (Glückler and Bathelt, 2011).

“so it really doesn’t matter where we are, well for the individuals it doesn’t matter where we are, but for pharmaceuticals looking in to [company], for us to be in the life sciences presence is important.... It’s absolutely about perception” (Interview Consultancy Firm 3 09/05/12)

However, several firms noted that they are struggling to either attract new firms to Liverpool or to attract the individuals with the specialist knowledge to relocate to the city. Given the nature of the firms, some of which require highly specialised knowledge that is embedded in particular individuals located elsewhere, it is important for the firm to try and internalise the knowledge by attracting such individuals to the city. This creates stable teams and reducing cognitive as well as spatial distance to achieve higher levels of action and convenience in production. Additionally, given the high levels of IP protection firms seek and long commercialisation processes, it is not likely they will assemble projects based on short-term relationships. This reflects the high demand placed on individuals working in such project ecologies (Lampel *et al*, 2008). One participant stated:

“I know I tried to bring a vaccine business here, oh 7 or 8 years ago, and the investors said to me quite clearly, I see the rationale, there are vaccine businesses in Liverpool but they’re manufacturing, we don’t think we can run an R & D business of vaccines in Liverpool because we can’t get the staff either to come, or we can’t get the qualities of staff that we can get further South.” (Interview Consultancy Firm 2 10/08/12)

The southeast is seen as being at the forefront of life science research providing multiple opportunities for industry academia relations and ventures, whereas Liverpool has been seen as an up and coming place for life sciences. Another reason behind firm interest in Liverpool as a location is the availability of funding from various levels of government. Local and regional government funding that firms

accepted from the institutions such as the NWDA or city council, came with conditions stating they had to start up or remain in the Liverpool area. For start-up firms the infrastructure in terms of the science parks and incubator support was exceptional and relatively cheap compared to sites in the South East. The business support offered by these sites was greatly appreciated by the small firms.

Liverpool is differentiated from other spatial concentrations of life science activity by having the aesthetic label as the UK's National Bio-Manufacturing Centre. Liverpool hosts the largest concentration of drug manufacturers in Europe. Although the Liverpool ecology has not always been noted as a national centre of life science activity, dwarfed by that of Cambridge, the ecology has more recently gained the label and subsequently been known as a place where life science happens. This carries a shared sense of self-understanding within the ecology. However, tags that carry the most weight in the life sciences tend to be related to larger firms and the number of blockbuster drugs developed in a particular location. This relates mostly to high levels of discovery lead firms in a particular location. The Liverpool ecology has lagged behind in regards to an established R&D base and is only recently, through the growth and success of RedX Pharma, beginning to be recognised for its discovery activities. Molotch (1996:229) argued that 'the positive connection of product image to place yields a kind of monopoly rent that adheres to place, their insignia, and the brand names that may attach to them... Favourable images create entry barriers for products from competing places'. This is an industry that prides itself on innovation, safety and expertise. The tag in this heterarchy is based on firms that have a history in this area. The organisation assets such as LSTM and the universities give the area a reputation for being at the forefront of innovation and research. Reiterating previous statements regarding the highly specialised nature of this industry, firms can be attracted and also boost the clinical areas of expertise that have developed in the ecology over time.

4.3.4 Projects

Typically the commercialisation of a new drug can take up to 15 years to develop, and approve. This is before the drug enters manufacturing and later distributed to be consumed. There are shorter timelines for the development of new diagnostic tools taking approximately two to five years to develop and acquire approval to enter the market. Other medical equipment depending on their application follows the short timelines of diagnostic tools. Each of the products can be seen as a project in itself that requires firms to organise production over a certain period of time and space. Given that each firm is highly specialised and that the production process is highly fragmented, projects rarely bring together inputs solely from the Liverpool ecology. As mentioned earlier, the life science industry follows a cumulative learning type of project ecology. The epistemic community can involve firms from the ecology and beyond. According to Grabher (2004) cumulative learning projects involve core teams that reduce cognitive distance with individuals taking active roles in all parts of the business or maybe switching roles. The teams tend to remain stable in these kinds of projects. This fits with the nature of life science production given the long-time scales and requirement of knowledge specific to a particular product (Moodyson *et al*, 2008; Gertler and Vinodrai, 2009). The industry uses economies of recombination based on products retaining key employees and using knowledge from past experiences. Networks of knowledge flows are based on experience and know how (Grabher, 2004).

Discovery firms in the Liverpool ecology are very much focused on one highly specialised project. This leaves the firms with fewer resources to explore synergies and new innovative paths with other firms in the ecology or beyond. Discovery firms rarely outsource valuable activities due to the nature of the business and the risk of losing their IP. They are generating knowledge with a commercial application not a completed product. Discovery firms make up the first stage of a much wider and fragmented or modular project (Grabher, 2004) but to the firm in Liverpool the discovery is the project that lasts a considerable period of time compared to other industries such as the creative industry. Between the discovery firms and the

manufacturing stage is a complex negotiation between the discovery firm and usually a larger pharmaceutical company with the capital to fund the project through the latter stages of approval that can be very costly. From the Liverpool ecology, one firm has been through this process and sold their firm containing the IP to a large US owned Pharmaceutical firm. The acquiring firm has taken this project and absorbed it into their existing pipeline moving the project over to the US and closing the firm in the UK. The original founder has since take the profit from this sale and started a new project learning from the last. Once a larger pharmaceutical firm has taken on the project and it has passed the approval stages, production shift to manufacturing of the product, then through to distribution and finally consumption.

Within the Liverpool ecology, there are a limited number of projects that provide trading zones for firms. One firm noted collaboration with the University of Liverpool over the use of particular equipment. This does not relate to the trading of business models or philosophies that Grabher (2001) outlined in the heterarchy concept. Rather it is closely related to the joint utilisation techniques used in the bootstrapping business (Jayawarna *et al*, 2011). On the other hand most SME's showed a higher level of connection within the Liverpool ecology but still had predominant connections that went beyond the ecology to other places. The majority of connections within the ecology were primarily related to business support. For example, firms located in the Mersey Bio incubator all had a connection to the consultancy firm operating the incubator. These relationships followed Weick's (1998) typology of improvisation with many of the SME's, mostly discovery firms, showing turbulence, ambiguity and improvisation in the day to day running of the firms.

Firms had to look beyond the Liverpool ecology for both supply and demand aspects of the business. On a supply aspect, firms have had to look beyond Liverpool for specialist knowledge and services in order to complete the production process, add value to their product and deliver a product to market. On the demand side, the potential customer(s) for these products and services tend to be outside of

Liverpool, given the relatively small population of firms compared with other places and the application of the product to humans.

It was clear from the research that most firms are dependent on connections beyond Liverpool regardless of the activity. The nature of these connections did vary in some activities. For example, the pharmaceutical manufacturers were part of a much bigger manufacturing process, completing one of either API mixing or finish and fill process and only in one case, both. Hence, their connections were limited to other sites mainly in Europe or within their company portfolio. There was no interaction with other life science firms in the ecology. The lack of project involving these larger firms reduced the number of trading zones with the ecology. Instead these projects resembled an orchestrated typology involving a lead firm, usually the parent company, directing production across its subsidiaries (Grabher, 2001, 2004).

The majority of firms in the Liverpool ecology had connections to the US. There are two types of connection: firstly, the US is a large consumer market of life science related products. Many firms had connections to distributors and discovery firms to which they provided a service or product. In addition, discovery firms in Liverpool looked to the US firms as potential customers. A small number had made a connection and entered talks with some of the larger US based firms. Secondly, eight firms had head offices or regional hubs located in the US that they reported to. These tended to be the multinational firms but also two firms that had recently been acquired now report to the US. More specifically in the US, Boston, Philadelphia and California were highlighted by several firms.

Other locations that have been frequently mentioned are Germany and Switzerland. Several firms show strong connections relating to research at various stages in the production network as well as a destination for outsourcing complex manufacturing and clinical testing. Only a small number of firms had connections beyond Europe and the US. Those that did commonly mentioned Asia and the Middle East. Connections to China related to scale up processes that formed part of

the wider production network. For consultancy firms, connections to Singapore related to the commercialisation of research and concepts in early start-up firms. Some firms rejected outsourcing to China due to the complexity of their products, IP protection issues and quality assurance purposes. Several firms emphasized the need for quality and reliability in their product to convince customers of its safety.

Levels of communication between firms differed depending on the life cycle of a project. At the start of a project firms stated they preferred face to face contact in order to broker a financial or contractual deal but also saw this as a way of performing due diligence on any firm they are outsourcing to. Trust is important and respondents felt they could establish this much easier with a face to face meetings.

“The most important things in any outsourcing relationship are, there’s got to be a level of trust. Ultimately it’s about delivery, it’s about communication, you know, outsourcing is dead easy when everything’s going well, it’s not easy when it’s not going well, and that’s when you find out the good firms because they’re the one that handle things not going well, properly. And so it’s, you know, the key thing is the relationship, that’s fundamental, if the relationship’s right you’ll pay more money for the service.” (Interview Discovery Firm 1, 10/08/12)

This was also true of any potential customers. Face to face contact allowed the Liverpool based firms to pitch their products or services to perspective customers and negotiate any gaps in knowledge along with any financial transactions. Due to the number of connections beyond the Liverpool ecology into Europe and the US, firms stated it was important to make very good use of the face to face contact in the initial meetings as traveling as far as the US and China for a small firm was not something they could afford to do on a regular basis.

“with the outsourcing, and again you need to be very careful when you’re outsourcing, to get a company that will relate like that, because you get

some of the bigger firms that they're contract manufacturing for so many clients, they just can't afford that personal interaction. So the company in Germany, the interaction was a lot more fixed, regimented, and that's not because they're the stereotypical Germans(!) they really, they couldn't work any other way, they just couldn't open the doors to you popping in whenever you wanted." (Interview Discovery Firm 4, 12/10/12)

Conferences and networking events were also highlighted as key temporary platforms for interacting with other firms. Within the Liverpool ecology there are fewer conferences and networking events since the abolition of the regional development agencies. This was noted by several firms. However, there are two locally organised events run by a consultancy firm and a diagnostic firm. The former is open to any life science related firm in the local or regional area. The latter is more specific to diagnostic and microbiologist related firms and researchers. Both are not exclusive to firms within the ecology but are open and welcoming to any related firm from any place. However, firms from across all the activities placed less emphasis on the local events due to the time and resources needed to attend. The small size of the Liverpool ecology meant that everyone knows everyone and so there is no need to attend. The range of firms in Liverpool is very diverse so the likelihood of creating and capturing value is low. Overall, firms found attending networking events run within the ecology offered limited value to their firms and gain very little compared to the industry events that are targeted and well attended.

A small number of firms did praise events held in Liverpool during the early conception of their business. These events allowed respondents to interact with people who are in the same situations and help with common business problem solving despite being specialised in different activities. The incubator spaces and early morning breakfast meets facilitated this exchange of information. Networking events organised by the regional development agency help business start-ups to meet venture capitalists and business angels. In addition, these events would familiarise people with current grants and government funding bodies. For early

start-up firms this was highly beneficial. However, these meetings rarely facilitate the exchange of scientific information or commercialisation specific information that was of benefit to the Liverpool firms.

In contrast, industry conferences that are sector specific and sometimes clinically specific to a firm have been given more emphasis by Liverpool firms. The majority of the conferences that respondents attended or intend to attend were based in the US. Again this is related to the size of the market and the number of firms in the US that dominate this industry. A small number of firms had been given subsidies to attend these conferences in order to pitch their company but also to pitch Liverpool as a destination the life sciences. This was conditional on receiving any public subsidy. These industry wide conferences allowed firms to meet existing clients and also to generate awareness and new business. Additionally, firms could look for new outsourcing contractors to assist their production and meet existing ones.

Projects have also been seen as the sites in which learning and gaining access take place (Ibert, 2004). The life sciences ecology does not confirm the way Grabher (2001) outlines in relation to projects providing the space for informal education. Projects or trading zones, whether they are conferences or collaborations, can indeed facilitate access to particular resources or individuals like the original conception outlines. The life sciences industry as a whole is driven and demands a formal education in regards to reputations based on the knowledge acquired, demonstrated and recognised through formal institutions such as universities. In regards to projects and life science ecology, the need for stability within an epistemic community is key with many of the core competencies kept within the boundaries of the firm (Amin and Cohendet, 2004). It is only when a product needs to move beyond a particular module that firms can begin to look at assembling teams to complete a particular project. Given the complexity of the projects for discovery firms they would orchestrate, rather than improvise, this process of production (Grabher, 2004).

4.3.5 Reflexivity

The environments firms operate in are not static and require continued interpretation and evaluation (Grabher, 2001). Firms will find themselves navigating through polarised periods of stability and instability. There can be changes that are driven from the wider industry and changes to the local milieu. As previously mentioned, the life science ecology is based on a cumulative learning typology where stability is essential given the long commercialisation processes compared with other industries (Grabher, 2004; PwC, 2014). Due to the resource constraints on the Liverpool ecology predictability is often sort in order to enable firms to get the product to a level of approval that allows for a viable sale or licencing agreement for the IP. For the firms reflexivity is difficult to achieve intentionally, however, effective organisation design and ways of channelling information can provide favourable preconditions for reflexivity (Grabher, 2001:362). Being able to interpret, evaluate and later organise effectively allows the heterarchy to reassemble seeing the organisation of ecology as a brain model of action (Hedlund and Rolander, 1990). In order to fully understand reflexivity here we must look at the division of labour in the ecology.

At a broad level there are two types of labour required in the ecology. Firstly, there are highly skilled jobs that are in driven by discovery firms and any other firm with research and developmental activities. Equally, the academic institutions seek to employ a star academic to further their own research profiles (Zucker and Darby, 1998). Those who are employed in these roles would not migrate easily across the epistemic community (Grabher, 2004), due to the highly specialised nature of their roles. These individuals can give the firms reflexivity in regards to knowledge generation and exploration, seeking out new and novel technologies and innovations. They can aim to speed up projects and deliver the commercialised products to their intended stage in the production network. These jobs are based very much so on know-how and experience (Grabher, 2004; Ibert, 2004).

For discovery firms there tends to be a shortage of labour locally to fill the positions that these firms are looking for. Discovery firms tend to want highly specialised people usually at degree level through to PhD and therefore have to look beyond the local labour market. However, basic lab and technical skills have been met locally or regionally.

“We’ve already tapped out the geography in terms of the available pool of talent in the immediate location. But then that’s always going to happen relatively quickly. But obviously if you go to another geography, there’s another available pool of talent that you can ...” (Interview Discovery firm 1 10/08/12)

“it was a nightmare in terms of recruitment because not many people wanted to come to Liverpool because they want ... they thought, they didn’t either want to ... Because we had quite a few applications from abroad but they didn’t want to move to Liverpool necessarily because they thought if anything happened, because we’re a small company, the job’s not massively secure. So if they, you know, hopefully it never happens, but lost their job with the company, well then they’re not in a good area to get another pharmaceutical job because it’s North West as opposed to down South.” (Interview Discovery firm 2, 23/10/12)

Discovery firm 2 echoes some of the wider concerns of other firms regarding what the Liverpool ecology can offer to potential key employees. The city has its own stigmas attached that have developed over time, but more specific to the ecology, the relative size and perceived vibrancy of life science activity here is a potentially negative factor in an individual’s decision-making processes. In comparison to other European life science centres (Cooke, 2004; Moodyson *et al*, 2008) Liverpool is relatively small and overly specialised in its composition due to the lack of firms or critical mass.

Secondly, there are lower skilled jobs based in the manufacturing and diagnostic⁵ sites of the ecology. There is a higher degree of migration in the epistemic community of lower skill employees. Many of the firms employing a lower skilled workforce react to changes in demand. These firms, unlike the discovery firms, have customers and products to sell. Therefore, having the flexible workforces and being able to assemble and reassemble large teams is essential to meet seasonal demands. Drug manufacturers only run flu vaccine production from January to September, meaning they have internal capabilities to be reflexive and plan for demand. Drug manufacturing placed a great deal of emphasis on the availability of labour and the quality of the labour pool in the Liverpool ecology. Due to the historical and current presence of medium and large manufacturers, labour for this activity has been readily available. Manufacturers tend to employ people who may have worked in more than one of the other manufacturers in the ecology. This allows a cross fertilisation and enrichment in the labour pool. Additionally, any firm making redundancies may find another firm taking those employees.

'I would, I think it depends, I think on the, from an operations perspective, so the operators that are running the manufacturing plant on a day to day basis, I would say that's more of a local/regional pull, you know people sort of, I suppose what you might have termed 'blue collar workers' don't necessarily move as far for a role. So I would imagine we attract more of those employees from the local or near community. For more, what you might call professional roles, then I think it definitely is a national market.'

(Interview Drug manufacture 3, 29/10/12)

Diagnostic and Medical Devices tend to have a mixture of different skills. Manufacturing and warehousing positions tended to be easy to fill locally like in drug manufacturing. There was a preference towards having sales staff with life science backgrounds to help sell the product. These tended to be harder to come by but not so hard that they affected the business. Consultancy firms do not tend to employ large numbers of people and rely on their own expertise and outsourcing.

⁵ Excludes diagnostic firms that are solely engaged in R&D or the R&D functions of diagnostic firms

Those with employees tend to employ a range of people from business and life science backgrounds. Usually head hunted though prior connections and generally outside the Liverpool ecology.

For the Liverpool ecology, one of the notable changes has been in the levels of funding available and where it is available from. Since 2000, firms in this industry have been able to take advantage of regional level funding through North West Development Agencies (NWDA). In addition, Liverpool is in receipt of European Regional Development Funding (ERDF) that in the current period lasts until 2015. The aim of these funds is to increase the economic development of Liverpool and wider North West of England. However, since 2010 the NWDA has been abolished and its funds have shifted to alternative and more centralised grant schemes such as the Technology Strategy Board and Regional Growth Fund (BIS, 2014). Firms in the sector, large and small, have felt the changes that have occurred in funding. It has been the discovery firms that have been affected by this change the most. Discovery firms tend to have no customers and do not sell products on a shelf to create value and continuous income, unlike the other activities in the industry that can rely on their expertise for consulting or manufacturers that produce huge quantities of goods for multiple markets. As mentioned earlier, the rigidity of the ecology leaves firms with little capacity to mutate because what they are trying to achieve seems only to be achievable by following a best practice model (Baden-Fuller, 2010). Monitoring and changing norms and routines in this generic business model or even experimenting with new organisational forms seem to be too unpredictable for firms to practice given the need for stability in the long term (Margretta, 2003; Grabher, 2001, 2004).

The result of this change in funding has left some firms stalled or having to reassess their goals and objectives. Discovery firms in the Liverpool ecology are engaged in intensive research and development and rely on grant application funding or the backing of investors to enable the firm to harvest knowledge that can be commercialised and sold on. It would be at this time that those who invested would see a return on that investment. Given the lack of private investors, most of the

discovery firms are funded by public grants and have relied on these for the first few years of their business start-up. With the public funds being limited, competition for this money has increased, not just for firms in the Liverpool ecology, but from firms elsewhere. So, what this does to the Liverpool ecology is create firms that are active by definition in law, but are inactive in the production of knowledge and IP.

“nobody’s got that sort of development level of funding. You know there’s quite a lot of people now who have got start-up funding to do the experiment, proof of principle, but to turn it from there to something that’s reasonably reliable is what we haven’t got.” (Interview Discovery Firm 5, 15/08/12)

Technical skills and academic knowledge are key inputs for firms in the Liverpool ecology. A recent mutation has emerged in the Liverpool ecology creating a learning organisation supported by firms and educational institutions.

“For the UTC we’ve got four key sponsors, which are ourselves, the University of Liverpool, Mersey Bio, and the Royal Liverpool and Broad Green Hospital Trust. Others stakeholders include Novartis, Pro Labs, Redx Pharma, Unilever, who else am I missing? Siemens are also interested as well, they’re not at the table yet but they are looking to be at the table.” (Interview University Technical College, 29/10/12)

The Liverpool University Technical College (UTC) focuses on the life science sector and aims to create a specialised pool of labour that firms can then choose from. There are two pathways the UTC offers to 14 to 19 year olds. These are vocational and academic education developed alongside industry requirements. There are two immediate benefits to both industry and students. First, firms can give their input to the curriculum, transferring industry level skill requirements into the young people through the classroom. This intends to provide work ready labour for the firms in the Liverpool ecology and reduce the amount of training provided by the

firms. Second, students will get the opportunity to work inside within the firms in Liverpool. This reinforces the skills that firms can transfer to students making them work ready or giving them the necessary practical skills to compliment further and higher education.

“they are about addressing skill gaps, so life sciences... needing highly skilled site technicians. So lots of the entrepreneurs see this as a way that they don’t necessarily have to employ PhD graduates in science technician’s roles. So that certainly will fulfil a skills gap there. The hospital think it is, it will be ... I don’t know if successful is the right word to say, but they are very excited on two, for two reasons, 1) they see it as a way to employ future people for themselves, but also for the bio campus that will be located quite near to the hospital. So I think for both of, for the life sciences there is you know an identifiable skills gap, there are a growing number of jobs and vacancies that need to be supported.” (Interview University Technical College, 29/10/12)

Within the Liverpool ecology, learning is not limited to the UTC, colleges and universities. The firms themselves are continuously learning and pushing knowledge forward in their sector. However, given that small businesses make up two thirds of the population and most of these businesses were formed by individuals with little or no business background, many took up the business master classes and mentoring schemes offered by the NWDA and Liverpool Vision at various science parks and incubators. Both are development agencies that offered business support with Liverpool Vision still doing so for anyone who needs it.

“one of the very key things for us was the support that we got from Paul in terms of his coaching, his management style, his ability to be able to give us little pockets of cash to pay for things like you know a lawyer to write us you know a service level agreement with a particular company we were setting up, and various little bits, a few hundred thousands, not hundreds of thousands, few hundreds here, couple of thousands there, and it amounted to not a great deal of cash, but when you’re starting up from scratch it made

all the difference along with his expertise.” (Interview Discovery Firm 4, 12/10/12)

In addition to these publically funded organisations, the consultancy firms also offered advice and guidance regarding business support but could go further and offer industry specific advice.

The heterarchical structure of the life science ecology in Liverpool is very complex and fragmented. The Liverpool ecology has several activities that have limited interaction with one another through production or informal contact. The only exception was one consultancy firm that operates the Mersey Bio business incubator where several discovery firms are located. These firms had been assisted with business advice in the early conception of their firms. The heterarchy also has firms that are by definition in law active but have no customers or products in production. They appear as entities filled with IP and no mechanism to commercialise it. The following section will look at how firms fit into wider production systems and how value is created and captured. Firms in the ecology have relied on know-how and experience of the consultancy firms in order to process information and have a reflexive ability that they otherwise could not have achieved intentionally.

4.4 Conclusion

This chapter as sought to answer research questions one and two. By giving an overview of the global life science industry it allows us to understanding the specificities that condition the industry at a local level. What emerged from the data was a concentration of revenue, power and influence in the USA and Europe. However, a common denominator affecting the industry at multiple scales is regulation. Regulation is both enabling and constraining to the industry. There are specific grants and IP protections that enable greater productivity and innovation. Yet due to the nature of the products being produced there is increasing regulation regarding the safety and pricing of the end products. The industry tends to be rigid

in structure due to the high up front capital requirements and long times lines in product development and commercialisation. These wider industry trends and mechanism translate through the Liverpool ecology, both enabling and constraining the evolutionary trajectory of the firms.

The life science ecology in Liverpool has undergone some significant changes. Predominantly a manufacturing centre for pharmaceuticals firms, the ecology has grown to include a wide range of activities but has a low diversity of organisational forms. There has been an increase over the last ten years of discovery lead firms taking advantage of life science related assets and supporting services. However, given the diversity and highly specialised activities of the heterarchy there are few connections between the firms and their projects. Rivalry is low due to several key factors that are unique to this industry such as long commercialisation cycles and privileged IP protection for new products. This has reduced the number of trading zones where firms can showcase their business models and where organisational philosophies can be examined and evaluated then later changed if needed. The majority of firms rely on external connections in order to complete their production process and also as an end market for the product. The main reasons holding firms and attracting them to be in the Liverpool ecology is funding criteria, pinning the firm to this location without choice and the recent recognition of Liverpool as a place where life sciences is 'happening'.

The need for stability and predictability, again driven by the long commercialisation processes and rigid regulatory environments dampens the ability of diversity and rivalry together to spawn a new organisation firm to fuel the fire for an enriched genetic pool in the ecology. As a result, the lack of cooperation on a cognitive and organisational level through tags and projects respectively, means that there are less shared norms and values as well as trading zones to again keep rivalry and diversity from being polarised in periods of rigid order to excessive disorder (Grabher, 2001). What seems to be apparent here is that the ecology is in a period of rigid order limiting the ability to change or even adapt quickly.

The life science industry is unique in that it has many protections, regulations and an excessively long commercialisation processes lasting up to 15 years. Instead of the projects and tags keeping an organisational and cognitive check in place on the levels of rivalry and diversity, it is the wider industry environment that appears to keep the ecology in check along with ecology specific mechanism relating to the funding availability. Together they have created a unique concentration of firms driven less so by ecological process outlined by Grabher (2001,2004) but more by institutional incentives and support.

Chapter Five

Video Game Ecology in Liverpool

5.0 Introduction

The video games industry is widely referred to as a creative industry and is a relatively modern activity in capitalist economies (Johns, 2006; Balland *et al*, 2013). Creative industries typically have project based production systems involving many actors, characterised by cycles of fads and the demand for novelty and innovation (Caves, 2000; Grahber, 2001; Storper and Venables, 2004; Stark, 2009). The video game industry can be traced back to 1961 with the creation of the first interactive computer game, Spacewar by MIT student Steve Russell (Johns, 2006). De Vaan *et al* (2013) observed, that since the 1970's, there has been a noticeable increase in the number of individuals and firms involved in the creation of video game products. This has been coupled with the advances in technology; both in the hardware and software elements of the industry. In the UK alone, the industry contributes around £1 billion to gross domestic product (Tiga, 2014), rivalling that of other creative industries such as film and television (Cadin and Guerin, 2006). Given that the economic significance of this industry in the UK and its predicted global worth of up to \$83 billion by 2016 (Develop, 2014), the phenomena of how the UK and more specifically Liverpool has contributed to this growth, deserves attention.

The interactivity required from the user and the cyclical nature of the consoles, differentiate the video games industry from other creative industries such as advertising or film and television (Cadin and Guerin, 2006; Johns, 2006). The focus of this research has been on firms that develop video game software. This is because no video game hardware manufacturing activity existing within the Liverpool ecology. Nowadays, the video games hardware and software production is a multi-billion dollar industry. In 2012 global revenues from the video games

industry were estimated at \$63 billion (Marchand and Hennig-Thurau, 2013). This included both hardware and software but also games produced for mobile devices and tablet computers. In the UK alone, video games sales exceed the combined sales of books and music for the same year (Gaudiosi, 2012). The enormity of consumption and industry growth at the global scale, doubling revenue over seven years to \$64 billion in 2012, has drawn academics to investigate the industry with numerous publications over the last five years, (see Cadin and Guerin, 2006; Readman and Grantham, 2006; Tschang and Szczypula, 2006; Johns, 2006; exception Balland *et al*, 2013; De Vaan *et al*, 2013) but still, this industry, given its economic significance, remains under analysed. Most studies have come from psychology, sociology and marketing, focusing on the impacts of video games on young children's behaviour. In geographical literature, issues surround virtual spaces; "Games of Empire" and representation of other cultures have been focused upon (Dyer-Witthford and De Peuter, 2009; Gordon, 2008).

This chapter will address the following research questions regarding the video games industry in Liverpool:

1. How have the industry ecologies of the life science and video game industries in Liverpool emerged?
2. How are the ecologies organised and connected beyond Liverpool?

To fully answer the research questions the chapter will cover several points. Firstly, the global video games industry will be mapped out including the size, structure and key change in production, major actors and their influence on the industry. Secondly, the chapter will look at the emergence of a video games ecology in Liverpool, charting the evolution of firms from 1980 to 2012. Thirdly, the organisation of the ecology will be explored using the heterarchy approach outlined in Chapter Two (Grabher, 2001). Finally, the chapter will conclude by summarising the answers to the research questions.

5.1 Global Video Game Industry

The aim of this section is to outline the structure and size of the global video games industry using secondary data. From the data, this section will then outline some of the major trends in the industry and by the end of this section will begin to show links into the Liverpool ecology. Since 1992 Liverpool has hosted three of the largest multinational firms in the industry. The top ten firms have been defined in this research as those with the greatest sales revenue in their industry. Sales revenue data has been chosen as the unit of measurement in this industry for several reasons. Firstly, revenue is the amount of money a firm receives in exchange for goods and services. This captures the majority of the firm's activities before adjustments are made in accordance with various tax regimes. Secondly, revenue is a universal measurement in all firms and excludes the firm's liabilities. Thirdly, revenue figures are publically available in publically listed firms and have been used to measure an industries' worth by many accounting specialists and academics. Within the annual reports themselves, firms use the revenue figure in various ways in order to show geographical variations of business segment. For the purposes of this research, this makes revenue an ideal and accessible unit to measure the global industry. Those firms with combined revenues from non-video game related sources have had those revenues omitted. For example, Namco Bandai owns a chain of health clubs. Revenue from this activity has been removed from their total revenue year on year.

There are two key elements to the video games industry. First, there is the video game, written as a piece of software and traditionally loaded into the hardware directly or onto portable medium such as a disc or cartridge. Second, there is the hardware on which the game is played, usually connected to a television or accessed through a hand-held device. There are also games that can be played on PCs or on the Internet via a PC and more recently, via mobile devices. However, as other studies have demonstrated, the majority of video games are played on dedicated hardware devices (De Vaan *et al*, 2013; Johns, 2006; Poole, 2000). According to Marchand and Hennig-Thurau (2013) 61% of games sold globally were

for use on consoles in 2012. Most notably the biggest increase in games sold since 2008 have been on mobile devices that account for 20% in 2012.

Cadin and Guerin (2006) argue that the video game industry has four major actors. Firstly, there are development studios that create the games, or the software. Secondly, publishers who finance and promote games tailored to specific consoles. Johns (2006) argued that these firms have significant power and influence in the industry, given their control and influence over finance and the distribution channels. Thirdly, console manufacturers that develop the platforms for games to be played on. Fourthly, the distributors who make the games and consoles available to the end user; these can be retailers and online suppliers. Both hardware and software are interconnected and reliant upon each other (Johns, 2006; Kent, 2001; Readman and Grantham, 2006; Marchand and Hennig-Thurau, 2013). Therefore the video games market has two indirectly linked sides. Rysman (2009) argued that in two sided markets both stakeholders benefit and are influenced by the other. Advances in hardware are met with increasing demands for software. The more software that is then available increases the desirability of the hardware. For other creative industries such as music, new hardware has primarily served to cut production costs (Leyshon, 2001), it has not been seen as a driver of demand like in video games production. Table 18 shows that in 2012 the ten major players controlled 77% of the video games market, with the three major console makers dominating 44% of the total market alone.

Table 18 Top ten firms in video game industry 2012

2012	Firm	Origin	Total Revenue (\$Bn)	Market Share %
1	Sony	Japan	9.79	16
2	Microsoft	USA	9.59	15
3	Nintendo	Japan	7.89	13
4	Namco Bandai	Japan	5.52	9
5	Activision Blizzard	USA	4.85	8
6	Electronic Arts	USA	4.14	7
7	Konami	Japan	2.23	3
8	Square Enix	Japan	1.56	2
9	Ubisoft	France	1.42	2
10	Zynga	USA	1.28	2
		Total	48.29	77
		Industry Total	63.00	100

It has been demonstrated in earlier publications by Aoyama and Izushi (2003), Johns (2006) and Cadin and Guerin (2006) that the video games industry is cyclical. This cyclical nature has been driven by the demand for novelty and innovation in hardware and software. The success of new hardware devices, as mentioned above, is dependent on the availability and quality of games around the launch. Cadin and Guerin (2006) argue that the three major console manufacturers (Sony, Microsoft and Nintendo) define everything in regards to who is authorised to publish software for sale on their platforms. This explains why they dominate the market as shown in Table 18. Hence, over time, third party publishers have had to develop and maintain strong links to console manufacturers, but developers have also strived to develop and maintain strong contacts to the publishers. This has been the standard industry business model for some time.

Video games firms are specialised in one of three core activities, console manufacture, software development or publishing. It is not unusual for larger firms to conduct more than one of the three core activities. In the video games industry the three major console makers, Sony, Microsoft and Nintendo, have occupied the top three spots for at least the last ten years. Their success is driven by their sales in consoles, control over publishing on their consoles and the ability to develop games (Aoyama and Izushi 2003; Cadin and Guerin, 2006; Johns, 2006). The remainder of the top ten are third party developers and publishers, who have strong links to the console makers, well-established franchises and the means to create new content for the consoles. The Liverpool ecology hosted two multinational video games firms, Sony (1993) and Activision Blizzard⁶ (2007) up until 2012. As of 2012 the top ten global video game firms can be seen in Table 18. As mentioned above, the top three positions are held by console manufactures Sony, Microsoft and Nintendo. Combined, the top three firms contributed 44% to the industry total for 2012. This reinforces their position in the market, given that they conduct all three core activities.

Johns (2006) has highlighted the unequal power relations between the console manufactures, publishers and developers, arguing that the console manufactures yield considerable power and influence as they are keen to have successful titles for their consoles, either developed in-house or by third party publishers. Developers come from a weaker negotiating position in regards to getting their games published onto one of the major consoles. It has also been recognised, that it is the software elements of the video game industry that generates the most revenue. However, it is impossible, using secondary data sources such as annual reports, to distinguish between software and hardware sales accurately in those firms conducting more than one of the core activities. Looking at the industry since 2005, as shown in Figure 7, the influence of the top ten firms on the industry total is quite clear with the exception of 2009 and 2010. Driving the growth in revenue until 2009 was the release of the 7th generation consoles.

⁶ Know as Activision at the time of Acquisition in 20072

Yearly Industry Total vs Top 10 Total

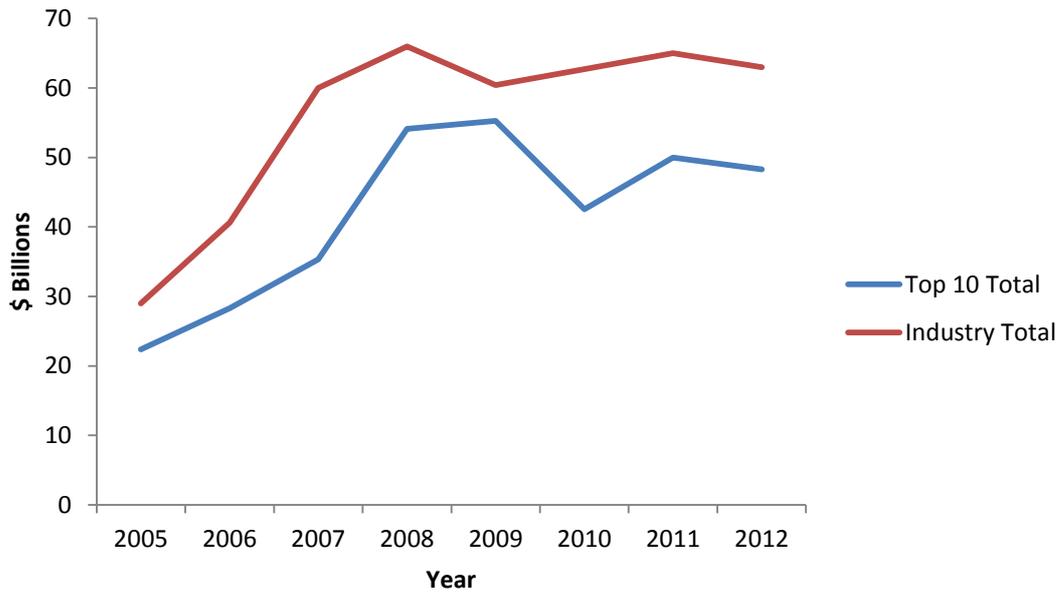
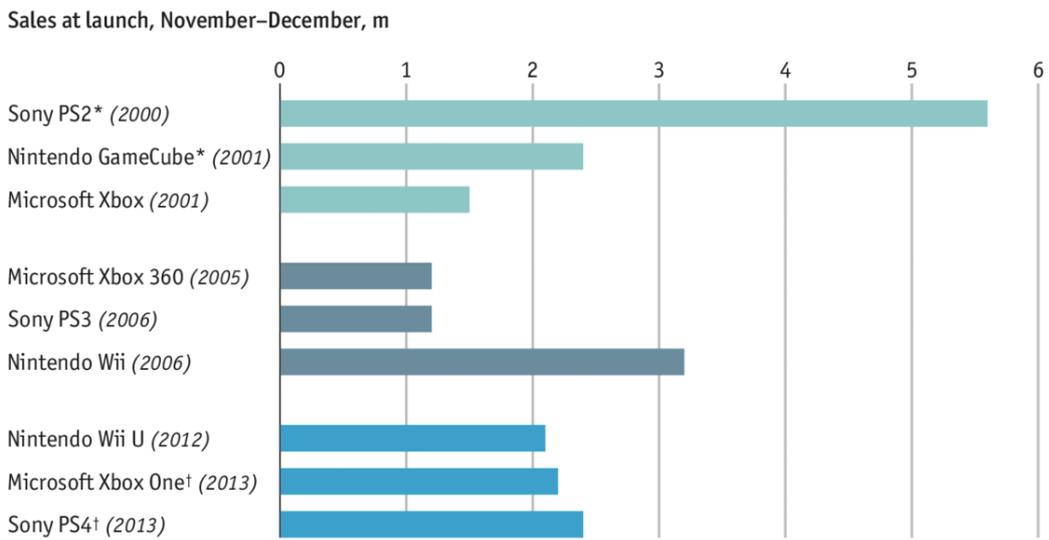
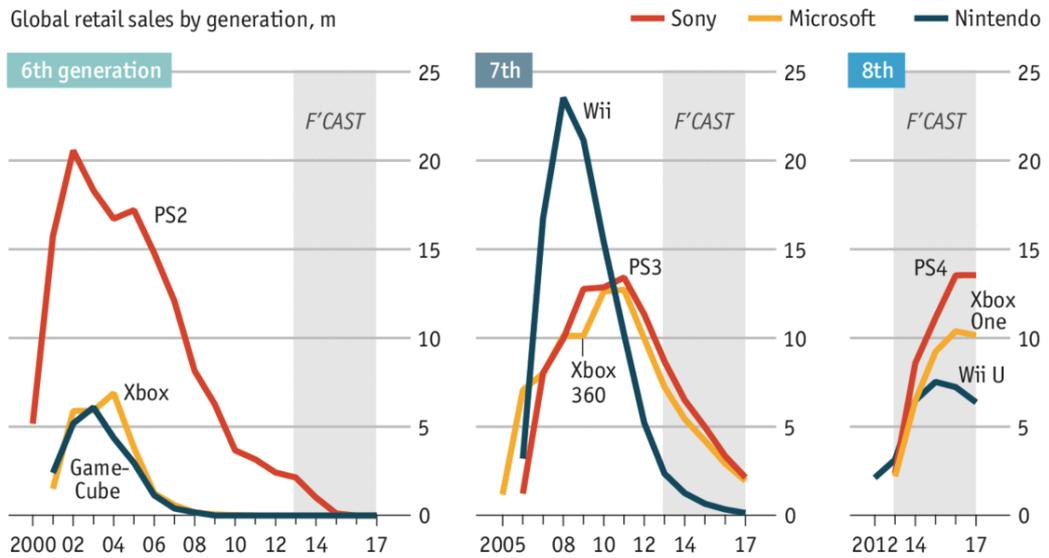


Figure 7 Top ten combined total revenue 2005 - 2012

Figure 8 shows the unit sales of the three major consoles. It is clear that the Nintendo Wii saw a clear surge in the unit sales of its console in 2008 and 2009. One of the major features driving the sales was the wireless remote and the ability to detect motion and rotation, allowing gamers to become more immersed with the console.



Source: IHS

*Japanese release dates: PS2 in March, GameCube in September †Forecast

Economist.com/graphicdetail

Figure 8 Console sales (Source: Economist.com/consolecombat, Figure 1)

Nintendo's influence on the market during 2008 and 2009 was highly significant. In 2008 Nintendo's revenue grew by 48% from the year before to \$16.72 billion with further growth of 11% in 2009 raising revenue to \$18.76 billion, the firm's highest ever yearly sales. The significance alone of Nintendo's console sales during this period, outstripping both Microsoft and Sony by almost two to one, has influenced the top ten-combined revenue. Although consoles sales and software sales cannot be separated for illustrative purposes, here Figure 9 removes Nintendo from the top

ten plotting it on its own. When Nintendo is removed, the remaining nine firms follow more closely the industry total fluctuations.

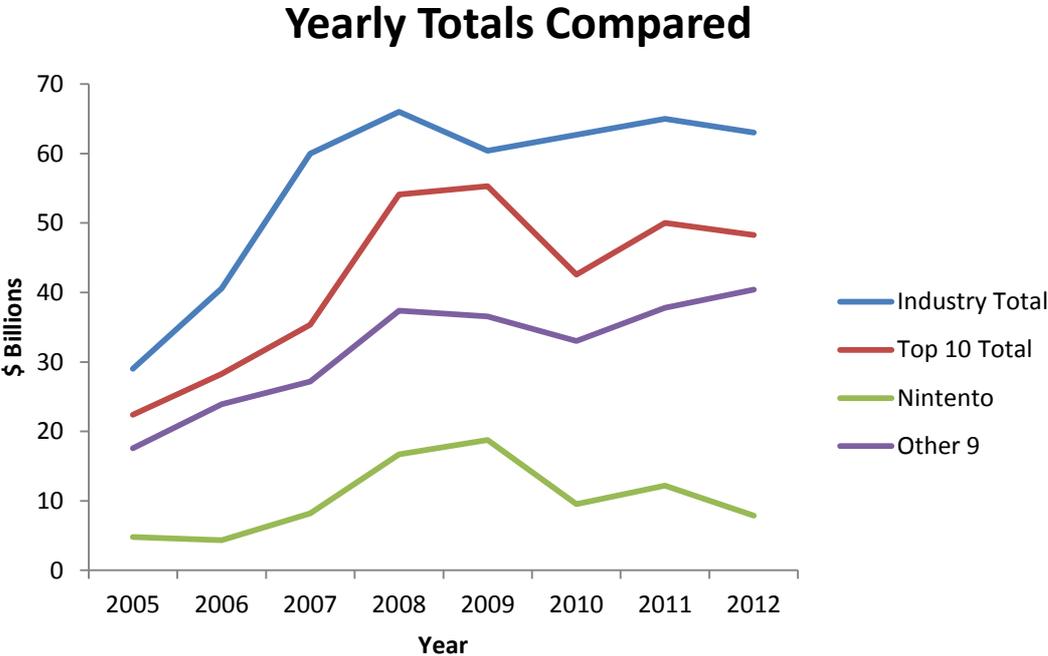


Figure 9 Combined revenue compared

In 2010, seven of the top ten firms reported substantial negative growth in revenues, with the top three reporting some of the biggest falls in revenue (see Table 19). There have been two causes attributed to the rapid decline in revenues in this particular year. Firstly, the global economy was recovering from a deep recession. As consumer’s disposable incomes reduced, expenditure on video games in the largest markets (US and Japan) fell. Secondly, referring back to Figure 8, console sales had stagnated or entered into decline affecting the revenues streams for the three major consoles manufacturers; Nintendo seeing the highest negative growth of -49% as Wii sales declined sharply.

Table 19 Top Ten firms 2010

2010	Firm	Origin	Total Revenue (\$millions)	Vs. 2009 (% Change)
1	Nintendo	Japan	9,537.59	-49
2	Sony	Japan	9,036.01	-10
3	Mircosoft	USA	6,079.00	-22
4	Activision Blizzard	USA	4,447.00	2
5	Namco Bandai	Japan	4,068.65	-5
6	Electronic Arts	USA	3,654.00	-13
7	Square Enix	Japan	2,066.39	-31
8	Konami	Japan	1,894.88	35
9	Ubisoft	France	1,177.58	-15
10	Zynga	USA	597.46	392
Total			42,558.56	-23
Industry Total			62,700.00	4

The three companies that saw an increase this year in revenues have owed that success to the launch of new games. For Konami, their increase in revenues has been attributed to the success and award winning game Metal Gear Solid Peace Walker and various soccer games (Konami annual report, 2011; IGN, 2010). Zynga has also seen substantial growth in revenues following the close relationship it has with Facebook and an increase in casual mobile gaming (Techcrunch, 2010). Zynga has been a formidable force recently in the mobile gaming market, using a strategy of acquisition and merger in order to gain market share and value. Having established the size, structure and significant financial trends of the global video game industry, the following section will look at the geography of the video games industry.

5.1.1 Geography of Video Games

Creative industries tend to locate in close geographical proximity, as firms tend to be dependent on a number of autonomous agents who provide highly specialised inputs and services (Caves, 2003). Video games production and consumption requires investment in order to foster advancement in technology. Hence, video game production and consumption is highly associated with advanced western

economies. Three key regions, the USA, Japan and Europe dominate video game production and consumption. Figure 10 shows the breakdown of the 2012 top ten firm’s revenues by country of origin. There are five Japanese firms in the top ten rankings by revenue and Japan has been the forerunner in video game development, hosting several other global video game publishers, developers and console manufactures (The Verge, 2014). The Japanese consumer market is smaller compared to the North American and European, but the number of companies and global influence on production is significant. However, since 2010 there has been a declining influence and revenue for Japanese firms on the wider video games industry (The Verge, 2014). The decline has been attributed to a number of blockbuster titles coming from the US and Europe designed for the 7th generation consoles (Xbox 360 and Playstation 3).

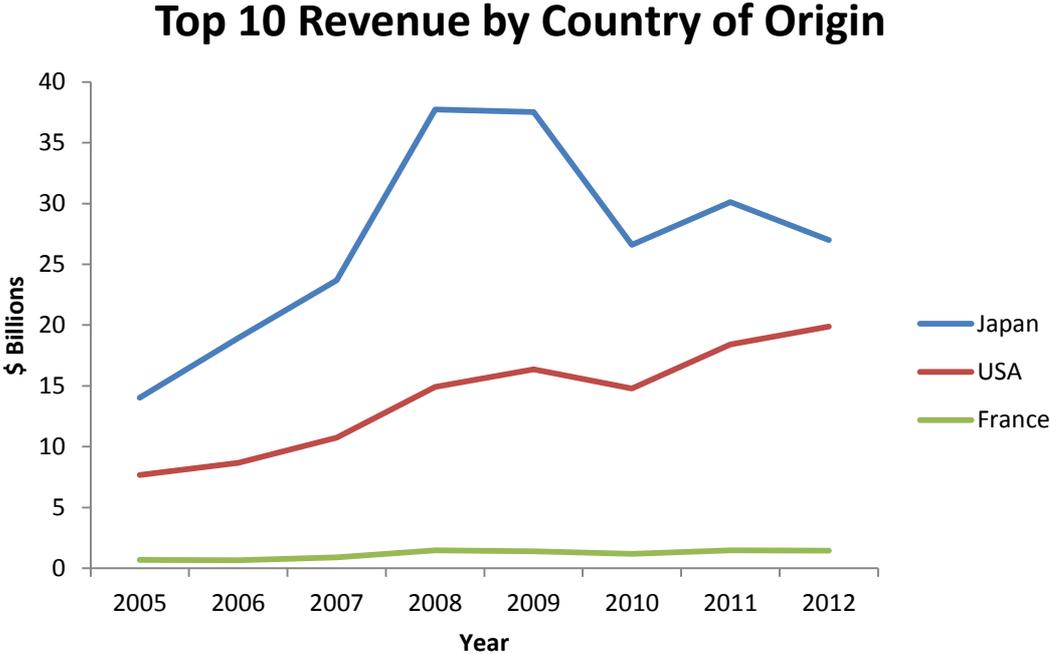


Figure 10 Top ten firms revenue by country of origin

Reinforcing the arguments above, Table 20 presents the percentage of revenue from outside the domestic market for the top ten firms. This has been calculated using the revenue data and geographical variations. The data gives us an idea of how concentrated a firm is on its domestic market and how firms in different parts of the world rely on sales beyond their domestic market. It’s clear that Ubisoft have

the highest percentage of foreign sales at 91% of the total sales. This can be attributed to the small size of the French market compared to the US or Japan. Ubisoft is the only European firm to rank in the top 10. All three of the major console manufacturers have high percentages of foreign sales, reflecting the dominance of their platforms globally and the fact that all of the major publishers and developers are designing software for these platforms. Software on the other hand can be highly culturally orientated based on consumer tastes which can be linked generally but not always to national identity and culture. Using sales data on the top selling video games in Japan, they have been predominantly fantasy based, with mythical creatures such as dragons (TechnoBuffalo, 2013). Whereas in the US, the top selling games have been warfare based (CVG, 2014). Hence, why in some cases, some firms show low levels of foreign sales as they are concentrating on their domestic market. Both Namco Bandai and Square Enix had reported losses in European markets recently but increasing revenues from the domestic market; offsetting some of the losses.

Table 20 Foreign sales of top ten firms

Sales Rank 2012	Transnationality		Firm	Origin	Foreign Revenue 2012 (\$m)	% Revenue Foreign	Vs. 2011 (% change)	Total Revenue (\$millions)
	Rank 2012	Rank 2011						
9	1	1	Ubisoft	France	1288.73	91	-2	1,416.19
2	2	2	Mircosoft	USA	8045.00	84	-7	9,593.00
3	3	3	Nintendo	Japan	6090.00	77	-6	7,898.20
1	4	4	Sony	Japan	6660.17	68	-2	9,794.37
7	5	5	Konami	Japan	1393.11	62	-2	2,228.98
6	6	7	Electronic Arts	USA	2152.00	52	3	4,143.00
5	7	6	Activision Blizzard	USA	2420.00	50	0	4,856.00
10	8	8	Zynga	USA	524.04	41	5	1,281.27
8	9	10	Square Enix	Japan	319.00	20	4	1,556.10
4	10	9	Namco Bandai	Japan	922.90	17	-4	5,526.35
Total					29814.95	56	-1	48,293.46

De Vaan *et al* (2013) have argued that there are ten key video game regions globally, based on the number of firms operating on one of the three core activities. Their data has been illustrated on Figure 11 showing the growth in the number of firms in these regions over time. In line with what has been observed more recently, Japan, the US and France have occupied the top ten regions. In addition, the UK has also maintained a significant proportion of video games firms and is Europe's largest market, but does not boast a UK based studio ranking in the top ten.

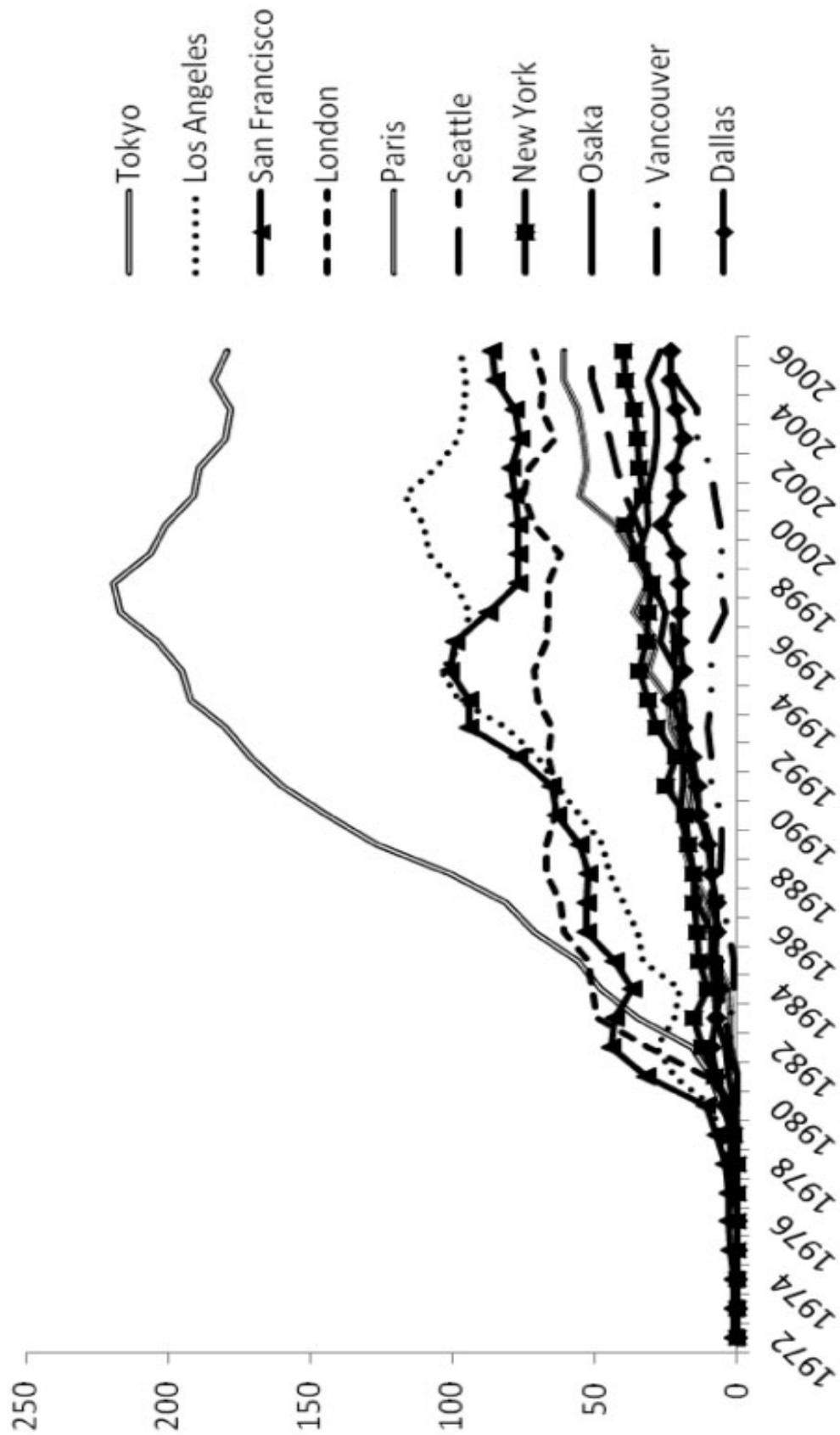


Figure 11 Annual numbers of firms in the top ten regions globally (Source: De Vaan *et al*, 2013: 978 figure 5)

Within the UK, there are several regions with high profile video game developers and publishers present. This is supported by the recent successes at the BAFTA Games Awards 2014, where several UK based developers were recognised including Rockstar Games, the creators of Grand Theft Auto V. The high profile award winning game was developed in Edinburgh in collaboration with studios in London and New York. Information from other recent UK developed games shows other regions such as Warwickshire, the southeast, and Liverpool are home to large studios such as Codemasters, BigBig Studios, Evolution Studios, Sony Computer Entertainment (SCE) and Activision. The BBC reported;

'By the end of the year [2012] there were 118 more studios and 336 more creative staff than there had been in 2011. Studios also invested £427m in games' (BBC, 2013)

The growth in the number of studios has been the result of larger studio closures in areas like Liverpool, Leeds and Dundee. Overall employment in the video games sector has increased in the UK video game sector as the quote above illustrates. Although there are no official government statistics to accurately track employment for video games, industry specialists have reported an increase in the number of studios and employment in the UK (Games Investor Consulting, 2013). This has been attributed to three key triggers. Firstly, the closure of larger multinational studio subsidiaries by SCE, Activision and THQ in selected parts of the UK which has led to an increase in smaller firms being established. Liverpool is a prime example of this and is the focus of this research later on in the chapter. Secondly, there has been a huge surge in mobile and tablet devices being used as gaming platforms. Hence, the new studios are able to transfer their skills into development for these platforms at lower costs to triple A gaming consoles⁷. Thirdly, the UK Government has announced a tax relief for video game firms in the 2012 budget that has already

⁷ Triple A games denotes games that have the highest development budgets and levels of promotion. These are usually played on one of the three major console.

stimulated growth in the sector (BBC News, 2013, TIGA, 2014). The BBC News (2013) state that 'British productions with a budget of £20m or less can apply for a 25% rebate on any expenses which are deemed eligible for tax relief'.

There is still a lack of comprehensive academic investigation into the UK gaming market, more specifically, where concentrations of firms exist and in what form and why they have emerged in that location. Hence, it is the purpose of this research to begin that contribution of filling in the gaps to understanding the agglomerations of the UK video game industry, by presenting later in this chapter the case for Liverpool's video game ecology. The next section will outline the key changes in the industry that have affected the way in which video games are produced and distributed. As the number of firms increases in core regions and the positionality of the major firms shows no signs of deteriorating, it makes the case of Liverpool's video game ecology more interesting.

5.1.2 Changes in the Nature of Production

Following Baden-Fuller and Morgan (2010), most industries have a generic business model or way of doing things. Figure 12 shows the production network for both hardware and software development in the video game industry. Typically, firms produce the video game software and hardware following this process. As previously stated, the chapter will only be focusing on the software development, seen in the lower part of Figure 12. This is due to the Liverpool ecology containing no hardware production. The process will be explained in greater detail later in the chapter in relation to the Liverpool Ecology.

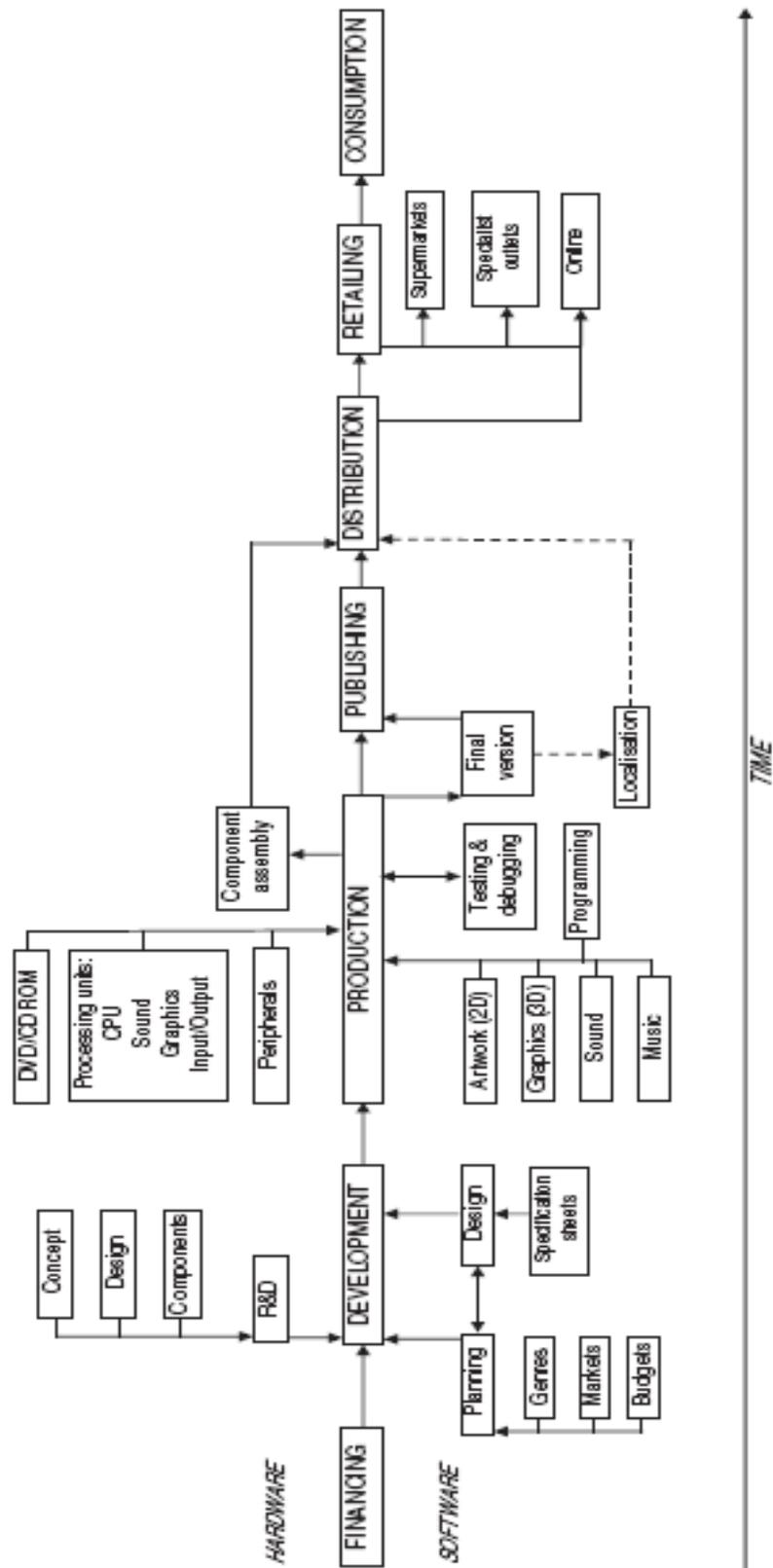


Figure 12 Seven stages and inputs of the video games production network (Source: Johns, 2006, Figure 2)

Since 2011, there has been a significant change in video game production in the Liverpool ecology. This is related to four factors influencing the change that come both inside and outside the ecology. First, new software and hardware platforms such as the Apple iOS and Android operating systems have emerged, opening up a less restricted and wider platform, giving access to a new market that has seen a huge expansion in the last five years (Forbes, 2014). Figure 13 shows the unit sales of the iPhone and iPad compared to the three 7th generation consoles. In 2011 iPad unit sales had almost caught up to the combined total of console units sold, with iPhone sales outstripping both significantly. Steinbock (2007) argued that since the early 2000's there has been a huge convergence between mobile telephone capabilities and internet accessibility through one device. More recently, we have seen the smart phone converge and become a gaming device as well as providing our access to the Internet, voice and text services. The mobile device platforms have lower barriers to entry in terms of cost, regulation and time. Application development has become highly attractive to firms in the Liverpool ecology, as many of the skills gained from working in the gaming industry are transferable to developing applications. As previously mentioned, there has been a surge in firms consisting of one to five person teams developing software applications for smart phone devices (Games Investor Consulting, 2013; TIGA, 2014). Firms are flexible and take advantage of a project-based way of organising (Grabher, 2001, 2004), by using other creative firms to provide inputs that the firm does not have internally (Caves, 2000).

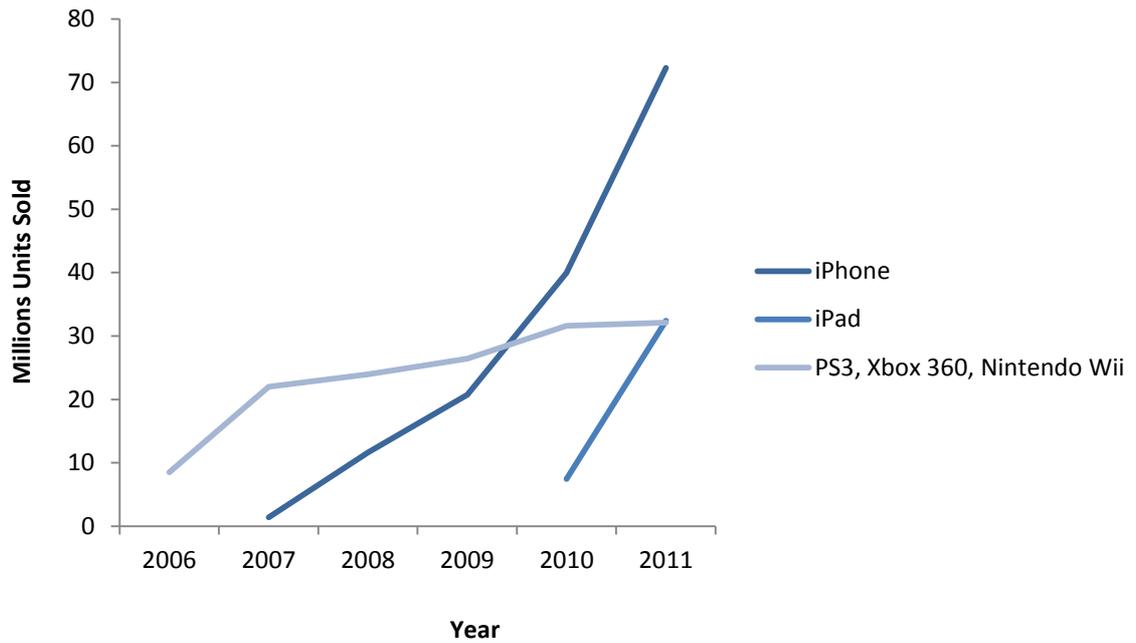


Figure 13 Unit sales 2006 – 2011 (Data Source: Apple Annual Report, Microsoft Entertainment Annual Report, Sony Computer Entertainment Annual Report and Nintendo Annual Report, 2006-2011)

Second, online publishing is reducing the dependence on the large publishers and retailers for the marketing and distribution of new games. For new mobile devices such as the smart phones, online publishing is the only way to distribute applications. This is done via app stores specific to the device. However, for triple A games the major console producers have begun to use online distribution to release extra content for games. Nintendo have used online publishing to re-release older games made for earlier generation consoles onto its latest generation console. It has not been as easy a transition for the big publishers crossing over to online publishing. They have faced huge pressure from retailers refusing to stock their games, if they are available online (DeCarlo, 2011). The gaming industry at the moment is using a mix of physical products and online virtual content. However, for games played on consoles there is still a relatively small amount of online content released compared with the traditional boxed product, at a ratio of two to one (ESA, 2012).

In addition to online publishing, there is one significant difference between publishing on a console and publishing on a mobile phone device. In regards to games developed for consoles, the console manufacturers and publishers retain strict control over publishing rights on their platforms. Most developers have to be certified, having met a number of criteria and maintain strong links to publishers (Cadin and Guerin, 2006; Johns, 2006). Developers who design software for mobile devices can release onto the app stores with relatively few regulations and just a small upfront cost. There are of course regulations regarding the content of the application and copyright. Instead, the developer pays the app store to release the software. As one experienced mobile developer states;

“It’s a lower barrier to entry for iPhone, Apple development licence from Apple is like £100, whereas if you go for something like Sony and the console stuff, it’s £20,000 around about. So right there you front load yourself with a lot of risk if you don’t, if you’re doing console development, whereas £100 that’s not, that’s a very low risk barrier to entry really.” (Interview Developer 10, 13/11/12)

Third, the larger publishers are increasingly becoming risk averse focusing on existing franchises rather than commissioning new titles. Although budgets have claimed to remain the same, the number of new titles and intellectual property has reduced (ESA, 2012). Instead publishers are building franchises using existing intellectual property.

“The budgets that are going into Triple A are remaining the same, which actually means there’s fewer Triple A titles, because the budgets aren’t increasing, they’re staying the same, so unfortunately we get FIFAs 12, 13 and 14, Modern Warfares 4, 5 and 6, and the publishers are less reluctant to take risks on new IPs and new franchises. If you’re spending 25 million on a

game, you want to make sure you can actually get a return on your investment, and if you're doing FIFA 13 you've got a better chance on that than Hokey Pokey Racing that no one's ever heard of. But there are still some publishers, Sony are good, Sony still take risks on new IPs, Little Big Planet, Heavy Rain and that type of thing.” (Interview Former SCE Manager, 16/07/12)

This has contributed to the rise in development for mobile devices in the Liverpool ecology, as developers struggle to get publishing deals or secure funding for triple A games development. Additionally, external investors still see video game production as a high risk investment, despite the potential high returns. Therefore, there has been a change in the way in which consumers access video games. This in turn is changing the way in which video game developers can organise. Hence a noticeable but small change that has occurred relates to how the publishers take risk. The traditional business model relied on the software developing firm to create and maintain close connections to publishers. However, it has been the case in Liverpool that publishers have approached a software-developing firm that has a successful portfolio. The developer said:

“Actually big companies have contacted us more than the other way round, so we've had a lot of, quite a lot of dialogue actually. We, the success that we've had with [game], and the success that we've had in terms of getting the [company] name out there has been, we've done I think a pretty good job of that, based on the fact that we've had a lot of interest. So it's not just us thinking that, I think just from the feedback that we've had, we've done a good job on that side. So a lot of the big players in the industry, publishing wise, have contacted us, not necessarily in the console space but in the mobile, the big players in the mobile space have contacted us ... it's just an on-going relationship with a few of them, with the view to future products being something that we can talk about because we have an established relationship.” (Interview Developer 10, 13/11/12)

This model reduces the risk for the big publishers, but also incentivises firms to do well and generate new opportunity. This is a point that will be raised later, when the chapter moves to analysing the Liverpool ecology under the reflexivity aspect of the heterarchy.

Fourth, there is an increasing need to understand the consumer game play in order to inform future developments across all platforms related to gaming (Games Investor Consulting, 2014). Many developers in Liverpool stated that creating a new game for new platforms is relatively straight forward, given their experiences working on larger budget games in multinational studios. However, increasingly, mobile developer firms are self-publishing and are subjected to new business models such as the freemium model. They need to further understand how they can translate those who download apps for free into paying customers.

“in order to improve engagement, retention, ultimately monetisation, because a lot of these games are free to play, people play free to play games, and so only a small amount of your player base will actually pay, it’s only about 2 or 3% of the total audience will be the ones who will engage in a transaction. And so it’s very important to understand exactly what the players that are paying, well what all players are doing in the game, but particularly the ones that are paying, what is it, what is the context in which they’re doing these transactions and what are the drivers?” (Interview Developer 7, 07/12/11)

The same applies for all games. Firms need to increasingly engage with the consumer in order to understand how to create and capture greater value. Part of the solution has been through the development of particular software dedicated to this function that is built into a game. Traditional methods of engaging with the

consumer have involved market research through multiple feedback mechanisms. More recently, with the increase in smart phone connectivity to the Internet, firms are embedding social media links into their games as a further mechanism to gauge consumer responses as well as setting up dedicated Twitter or Facebook accounts for each game so that consumers can 'Like', share game play experiences and post comments for feedback.

The changes that are presented here are the more significant movements in the game industry. Not only have they affected the global video games industry but they have also affected firms in the Liverpool ecology. This section has begun to connect the global phenomena in the industry to that of the Liverpool ecology, with developers showing the learning and reflexivity needed in such a cyclical, innovative and novelty lead industry. The following section will go further, by looking at selected merger and acquisition activities, again, highlighting how the Liverpool ecology fits into the wider industry.

5.2.3 Global Merger and Acquisition Activity

Innovation in both technology and in business models continues in the video game industry, as illustrated in the previous section. Another change in the industry can be observed through merger and acquisition (M&A) activity. In the last 20 years, there has been a noticeable trend of publishers acquiring small and independent developers. Johns (2006) argued from 1993 to 2004 that we could observe a period of industry consolidation and a move toward vertical integration, with the major players seeking to increase their power and size, not just in national markets but also in foreign markets. Upon further reading into annual reports, that justify the acquisitions in the whole period shown from 1993 to 2012, it also became apparent that firms are seeking to increase value by strategically acquiring firms, in order to internalise existing franchises and expertise. This is most noticeable in recent acquisitions by Zynga, who within a 12-month period (May 2010/11) acquired 14

firms to increase the company size, revenue and value by internalising successful game franchises. The data in Table 21, again, reinforces the argument that major publishers who dominate 77% of the market are acquiring some of the other 23% of smaller development studios. In addition, the acquiring company tends to be from one of the three major regions. As well as Zynga, Ubisoft has been one of the most active firms, acquiring developers around the world including Brazil and India.

Table 21 Selected merger and acquisitions 1993 - 2012

Year	Acquired	Location	Activity	Acquirer	Location	Activity	Stake
2012	Gaikai	US	D	SCE	Japan	PD	100%
2012	OMGPOP	US	D	Zynga	US	PD	100%
2012	Buzz Monkey PopCap Games	US	D	Zynga Electronic	US	PD	100%
2011	Inc.	US	D	Arts	US	PD	100%
2011	Owlient	France	D	Ubisoft	France	PD	100%
2011	RedLynx Sucker Punch Productions	Finland	D	Ubisoft	France	PD	100%
2011	Newtoy	US	D	SCE	Japan	PD	100%
2011	DNA Games Floodgate	US	D	Zynga	US	PD	100%
2011	Entertainment Quazal	US	D	Zynga	US	PD	100%
2010	technologies Media	Canada	Online	Ubisoft	France	PD	100%
2010	Molecule	UK	D	SCEE Electronic	Japan	HW, PD	100%
2010	Playfish Ltd	UK	D	Arts	US	PD	100%
2010	Bonfire Studios	US	D	Zynga	US	PD	100%
2010	Unoh Serious	Japan	MD	Zynga	US	PD	100%
2010	Business Challenge	US	D	Zynga	US	PD	100%
2010	Games	US	D	Zynga	US	PD	100%
2010	Dextrose	Germany	D	Zynga	US	PD	100%
2009	South Logic Hybrid	Brazil	D	Ubisoft	France	PD	100%
2009	Technologies	Canada	D	Ubisoft	France	PD	100%
2009	Nadéo studio	France	D	Ubisoft	France	PD	100%
2009	Action Pants	Canada	D	Ubisoft	France	PD	100%
2008	Pune Massive	India	D	Ubisoft	France	PD	100%
2008	entertainment	Sweden	D	Ubisoft	France	PD	100%
2008	Danger Inc.	US	D	Microsoft	US	PD	100%
2008	Blizzard	US	PD	Activision ⁸	US	PD	100%

⁸ Activision and Blizzard bought by Vivendi in 2008 creating new gaming division Activision Blizzard

				Vivendi			
2008	Activision	US	PD	Games	US	PD	52%
2007	Digital Kids	Japan	D	Ubisoft	France	PD	100%
2007	Sunflowers	Germany	PD	Ubisoft	France	PD	100%
2007	Cellius	Japan	D	SCE	Japan	HW, PD	49%
	Evolution						
2007	Studios	UK	D	SCEE	Japan	HW, PD	100%
2007	Bigbig Studios	UK	D	SCEE	Japan	HW, PD	100%
	Sigil Games						
2007	Online Inc	US	D	SCE	Japan	HW, PD	100%
	Bizarre						
2007	Creations	UK	D	Activision	US	PD	100%
2007	DemonWare	Ireland	HW	Activision	US	PD	100%
				Electronic			
2007	BioWare	Canada	D	Arts	US	PD	100%
	Pandemic			Electronic			
2007	Studios	US	D	Arts	US	PD	100%
	Reflections						
2006	Interactive	UK	D	Ubisoft	France	PD	100%
	Banpresto Co			Namco			
2006	Ltd	Japan	D	Bandai	Japan	PD	100%
	Secret Liar			Vivendi			
2006	Studios	US	D	Games	US	PD	100%
				Vivendi			
2006	Ch'in	China	D	Games	US	PD	100%
	Zipper						
2006	Interactive	US	D	SCE	Japan	HW, PD	100%
	Massive						
2006	Corporation	US	D, Ad	Microsoft	US	PD	100%
2006	Lionhead	UK	D	Microsoft	US	PD	100%
	Mythic			Electronic			
2006	Entertainment	US	D	Arts	US	PD	100%
	JAMDAT			Electronic			
2006	Mobile	US	MD	Arts	US	PD	100%
2006	RedOctane Inc.	US	PD	Activision	US	PD	100%
2006	Juice Games	UK	D	THQ ⁹	US	PD	100%
2005	Bandai	Japan	PD	Namco	Japan	PD	Merger
	Guerrilla	Netherland					
2005	Games	s	D	SCEE	Japan	HW, PD	100%
				Electronic			
2005	RenderWare	UK	HW	Arts	US	PD	100%
				Electronic			
2005	Ubisoft	France	PD	Arts	US	PD	20%
				Electronic			
2005	Digital Illusion	Sweden	D	Arts	US	PD	68%
	Vicarious						
2005	Visions Inc	US	D	Activision	US	PD	100%
2005	Toys For Bob	US	D	Activision	US	PD	100%
2005	Beenox	Canada	D	Activision	US	PD	100%
2004	Tiwak	France	D	Ubisoft	France	PD	100%
	Criterion			Electronic			
2004	Software Ltd	UK	D	Arts	US	PD	100%
2004	Gameloft SA	US	D	Ubisoft	France	PD	27%

⁹ THQ closed Juice games in 2011 as part of a company consolidation

	TDK			Take 2			
2003	Mediactive Great Plains	US	PD	Interactive	US	PD	100%
2003	Software Inc.	US	D	Microsoft	US	PD	100%
2003	Placeware Inc	US	D	Microsoft	US	PD	100%
2002	Rare	UK	PD	Microsoft	US	HW, PD	100%
2002	Luxoflux Corp.	US	D	Activision	US	PD	100%
2002	Gray Matter	US	D	Activision	US	PD	100%
2002	Shaba Games	US	D	Activision	US	PD	100%
2002	Z-Axis	US	D	Activision	US	PD	100%
2002	Eden Studios	France	D	Infogrames	France	PD	100%
2002	Shiny Ent.	US	D	Infogrames ¹⁰ Vivendi	France	PD	100%
2002	Massive Ent.	Sweden	D	Universal	France	PD	100%
2001	Square Enix Treyarch	Japan	D	SCE	Japan	HW, PD	19%
2001	Invention Dreamworks	US	PD	Activision	US	PD	100%
2000	interactive Hasbro	US	D	Electronic Arts	US	PD	100%
2000	Interactive	US	PD	Infogrames	France	PD	100%
2000	Paradigm Ent. Bungie	US	D	Infogrames	France	PD	100%
2000	Software Verant	US	D	Microsoft	France	HW, PD	100%
2000	Interactive	US	D	Sony Corp.	Japan	HW, PD	100%
2000	Volition	US	D	THQ	US	PD	100%
2000	Sinister Games Grolier	US	D	Ubisoft	France	PD	100%
2000	interactive	UK	D	Ubisoft	France	PD	100%
2000	Red Storm Ent. Elisnore	US	PD	Ubisoft	France	PD	100%
1999	Multimedia Expert	US	D	Activision	US	PD	100%
1999	Software	US	PD	Activision	US	PD	100%
1999	Neversoft Ent.	US	D	Activision	US	PD	100%
1999	Accolade Gremlin	US	PD	Infogrames	France	PD	100%
1999	Interactive	UK	PD	Infogrames	France	PD	100%
1999	GT Interactive	US	PD	Infogrames	France	PD	100%
1999	Ozisoft	AU	DR	Infogrames	France	PD	62.50%
1999	Beam Software	AU	D	Infogrames	France	PD	100%
1999	Talonsoft CD contact	US	D	Take 2 Interactive	US	PD	100%
1998	Data	Belgium	DR	Activision	US	PD	100%
1998	Head Game Crystal	US	PD	Activision	US	PD	100%
1998	Dynamics	US	D	Eidos	UK	PD	100%
1998	Rare	UK	PD	Nintendo	Japan	HW, PD	25%
1998	Reflections	UK	D	GT	US	PD	100%

¹⁰ Infogrames Inc renamed Atari Inc in 2003

				Interactive			
1998	Westwood studios ¹¹	US	D	Electronic Arts	US	PD	100%
1998	Virgin Studio	US	D	Electronic Arts	US	PD	100%
1998	Atari corp.	US	PD	Hasbro	US	PD	100%
1998	Microprose	US	D	Hasbro	US	PD	100%
1997	DMA	UK	D	Gremlin	UK	PD	100%
1997	Mainstream Interactive	AU	PD	Gremlin	UK	PD	100%
1997	Spidersoft	UK	D	Take 2 Interactive	US	PD	100%
1997	Digital			Titus			
1997	Interaction	UK	D	Interactive	France	PD	100%
1997	Millenium	UK	D	SCEE	UK (JP)	PD	100%
1997	Maxis	US	D	Electronic Arts	US	PD	100%
1997	Centresoft	UK	DR	Activision	US	PD	100%
1997	NGB						
1997	Distribution	Germany	D	Activision	US	PD	100%
1997	Raven						
1997	Software	US	D	Activision	US	PD	100%
1996	Core Design	UK	PD	Eidos	UK	PD	100%
1996	Ocean						
1996	Software	UK	PD	Infogrames	France	PD	100%
1996	Probe	UK	PD	Acclaim	US	PD	100%
1996	Iguana	UK	PD	Acclaim	US	PD	100%
1996	Atari Games	US	PD	Midway			
1996	Games			Games	US	PD	100%
1995	Rare	UK	PD	Nintendo	Japan	HW, PD	25%
1995	Bullfrog	UK	PD	Electronic Arts	US	PD	100%
1995	Domark	UK	PD	Eidos	UK	PD	100%
1993	Psygnosis	UK	PD	Sony Corp.	Japan	HW, PD	100%

Key: HW = Hardware, D = Developers, P = Publisher, MD = Mobile Developer
 (Source: Johns, 2006:167, table 4 and original research)

The case has been made time and time again that small and large businesses play a vital role in economic development and growth (Edmiston, 2007; Curran and Blackburn 1994; Jayawarna *et al*, 2011). Over the last decade, Liverpool has been host to many multinational firms, ranking in the top ten of the video games industry. Fox and Murray (2004) have argued that the net employment impact of large-firms in several cases is actually close to zero. Edmiston (2004) has also supported this view in empirical research highlighting that large firms, although attracting an average of 1000 jobs to a location in the US, have driven away 715

¹¹ Westwood Studios closed in March 2003 – all willing staff absorbed into EA's LA Studio

other jobs that otherwise would have been established. In Liverpool, there have been four acquisitions of independent developers over the last 20 years. These are shown in Table 22. Since these acquisitions three of the studios have been closed in 2011/12. Only Evolution studio still exists and is connected to the Liverpool ecology. As mentioned previously, major changes in the industry regarding the closure of multinational studios in the UK, has had a significant effect on the emergence of new studios and an increase in employment.

Table 22 Video game acquisitions in Liverpool

Firm	Acquisition (\$ millions)	Acquiring Firm	Date	Source	Jobs
Psygnosis	Unknown	Sony	1993	Japan	100
Bizarre Creations	67.4	Activision	2007	USA	200
Juice Games	3.75 ¹	THQ	2006	USA	60
Evolution Studios	Unknown	SCEE	2007	Japan	47

¹ Figure is approximate, based on 2006 annual report data regarding two acquisitions at \$7.5 million. No specific data available on the exact amount.

For the video games ecology, the large firms have played a vital role in developing a reputation (also see Tags in the heterarchy) for the Liverpool ecology and also attracting large projects (Grandadam *et al*, 2010) such as the ‘porting’ of existing games onto the new hardware device, the PS vita, in 2011 through SCE Liverpool. Over time, the large firms have also attracted and rotated a large and talented work force into the ecology, allowing employees to work across international operations. Their acquisition of already strong independent studios reinforced the stability and peer regard of the firms and the ecology (Pratt, 2006). Major acquisitions in the Liverpool ecology came from the MNE ranking in the top 20 global firms SCE, Activision and THQ. Since 2011 all three MNE have closed these operations, with the exception of Evolution Studio, due to a wider reorganisation of activities for SCE and Activision and the disappointing sales at THQ UK. All studios acquired the intellectual property of the acquired firms and have continued the franchises in other development studios around the world. The following section will look at the

emergence and evolution of the Liverpool video games ecology, before looking at the organisation of the ecology using the heterarchy approach.

5.2 Emergence and Evolution of Liverpool's Video Game Ecology

The first research question examines how the current firms in the Liverpool ecology have emerged. This section will look at the evolution of the video game ecology from its conception, before looking at the current ecological structure. The video games industry in Liverpool can be traced back to 1980 with the establishment of a small firm called Bug Byte; an independent games developer for the first generation of games consoles (Atari Systems). Bug Byte was a success with its 2D game Manic Miner in 1983. At the time, this game was a huge success in the UK market and is nowadays considered by some enthusiasts as one of the top 20 British video games of all time (Hartley, 2013). The company had successfully developed other games but went into liquidation in 1985 following a new generation of consoles, a tough trading period and an industry 'shake out' (Kean, 1985). Bug Bytes intellectual property and franchises were bought by another British firm Argus Press PLC, located in London.

However, Bug Byte started an evolutionary process in the Liverpool video games ecology, providing a platform for two spin-off companies, Imagine Software and Software Project. Imagine Software was an ambitious company spending more than was the industry norm on packaging and advertising. Imagine Software only operated from 1982 to 1984 and was acquired by Ocean in 1984, a Manchester based firm. Software Projects did survive longer than Imagine Software, but the company ceased trading in 1988 after completing several games for the first and second generation consoles. The company had no liquidity issues but it was the decision of the owner at the time to close the studio. Ocean Software was later acquired by Infogrames in 1996, a French company with headquarters in Paris and New York. Infogrames renamed Ocean Software to Infogrames UK but closed its Manchester based office in 2005. In line with the data in Table 21 and 22, Liverpool has not been

immune to the power and influence of the larger studios through M&A activity. This reinforces the argument that video game publishers at the time were trying to internalise successful studios for their intellectual property, franchises and in some cases for the talent held in those studios.

Three significant companies, from which many of the current firms emerged, came out of this series of acquisitions. Firstly, in 1984 Psygnosis came out of the closure of Imagine Software, a British developer known for high budget marketing and product packaging that ultimately led to the company's demise under high levels of debt. In 1993 Sony Computer Entertainment (SCE), a hardware manufacturer, publisher and developer, acquired Psygnosis. This was the first major video game software and hardware related firm to enter the Liverpool video games ecology. Digital Image Design was acquired by Rage Games in 1996. After this acquisition Evolution Studios was formed in 1999 between a former Digital Image Design employee and a former Psygnosis employee. Evolution has also become a SCE owned studio. The evolutionary pathway leading to this acquisition is shown in figure nine. Secondly, after the collapse of Rage Games in 2003, due to financial issues, Juice Games was established by former Rage Games employees. Juice Games was acquired by THQ in 2006, the second large multinational publisher/developer to enter the Liverpool video game ecology, shown in Figure 14. Thirdly, in 1988 Raising Hell Software was formed as a new studio in Liverpool. The studio was later renamed Bizarre Creations and worked closely with Psygnosis, before it was acquired by SCE. However, Bizarre grew to be Liverpool's second largest video games studio but was acquired in 2007 by another multinational publisher and developer Activision. By 2007 the Liverpool video games ecology had three major multinational video games firms located within it, two American and one Japanese. Figure 14 charts the evolutionary pathway of the games industry until the current day. From the changes in the video games ecology stemming from the 1990's, it reinforces the argument above, that firms were seeking to integrate more of the production network into their firms. As Marchand and Hennig-Thurau, (2013) argue, it is the video game software that makes the most money for firms, not the

hardware. This was widely becoming the accepted business model for large publishers and console manufacturers, to protect and provide new innovative software content.

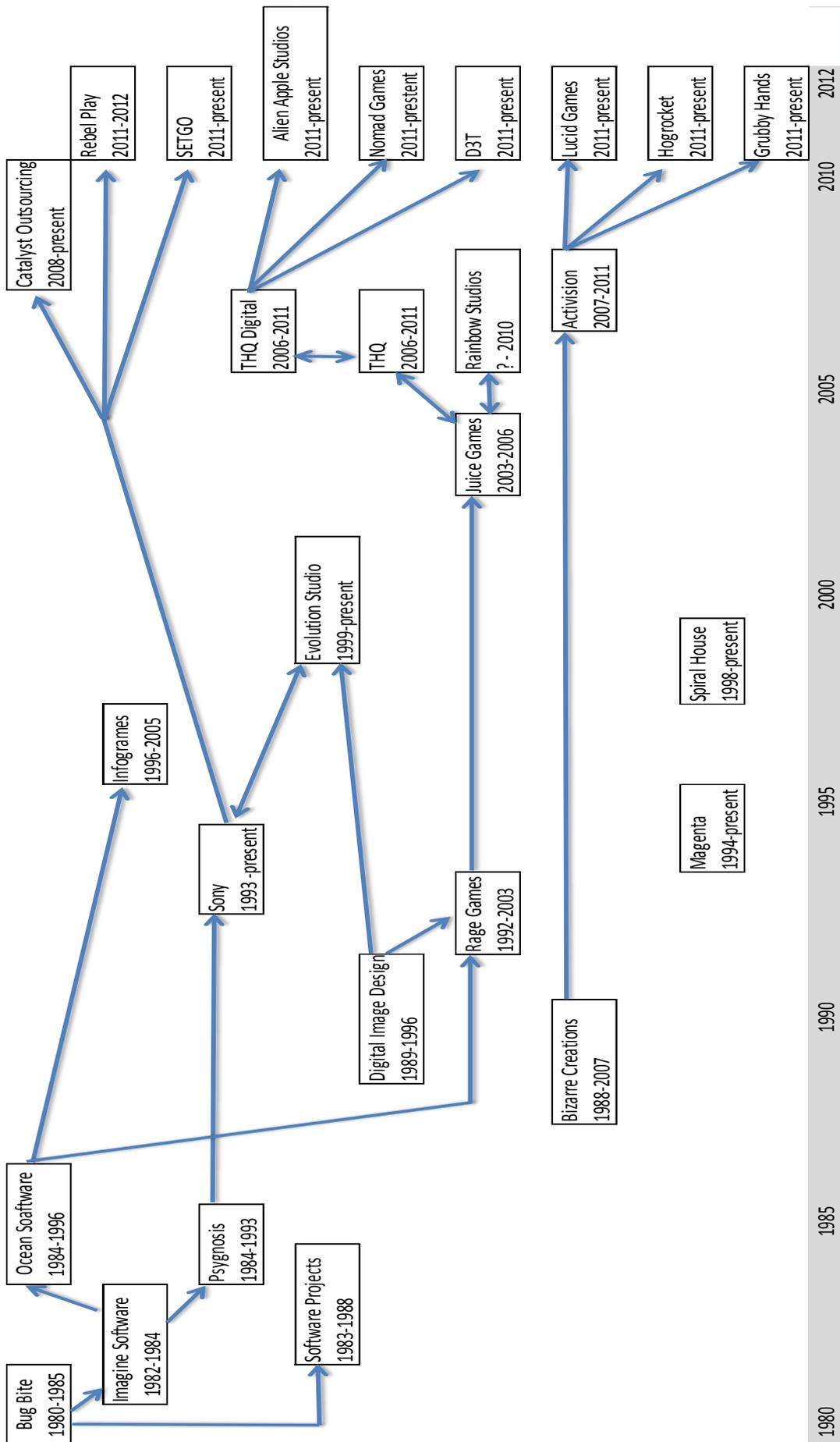


Figure 14 Evolution of Liverpool Games Industry 1982 till 2012

Following Edmiston (2007) in the Liverpool ecology, new firm start-ups have been the result of former employees leaving larger firms because either their innovations were hampered in their existing enterprise or because the entrepreneurs wanted to ensure the rewards for themselves (p90). The closure of the three large studios in the ecology also sparked an increase in entrepreneurial activity, with former employees taking the opportunity of pursuing their own ideas (see Table 23).

Table 23 Firm closures in the Liverpool ecology

Company	Year of Acquisition	Year of Closure	Reason	Result
SCE	1993 (Psygnosis)	2012	Reorganisation of international operations	Five known spin outs located in the Liverpool ecology. A number of freelancers are still available in the Liverpool ecology
Activision	2007 (Bizarre Creations)	2011	No buyer found after the parent company decided to offload the struggling studio ¹	Three know spin outs located in the Liverpool ecology
THQ	2006 (Juice Games)	2011	Firm reorganisation and consolidation due to financial issues	Three spin out firms locating in Manchester

Sources: Annual reports

¹Eurogamer (2011)

It was observed that several new entrepreneurs have started up firms as a means of survival self-employment, with the hope that they will secure contractual work (Fraser 2004, Edmiston, 2007). Hence, entrepreneurs have been spotting opportunities through the structural holes in the ecology and wider video game ecosystem and have been seeking to exploit them before the major closures and thereafter (Burt, 2001). Bathelt (2004) observed similar reactions to firm closures in the Leipzig media cluster, whereby redundancy is in fact an opportunity for those individuals to become business owners in the Liverpool ecology. These individuals had embedded themselves socially into the Liverpool ecology by starting families and owning homes here. In the empirical data, respondent's cited their family and

long term commitments to the area as the main reason for staying in Liverpool and becoming a part of the video game ecology. As mentioned later in the diversity section, there are other reasons that have helped the firms here in the Liverpool ecology, such as the labour market and availability of people to develop new novel innovations.

“So we basically formed [company] immediately after Bizarre Creations was closed, so February this year, yeah, so Bizarre was closed on the 18th February and pretty much the Monday after, so the 21st, we were up and running, kind of! Without any contracts or being able to pay staff, a group of us just decided like you know we’ll start a new company, we’re not going to get paid, so we’ll do it, we’ll give ourselves like three months of not getting paid to kind of see how things go basically, and try and win a contract”
(Interview Developer 8, 30/11/11)

Many of the new firms that have emerged in the ecology stated they used their own funds from redundancy or personal savings to establish themselves. Many of the smalls firms have had to rely on contractual work from larger studios to provide a cash flow in order to keep the business active and support the development of their own games. The quote above eludes to the challenges a new firm in the video game ecology faces, with individuals coming together without any projects to provide cash flow, only their ideas for future games. As another developer adds below:

“what we’ve been doing is when there’s outsource work to do, we’ll do that, and when there’s not we’ll work on our games.” (Interview Developer 3, 16/07/12)

A minority of firms had received investment from a mixture of public and private funds. Only one of the newly established firms (post 2010) had received private investment from a local source. Most of the private funding that was sought by newly established firms came from London based investors, with one firm drawing investment from Australia. Another firm had received a small amount of public funding from the Technology Strategy Board (a national funding body) in order to develop new software for character building. Initially the founders concern is to provide an income to support themselves and their personal liabilities. However, the majority of firms in the ecology concluded that they did not need to seek large investments in order to establish their firms.

“it’s self-funded [the firm]. But if you keep the costs down, which I am doing, you don’t need a lot of money to set up, you just need to be able to pay your bills and not worry, I think that’s probably the mistake a lot of people make, they think right I’ll set up, and we don’t need to earn anything for a bit, but you actually still need to pay your bills if you’ve got them, everyone’s got at least some bills.” (Interview Developer 3, 16/07/12)

There are firms in the Liverpool ecology that have not received any additional help and have solely maintained a business model funded by redundancy packages, savings and contractual work. However, there are some firms that have found themselves stuck in a cycle of not being able to focus on their core business strategy of developing a new video game. Instead, following on from developer three above, firms have to take on contracting work in order to plug short-term cash flow issues and try to reinvest whatever is left into their own ideas and development. This problem arises from the imbalance of initial capital, time and human resources. Developers have to take on contracting work in order to provide a living for themselves; the opportunity cost is time on their own developments.

“you can say well OK, let’s make a game, and we’ll make a game that competes with anything on the iPhone or what have you, but you know you need to pay other people to do that, and if you haven’t got the money to do that, you can’t really go anywhere, which is why so many companies get stuck doing work for hire, like we are, we’re doing this porting work, which will be seen as work for hire. You kind of get stuck in a trap because you need to keep earning money to pay the bills or what have you. But it takes you away from actually doing what you really set out to do” (Interview Developer 6, 01/02/12)

Contracting work was usually spoken about in two to six month terms, providing only short-term stability. Here firms are not able to follow the traditional business model of financing a development and focusing on that core project through to completion.

“No it’s rolling, they’re kind of two month jobs at the moment. I’ve got a 30 day job that’s just come in, and the other ones are about two months. So it might, if I was doing the artwork it might take me two months to finish it, before I get to the end of it, maybe two weeks before, I’d be asking for the next bit of work.” (Interview Developer, 5, 07/12/11)

The independent small and medium firms have instead found themselves performing two core roles within the ecology. Firstly, that of an independent video games developer, establishing new projects and making ideas a reality following a traditional business model. Secondly, an actor that becomes a part of a much bigger project, performing the task of an outsourcing agent, providing inputs for other projects lead by other firms. Although most of the firms strive to develop their own video games, they are turning to outsourcing and contractual work offered by the large firms to provide revenue for the firm to reinvest in development. As the

traditional business model dictates, the power and control over finance is yielded by larger publishers and hardware manufactures. Hence is it up to the developers in the Liverpool ecology to develop and maintain strong ties to publishers and hardware manufacturers, in order to survive and evolve their firms and projects.

5.3 Liverpool Video Game Heterarchy

Using Grabher’s (2001) heterarchy approach, introduced in Chapter Two, this section will provide empirical findings that answer research question two and provides further details that compliment research question one, outlined at the beginning of this chapter. The previous section has shown how the video games ecology has emerged and how the ecology currently looks. The heterarchie’s six features have been used here to examine the organisation of the Liverpool video games ecology and how it is integrated into wider production networks.

5.3.1 Diversity

During the empirical investigations of this research, there were 30 video game firms within the Liverpool ecology. This included one multinational studio and 29 small and medium size firms shown in Table 24. Of the 29 small and medium firms, their functions included software development for one of the three major consoles in the market (Playstation 3, Xbox 360 or Nintendo Wii), iOS devices, Android or Kindle Fire, as well as firms providing outsourcing and online publishing services.

Table 24 Ecology composition 2012

Firm Activity	Number of Firms	Micro	Small	Medium	Ownership	Platform
Developer	25	4	20	1	Independent	Mobile and console
Online Publisher ¹	1	0	1	0	Independent	Mobile and console
Sound	1	1	0	0	Independent	Mobile and console
Visual art and graphic ¹	1	0	1	0	Independent	Console
Outsourcing	1	0	1	0	Independent	Console

¹Only firms with experience working on video game projects and current projects are included

By 2012 all multinational studios had closed their operations in the Liverpool ecology for reasons given in Table 23. The Liverpool ecology changed from having nine well established video games firms, to having a total of 30 firms in 2012, focused heavily on software development. A breakdown of the ecology composition is presented in Table 24, showing high numbers of software developers compared to other aspects of the video game activities. However, some firms in the Liverpool ecology found themselves providing services beyond the primary activities that are highlighted in Table 24. As mentioned in the last section, firms are performing outsourcing activities in order to fund their developments. Hence, firms primarily classed as developers can provide specialist services such as artwork or coding to larger firms in order to provide themselves with cash flow. As Fraser (2004) argued, the survival of firms requires the entrepreneurs to do what is necessary. In terms of seeing diversity through an ecological perspective, we have to acknowledge that every niche or habitat is one of its own kind (Howkins, 2010; Toulmin, 1990).

Diversity in Business Models

The previous sections have concentrated on how some firms are still focusing on their links to the larger firms and the issues they are having regarding time and finance with their own business models. In the Liverpool ecology, there have been three new business models developed that have led to successful development and publication of games. This was achieved by focusing on alternative hardware devices, notably mobile smart phone platforms Apple iOS and Android. Other platforms include Kindle Fire and the internet through various gaming web sites. One of the noticeable trends in the video games industry has been the increase in consumption through alternative devices other than video game consoles. Firms in the Liverpool ecology have used their industry knowledge gained from previous employment, as well as using a similar production model outline in Figure 14, to develop video games for mobile hand held devices. Mobile device platforms have fewer financial and publication restrictions, reducing the barriers to entry. Firms in

Liverpool have been taking advantage of the new online business models such as subscriptions, freemium and in game purchasing (Marchand and Hennig Thurau, 2013).

The Liverpool ecology also has two firms using new business models that are different from the industry standard. One firm ran a dedicated outsourcing function and developed no original content, starting in 2008 when all three major publisher developers were still in the Liverpool ecology. The firm took advantage of connections it had made and maintained to the major studios in the Liverpool ecology, through previous employment in SCE. The large video game firms have been using outsourcing for some time but managing through dedicated external development teams.

“we’ve outsourced, outsourced throughout the whole development. Whenever we found we needed something that we couldn’t do or we could find cheaper or we just wanted quicker, we outsourced. So there might be a sound recording of you know car engines, stuff like that. We had graffiti from a world famous graffiti artist done. And all the way through to vehicles, characters” (Interview Former SCE Manager, 16/07/12)

The dedicated outsourcing firm was able to exploit the existing business model to push for further use of outsourcing for key inputs in production. Rather than the external development teams having to manage several connections to multiple firms, the outsourcing firm consolidated this to just one. The outsourcing firm has been able to convince other developers, through their reputations and trusted connections, that they can manage the production of specific inputs across the entire development network. In essence, the firm has spotted a structural hole in the Liverpool ecology to provide these services but also to make use of freelancers

or other dedicated video games firms that are also looking for work in the ecology (Burt, 2001).

Freelancers have become increasingly important to the sector. They provide inputs that otherwise may not be readily available inside the existing organisations. Kitching and Smallbone (2012) highlight the growth in the freelance population across the UK, arguing further, the need to distinguish them as different to small business activity. Typically the term 'freelancers' has been used to refer to independent workers in creative industries such as; advertising and film and TV (Storey *et al*, 2005; Moeran, 2009). It's not that dissimilar in the video games industry of recent. Firms of all sizes in the ecology looked for freelancers with particular skills, such as programming, to fill capacity shortages and keep costs low. The search for such individuals was local and national for Liverpool based firms. Hence, freelancers add to the diversity of the ecology and business models being used by established firms. However, building on the intra-firm relations, freelance individuals in the Liverpool ecology tended to be former employees of one of the larger multinational studios in the Liverpool ecology. Additionally, some freelance connections beyond the ecology were the result of social interactions on previous projects. These emerged when the now new owner-mangers worked in the larger studios. This reinforces the value of both the intra and inter organisational relations that have permeated the boundaries of old firms into new ones. Kozica *et al* (2014) argue that firms are increasingly becoming reliant on highly skilled freelancers as a sources of external knowledge, increasing the absorptive capacity of firms through such close interactions, especially in creative and technology based industries. The use of freelancers has allowed firms in the Liverpool ecology to increase in number and diversity yet kept costs in the business model low and the firm competitive and adaptive.

The second firm has challenged the traditional publishing business model in order to focus solely on the growing digital gaming space. The more recent generation of consoles are connected to the Internet and allow games to be downloaded rather

than purchased via traditional mediums such as retailers. So online publishers focus on the development and publishing of games through online distribution channels only. As a participant from the firm puts it:

“we said our business model is basically online only, it’s like the punk rock business model but for games. We haven’t, we’re not going to have a lot of money, you know, if we had a pot of say £1 million, we could raise £1 million and we would try and make four or five games with that, and the profit that we make from those games will fund the next games” (Interview Online Publisher 1, 30/11/11)

As Baden-Fuller and Morgan (2010) argue, firms will morph their business models over time to respond or take advantage of changes in consumer demands, utilising organisational learning and adaption through business transformation. Weick (2007) argued through an ecological lens, if the actors appears single minded or in this case simply confirming to just the industry norm, then we are not paying enough attention to the dynamics the ecology. Toulmins (1990) argues that diversity is a cornerstone of the ecological perspective and it is not just influences from beyond but within the ecology that impact the mutation of firms and their business models. The response of the online publisher was to acknowledge that there will be a lack of financial resources to support this activity initially, not just within the Liverpool ecology but beyond it. However, as Margretta (2003) argued, the firm has to experiment through its business model. A new online publishing model is gaining traction in the industry as many developers designing games for mobile devices find themselves in a very noisy market place when they go it alone. Many of the developers come from a very specific background in relation to the wider video game production network. Hence, firms have to learn how to advertise their own games to stand out in the market place. As one respondent puts it:

“if you’re self publishing, you need to not only finance obviously the development of the game, but you also need to have something left in the tank once you’re done with the game to promote it, and OK a lot of that can be done through PR and you might be able to call in some favours...But I think also at the same time realising it really is quite a struggle to continuously talk about yourself essentially, and keep awareness” (Interview Developer 4, 13/12/11)

Faced with these problems and the increasing number of self-publishing developers, some firms are starting to look for online publishers such as the firm in Liverpool.

“I’m turning to online publishers now, self-publishing, I think it’s too tough. There’s too many games, too many apps, it’s very, very difficult to get anyone to look at what you’re doing, especially if it’s not completely unique. If it’s completely unique then you’ve got a chance of it being picked up by a reviewer or something like that, but if it’s not, if it’s middle of the road then they just get lost. Without the publisher pushing it I think it’s tough. So the first two releases I put out, I self-published, from then on I’m turning to publishers.” (Interview Developer 3, 16/07/12)

The closure of the major studios in the Liverpool ecology has impacted both the composition and the diversity of business models used by firms. Small firms are shifting away from developing big budget video games, to smaller budget developments published through a variety of hardware devices and online channels. The Liverpool ecology has lost three major publisher developers (SCE, THQ and Activision) but gained an independent online publisher and a dedicated outsourcing firm. This has increased the number of firms in the ecology compared to previous compositions dominated by major players and a few firms developing

for the major gaming consoles. However, the diversity has changed and can be argued to have increased in the Liverpool ecology, but there seems to be a dominance of small and medium sized developers leaving many other structural holes in the ecology. One such structural hole exists in relation to a lack of large third party publishers. This creates a gap in the entire production network in the ecology, reducing the geographical proximity that independent developers have to publishers, given their significance in the industry (Cadin and Guerin, 2006). As Sabel (2001) argues, the greater the diversity of actors the more likely it is that firms will reach out and form partnerships and other forms of interaction within close proximity. Scott (2000) has also argued that the creative industries rely on close proximity, due to the nature of inputs required in production. The following section explores the interactions in and beyond the ecology in more detail.

5.3.2 Rivalry

Firms in the ecology have sought to organise in different ways in order to remain competitive and provide a sustainable business model from which they can survive in a rapidly changing industry, driven by novelty and technology. Following on from the diversity section, there are a number of functions and connections between firms within and beyond the ecology. Two trends emerge from the empirical data. Firstly, the remaining major video game firm (SCE) had a complex relationship with local firms. The firm had a preferred contact list that was heavily influenced by the individual running the external development team at the time. When a former SCE manager was asked, he said:

'There was a lot of local people because whoever was running the outsource either knew them or they could get a better price locally from them.'

Interviewer: Were these former employees?

Sometimes but not always. There's some, like there's ex-employees contracting for Sony now.' (Interview Former SCE Manager, 16/07/12)

This meant that anyone who was to become involved on a project would have to meet a number of criteria in order to get listed, then depending on the nature of the work the firm would either bring individuals into the firm or completely externalise the input required.

"We didn't, I don't think we outsourced any code but we definitely had external people in, working with our team. We didn't do that so much with art. The programmers, we found it easier that the programmers were on site. Whereas artwork tends to be a bit more like a jigsaw piece, you can do it in isolation and just slot it in and it works." (Interview Former SCE Manager, 16/07/12)

These can be seen as control mechanisms in order to reduce risk and uncertainty in the management of particular projects that are vital to the development. Other factors include time and cost for the firm. Oakley (2004) argues that successful networks take a long time to develop and trust between individuals is a crucial ingredient. Turok (2003:552) argues that trust in creative industries 'enables [firms] to overcome some of the limitations of pure market relationships and short-term contracts, and to undertake risky or costly ventures without fear of opportunism'. Trust for the video games firms stem from the ability to deliver based on past experience and reputation. Drake (2003) argues that reputations can be catalysts for creativity, illustrating a skills base that is tried and tested. In regards to SCE the firm employed selected firms within the ecology and former employees as freelancers in order to provide certain inputs. In turn, this strengthens individuals learning, reputations and trust. Maintaining the connections and ability to remain adaptable enriches the genetic pool within the Liverpool ecology. Grabher (2001)

argues that rivalry between firms within the ecology also provides a richness and more diverse genetic pool for the evolution of new organisational mutations. The role of SCE and other multinational studios that were once within the ecology, has been one of embedding skills and the diversity of the actors that can compete, not just with one another, but beyond the ecology.

Secondly, an outsourcing firm that spun off from SCE has become a hub for networking and outsourcing for independent developers as well as SCE. The outsourcing firm is in a unique position in Liverpool; it has no direct competition as its business model is primarily focused on the management of outsourced inputs from other firms. Justifying the move towards providing outsourcing services, the firm said;

'a lot of people always want to set up their own development teams and make games, in the current climate I thought to myself that's probably not the best thing to do, because it's high risk, and I thought, well do you know what, if I set myself up as a service provider, outsourcing is happening, the developers and the publishers need outsourcing, they can't manage it, and it's a very similar model to the film industry, where they bring the most talented writers, script designers, costume designers, lighting people and cameramen together, they do a film and then they all go their separate ways' (Interview Outsourcing firm 1, 11/01/12)

Artwork management provision is the firm's largest service but the firm had, in the past, provided coding inputs, sound and scriptwriting services. The firm does have indirect competition from other small firms, who themselves, are taking on contractual outsourcing work. However, the firm did not highlight this as a threat to their business as they offer much larger capacity and dedicated service. Interestingly, due to the connections the firm has with the ecology and several beyond it with publishers in other places, it has a privileged position to draw in and

disseminate work to firms who need it within the Liverpool ecology and also interact with firms outside the ecology. Working in order to draw in projects, increases the ability of the other firms in Liverpool, in turn increasing the rivalry and richness of the genetic pool. This raises the abilities of those firms involved with projects and allows them to become exposed to other organisational mutations.

'we've got suppliers in Liverpool, Manchester, London, France, Amsterdam, the Far East, North America on the west coast, continental Europe, Australia, we tend to find people for the right reasons. That's why we ask the customers is it quality, time or cost? If they say, well we need, we've got a fixed budget, I'll say well the only people that can do that amount of work for you for that amount is probably in China or India, yeah but the quality's rubbish, well you can't have all. Or they can turn round and go right, we need Liverpool modelling for a video game and I need it in two months, and I can work that they'll need seventy artists. So straight away the criteria for business is find a service provider that has seventy artists free. Now some companies we use have only got twelve artists, one of the other companies has got 850.' (Interview Outsourcing Firm 1, 11/01/12)

This means that some of the small developers, who are looking for contractual work for survival, turn to the outsourcing firm and become a part of their production networks, integrating them into wider systems of production.

There are some studios in the ecology that bypass the outsourcing firm when looking for contracting work or even to provide an input for their own productions. Firms are looking for inputs that are not provided internally or that can be sourced using their own connections which they trust in order to avoid the risks of the market mechanisms outlined above (Oakley, 2004). Inputs coming from outside the ecology have predominantly been relating to artwork, sound and testing. In many

cases, even if these inputs are provided internally, the small size of many firms can mean that they aren't able to take on the additional work. Given the demands already placed upon video game firms, other creative firms in Liverpool don't feel they have enough experience or an interest to work on a video game project.

'the translations are done by a company in Sweden because they offer the best all round package and they're the best price. We, our music licensing we outsource to a company in London, even though this building's full of musicians and a music licensing company literally there, through this wall! But when I spoke to them they were just, it wasn't their kind of thing.'
(Interview Online Publisher 1, 30/11/11)

Referring back to the diversity arguments made by Sabel (2001), within the Liverpool ecology, we have seen an increase in the number of firms but the size of the firms have been much smaller, limiting their capacity to take on additional activity.

"well I've found that if you shop around you can get local people to do it for the same price anyway, it's no cheaper. Then you just find that if you want 50 people working on your project, there aren't many local firms that have got 50 people who are spare that can jump on it, so you'd have to use lots of different places and individuals, which has got a different amount of overheads." (Interview Former SCE manager, 16/07/12)

From the position of the outsourcing firm there are three fundamental questions to be asked in regards to outsourcing a particular input. Although all firms would claim they are looking for the best quality product, they also have to take into

consideration the cost and time it would take to complete the concept they require. In the words of the outsourcing firm they said:

'say if they come [a video games firm], [and said] do you know what... I want City of Liverpool modelling for a first person shooter, what we would do is we would go, OK, what's your criteria? Do you want the best quality buildings? Do you want, have you got a budget restriction, or have you got a time restriction? And most software development, that triangle of cost caught in time is really applicable to games' (Interview Outsourcing firm 1, 11/01/12)

The outsourcing firm has a privileged position, having capitalised on an increasing trend in video game production. Like other creative industries, video games are moving further towards a project based production system involving many different actors both internally and externally to the firm (Grabher and Ibert, 2011). Large permanent workforces are becoming less cost effective for firms to maintain. For example, the large studios when dealing with constrained resources such as time and money they outsource work and can still maintain the level of quality they require. What this means for the producers is that they have to manage several connections in the production process. The outsourcing firm overcomes this problem for the studio and manages those connections on behalf of the larger studio, reducing the studios external connections. This reduces the number of external connections a studio has to maintain but increases those for the outsourcing firm.

"Now freelance and contract work is established in TV and film, and radio and other sorts of media, however in the games industry it wasn't, they like to tie people for long periods of time. If I'm going to invest 40K a year on a programmer, I want to keep him here for as long as possible, and they don't like that short term approach. However, that's the way that the industry had

to go, and that's the way that the industry has gone. I think people were scared of doing it because they didn't know what to do, so... we hit the ground in August 2008, and it was basically a one stop solution where they go [the client]... we have been trading for four years going from strength to strength" (Interview Outsourcing Firm 1, 11/01/12)

The quote above highlights a structural hole (Burt, 2001) in the Liverpool gaming ecology that the outsourcing firm filled in 2008 when there were three large studios plus some smaller developers in the ecology. However, it tends to be senior managerial employees who are able to spot gaps in the market (Kleppers, 2010). The founder of the outsourcing firm is one example, explaining below how he came to see the trend and opportunity to spin out:

'I was a senior producer there for four years and then we were working on multiple titles, multiple teams, and all the teams were struggling to manage things that were happening within their studio, and a lot of them were outsourcing, and it was human nature that out of sight, out of mind, there was more urgent and important things that needed addressing and managing externally, but because someone was next to you saying oh come and have a look at this, they tended to focus on that. So I started speaking to a lot of these people and they all had similar problems, they wanted to focus internally but had to manage outside of their office' (Interview Outsourcing Firm 1, 11/01/12)

Other firms in the ecology have recognised the usefulness of the outsourcing firm, helping them to plug gaps in their production networks and integrating into wider ones. Several firms would turn to the outsourcing firm for inputs relating to artwork. Given the diversity of the games being produced and the wealth of

connections the outsourcing firms has, firms were likely to get an input specific to their requirements. Equally, the online publisher stated:

'They [outsourcing firm], we'll go to them for the production side of things, so we'll outsource almost all the production to them, because they're really good at that. We'll also get them to help us find other companies that we need to outsource to' (Interview Online Publisher 1, 30/11/11)

Teece (2010) argued that firms could create new business models or refine existing ones. This shift in the production process has allowed the outsourcing firm to become a key actor in the Liverpool video games ecology, drawing in projects and securing wider connections that can enrich the genetic pool of the local ecology. Upon further investigation, the company boasts 45 production based connections to locations including the USA, China, South Korea and parts of the UK, of which only three are within the Liverpool ecology. Several firms in Liverpool do use the outsourcing firm in order to get parts of their game developed completed. However, an overwhelming number of firms relied on connections beyond the ecology that they had used previously throughout their time in larger firms. SCE, Activision and THQ had connections to internal and external studios based all over the world, given their size and influence. Now former employees running established firms in the Liverpool ecology continue to work in similar ways making use of those connections that stem beyond the local ecology. So if the firms are looking beyond Liverpool, even if they go through the outsourcing firm whose connections are predominantly external, it highlights a lack of diversity and then rivalry in terms of the richness inside the ecology. Firms tend to be focusing on core activities of game development; that of managing the project and sourcing inputs rather than specialising in particular inputs for the marketplace. If there is then a lack of internal ecology rivalry, Grabher (2001) argues that the evolution of new organisational mutations would be much slower. Although this doesn't slow the rate of new firm start-ups it is reducing the ways in which organisations function in

the ecology. There is a lack of challenge to the existing business model, reducing innovation in organisational form (Baden-Fuller and Morgan, 2010).

Rivalry does not just take place in the ecology. There are other places that act as trading zones for the firms (Maskell *et al*, 2006). Conference attendance has been key in securing work and maintaining and increasing the number of external connections. Firms highlighted conferences as key places to meet people face to face, secure work and sell their products or services.

“with any of the clients, customers that we’re hoping to sign up in the four to six weeks, there’s always been a face to face meeting, that’s, and that’s usually where the trade shows come in, and that’s usually how the relationship starts or gets deepened, you know, because you may have made contact over e-mail and had a conversation over Skype, we use Skype quite a lot because we demo the software using screen sharing, so somebody can be on the other side and they just see what we’re showing on our computer as it were. But then there’s always, because ultimately you’re looking for somebody to pay you money, there always needs to be that personal connection, at this stage anyway.” (Interview Developer 7, 07/12/11)

Over the last two years, firms in the Liverpool ecology attended and hosted several events. Although not all firms attended those outside the ecology, almost all attended the ‘Indie Show Case’ event. All participants had experiences of conferences and signalled them as important temporary places to establish and maintain connections vital to the firm’s future. As one participant refers to a contact he has worked with but never met:

“The guy I’ve never met and just done the Samsung project for was saying are you at Games Con in Germany? And I thought, well I wasn’t but I might. Because I wouldn’t mind meeting this guy...that’s what most people go for, to sort out the next deal. They’ll be showing off what they’ve done and they’ll be trying to get publishers on-board. And certainly for developers, they’ll be trying to get someone to publish, either publish the title that they’ve got or sign a deal for them to do the next game with them, pay for development ...Yeah I think people, a lot of people prefer doing business face to face ... and I think when you’re trying to get outsourcing contracts and stuff you’ve got to go to these places, you’ve got to go and see them, you’ve got to set meetings up, all in advance.” (Interview Developer 13, 16/07/12)

In 2011 Liverpool hosted the Develop conference that brought external companies to the city. This provided a huge industry trading zone within the Liverpool ecology. One industry magazine reported:

“This year's conference line-up, with over 22 sessions, reflects the changing landscape and really drills down into what some of those opportunities are today and tomorrow. And, as ever at a Develop Conference, there will be plenty of opportunity for catching up with old & new friends over a coffee during the day or better still over a beer at the after party.” (MVC, 2011)

Table 25 shows a list of the sessions that were held at the conference, showing that SCE held the keynote session before their exit from the Liverpool ecology in 2012.

Table 25 Develop conference Liverpool session 2011

Conference Session	Speakers	Type of Firm	Firm Origin
Keynote: Sony talks	Michael Denny, John	Multinational	UK and European

strategy, creativity and Innovation	Rostron, Graeme Ankers and Matt Southern		studio heads
The rise of free to play on mobile: Best practice	Dan Keegan – Open Feint ¹	Independent	California
iPad game Design: It's different?	Gareth Jenkins – 36peas	Independent	UK
10 Tops for successfully using data to improve online game revenues and player satisfaction	Chris Wright – Games Analytics	Independent	UK -Edinburgh
Convergence is changing and change is good!	John Nash – Blitz Games Studios	Independent	UK Warwickshire
Where is the fun? Measuring social interaction	Graham McAllister – Vertical Slice	Independent	UK - Brighton
Dynamic resolution rendering	Doug Binks – Intel	Multinational	US – Santa Clara
Tackling physics	Stephen Frye - EATech	Multinational	UK - Chester

¹Firm has since been acquired by an American developer

Alongside the conference, three small firms organised a conference called 'The Indie Show Case'. This attracted some firms from outside the ecology who were attending the develop conference, along with most firms from within the ecology.

'we wanted to do a fringe event around the Develop Conference that was at the Hilton, and we would do it in the evening, and twenty four companies came and exhibited essentially, spent three hours sort of showing off projects that they had worked on, and we had about 120, 130 people through the door, attending the event, they were, partly they came because we had an

agreement with the conference organisers, that delegates from the conference could come across' (Interview Developer 7, 07/12/11)

The motivation for 'The Indie Show Case' was to bring people within the ecology together and be more open about development capacity.

"we're trying to get community together again of companies working for each other... games companies, they don't want to share secrets with one another, and they never want to tell someone what they're working on, because they think they're working on the best thing, and because of the competition from Canada, the US and the commercial situation we find ourselves in, they do have to speak to each other now, and they do have to say listen can I borrow one of your artists for three weeks? Because I don't want to hire someone, your artist isn't doing any work, can I borrow him? And those walls are coming down." (Interview Developer 7, 07/12/11)

The developer above stated that the motivation for arranging such as conference was to use the opportunity to try and connect firms within the ecology and where possible, to share projects amongst firms. Other firms in the ecology had conducted similar practices at other conferences.

'at that conference [Game Developers Conference, GDC] we had some prearranged meetings that we'd kind of arranged over phone calls and stuff, and then we also had some that just happened as we were there. And I'd say that they led to opportunities kind of further down the line, say three or four months down the line we kind of had opportunities there. And we also had one that, an opportunity with Nintendo which we talked about while we were at the conference, we'd already had a few conversations with that, and

then a few weeks later we actually put a pitch into Nintendo' (Interview Developer 8, 30/11/11)

As previously mentioned, the outsourcing firm had connections within the ecology to other firms. It used these connections to increase its own capacity to meet demand for their services. The outsourcing firm was one of the key organisers of the event and has since benefited from understanding who and what capabilities exist within the ecology. There are other conferences within the gaming industry; the biggest conference is the Games Development Conference, where most of the big publishers and developers are present. Only the outsourcing firm and one of the new developers attended this event during 2011. As illustrated above by the developers' quotes, both had used their attendance in order to secure work and meet face to face with clients.

5.3.3 Tags

Psygnosis, Bizarre Creations and Digital Image Design all had strong connections to publishers and a track record for producing blockbuster gaming titles in the early stages of the ecologies evolution. Hence these firms were seen as strategic assets to the larger publishers that acquired them as discussed in Table 21 and 22. This also supports the arguments made previously, that around the 1990's and early 2000's, the larger publishers were seeking to internalise as much of the production process as possible in order to retain control of software production, seen as one of the main sources of revenue (Cadin and Guerin, 2006).

"Liverpool's got a really strong history of video games. When you think that, well the North West has got a really strong connection... I worked at Ocean, and when you tend to find large publishers, you always get spin off companies, so Ocean there was three or four companies that span off from that, then you had Psygnosis and three or four companies span off from that,

so Liverpool's always had a rich heritage, and there are actually over twenty game companies, whether it be mobile, PC, browser based or console based in Liverpool at the moment.” (Interview Developer 11, 14/02/12)

As individuals were drawn to work for the one of the major publisher developers based in Liverpool, they also embedded socially into the city. Social embeddedness refers to social relationships that are a valuable asset to the individual and then the firm he or she is employed. Its value stems from the access to resources that it engenders through an actor's social relationships (Granovetter, 1992; Moran, 2005). The resources can be physical inputs or different types of knowledge. There was an overwhelming majority of firms that stated family as their first reason for remaining in the Liverpool video games ecology. Firms did note that many of their former colleagues had left to go and work in other places such as Canada and the US where the video game industry was much larger and had greater opportunities to work for the larger publisher developers. Having the family support networks embedded within the ecology provided emotional and in some cases indirect financial support for new business owners (Jones *et al*, 2014). However, family alone was not the only factor as to why firms chose to establish within the Liverpool ecology. As already mentioned, there is a rich games history in Liverpool, based on the number of large publishers that have been here over the last 30 years.

Several firms stated that their location is not important and they could operate anywhere. However, what was important to them in terms of location was security and privacy. When looking at the locations of many developer firms, very few were located in incubator spaces or open planned shared offices. Before sharing an office or using incubator space, firms would opt to use their own homes. There are three reasons for this. Firstly, there is a cost issue for many small developers. The cost of office space and lease terms can be high and long, hence making use of free and secure space is a better option. Free space for some firms included using their spare rooms in their house or rotating around each of the team member's houses.

“cost, cost’s good, because it’s free! There’s no commute. I’ve got everything that I need ... because I’ve got a proper customer office, it’s not like I’m in a back room, you know, it’s all fitted desks, a row of PCs you know, everything’s there, all the scanner, decent colour printers you know, it’s properly equipped.” (Interview Developer 6, 01/02/12)

Secondly, during the creative development process, ideas need to be formed in secure places to protect intellectual property rights and allow cognitive proximity to be established. Cognitive proximity relates to individuals sharing the same knowledge base, which in turn can increase the ability to work together (Boschma, 2005). The entrepreneurs need both social and cognitive proximity in order to be able to collaborate together and produce a concept for production.

“We learnt fairly early on that we needed to make sure that we were working from the same office each day for a long period during the development of our first game..., we tried to work remotely as much as possible, sort of talking over Skype and stuff like that, but we realised that it’s far better, far more productive to actually be in the same together.” (Interview Developer 10, 13/11/12)

The developers felt that cognitive proximity was also enhanced through geographical proximity to one another; being in the same room help to facilitate the creative process rather than working across distance or virtually. Grandadam *et al* (2013) argued that in the video game industry face to face contact in the early conception of ideas is vital to the creative process.

Thirdly, hardware manufacturers retain significant control over who can develop for their consoles. They require developers to use a development kit specific to the console. Manufacturers rely on the reputation of developers as a vetting process before releasing a development kit. Not only does the developer have to be known to the console manufacturer, they need to be able to provide a secure place to keep the equipment so that the intellectual property is protected.

“you wouldn’t do that sort of development in Base Camp [an open planned incubator space], you wouldn’t get the deal, you’d never get a Playstation 4 kit in a place that wasn’t absolutely secure. “ (Interview Developer 3 16/07/12)

Even though the Liverpool ecology has lost its major publisher developers, there are firms within it that still build and draw from the reputation and maintenance of contacts they had whilst working at those studios or from working with them. The diversity of firms and the morphing of business models may soon change the tags the Liverpool ecology has developed and are currently associated with. The Develop Conference has been used to showcase the talent and continued innovations of the Liverpool video game ecology, showing a youthful and vibrant community of firms with innovative business models and creative gaming ideas.

5.3.4 Projects

Some of the major changes in the video games industry have already been outlined in previous sections. This section will look at how video game firms in Liverpool are integrating into wider production systems and what is involved in the production of video games in more detail. Figure 15 represents a modified production network focusing on video game software development. This is based on data from firms in the Liverpool ecology. There are many similarities to the production of a traditional video game as seen in Figure 12. Finance is an important aspect of many production

networks and is essential to move a concept or idea into development. As inputs are procured, firms need to be able to pay wages or external firms. Typically, video game developers seek a publishing deal that funds a concept into production. This is usually paid in instalments. As discussed earlier, developers in the Liverpool ecology have been using their redundancy money and savings to move ideas they have into development. The development stage is a highly creative stage where characters, storylines and genres are explored, tried and tested. This is the most creative aspect of the production network, requiring close and regular contact throughout, in line with other creative industries (Hartley, 2004; Scott, 2000). Decision-making needs to be consistent and fast in order to get a concept developed (Caves, 2000; Drake, 2003).

“if you’re in separate locations you tend to come up with an idea, or ideas, and just, and run with them, and then you take a more complete kind of bunch or set of ideas to each other, and because they weren’t done together then it’s hard to get an agreement of new direction between each other. Whereas if you come to those conclusions together then you’re a lot more likely to agree on that direction.” (Interview Developer 20, 13/12/11)

Firms interviewed in the Liverpool ecology kept the development stage completely in house and use no external connections during the process. This has generally been the case for developers to retain as much control over the initial idea. This is typical of the industry, for example, larger studios do not give development kits to anyone unless they are in a secure location and on a preferred contact list.

A new stage has been included in Figure 15, this is pre-production. Once the developers have a concept they design a demonstration product. At this point, the developers will look at the in-house skills set and begin segmenting the pre-production process. This stage is used to test the technology, programming, artwork

and sound and how they interact together. This is known as proof of concept. For video games developers this has become a crucial point in the production process as it tests a small production of the game before “green lighting” its full production. For smaller developers in Liverpool this is an optional stage. Some firms use pre-production to test their concept functionality and others use this stage to test on a selected number of customers as well. There is a feedback loop to the developers from the pre-production stages. This enhances the organisational learning process by detecting early problems and the viability of scaling up the project. For the publishers, the pre-production stage is another way of exerting control over the process to make sure the product is viable.

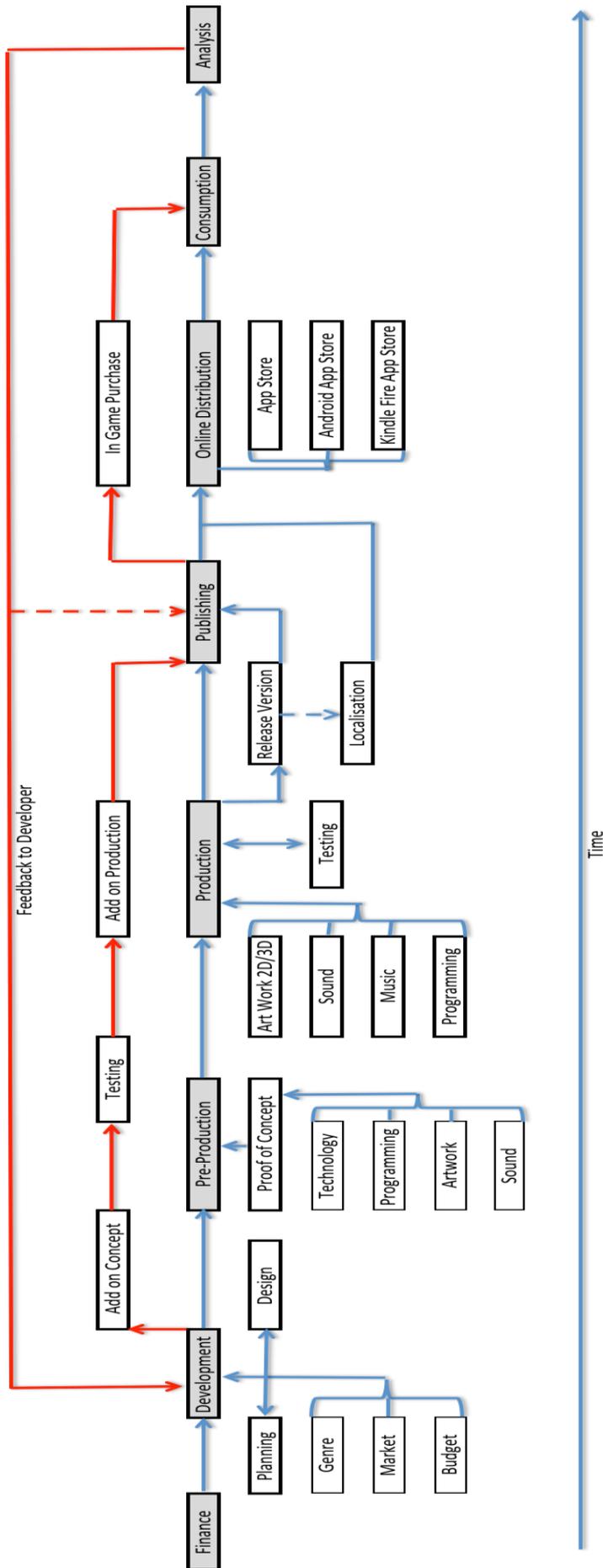


Figure 15 Game software production network (Adapted from Johns, 2006, Figure 2)

The production stages stay the same for both small and large video games firms in the Liverpool ecology. The only difference is towards the end of the production stages when the publishing routes differ. Games developed for mobile devices tend not to have a final version; instead there is a release version.

“an online game is essentially never finished, you’re constantly updating it, you’re always making changes and new content, and of course to inform you as a developer what changes on the one hand you should make, but also how effective those changes have been in influencing the player behaviour you need a tool to help you analyse that” (Interview Developer 17, 07/12/11)

In order to reduce the cost and time inputs, developers only create a release version containing a small amount of content. This can be made free to purchase through the application stores or charged at a cost determined by the developer. When the application is purchased, the game play can then be analysed. This is a new addition to the production networks for video game developers. The developers use game analysis software to inform further development of the software. Other methods that have been used to analyse game play include online forums, blogs and traditional market research methods. This completes a loop, making the production process more effective as it reduces time inputting data into software, allowing quicker analytics than the traditional business model.

For video games developers, a final version is usually produced as seen in Figure 12. However, this is set to change as the games industry begins to analyse game play through online connections shown in Figure 15. The online connectivity of current generation consoles allows publishers to release new content or virtual goods directly to the consumer.

“The whole revenue from on line gaming worldwide is projected to grow to something like \$25 billion in the next couple of years. Virtual goods is, they describe it as digital items with contextual meaning. And essentially what it means, people buy these virtual goods for two reasons, they’re either decorative, so they allow them to change the appearance of the in game character, so they can buy themselves a fancier hat or a bigger sword or you know something that other players might not have spent the money on. And a lot of that is done through micro transaction, in fact I think on the app store now over 60% of the revenue is generated through in app purchasing, so essentially the game or the app is free to download. And then to extend the functionality of the app, or get extra features, you make a purchase inside the app, that’s why it’s referred to as in app purchasing.” (Interview Developer 7, 07/12/11)

In game purchasing trends are also analysed to inform future development of a franchise or for additional add-on content. This has been a new addition to the business models of many video games firms, especially those in the Liverpool ecology. Being able to tailor particular products based on direct consumer feedback meets the customer demand much more effectively.

Firms in the Liverpool ecology have acquired greater autonomy than in traditional video games production networks. Firms developing for mobile devices such as iOS and Android have complete control over the development, pre-production, production and publishing. The firms that are still working on console based games are still constrained by the relationships to publisher and console makers outlined by Johns (2006) earlier in the chapter. The degree to which firms have control over finance is less clear cut for mobile platform producers. Those that have used their redundancy and savings money have complete control and do not have a third party publisher to answer to. Equally, those firms who raise money through outsourcing work to fund their development also have complete control. However,

there are still firms in the Liverpool ecology that have raised money from publishers or other investors and remain accountable to them. Firms in the Liverpool ecology are more likely to develop, produce, self-release and analyse.

“what you see now is that essentially a lot of the development, well the other thing that’s changing is that this whole chain is often entirely owned by the developer now ..., so especially if it’s on line, especially if you’re doing, even if you’re an app developer, whereas it used to be that this is development, this is publishing, and never the two shall ...” (Interview Developer 9, 13/12/11)

However, without a large publisher and reserves of capital to advertise, firms are also responsible for their own publishing techniques. Firms publishing onto mobile devices have to take a different approach to raising awareness of their developments.

“the publishing side of things is very, very much integrated with every single stage of up to that point. So really publishing starts from day 1 of the company, we, getting our, the brand awareness of the [company] name out there and talking about our development process, talking about our company, talking about ourselves on our own blogs, social, Facebook, Twitter, all that side of things we consider publishing, because all that feeds into when we do actually come to release the game” (Interview Developer 8, 30/11/11)

Developers can use external firms to market and raise awareness of their product but this tends to be costly or requires a lot of relationship building and maintenance to get a publisher on-board. Given the types of firms and how they have been established, involving an external advertising firm is not always going to be viable.

This can be a barrier for developers planning to release video games onto already crowded mobile device's application stores. Creating awareness and increasing the discovery of their application amongst thousands of other applications can be difficult with small budgets but as mentioned above, there are ways in which firms are getting around this. In traditional video game production networks publishers have a lot of control over the production process, especially how the video game will be marketed. They have much larger budgets to spend on the marketing of a game to help it through to consumption.

Within the Liverpool ecology, when a firm decided to outsource a function, they had to look at the function carefully and decide if the task can be codified to a simple brief or whether it involved interpretation and creative input to develop. Martin (2013) argued that in industries characterised by symbolic and synthetic knowledge bases, or those firms that rely on a tacit form of knowledge, benefit greatly from geographical proximity. For video games firms, the development of ideas, which is typically symbolic knowledge, firms would appear to work better in close geographical proximity but also cognitive and social proximity (Malmberg and Maskel, 2006). Malmberg and Maskell (2006) argue that it is not enough to just have geographical proximity in the production of knowledge. Of all the inputs required in the production processes, firms were mostly outsourcing artwork using connections within and beyond the Liverpool ecology. If the task was simple and could be written into a simple brief, codified, then the work was more likely to have left the ecology. Artwork of this kind usually went to firms located in China and South Korea. If the artwork could not be simplified into a written brief and required interpretation or specific details known only by the developer, the developing firm took time to visit the artist during production. So it came down to cost, quality and time.

“we ask the customers is it quality, time or cost? If they say, well we need, we've got a fixed budget, I'll say well the only people that can do that

amount of work for you for that amount is probably in China or India, yeah but the quality's rubbish, well you can't have all. Or they can turn round and go right, we need Liverpool modelling for a video game and I need it in two months, and I can work that they'll need seventy artists. So straight away the criteria for business is find a service provider that has seventy artists free. Now some companies we use have only got twelve artists, one of the other companies has got 850." (Interview Outsourcing Firm 1, 11/01/12)

Liverpool based developers found that most local artists did not have the capacity or industry experience to undertake their projects. Most of the firms or individuals who are able to do artwork are constrained by their size and therefore resources such as time and money. There are three factors mentioned above that interviewed firms allude to. These are time, cost and quality. Each one is traded off against another and this determines, to some extent, the type and location of the firm to be employed to carry out the work. Going back to a previous developer's comment, the price differences between a firm in China and one in Liverpool are not that different but the quality and capacity to deliver on time to the studios differs considerably.

5.3.5 Reflexivity

One observation within the ecology was the contracting of developer firms and individuals to "port" video games onto mobile devices for SCE. For the firms and individuals this has two benefits. First, the ability to undertake contract work to help keep their own firms alive in the ecology using work from the larger firms. Second, the firm retains the flexibility over what it can do instead of the firm owners being employed and ultimately controlled by the larger studio. Again, this goes back to the diversity and composition of the firms in the ecology. Most are made up of one to three individuals.

“they employ my company to provide a contract programmer, which happens to be me as the director, so it’s not an individual contract, therefore they can’t really control what I do. If I was an employee of them, there’s no way I’d be able to do any of this external stuff though, they’re very tightly controlling of IP and stuff like that.” (Interview Developer 13, 16/02/12)

Porting has required a rewriting of the original software to run on smaller devices created by the console manufacturers. Like other creative industries, developers are finding they are resorting to contractual work to fill short-term cash flow issues to deliver their business models (Hartley, 2004).

Firms in the ecology have been reliant on the labour pool left behind after the closure of the three major studios. Only one studio had employed individuals on full term contracts; two graduates from the universities within the ecology. However, the firm stressed that they are not geographically limited in their recruitment.

“well it’s quite an interesting one because like we thought that we’d probably take mainly Bizarre employees on, and we have done, I mean admittedly, but we’ve just taken on two graduates and you’re looking, you’re not just looking at Liverpool, you’re looking at the whole UK, and we have talked to John Moores as well about the, you know, maybe doing something with their, on their games course to maybe help out with them, to maybe get some graduates from that.” (Interview Developer 8, 30/11/11)

Even though the big three studios left a large number of individuals redundant in the ecology, some have created their own firms but the majority have moved away to take up other opportunities in Canada and other parts of the UK.

'Most people went to other jobs in the UK or to Canada, there's tax breaks in Canada for game development, EA and Ubisoft have some big studios over there, basically because they can employ hundreds of people and see some good tax breaks for that.' (Interview Developer 8, 30/11/11)

Again, linked to the type of firms in the Liverpool ecology and the restructuring in the wider gaming industry, there is a lot of uncertainty in the consistency of work and type of people needed in these firms. For the outsourcing firm, they commented on a skills shortage in regards to 'good' producers, who tend to be more high level experienced individuals in larger studios. Producers are hired based on their own experiences with a particular genre of game.

"Probably a shortage of good producers, if I had another two producers I could probably take on more work, we're at a tipping point at the moment that if I can't, if I take on any more projects, I'll drop a plate because there's a lot of spinning at the moment, so I would be reluctant to take on another job at the moment because I don't have the resources to do it. Also I don't want to take on a full-time member of staff unless I get a big job, if I get a two month job then there's not many contract producers out there that aren't asking a ridiculous salary, that I can pull in and help the business."
(Interview Outsourcing firm 1, 11/01/12)

In order to overcome a potentially debilitating risk of employing more individuals to meet current demand, firms in the ecology are relying heavily on contracting out work along the production process. Not all firms are growing and able to take on graduates and the slack in the labour markets. Instead, firms are remaining small and flexible, retaining core functional skills and then relying on trusted and maintained connections within and predominantly beyond the ecology. Like advertising and film and television, it holds true that the video games business is

indeed large but small because everyone knows and talks to one another (Grahber, 2001; Jones, 1996). For the ecology, this in some way counteracts any ruthless rivalry between firms, instead pulling the ecology together like that of a wholly functioning organism. Likewise, the formal qualifications that can dominate other sectors such as the life sciences are not as important as the experiences, originality and predictability individuals can offer within the ecology.

5.4 Conclusion

This chapter has sought to answer research questions one and two, detailing the emergence of the video games ecology in Liverpool, its organisation and how it is integrated into wider production systems beyond Liverpool. In order to understand how a place specific ecology has been composed and integrates into wider systems, an overview of the global industry has also been presented, showing the structure and influence of the major console manufacturers and publishers. It has been shown through various global industry level studies (Cadin and Guerin, 2006; Johns, 2006, Balland *et al*, 2013) and further analyses here that the position and influence of the larger studios still has an effect on smaller independent developers. M&A activity still demonstrates how larger firms are located in one of the three core regions and are acquiring smaller developers to internalise new and existing franchises as well as move towards vertical integration (Johns, 2006).

Liverpool ecology has not been immune to the influences and activities of the larger studios and has undergone many changes since its early conception in 1980. Over the evolution of the video games ecology American based third party publishers have been attracted to acquire Liverpool based firms, most notably Infogrames, Activision and THQ. Only SCEE retains a presence in the Liverpool ecology. It can be argued that Liverpool's direct connections in regards to multiplatform console publishing have been significantly reduced as the third party publishers have all left, leaving only London based offices in the UK. A new wave of firms emerges out of the ashes of the restructuring and closure of three multinational studios post 2010.

Some have changed their business models to focus on small application development for mobile devices, whilst still using their existing skills on triple A games to fulfil contractual work for short term capital.

Margretta (2003) and Teece (2010) argued that firms have to experiment and morph their business models to fit with changes in the industry environments. Equally, the firms are also affected by the place in which they find themselves. The Liverpool ecology diversity has reduced although the number of firms has increased. Firms are coordinating activities based on their internal capabilities or lack of. Inputs were then subjected to a time, cost and quality matrix that determined how the input would be met. Whether that input could be met within the ecology or whether it has to leave and be produced by firms in other places. Ecology rivalry between firms is reduced as there is a sense of community or neighbourhood, instead pulling the ecology together like that of a wholly functioning organism where people feel as if they are the same boat. Giving a sense of share identify within the ecology.

However, firms are increasingly working online, reducing the barriers to geographical distance despite the advances in technology showing an increased trend towards co-location and inter-firms relationship (Balland *et al*, 2013). Online mediums are enabling firms to pay to upload their products onto a faceless application store. Although the interactions within the development process have stayed the same, with the importance of face to face contact still asserted.

The relationships between developer and publisher are also changing. Johns (2006) and Cadin and Guerin (2006) argued that the publishers are key players in the industry and developers have to maintain relationships with them. The empirical data has shown that developers are increasing governance over the entire production process and bypassing large publishers by developing for smart phone

devices. At the same time, firms do not ignore the need in some cases to involve a publisher to deal with promoting the game, but they have more control and influence over the initial development with the inclusion of a publisher.

Chapter Six

Anatomy of City of Liverpool: Place, institutions and infrastructures

6.0 Introduction

There have been many theoretical and empirical studies exploring the many different types of cities and infrastructures to support entrepreneurship, creativity and innovation (Porter, 1998; Florida, 2002, 2008; Cooke 2004, 2005; Glaeser *et al*, 2010; Kasabov and Delbridge, 2008; Scott, 2006). Common narratives point towards investment in industry related infrastructure, such as cultural or knowledge-based assets used to foster a fertile place with talented people, firms and institutional actors who can generate and commercialise new ideas (Asheim and Gerlter, 2005; Florida, 2008). Such assets can include museums, art galleries, bars and restaurants, universities, science parks and incubators (Ratinho and Henriques, 2010; Bruneel *et al*, 2012; Xiao and Ramsden, 2013; Ebber, 2013; Grandadam *et al*, 2013). The list is not exhaustive but provides avenues to examine the geographical context of the ecologies under investigation, the particularities of place and the characteristics of the City of Liverpool. Hence, the main focus of this chapter is look at how the ecologies fit into the anatomy of the city of Liverpool and how the two ecologies outlined in Chapters Four and Five are supported by the infrastructures of the city. This chapter will bring together the previous two case studies and answer research question three which asks: how are the two ecologies situated in the anatomy of the city? Both industries have different evolutionary pathways and future trajectories but exist in the same city.

To begin, the chapter will review existing conceptual approaches of the city and its significance in capitalist economies. Secondly, using Cohendet *et al* (2010) conceptualisation of the anatomy of the city, composed of the upper, middle and lower grounds will be applied to Liverpool in relation to the two ecologies outlined in Chapters Four and Five. It has been argued in Chapter Two that this concept supports and can be developed by the rational framework. Hence, through this

concept, we can identify infrastructures, institutions and actors that add to the exploration and exploitation of ideas in both ecologies. The chapter will outline the video games city and the life science city respectively. The chapter puts forward a conceptualisation of the middle ground, complimented by institutional thickness literature. Thirdly, a discussion of the main differences between the ecologies and how they are situated will be presented. Finally, the chapter will conclude with a synthesis of the arguments presented in this chapter.

6.1 The City

From the historical beginnings of capitalism, cities have functioned in important ways, as sites of agglomeration and specialised production activities (Scott, 2000:23). Hall (1998) has documented, in great detail, the privileged role cities have played across the world as centres of economic activity. Not only are cities places of economic activity, they are also hives for creativity and innovation hosting a rich diversity of people, especially in western economies (Florida, 1995, 2008; Howkin 2010; Lowe and Gertler, 2007; Scott, 2000; Tay, 2005). Many cities host a variety of actors and institutions that have the capacity to develop and exploit knowledge bases (Asheim and Gertler, 2005; Asheim and Coenen, 2005). However, we have to acknowledge that the city is also a site in which there can be deprivation and decline but also renewal (Harvey, 1997). A critique we can raise is that when analysing these sites we are only seeing a cross section through a developmental trajectory. This emerges out of a path dependent evolutionary process, structured by phenomena occurring within and beyond the city (Scott, 2000). It is difficult to overcome this without the use of longitudinal studies and a continued empirical investigation. However, using the theoretical framework in Chapter Two and as shown in Chapters Four and Five, the empirical research has sought to interrogate the path dependent processes and emergence of particular ecologies, institutions and actors in Liverpool (David, 1985, 1994). So, we have to accept that what we are seeing is a cross section in time but be aware that what is shown in this chapter and in previous chapters, is that we address, as best practice, the trajectories that have led to current contextual configurations (Bathelt and Glückler, 2011).

Cities can be understood and analysed in relation to their history, culture and economy, requiring a multidisciplinary approach and therefore attracting attention from across the social sciences (Harvey, 2006; Jacobs, 1984; Knox and Pinch, 2006). Westernised thinking behind what a city is and what it should look like has changed significantly over time in relation to broader political economy and academic paradigm shifts. To begin, the seminal work of Mumford (1937) titled 'what is a city?' has gained significance, particularly in urban geography and planning studies, as a foundation towards more contemporary thinking of the city. Mumford (1937) introduced a social element to the theorisation of the city, moving beyond the fixed measures and reducing cities to population size, density and attributes of the built environment. These were deemed inadequate by Mumford (1937), arguing that cities are social dramas. The metaphor of theatre is used in his work and runs as a narrative in current work on urban settings. For Mumford (1937), cities are the stage in which people play out their social interaction, enriched by diversity in people, education, commerce, art and other institutions found in cities. Understanding the seminal work of Mumford (1937) here underpins the ideas of more recent analysis, proving that new farmworkers are indeed novel yet built on principles set decades before. Hence, cities have long been sites made up of institutions such as government citadels and economic markets but conceptualisation and planning has strongly recognised and included community.

Soja (1980) argued that cities have a socio spatial dialectic meaning; people change the place (the city) as they live and work, yet the place conditions their behaviour. Cities have a two way process where social relations are constituted, constrained and mediated through the city. The fundamental link between people and place goes beyond Mumford (1937) and has been taken up by urban geographers such as Harvey (1973), Dear and Wolch (1989) and Knox (1994). This thesis, in its efforts to understand the city, embraces the connection between people and place through the post structuralist lens taken in much of the human geography literature (Knox and Pinch, 2006). The approach strongly opposed the idea that the world or in this

case the city can be explained through one single hidden underlying structure (Duncan, 1980; Knox and Pinch, 2006). This research suggests that cities have numerous shifting and unstable dimensions that we should understand as evolving and changing. Ingersoll (1992) stated that cities are almost impossible to describe, noting that they are not as they used to be with physically defined boundaries, usually a wall; instead their boundaries are increasingly ambiguous with flows of people and capital permeating their geographically defined boundaries. Over the last 30 years, there has been significant economy changes which have led to urban restructuring and the way in which we can conceptualise our cities (Knox and Pinch, 2006). Economic change has been one of the defining factors in the trajectories of cities; propelling those cities that are able to capture and nurture high value creating activities and leaving other cities behind having to pick up low value activities (Sassen, 2006a). The most significant change has been the shift in cities being dominated by manufacturing activity to being dominated by service sector activity. In short the change has been driven by the wider changes in political economy and in the post Fordism era where mass production fell to more flexible methods of production and organisation (Piore and Sable, 1984). Table 26 summarises the main economic changes and as a result, the main characteristics of the city for that era.

Table 26 Changing contexts and cities

Economic context	Main Characteristics
Preindustrial cities	Small Scale waling cities Vertical differentiation based on social divisions Core - elite of the city Periphery – mass of population
Industrial capitalist city	Fordism paradigm Dominated by mass production and consumption Rigid production systems Elite migration to periphery or suburbs Poor/working class occupy inner city
Post Fordism to flexibility	Increasing use of technology in production Flexibility in workforces Deindustrialisation of cities Move towards service based economy New industrial spaces – clusters
Globalisation	Emergence of global cities and global command centers (Sassen, 1997) Knowledge economies and information cities Intensified social polarisation Increased competition between cities

(Adapted from Knox and Pinch, 2006)

Sassen (1997) argues that ICT has played a significant role in the development of cities and what we have seen more recently is the emergence of global cities. Global cities are characterised by social polarisation, presence of large financial institutions, multinational headquarters, a stratum of well-paid workers. It is the people who in turn demand particular consumer services and provisions such as restaurants, shops and bars that in turn utilise large number of low paid workers. Hence, there is a cycle in global cities feeding a growing inequality. Sassen (1991) argued in her work that with increased globalisation and adoption of ICT, the global

capital is becoming increasingly reliant on global command centres of the world. These are places where large financial institutions exist such as London, New York and Tokyo. Based on Sassen (1991, 2006a) and Beaverstock *et al's*, (2000) analysis and characteristics of global cities, Liverpool does not represent a high-ranking global city able to call upon the resources of alpha cities such as London or New York. According to GaWC (2012) the classification of world cities places Liverpool in the lowest category of sufficiency of services. GaWC (2009; 2010) state that the sufficiency of services category 'are cities that are not world cities as defined here but they have sufficient services so as not to be overly dependent on world cities. Two specialised categories of city are common at this level of integration: smaller capital cities, and traditional centres of manufacturing regions'. Liverpool's rank in GaWC ranking has fluctuated, beginning in 2000 with sufficiency of service, becoming unranked in 2004 before entering again in 2008 with sufficiency of service. It was only in 2010 that Liverpool was ranked as high sufficiency of service, maybe reflecting the recent 2008 European Capital of Culture and EU Objective One stimulus taking effect. However, Southern (1999:13) argues that the global cities framework does little to explain the roles of those places that cannot call upon the resources, or centralised activities of global command centres. The work that has been done surrounding global cities focuses on focal cities in the global economy, arguing that that peripheral cities are left to pick up what is left, such as back office activities that can be done over greater distance (Sassen, 2006a). The framework does not help to explain the precise role of non-global cities but allows us to place the city of Liverpool into a wider context and thus answers the question raised by Southern (1999) as to what is the role of northern English cities, or for this thesis, how can a city such as Liverpool host two innovative and dynamic industries one of which requiring large amounts of capital not found in the local; and both requiring a labour market of highly skilled innovative and creative people we typically find in global cities (Beaverstock *et al*, 1999; Scot, 2000; Cook *et al*, 2011; Faulconbridge *et al*, 2011).

The study of the city has drawn many scholars to use metaphors to help with the imagined geographies and processes in the city. Following the narrative of this

thesis, using the metaphor of the ecology to understand the life science and video games industry in Liverpool, this final chapter will look at the city through the anatomy of the city framework (Cohendet *et al*, 2010). Knox and Pinch (2006) highlight that many social scientists have used similar metaphors describing the city as a body; a living organism with a system, with a hierarchy of cells and circulation through various arteries; often portrayed as sick or unhealthy. Cities have been referred to as networks defined by a conjunction of many overlapping webs of social and economic interaction. More recently, ecology has used as more holistic and adaptable narrative in order to capture the environment of cities, and the multiple industries and people within it (Howkin, 2010). However, the use of the ecology metaphor is abstract and developmental with few conceptual or empirical underpinnings. Yet as shown in Chapters Two, Four and Five, Grabher (2001) provides a heterarchical underpinning derived from the biological sciences. Hence, utilising metaphors commonly seen in biological sciences and evolutionary biology help us to make sense of how the processes of the city can be imagined. This chapter will use empirical investigation to show the interconnectedness between firm ecologies and place. Following Soja (1980), not only is there a dialectic between people and place but also the industry and place. People make up the workforce, firms and institutions found in cities, and are conditioned by and influence by place. This requires a framework that does indeed focus on the city, both on the people and the physically built environment, but it can also be used to understand the city in relation to particular industries. The following section will briefly revisit the anatomy of the city framework outlined in Chapter Two and apply this to the city of Liverpool in regards to the two industries.

6.2 Anatomy of the City

Cohendet *et al* (2010) proposed the concept of the anatomy of the creative city, focusing on three layers, the upper, middle and under grounds. In the previous two chapters this thesis has looked at the heterarchies of two industries, focusing on the firms that make up the Liverpool ecologies. The heterarchy approach provided

answers to research questions one and two focusing on the two ecologies, but does not focus directly on Liverpool itself with the exception of tags. What is proposed in this chapter is the application, critique and modification of Cohendet *et al's* (2010) conceptualisation, which is based on three layers that constitute the anatomy of the city. The framework will be used to investigate infrastructures, institutions and actors that make up the city of Liverpool. The framework emphasis, both on the city and the industry ties the two together, rather than seeing one as privileged over the other. Whereas the primary focus of the original conceptualisation is on creative cities, this chapter will use the frameworks fundamental theoretical underpinnings outlined in Chapter Two, to look at what the anatomy of the city looks like for both the creative and science ecologies. There have been several papers on the video game industry building on this concept but focusing on creativity (Cohendet and Simon, 2007; Cohendet *et al*, 2010; Grandadam *et al*, 2013). For the life sciences there have been several publications that suggest a set of characteristics needed in order to replicate a successful ecology of such firms with processes of learning and innovation (Zucker and Darby, 1998; Powell *et al*, 1996, 2002; Cooke 2001, 2004, 2005; Feldman and Francis', 2003; Gertler and Vinadrai, 2009; Nilsson, 2001, Lowe and Gertler, 2007; Moodysson *et al*, 2008). These studies have been done at various points in time and have tended to focus on key issues in rather large life science clusters, predominantly in the USA, Cambridge (UK) and Scandinavia. Missing from the literature, is an examination of an emerging and relatively smaller agglomeration of firms in an English city, beyond the main corridors of the South East and London, as well as using the anatomy of the city framework on a life sciences industry. The aim of this chapter is to examine the upper ground and undergrounds, but crucially, to develop an understanding of the composition of the middle ground, particularly involving the degree of institutional presence. Furthermore, we can then explore what the middle ground does for both industries. Although the anatomy of the city concept is relatively new, theories and recognition of institutions at various scales are not (Amin and Thrift, 1994, 1995; Giordano, 2001; Peters, 2011; Suddaby, 2010; Bruton and Ahlstrom, 2010).

To enrich the conception of the middle ground, the chapter will introduce the concept of Institutional thickness as a theoretical perspective on how institutions can play a role in the economic development of cities and supporting industries (Amin and Thrift, 1992; 1995). Institutional thickness is defined as 'explaining the possibility of place centeredness, that is local agglomeration within global production filieres, particular emphasis is given to the role of certain institutional conditions, ranging from strong local institutional presence through to the strength of shared rules, conventions and knowledge' (Amin and Thrift, 1994:2). The theory of institutional thickness has been applied and critiqued for some time now. However, the fundamental concepts on which it is based still resonate in through the theorising of a middle ground in this framework. The idea of share rules, convention and knowledge have strong links to the ecological perspective outlined in Chapter Two and used in Chapters Four and Five. Grabher's (2001) conceptualisation of 'tags' highlight share conventions and norms practiced daily within the ecologies amongst firms. Although the literature on institutional thickness can overemphasises the role of formal institutions, informal or self-organising firms or institutions share some of the characteristics and process of institutional thickness. Equally, we are in a time where cities and regions are seeing the roll back under austerity measure imposed by the current conservative government. The role back has seen a thinning of institutional presence in particular places (Henry and Pinch, 2001). Amin and Thrift (1994, 1995) argue that there are four organisational components and processes to institutional thickness in the locality. Henry and Pinch (2001:1174) outline factors as:

- (1) A strong institutional presence of a plethora of diverse institutions such as firms, training centres, government agencies, trade associations, marketing boards, etc;
- (2) High levels of interaction amongst the institutional network in the locality, which may, in time, constitute a 'social atmosphere' of shared rules, conventions, and so forth;
- (3) Structures of domination and patterns of coalition, which result in the gain of collective representation and inhibit rogue behaviour;

(4) A mutual awareness of a common enterprise or 'industrial purpose' amongst participants and institution, so this common enterprise may be extended and supported, by various wider sets of regional social structures such as ethnicity, sexuality, regional identity, gender, etc.

(Henry and Pinch, 2001:1174)

In outlining these organisational components and processes, they are analogous to the ecological approach taken in the previous chapters. Both the ecological and institutional thickness approaches identify diversity as a key factor contributing towards the development and survival of particular industries (Grabher 2001; Henry and Pinch, 2001). Diversity involves many different firms providing different inputs but also a variety of institutions supporting or complimenting aspects of the production process and becoming a part of the anatomy of the city. High levels of interaction, involving formal and informal communication through various mediums such as face to face or email, are again analogous to rivalry and projects in the ecologies framework (Grabher, 2001). High interaction on a formal and informal basis between actors and/or institutions is key in institutional thickness but also in ecologies to enrich the diversity in the genic pool. Institutions can act in similar ways in order to learn and adapt to changes in the economic environment. In addition, projects allow some elements of rivalry to be dampened, allowing cohesion in the ecology and mutual existence. This is reemphasising the socio-spatial dialectic in which cities condition behaviours, but equally the practices, routines and norms become part of the city's institutions and way of thinking, thus informing the physical infrastructures needed in order to support these interactions. Having a common understanding or awareness of enterprise or industrial purpose, links to the tags feature of heterarchies in the ecology approach. However, the ecological perspective used in previous chapters is insufficient to fully explore the geographical context, institutions and infrastructures in Liverpool. Therefore, the anatomy of the city framework, complimented by the institutional thickness concept, answers research question three in much more detail. Equally, institutional thickness alone would not fully explore the infrastructures of a particular place; focusing solely on the institutions, whereas the anatomy of the

framework meets the gap. Additionally, there is the link between using the anatomy of the cities framework complimented by institutional thickness and the previous ecological approach as noted above. This justifies and gives grounding to the metaphors being used to look at both industries and cities in this thesis.

More recently, Glaeser *et al* (2010) have begun to raise further questions regarding entrepreneurial activity in cities and the need to investigate the structures and institutions, aiding or constraining levels of entrepreneurship. As this thesis focuses on the middle ground which is composed of institutions, institutional thickness can provide to key insights into the role of connectivity and articulation within localities. Hence, we can determine the intuitional thickness or even thinness (Henry and Pintch, 2001) of the middle ground for both ecologies and the processes towards institutionalisation that lead to thickness (Amin and Thrift, 1995). Overall, this thesis would argue that the anatomy of the city framework, complimented by institutional thickness, becomes theoretically holistic in that it is not overly focused on institutions and the physical attributes of the city but includes an upper and underground recognising people and the firms in the city, supporting a socio-economic spatial dialectic (Soja, 1980). Supported by the previous arguments and a poststructuralist epistemology, this thesis like any other study of the city, has to recognise a plethora of people, institutions, organisations, firms and infrastructures.

6.2.1 A Video Game Ecology in the Anatomy of City of Liverpool

Cohendet *et al's* (2010) work centres on the anatomy of the creative city using the empirical investigation of Montréal's video game industry. Existing literature, specifically on agglomerations of video games firms is still emerging. Previous studies have focused on aspects of the entire industry, leading multinational firms or places that are key sites of video game activity such as the USA and Japan (Aoyama and Izushi, 2003; Broekhuizen *et al*, 2013; Cadin and Guerin, 2006; Subramanian *et al*, 2011). There is a growing body of literature on other creative or cultural industries, as they make up a significant proportion of advanced economies (Hartley, 2005). Creative industries describe the conceptual and practical

convergence of the creative arts embedded in individuals with the cultural industries that bring products or service to the masses (Hartley, 2005). Scott (2000) argues that with increasing disposable incomes comes an increase in the consumption of cultural goods of all kinds. Given that creativity is embedded in individuals and that cities are places of dense interactions and expression between individuals, cities have become sites of creativity in a new global capitalist cultural economy (Knox, 1995). Much of the literature on cultural creative industries is focused on the larger agglomerations in cities such as London, Paris and Tokyo (Tay, 2005), however there are publications on other cities such as Manchester and Vancouver (Johns, 2011; Coe and Johns, 2004). It is the larger global cities that have had an evolved critical mass and ability to attract creative talent (Sassen, 2002). Creativity, as seen by Scott (2000) and Cohendet *et al* (2010) emerges out of the geographic milieu and production system, making creativity an inherently local process. It has been a long standing argument that creative industries and cities are interlinked (Salais and Storper, 1993; Scott, 2000; Tay 2005; Thrift, 1994).

'In cultural-product industries, the connection [between creative industries and cities] has special significance because of the intensity and idiosyncrasy of the relations between cultural attributes [museums, art galleries, cafes, restaurants etc.] of place and the qualitative aspects of final outputs' (Scott, 2000:4).

Equally firms in these industries tend to agglomerate to facilitate ongoing interactions and speed the pace at which projects are completed (Cook *et al*, 2011). Given its tacit nature and the more emotional and inspirational aspect of creativity, face to face contact has been seen as routine among many creative industries (Grabher, 2001; Johns, 2011, Cook *et al*, 2011). So this close contact will mean that intense learning is most likely to be in evidence. On the job portfolio working and know how learning practices dominate the industry (Hartley, 2005). Linking the practices and techniques needed in such industries, but also the emotive content of production. This section has shed some light on the fundamental factors that have

emerged in creative cities. The following section will explore the three layers that make the anatomy of the city for a video games ecology.

Upper ground

Cohendet *et al* (2010) and Grandadam *et al* (2013) work adds towards the academic literature on the video game industry and cities in particular. Their work centres on established agglomerations of video game firms situated in cities that have several leading multinational firms and a community of independent SME's, in turn making a vibrant community of creative firms and people. However, both papers are focused on Montréal, Canada. One of the differences between the existing literature and this research based in Liverpool, is rapid change in the composition of the ecology, due to the departure of multinational firms and high number of new firm start-ups. Cohendet *et al* (2010) observed that in the Montréal video games cluster, Ubisoft (a French developer and publisher) acted as an anchor firm (Feldman, 2003), fostering the creation of service organisations and video game start-ups. There is one striking difference between the Montréal gaming cluster and what this research observes in Liverpool. Montréal has been the focus of much institutional intervention through public policy aimed at attracting firms and developing a video games cluster (Pilon and Tremblay, 2013). Pilon and Tremblay (2013:1) argue that 'in Montréal, it is the public policy contributing to financing jobs in the Multimedia City and the French language that brought Ubisoft to the city; this contributed to make the city well known in the field, creating a "brand" for the city and thus fuelling the cluster development'. Compared to other video game agglomerations, like in Los Angeles and Liverpool, there has been far more state intervention and support rather than grassroots developments or growth through cross fertilisation with other creative industries.

Over the years, there have been several successful start-up firms, enriching the diversity in the Montréal ecology, again supported by financial programmes aimed at job creation and enterprise developed by the Quebec Government (Pilon and

Tremblay, 2013). The presence of such a large and well know publisher, ranking in the top 10 global firms (see Chapter Five), also attracted other large publisher/developers to locate in the cluster in order to take advantage of the service organisations and other institutional intermediaries. Within the cluster, there are also professional associations with over 400 members (Grandadam *et al*, 2013). It has been the case that people from the Liverpool ecology have move to Montréal after the closure of the big studios.

'Most people went to other jobs in the UK or to Canada, there's opportunities in Canada for game development, EA and Ubisoft have some big studios over there, basically because they can employ hundreds of people and see some good tax breaks for that' (Interview Developer 8, 30/11/11)

In the Liverpool ecology, the multinational firms (before their exit in 2011) did act as a hub, with several smaller firms being able to take advantage of externalised projects (Markusen, 1996). Linking back to Chapter Five, the MNE wanted to minimise the number of connections they have to manage internally. Utilising the outsourcing firm, work began filtering through to other firms in and beyond the ecology. Cohendet *et al* (2010) outlined a similar mechanism used by multinational firms but the configuration used a brokering firm rather than a dedicated outsourcing firm. The current composition of the Liverpool ecology owes its diversity and composition to the closure of the large studios in the upper ground, but the ecology has a long history, as outlined in Chapter Four. The last five years have seen a growth in the number of video game firms within the ecology and their geographical pull towards one particular location in the city, the Baltic Triangle development zone.

Bathelt (2004) observed a similar phenomenon in the Leipzig media cluster in Germany. He argued that forced entrepreneurs are those who have suffered from a job loss resulting in self-employment. Fraser (2004) termed this phenomena survival self-employment, whereby the founders' initial concern is to provide an income to

support themselves and/or a family. Many entrepreneurs' start-up firms as a means of self-employment doing what they have been trained to do.

'So we basically formed that immediately after Bizarre Creations was closed, so February this year, yeah, so Bizarre was closed on the 18th February and pretty much the Monday after, so the 21st we were, we were up and running, kind of! Without any contracts or being able to pay staff, a group of us just decided like you know we'll start a new company, we're not going to get paid, so we'll do it, we'll give ourselves like three months of not getting paid to kind of see how things go basically, and try and win a contract.' (Interview Developer 8, 30/11/11)

As the business grows they begin to take on people. As mentioned in Chapter Five, firms were using savings and redundancy money to fund the initial start-up (Rouse and Jayawarna 2006). Bathelt (2004) argued that this group are among the firms with the lowest sales figures as they are not concerned with high growth. We can also observe spin offs from a former firm. These are firms who leave an established organisation by their own choice to form a new venture. Usually the large firms are considered as focal firms that are globally connected and significant actors in the local economy where they are situated (Sassen, 2006a). This is not to say that small businesses produce the same types of people. Entrepreneurs, in this sense, have a vision that they wish to capitalise on themselves, away from the focal firm (Edmiston, 2007). This exemplified by the outsourcing firm who stated:

'So I spotted an opportunity and though, do you know what, I can, we can do this. I was at a time at Sony where either if I didn't do it there and then I would never have done it, and a lot of people always want to set up their own development teams and make games, in the current climate I thought to myself that's probably not the best thing to do, because it's high risk, and I thought, well do you know what, if I set myself up as a service provider, outsourcing is happening, the developers and the publishers need outsourcing, they can't manage it, and it's a very similar model to the film

industry, where they bring the most talented writers, script designers, costume designers, lighting people and cameramen together, they do a film and then they all go their separate ways ...' (Interview Outsourcing Firm 1, 11/01/12)

In some cases they may become a supplier to the focal firm. Firms that are formed through the spin off process involving a successful firm, generally have routines inherited from the previous firm that can in essence breed further success (Klepper, 2010). The owner-manager generally selects the best practice or improves upon the bad practices of his or her previous employer. These have been characterised as leaks from master firms or inherited characteristics. It is the local success of established firms that “breed” further success (Klepper, 2010; Dahl *et al*, 2011). Given the project based organisation and shorter timelines of projects compared to the life sciences, there is an increased need to explore new trends and develop new ideas. The large firms were making use of the existing pool of talent and since their closure SMEs have been able to cherry pick from the labour market. In opposition to Grandadam *et al* (2013) who suggests that larger firms take the lead in organising events, what we are seeing in Liverpool is that the smaller firms who are self-organising, see a sense of urgency to bring the firms together. Events such as the Indie Show Case network are essential to revive and refresh the creative process by opening small worlds to global stages.

Underground

Florida (2005; 2008) argues that cities need a creative class to provide a form of knowledge externality for firms. This is done through having a concentration of high skilled individuals. In relation to the anatomy of the city, these individuals can be found in the underground. These individuals have a shared interest in their activity which defines who they are. The underground can be the source of labour for the firms in the upper grounds. They can seek to internalise those who seem to be on trend and provide novel ideas. However, as Markusen (2006: 1932) states ‘ raw

agglomerations of artists and members of related occupations do not ensure that synergies develop among them, or that their ranks will grow over time'. Focusing on who these people are ignores the need to look at the context they are in and how relationships between firms, institutions and even individuals can be built (Cohendet *et al*, 2010; Florida 2005, 2008). In the Liverpool ecology the departure of all three large firms has left a pool of talented video game developers. As Feldman and Francis (2003) argued in life science agglomerations, the current diversity in the video games ecology in Liverpool has been caused by the closure/downsizing of MNE operations.

Middle Ground

As the upper ground has highlighted, there are no dedicated consultancy firms in the ecology. Instead the city hosts a variety of physical assets that have been used by those in the ecology. A large number of cafes, bars and restaurants are deemed supportive in creative industries and cities by providing space for exchanges and relationships formations (Scott, 2001, Cohendet *et al*, 2009; Cook *et al*, 2011, Gleaser, 2010). However, the video game ecology in Liverpool is situated predominantly in a local development agency led initiative named the Baltic Triangle. This is located close to the water front in the historical port area. It is a brownfield development of several warehouses. Amin and Thrift (1994, 1995) argued that a shared initiative, or common project, is likely to foster more coherence and mobilises the region more effectively. The Baltic Triangle project aims to develop a site for creative industries in order for those industries to locate and grow with the potential for cross fertilisation. This adds to the outcomes of successful creativity and institutional mechanisms that are fundamental to the constitution of production and exchange of relationships (Cook *et al*, 2011). Cook and Johns (2011) have studied the film and TV industry in Liverpool and noted the Baltic Triangle as a unique development site for creative activity. The area makes up a significant part of the middle ground with the aim of fostering connectivity between varieties of different creative industries.

'Imagine an area where musicians rub shoulders with photographers, artists, fashion designers, digital agencies, architects, film-makers, young entrepreneurs, recording studios and there's a bunch of drinking holes and eateries, nightlife venues, internationally acclaimed arts festivals and galleries to drop-by on. That's us... Quietly, under the radar, just getting on with our stuff' (Baltic Triangle, 2013).

Figure 16 and 17 shows the area the Baltic triangle covers and a photograph showing the types of space that is available.

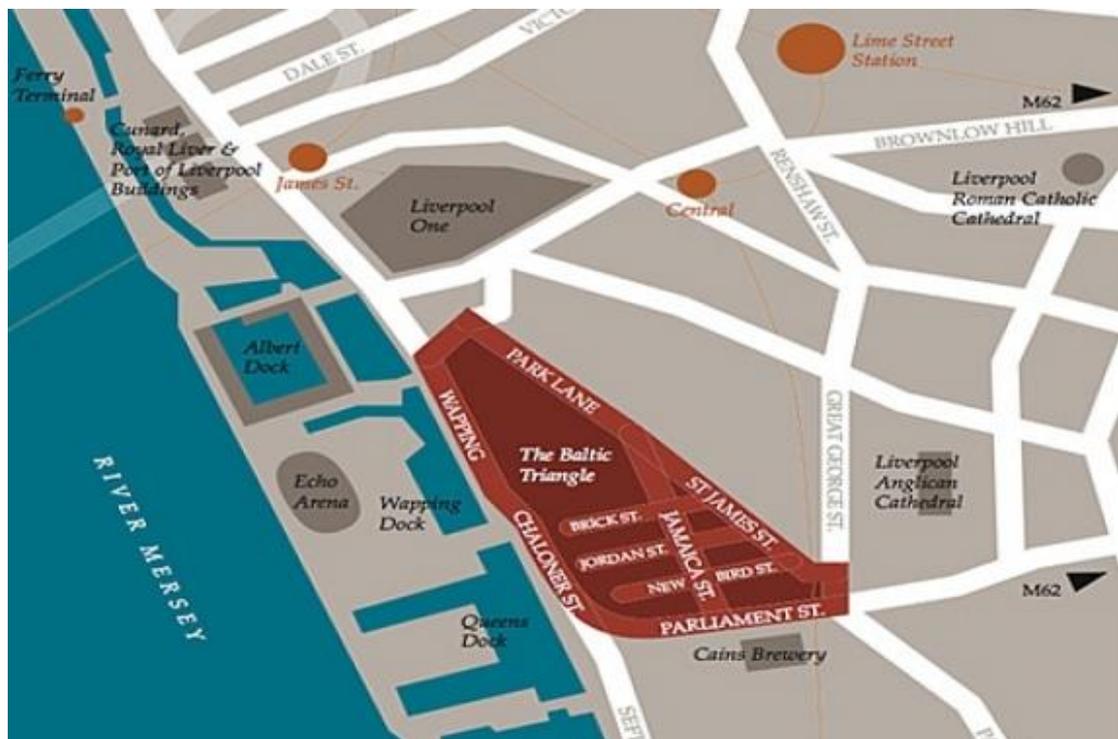


Figure 16 Baltic Triangle Map



Figure 17 Baltic Triangle photo and studio space (Baltic Triangle, 2013)

The aim of the £12 million project was to deliver a space for Liverpool creative firms to locate at lower cost. As the lead development agency Liverpool Vision stated:

'a lot of people were coming to us and saying, I just can't get into the City Centre anymore - the journey has been very varied, but one of the things we do is support and I was heavily involved in the capital of culture bid and I wrote significant parts of it and this is why I was so pissed off by the lack of music industry consideration and the success of the capital of culture was great and the City Centre boomed, but this also meant that a lot of people moved their premises especially where we were around Bold Street and Concert Square area, the Landlords like a flash increased their rent – I mean that is what Landlords... in inline with where is trendy they think actually, we can charge a bar 10 times what we are charging a business and that is not good news for any company and we were hearing a lot of this. Then there were was a lot of room around the Baltic, links to the Biennial so people started talking about it saying, you can't do that, so we paid for a demand study along with the Arts Council and this came back saying yes, the creative industries are going to grow and there is a lot of demand for cheap space and there isn't a lot of cheap space at the moment' (Interview Development Agency 1, 21/06/13).

Empirical investigation drew attention to the Baltic Triangle development as the place video game firms had chosen to locate. The low cost office space and short term lease agreements suits the young firms using a limited pool of resources. The development agencies who also occupy the middle ground supported and focused their efforts on business networking and support in this area.

'I mean if I go for a meeting down there, in the Camp and Furness, I can guarantee that I won't be able to get away without bumping into another business, and that must be a result if people can get work like that – getting work that they wouldn't have otherwise got. Lots of networking happens down there – there is the Baltic Creative Showcase on Monday and then

there is our Accelerator programme' (Interview Development Agency 1, 21/06/13)

Key processes supporting agglomeration and the impotence around shared space and close proximity have been identified across many studies of the cultural and creative industries. Scott (2001) argued that the close proximity of creative firms allows for action to be done in much shorter time scales. Grabher (2004) adds that it also provides cognitive proximity on shared projects, again reducing time and increasing a sense of community. Cook *et al's* (2011) study of the Television and film industry in London showed several key benefits of agglomeration. Topping their list and concurrent in other literature was the need for face-to-face contact. This allows for the emotive characteristic of creative projects to be conveyed thoroughly through face-to-face interaction. Relationship building is also essential to trust and reciprocity in the creative industries (Scott, 2001; Hartley, 2005).

'It is because cultural artefacts are being created which convey meaning, emotion and information Accordingly it is of paramount importance that those engaged in their production understand the meaning which is to be conveyed. In order to come to that understanding, communication with the maximum 'bandwidth' is required: face-to-face contact' (Cook *et al*, 2011:2924)

Although there have been fewer cases of collective projects involving a plethora of firms in the Liverpool ecology, there is a perceived benefit for being with those firms who are in a similar position. There is a community of 'we are all in this together'. As mentioned in Chapter Five, a limited number of firms have tried to look for inputs within the ecology through cross fertilisation with music producers and animators but during this research were unable to. However, what still holds true is that face-to-face contact is important as well as relationship building with skilled workers. It was noted in Chapter Five that one developer travelled to a music producer in order to reproduce some of the agglomeration externalities.

Returning to Cohendet *et al's* (2010) concept, there was a need for spaces in which firms can locate but also the spaces in which individuals can explore away from the commercialised world of the upper grounds. The Baltic triangle offers such space with a number of bars and restaurants located within and around it. This invites in a new wave of individuals who may wish to seek to express or validate their ideas. Having a middle ground, such as the Baltic triangle, with many of the facilities outlined by Cohendet *et al* (2010) increases the probability of firms being able to see ideas begin to develop into opportunities for commercialisation. As Scott (2000) argues, the need for close interaction in creative industries increases the likelihood of synergies, as the critical mass of creative firms grow in this area. As one developer noted:

'The group of guys who I wanted to start the company with, they were keen on staying in the area [Liverpool] because they've got family and kids, all the practical kind of things. But then also it's a good city to start a company because, a games company especially, because it's got great nightlife, it tends to be younger graduates who come into a games company, so it's good for attracting graduates. And also it's cheap to have an office as well'
(Interview Developer 8, 30/11/11)

As well as the night life and Baltic Triangle there are other features of the city that could be included in the middle ground. Although the research participants did not single out any of the city's cultural assets, they did acknowledge them as integral to the quality of life and vibrancy of the city. Other public assets include the museums, art galleries, shopping and leisure activities. These are places in the anatomy that add to the experiences of those working in creative industries. Returning to the debate on institutional thickness, Table 27 shows where the video games industry meets the favourable conditions of institutional thickness set out by Henry and Pinch (2001).

Table 27 Outcomes of favourable institutional thickness condition

Institution Thickness Outcome	Observation
Institutional persistence – local institutions are reproduced	<p>There has been less institutional support and direction for a video game industry in Liverpool. The NWDA has provided broader creative industry support along with North West Vision and Media. Both organisations have since been disbanded.</p> <p>There has been a self-organised virtual institution produced known as North West Indies, a closed network through which members can share information and advertise for various inputs.</p> <p>Liverpool Vision has been one of the largest champions of the sector since the NWDA demise. They have provided business support and were heavily involved through Liverpool ACME in the initial development bid for the Baltic triangle.</p>
Archive of common held knowledge (formal and tacit)	<p>Liverpool does have three universities, all of which offer computing related courses that can enrich the labour market. There are cases in the ecology where firms have taken on graduates and also interns from the universities.</p> <p>More recently there has been the development of the UTC with a specific Studio School tailored towards the video game industry. This strengthens the ties between industry and academia with curriculum development involving the</p>

	<p>school, universities and industry. This further enriches the ecologies labour market and potential for new ideas to be yielded from such centers.</p>
<p>Institutional flexibility – ability to learn and change</p>	<p>There is limited evidence to support the change in institutions towards the video games ecology. The firms themselves have changed and responded to market pressures and the lack of institutional support.</p> <p>Liverpool Vision has undergone considerable change with its focus turning towards marketing the city and business support. The institution has recognised the changing needs of firms and the development of the Baltic Triangle but has also undergone significant cuts in funding.</p>
<p>High innovative capacity – region and firms within it</p>	<p>There has been innovation in the business models of the video games firms. Many of the new startup firms have moved away from triple A game design onto mobile application development. There is a firm that is capitalising on the increasing need for inventive ways to analyse game play and feedback mechanisms.</p> <p>The innovation is based the firm’s own experience and capacity to drive new ideas to the market.</p> <p>Additionally, as noted in Chapter Five, many firms have found themselves in cycles of contract-based work in order to keep their businesses alive rather than focusing on</p>

	<p>pure development of new games and software. This can be seen as a distraction from innovative practices and rather a means of survival employment.</p>
<p>Trust and reciprocity as a behavioral norm</p>	<p>There is a collective atmosphere of firms being 'in the same boat' describing their feelings towards being made redundant and venturing onto a new enterprise. Trust has become a behavioral norm with the video game industry and broader creative industry. For Liverpool, the collective support to organise conferences and have informal conversations is partly the way towards building relationships and deepening the trust. It is documented in this thesis that many of the new firm owner managers formally worked together in one of the three larger studios. Hence, inheriting already developed relationships and levels of trust. Some firms have used these practices with connection beyond the ecology.</p>
<p>Common project that serves to mobilise the region in an effective manner</p>	<p>The Baltic Triangle development is a collective project aimed to house the creative capacity of the city. Although there is no evidence from this research that firms within the ecology are cooperating on a collective project, repeating arguments above, there is a collective mind set amongst the new firms having previously worked together.</p>

The Baltic triangle has been a key development as a physical asset; it is supported by many institutions at various scales and adds to the institutionalisation process

leading to institutional thickness. The Baltic provides a focal point on which firms in the creative industry can gain access to those with experience in access resources as well as to create a local buzz. The development is small in comparison to other public/private intervention lead strategies such as Media city in Salford, yet it has great significance in the video game ecology as a formal and informal place of interactions which hosts a large proportion of the entire ecology. Furthermore, the video game industry in Liverpool has begun to develop virtual networks such as the North West Indies where developers can post and advertise particular demands for inputs or share knowledge. The virtual institution came about after the closure of the multinational firm in 2011 and was established by a former employee, who at the time, had just set off on his own business venture. Cohendet *et al's* (2010) framework does not consider virtual spaces as part of the middle ground. Given the technological capabilities of this sector and the success of the developer's efforts, it makes sense to include this into Liverpool's middle ground.

'[North West Indies] was initially just a private mailing list for people to just e-mail round and help each other. And it kind of spiralled bit, you know, people told people and people told people. At the minute ... And then we started to get a little bit of kind of proper coverage you know, it was in the Liverpool Post, Euro Gamer did a feature on what happened after Bizarre closed and they were interested in hearing about North West Indies, so I was featured on one of their video presentations they do. We're in touch with a couple of other little journalists and stuff. But you know we've been in the paper a couple of times. And now it's, I think there's like 60 of us representing a, there's over 30 companies' (Interview Developer 9, 13/12/11)

The video game ecology in Liverpool, as mentioned in Chapter Five, has been able to embrace the virtual spaces and extend interaction into this space. Within the anatomy of the city, virtual spaces are equally as important for creative capacity building and as a mediating or brokering facility between those who seek to commercialise into the upper ground and those looking into the underground for

new opportunities and project inputs. Hence, virtual spaces in the middle ground become an integral part of connectivity between an underground labour market and of ideas to that of the upper ground commercialisation and coordination of projects. The following section will outline the anatomy of the life science city before the chapter will look at the two anatomies in one place.

6.2.2 A Life Science Ecology in the Anatomy of City of Liverpool

The life sciences ecology is configured differently to that of the video game ecology. Fundamental differences, which are highlighted in Chapter Four, include several subsectors that make up a life science industry along with the much longer product development timelines and the needs for significantly higher capital. This section will use the anatomy of the city framework in order to examine the geographical context in which the ecology is situated. The current literature has focused predominantly on clusters of life science activity, drawing out observations as to why such agglomerations occur. Common amongst these suggestions are the presence of star scientists in leading research lead universities (Zucker and Darby, 1998). Feldman and Francis' (2000) and Klepper (2010) argued that a large presence of government lead research institutions or a mixture with highly successful firms breed successful spinouts in areas that are well serviced by venture capital. Additionally, studies have drawn attention to leading clusters or mega centres (Cooke, 2004) such as Cambridge (UK) or Medicon Valley in Demark and Sweden (Moodyson *et al*, 2008). The following section will utilise the anatomy of the city framework for the first time on a life science ecology, complimented with the concept of institutional thickness.

Upper ground

In Liverpool, the life science upper ground has a diverse set of firms specialised in various life science related activities across the entire production network. Chapter Four provided in-depth analysis of the firms and the ecological composition. However, the upper ground is also characterised by the presence of institutions. In

the City of Liverpool there are several research orientated institutions, universities and more recently education and training facilities known as university technical colleges (UTCs) for people aged 14 to 19, underlining the commitment to the long term development of the labour market specifically for this ecology. Cohendet *et al* (2010) argue that one of the key contributions of firms and institutions in the upper ground is to provide the capacity to finance and unite many different types of knowledge and test new innovations in the market. Albeit the original concept focused on the creativity that is novel and cyclical in nature, meaning projects require less time and resources. The life sciences are the complete opposite in comparison. As mentioned in Chapter Four, the timeline for drug development can range from ten to fifteen years and diagnostic devices of up to six years, exploration to consumption (Zeller, 2001; Schweizer, 2005). Meaning an upper ground would have to be rich and diverse yet have a critical mass of specialised firms in one particular area in order to provide the means to explore and exploit within the city. This extends the role of the upper ground to one that integrates exploration, examination and exploitation.

Immediately, the framework is not as clearly applicable when situating the life science ecology into the anatomy of the city of Liverpool, using the clearly defined mechanism that works in a creative ecology. The concept's principles are not as easily transferable to an industry based on longer timelines with a highly specialised knowledge base. Another obvious reason is the difference in product development both in terms of time and resources. There is a clear detachment from culture in regards to this industry, placing more emphasis on economies of value, scale and scope. Novel trends and the exploration of new ideas do not emerge from an underground like in the process of creativity outlined by Cohendet *et al* (2009, 2010). Instead, exploration stems from peer reviewed validated institutions, such as the firms R&D functions and institutions such as universities and dedicated biotechnology firms (Cooke, 2005; Schweizer, 2005). In fact, we find these exploration capabilities in the upper ground due to the nature of the industry requiring high upfront costs in the research and development phase of a product's development and an extensive validating process, in order to ensure institutional

regulation can be met. In addition, the research and development firms that are in the upper ground in Liverpool do not have it within their capabilities to take a product through to consumption, instead they will take it only to mid approval stage before seeking out a licencing, merger or acquisition strategy with a larger firm. This is not unique to Liverpool but systematic of science cities in general, conditioned by the business models of life science firms. The barriers to entry make it hard for an upper ground in a life science city to be changed rapidly or see rapid development and renewal of the ecological composition over time. Cohendet *et al* (2009, 2010) also argued that the upper ground relies on communities of specialists in the upper ground in order to provide inputs into production processes. The research highlighted that firms in Liverpool require specialist firms to provide testing facilities for new products, product specific knowledge through access to academic journals, industry specific safety consultants and chemical compounds. As well as communities of specialists, there are requirements for business services within the city. Firms generally sourced aspects of security and facilities management within the city. Although not an essential input, in regards to the production of a new or existing product, they are important to the daily functioning of any business.

For the life sciences ecologies the majority of inputs were sourced from beyond the ecology, stretching the connectivity of firms and the upper ground. Emphasising the relation dimension of contingency, firms and place are increasingly influenced and reliant on other places (Bathelt and Glückler, 2011). It is here that the anatomy of the city becomes joined with other places through rhizomes and knowledge inputs, drawing and embedding these into the anatomy of Liverpool. Hence, unlike Cohendets *et al*'s (2009, 2010) original conceptualisation that paints an inherently localised anatomy of production and the learning process, the life sciences are reliant on highly specialised knowledge and must find the abilities and support to tap into the ecologies of global pipelines and buzz of knowledge (Bathelt and Schuldt, 2010; Moodyson *et al* ,2008a, 2008b).

Underground

The underground can be retained in the science city conceptualisation as a source of skilled and experienced labour. There can still be explorations here of products and services that may complement the sector. As Cohendet *et al* (2010) originally stated, firms in the upper ground can at times look to the underground for people to draw into their organisation. There is a two way process that occurs between the upper and under ground in a city hosting a science-based ecology; one of cross fertilisation. For example, the universities train and educate a large number of graduates, some of which will stay in Liverpool and enhance the labour market whilst others will leave and influence labour markets in other places. The life science ecology in Liverpool requires a variety of skills from the labour pool in order to help fulfil their own exploration and commercialisation processes in the upper ground. Cohendet *et al* (2010) originally argued that the underground primarily focused on exploration, disconnected from the commercialised world of the upper ground. Given the nature of this ecology in Liverpool and following wider industry norms, exploration is costly in terms of time and resources. Knowledge and validation of knowledge is key to the exploration and innovation in this sector. In Liverpool the place in which this activity occurs is predominantly within universities and a small number of dedicated R&D functions. As mentioned earlier, these are situated in the upper ground of the anatomy. Here, the underground can be extended into these places and can be conceptualised as being a part of education institutions and firm anatomy but heavily intertwined into the city. It is intertwined because it is the universities in the ecology that have the ability to train graduates who make up the labour market that also is included into the underground, but also the freedom to explore and validate knowledge without the pressures of the commercialised world.

Within the science city we have the clear distinction of the upper ground and who occupies this, but the anatomy becomes much more complex when understanding the underground in the life science ecology. Clearly the ecologies are situated and are reinforcing the position of the city through cross fertilisation. However, how do

those who explore meet the world of exploitation through commercialisation of knowledge? The next section will look at the middle ground and its role in connecting the underground and upper ground and bringing ideas to market.

Middle ground

Lowe and Gertler (2007) and Gertler and Vinadrai (2009) argue that successful life science agglomerations usually have a distinctive set of common factors and conditions. Such factors and conditions include well-funded research lead universities, effective commercialisation system, abundant venture financing, active industrial associations, star scientists, recruitment programmes and a wealth of experienced managers and entrepreneurs. They add that what is often ignored, are the institutional configurations supporting such an industry (p.590). According to Grandadam *et al* (2013) the middle ground acts as a broker that mediates between the upper and low grounds. This can provide us with further explanation about how the life science ecology is emerged and is supported. Parts of the visible middle ground in relation to life sciences can be seen in Figure 18. There are fourteen key assets highlighted in the city as well as plans to develop a biocampus in Figure 19. The biocampus would combine several research and clinical institutions shown in Table 28 and illustrated in Figure 19.

Table 28 Biocampus Partners

Institution	Role
University of Liverpool	Research lead university with an international reputation. Member of the Russell Group and key in the knowledge economy framework for Liverpool's economic development.
Liverpool John Moores University	Global reputation for excellence in teaching, research and commercial enterprise and technology transfer. Health and health-related research accounts for two thirds of research activity at LJMU.
Liverpool School of Tropical Medicine	First institution to dedicate research towards tropical medicine. Strong international research profile with over £159 million in research contracts. Huge contributor to the knowledge economy framework.
Royal Liverpool Hospital (rebuild)	One of the largest university teaching hospitals in the UK. Centre of excellence for research, development and innovation harnessing collaborative relationship with the above three research lead institutions. Incorporates a Biomedical research unit, the only one of its kind in the UK. Several specialist research areas including cancer and pancreatic disease.
The Clatterbridge Cancer Research Centre	UK's leading providers of non-surgical oncology treatments including pioneering chemotherapy, radiotherapy and proton therapy. Its location close to the above institutions is unique allowing cancer research, development and treatment to take place with specialists all in one area.

MerseyBio	Specialist incubator for micro and small enterprises related to life sciences. Provides laboratory and office facilities to house early-stage life science and technology companies at the heart of Liverpool's Knowledge Quarter. The incubator is supported by a dedicated team, 2Bio, who manage the facilities' operation on a day-to-day basis and can also provide technology commercialisation, intellectual property strategy and due diligence and market analysis support.
Liverpool Science Park	Similar to the above, the science parks offer a wide range of spaces and facilities in the Knowledge Quarter. Home to over 70 firms, some of which have been attracted from overseas. Firms range from established to early start-ups.

(Source: Company web sites and Liverpoolbiocampus.com, 2013)

This can be seen as a step towards creating a more coherent and dense middle ground where public health organisations, universities and industry can interact and create a climate like that of a middle ground outlined by Cohedent *et al* (2009, 2010).

merseyside life sciences cluster

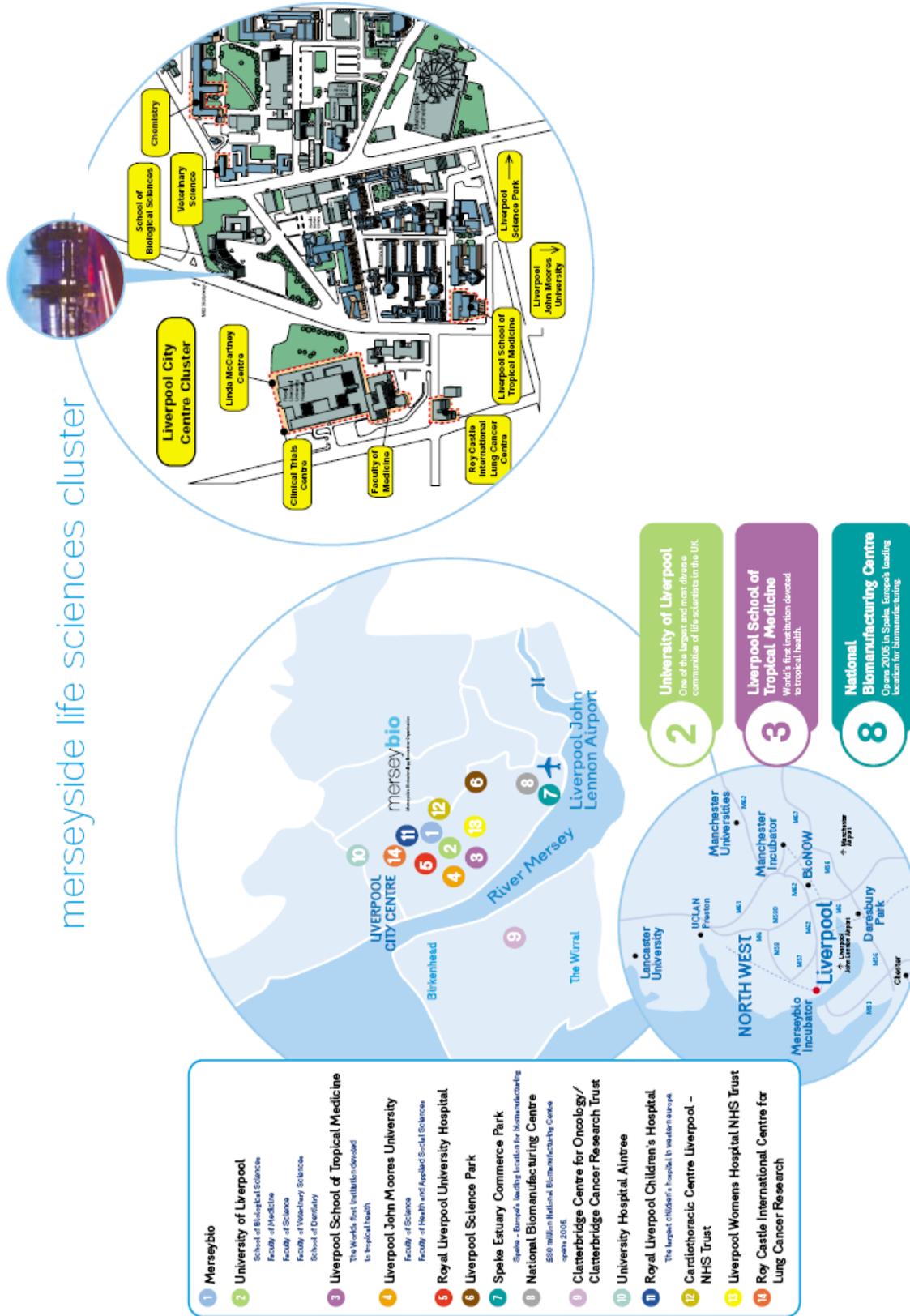


Figure 18 Public assets in the Liverpool Life Science Ecology (MerseyBio.com, 2012)

Over the last decade the Liverpool ecology and partially the anatomy of the city has been influenced by one institution in particular, the North West Development Agency (NWDA). Other institutions include Liverpool city council and Liverpool Vision. The NWDA took a regional approach to the life sciences ecology in line with current policy and academic thinking, focusing on regional competitive advantage (Amin 1999; Giordano, 2001). As the public organisation states in interview:

“there was a biomedical sector champion which was basically run out of Merseybio, so when Merseybio was established somebody was established at MerseyBio funded by the public sector who’s role it was to coordinate and drive the bio-incubation and that sort, but basically the RDA wanted to regionalise all that” (Interview Public Organisation 1, 02/08/10)

Many other institutions in the city learned quickly that the NWDA wanted to create a regional presence rather than an individual city focus. Instead of the city being able to create the anatomy needed to support an ecology of its own, it had to work within a wider geographical framework of the North West region. However, the strong regional focus has been halted since the new conservative government took office in 2010, leading to the disbanding of the NWDA and other regional development agencies. Rather than a total elimination of a tier of institutional support, there has been a realignment of economic development to the sub regions through the creation of Local Enterprise Partnerships (LEPs). Due to the dominance of the NWDA from 2000 to 2010, city level institutions devoted fewer resources to the sector relying more on the efforts of the NWDA. This is probably reflected in the scale of resources (time, money, human capital, knowledge) needed to support such a complex and expensive industry. Whereas in the video games sector firms are dealing with smaller resource demands, have lower entry barriers and have done much better in spawning new firms without the intense institutional interactions and brokerage needed through a regional or local body. However, the realignment of economic development thinking to sub regions in the UK has meant that key cities in those sub regions become more dominant. Liverpool has become the focal point of the Merseyside region, also known as Liverpool city region.

Referring to the components and processes that make up the institutional thickness of a locality outlined by Amin and Thrift (1994, 1995); we can observe several predicted outcomes from favourable institutional thickness conditions in Table 29.

Table 29 Outcomes of institutional thickness

Institution Thickness Outcome	Observation
Institutional persistence – local institutions are reproduced	<p>With the disbanding of the NWDA there has been a new LEP formed in its place reconfigured at a different scale. The major difference is the coordination and financial backing behind the new institution in significantly reduced.</p> <p>The local development agency Liverpool Vision has also had a change in its remit away from economic development and regeneration to marketing and business support.</p> <p>The creation of a UTC has been fundamental to the sustained improvement of the labour market and provides a tailored workforce to the needs of the ecology. Curriculums are developed in partnership with firms and universities in the anatomy of the city.</p>
Archive of common held knowledge (formal and tacit)	<p>Consultants are the largest source of archived formal and tacit knowledge for the sector in Liverpool. The role of several key consultancy firms in the development of new early start-up firms is pivotal. Linked to Table 28, the MerseyBio incubator is a fundamental source of information sharing.</p>

Institutional support, in the form of technology transfer, training and education, access to producer services such as market intelligence, business innovation, and finance, tends to be sector specific, so that help can be targeted to firms (Amin, 1994).

UTC further disseminates industry specific codified and tacit knowledge into a potential future work force.

Institutional flexibility – ability to learn and change

The city has demonstrated that many of the institutions are able to change, although not always through choice. The disbanding of the NWDA has meant that many localised institutions have changed their roles to meet the demand of firms in the life science ecology. However, business supporting institutions have become less able with reduced funding.

Firms have noted, in Chapter Four, issues in the labour market in terms of attracting and retaining key workers. Although the training and education provisions are deemed to be excellent in Liverpool, the labour market still suffers a shortage of skilled laboratory works and key scientific personal with firm specific specialisms. Equally, there is a lack of venture capital and therefore funding to allow firms the ability to try and test new ideas.

Other institutions such as universities show a continued ability to change and learn in

regards to knowledge transfer and generation. However, the commercialisation of knowledge held in these institutions is still slow and uneven.

Large cognitive proximities exist in terms of firm specific knowledge in the Liverpool ecology. Economies of association are limited, reducing the flow of formal and informal information.

High innovative capacity – region and firms within it

The composition of the life science ecology, outlined in Chapter Four, highlighted that there is a limited number of R&D lead firms. However, there are active research lead institutions such as the universities and research centers outlined above. It is worth reemphasising that Liverpool has experienced slower commercialisation of innovations from local universities compared to other established life science mega centers such as Cambridge UK (Cooke, 2004). The region and firms are innovative but not as innovative in comparison to other places. There are more manufacturing and development facilities in the ecology than there are that are innovative and actively pursuing commercialisation.

Trust and reciprocity as a behavioral norm

Trust was not clearly highlighted in the research as fundamental to business. Given the rigidity in the nature of the business models, firms could not rely on economies of repetition (Grabher, 2004) or close connections. Trust could be referred to in relation to scientific knowledge, reputation

and capabilities to deliver but not as an overarching driver in business models. Limited possibilities to exercise trust are mostly likely to be a symptom of the complexities in the nature of the product being developed and the highly regulated environments, meaning that firms have to comply with institutional frameworks regardless of the levels of trust.

Firms tended to have little engagement with other institutions other than the NWDA. Hence, more recently, firms would voice their issues through gatekeepers or industry leaders in Liverpool. Equally, the reluctance of the city leaders to embrace fully the ideas of industry leaders is exemplified in the quote below this table.

Common project that serves to mobilise the region in an effective manner

There are two projects in Liverpool that seek to mobilise the city's firms and institutions. The first is the National Biomanufacturing Centre (NBC) in Speke. This was completed in 2005 and championed as the largest concentration of pharmaceutical manufacturers in Europe with firms including Novartis, Medimmune and Eli Lilly.

The second project, as already mentioned above, is the Biocampus that aims to bring together several research lead institutions with the aim to spin off new firms and support existing ones. The two projects have sought to build on the ecologies' and cities' capabilities by bringing them together into

projects emphasising typical agglomeration effects. The former has demonstrated fewer agglomeration effects or even, in terms of the ecology, a low ability to integrate and facilitate rivalry or localised firm projects, due to the insular and rigid nature of their activity.

Cooke (2005) has argued that the formation of life science clusters is due to the presence of science based infrastructure, such as research and development intensive universities or government laboratories. Such actors are also known as public research organisations (PROs). Cooke's (2005) observation is based on the Cambridge life science cluster in the UK and states that universities act as magnets to firms and draw them to locate within close proximity in order to benefit from knowledge inputs and outputs. In Liverpool, universities have been placed in the upper ground as an innovative institution, along with established firms. However, universities have a role in the underground as a place where knowledge is free of the commercialised world. Further universities have the ability to finance, utilise various resources and combine various platforms of knowledge, making them an institution spanning many layers of the anatomy of the city and providing different functions (Cohendet *et al*, 2010). In the Liverpool ecology, only one firm noted the university as a pull factor to their decision to locate in the city.

'... Liverpool University is very strong in particular areas of healthcare, you know it's very strong in cancer for example, which is one of the reasons that we're here' (Interview Discovery Firm 1, 10/08/12)

'it was quite handy because you know the access to you know the university facilities, although you don't get them for free, obviously we have to pay for them but it's just handy being on the campus and as a technology start up and having access to chemistry or wherever, to do that.' (Interview Discovery Firm 2, 23/10/12)

'the university in general is good, and I think what's good is because we've got access, because we're part of the university building, to the library, for the electronic journals and things, so that's a massive saving. And that sort of thing. I think just being in proximity of the university, we've got easy access to you know chemistry, for what we do, for the tech, you know the centre for materials discovery, to use their equipment because obviously it costs thousands and as a small company you haven't got the money to fork out on this kind of stuff' (Interview Discovery Firm 4, 12/10/12)

Other firms recognised the university as key to providing a skilled work force they could potentially draw new recruits from, reinforcing the need for an underground as a source of labour for high skill jobs (Goddard *et al*, 2012). Zucker and Darby (1998) further argue that a cause of agglomeration in life sciences is the presence of "star scientists" linked to research lead universities. There was no evidence found in the life science ecology that firms have or were making strategic use of 'star scientists' in any of the universities in the Liverpool ecology. Hence the universities and dedicated research firms in the Liverpool ecology have not occupied the middle ground but are certainly playing a noticeable role in the upper and under grounds. The university is playing a role in the training and development of the labour pool through its degree programmes. The university's reach has been extended down the education system into secondary and further education. Linked to Table 28, the UTC is providing further institutional thickness by delivering a curriculum devoted to the life sciences, designed and delivers in partnership with local industry.

'The UTC is performing a critical role in trying to plug that gap. Now that doesn't mean that kids coming through the UTC won't go on to university if, you know, if they're academically minded, but if they do, with the training they'll receive in the UTC, added to a degree, those kids will be like gold dust, they'll be hugely valuable in the jobs market, not just in the UK but beyond ...' (Interview Discovery Firm 1, 10/08/12)

Feldman and Francis' (2003) argue from empirical study in Washington (USA). Rather than suggesting a magnetic pulling force, they argue that a number of key triggers within the local economy sparked cluster emergence. The downsizing and closure of public laboratories triggered investment in the region. This cannot be observed in the life science ecology in Liverpool. Although there are several institutions occupying the upper ground, such as the School of Tropical Medicine and several MNE, none have triggered a wave of new firm start-ups as a result of their closure. However, public policy interventions in this sector have been significant since 2000. As mentioned in Chapter Four, the MerseyBio incubator has been a place where many new firms have been established and grown. Hence, the MerseyBio incubator, as a place, forms part of the middle ground in the anatomy of the science city. This is a place where we find several SME's located with facilities such as shared dining facilities, located on the university of Liverpool campus and one of the consultancy firms who act as a broker, connecting firms with the resources they need.

'at the same time they're starting from a very, a very dark place, I think in terms of commercialisation! At the university ...I think what it is is this attitude that if it, if I own it, I control it, therefore I'm king of the hill, or if somebody else comes along and shows an interest, that means they're trying to steal it from us. So you know there's a complete amount of you know, it ranges from you know paranoia through to complete psychosis in terms of the sort of institutional behaviour on these things... in Liverpool it's very, very magnified' (Interview Consultancy Firm 3, 09/05/12)

What is interesting is that the original concept placed consultants in the upper ground, but in Liverpool's anatomy they seem to be able to broker and mediate more effectively the other institutions in the middle ground. The consultants in the Liverpool ecology seem to add to the institutional thickness using their ability to both process industry specific knowledge and connect individuals and businesses through the layers and across places. All of the consultants in the Liverpool ecology

have vast experience in the life science industry and have used that to support the ecologies in Liverpool.

The spin outs located, predominantly in MerseyBio and other incubators, have generally come from universities within and beyond the ecology but mostly from external entrepreneurs. The development of this ecology cannot be attributed solely to the upper ground but to the ability of consultants and public organisations to broker ties between those with ideas and those with capital to start new firms. However, many recognise the efforts of consultancy firms and others in the ecology but some still don't see this as enough.

“What we need to be doing in biotech is creating an environment for companies, where companies are much more heavily integrated with their local area and the local environment. So, the company should be at the centre of a network where they have strong links into academic research, they have strong links into clinical research, because clinical needs need to inform, and by companies I mean therapeutic companies, clinical needs need to inform what you're doing in developing new therapies. They critically need to have strong links into education, because we can't complain about you know not having the right kids coming through into the industry if we're not prepared to do something about it to help foster that.” (Interview Discovery Firm 3, 23/10/12).

Those brokers have not made the middle ground an area of purely innovation or creativity but primarily one that is enabling survival through the availability of public grants and small amounts of seed and venture capital funding and access to knowledge beyond the ecology. Chapter Four highlighted that older and larger firms are much more insular in their approach and have limited synergies with other firms in the ecology. They make little or no use of a middle ground as they do not seek out innovations in science due to their activity. Equally, the firms have demonstrated that they are successful but they are not producing spin out firms as Klepper (2010) has argued the case for in Silicon Valley. This predominantly relates

to the large pharmaceutical manufacturers and diagnostic firms. The larger multinational firms situated in the city, such as Novartis and Eli Lilly, have been identified in several policy documents and marketing publications. What seems to be apparent are other institutions, such as economic development agencies, such as those situated in the middle ground, are using them as pull factors to external firms or actors. As this research has shown in Chapter Four, the contribution of the multinational subsidiaries to the ecology is minimal. However, their presence has provided a narrative towards a common project known as National Biomufacturing Centre. A public funded private lead initiative, adding to the life science institutional thickness of the city (Amin and Thrift, 1994, 1995; Henry and Pinch 2001). Whereas the Cohendet *et al* (2010) framework would include such large multinational firms as key financiers and enablers to commercialisation, the Liverpool life science ecology does not benefit from the presence of such firms, instead having to find resources from elsewhere. Equally the large firms are not acting as anchor firms within the anatomy as predicted by Cohendet *et al* (2010).

Cohendet *et al* (2010) argued that a fertile middle ground, with the physical places to stimulate cognitive space, allows for the exchanging of knowledge and potentially other resources. If knowledge can be transferred easily over long distances then knowledge intensives firms ought to be dispersed geographically (Gertler and Vinadrai, 2009). However, literature on knowledge spill over and absorption point to the documentation of a highly localised place sensitive geography amongst life sciences firms (Feldman, 2000 and Asheim and Gertler, 2005). Here the vast majority of the literature implicitly point to factors associated with the type of place and spatial proximity needed to facilitate knowledge exchange and learning through mediums such as face to face contact (Amin and Cohendet, 1999, 2004; Grahber 2001, 2004a, 2004b; Malmberg and Maskell, 2006; Maskell and Malmberg, 1999b; Maskell *et al*, 2006). Data suggests that the highly diverse nature of the Liverpool ecology means a lower probability of overlap between firms and the ability to collaborate. As Malmberg and Maskell (2002) noted early on, intra-organisational learning is potentially limited when excessive cognitive distance exists between local firms, leaving space for institutions to help

bridge that gap and find a common ground between firms as well as to facilitate external connections. This appears to be the case in the Liverpool ecology. Many firms are looking beyond the ecology for inputs or are focusing specifically on their own product in order to protect its IP. As mentioned earlier, the older the firms are in the ecology, the more insular they tend to be and given the relative youth of the other firms, they focus on commercialising their own initial IP on which they founded the company. As the two firms below responded:

'I guess the bottom line is that we set out with the technology these guys started the company with and we're busy trying to exploit that, so there's not a lot of reason to be honest to stretch out to the university and other people at the moment, we don't have a need' (Interview Diagnostic Firm 1, 31/07/12)

'We looked at initially in the whole UK, but because of the specialist nature of the manufacture of diamorphine, it's a freeze dried product in an hermetically sealed glass ampule. We had to go into Europe and it just, I suppose our outsourcing idea evolved from the fact that we couldn't afford to build a new plant' (Interview Discovery Firm 4, 12/10/12)

This is further exacerbated by the nature of the pharmaceutical drug manufacturers in the ecology.

'Ah it is quite common, I would say that's quite common you know, they [drug manufacturing firms in Liverpool ecology] tend to act in isolation. You know a lot of them had a history that's come in a very convoluted way, so you know they have ties to where they came from... So you know they had a history and therefore they're, they are pretty, pretty ... You know they operate in a unitary way, being part of a corporate entity they'll have to meet corporate standards' (Interview Consultancy Firm 2, 30/04/12)

This means firms have few opportunities to find synergies that can improve organisation learning within the ecology. Instead firms appear to see a gap in their capabilities and search for another firm outside the ecology to provide that service in order to fill the gap in the production network.

'So any in vivo work for example, animal work, is done outside, with contractors. Any chemistry scale up work is done outside, any formulation development for first in line formulations, if we were going that far, would be done with another company, some analytical testing is done outside. Analytical, we do some in Liverpool, in vivo work has all been outside of Liverpool. Primarily UK though. We've done, we're also the sort of specialist in vitro testing that we've done elsewhere and you know that's gone as far as California and China. The other thing is that we do supplement our chemistry resource in China.' (Interview Discovery Firm 6, 03/05/12)

Cognitive distance appears to be exacerbated in smaller agglomerations like that of the Liverpool life science ecology. Fewer firms that are increasingly specialised leave less chance of overlap. So, even though there are conferences organised by firms in the ecology, they are very specific in their audience by attracting the same people but discussing different topics specific to their sub sector. The high fragmentation has led to an inability to simply share ideas, a common language and even connections unless the firm is a broker, such as consultants or VC. These are known as institutional mediums or structural supports (Fields, 2008; Lowe and Gertler, 2009, Jayawarna *et al*, 2011). Hence, the data shows in previous chapters that firms have to look beyond the ecology and attend conferences in larger ecologies. These are held in places where a middle ground exists, that facilitate relational and cognitive proximity, in order to create temporary space that can be extended to Liverpool through establishing global pipelines (Bathelt *et al*, 2004; Maskell *et al*, 2006). Although cognitive distance emerges between the activities of the firms in the Liverpool ecology, all of the SME's firms share common day-to-day issues. So the cognitive distance decreases when we look at how a business should run rather than at the knowledge needed in their production. As one discovery firm says:

'Now they're (other firm) in completely different areas to us, but it shouldn't actually matter whether they're in different areas or not, you know, we share common issues, which small companies looking to grow, we're going to have issues around funding, we're going to have issues around facilities, we're going to have issues around staff, we're going to have issues around the perception of the industry nationally and you know, national policy that's going to allow the industry to thrive. So it's important that those sort of links are engendered.' (Interview Discovery Firm 2, 23/10/12)

This reemphasises arguments about a middle ground that works for businesses, given the composition of the life science ecology. The middle ground can only facilitate knowledge exchange with the inclusion of industry specific consultants, not simply through the availability of public shared spaces or temporary spaces like a conference. However, the middle ground can facilitate organisational learning through the use of institutional mediums such as development agencies, consultants and even experienced firms. Human capital (experienced and enthusiastic actors) exists in these organisations that can benefit the development of the ecology. So, over time, the middle ground becomes a place for organisational survival, learning and knowledge exploration. This emphasises the arguments of Amin and Thrift (1995) that institutional thickness is not about simply replicating institutions that work in one place but allowing a process of institutionalisation to occur. The factor of path dependence and evolution need to occur so actors and institutions take up the roles that are needed in the city. There is no case that locally based institutional thickness is a precondition for urban economic regeneration (Keeble *et al*, 1999). What does hold in the debate is that 'access' to institutional thickness is what matters, especially for the life sciences in Liverpool, as R&D has not always been secured in the anatomy of the city. Additionally, the city has neither a thick or thin middle ground, more a developing institutional thickness, but is producing an effect where firms have to look to other places. Hence, you do not need to depend on localised institutions but can in fact rely on institutional process across multiple scales (Henry and Pinch, 2001).

Kasabov and Delbridge (2008) bring many of the points together and conclude that a life sciences cluster's success and development is based on a number of traded and "soft" interdependencies. Traded interdependencies are globally active research firms and institutions such as universities and government research laboratories that lend an element of commercial prowess, which is based on the reputation of a selected number of such firms and institutions located within the area. Access to start-up capital is a vital component of any new and existing business. Areas that are well served by venture capitalists or business angels tend to foster more start-ups (Powell *et al*, 2002). Management capabilities are essential in running a business. The firm has to be able to recruit locally or be able to attract high quality managers who understand and can demonstrate the ability to drive the firm. Firms rely on a readymade pool of scientifically educated labour, without which would make the firm's operations difficult, as they would have to look beyond their locality for employees.

Soft interdependencies refer to the facilities that generate knowledge transfers and diffusion of tacit uncodified knowledge. These include networking events, forums and trade fairs. Grandadam *et al* (2013) argued that such events or projects that take place fertilise the middle ground of the city, allowing communities from within the ecology and beyond to come together. Liverpool's ecology has been host to several networking events, all of which have been organised by local firms. The middle ground has supported this through the physical places to hold such events. The events have taken place out of normal working hours in hotels in the city centre. Hence, it is not only the creative industries that make use of such cultural assets; high technology firms also need venues that can facilitate their activities. Public policy has also played a role in the Liverpool ecology by creating spaces for interactions within science parks, providing protection for smaller firms and directing public research organisations research strategy by making public funds available for specialised research projects.

Finally, the deliberate built infrastructures of the middle ground, such as science parks appear underutilised by the firms in the ecology. Through this research, it was discovered that many SME's are only using post box facilities in the science parks and locate elsewhere. These firms are using the tags associated with the ecology to give outside relations a perception that they are located in a fertile city of science. On occasion, firms would simply hire out a seminar room or boardroom to have meetings with clients from outside the ecology. If we pause here, it is worth noting that this is not necessarily a negative feature of the anatomy of the city. The fact that these middle ground infrastructures exist to facilitate such interactions, albeit with mostly external actors, benefit the ecologies organisation and wealth. Without this type of middle ground the ecology could be less diverse due to firms locating elsewhere. Therefore, firms are less able to challenge existing norms in the industry business model and as a consequence, innovate it. Additionally, the national biomanufacturing site has the major players but related SMEs located around them. As stated in Chapter Four, these firms are very insular and do not really collaborate/integrate with other firms in the ecology due to the nature of their activity and internal organisational structures. These firms are a part of large internal organisational systems of production. There are by far more explicit public assets that complement the life sciences in the Liverpool ecology than for any other sector. This should indicate a vibrant middle ground fertile with opportunity. Instead the anatomy of the city is one with potential. As argued above, the middle ground is one where firms learn about organisational development, rather than product or service development. Cognitive crossover in regards to the knowledge inputs required for commercialisation are limited, but issues relating to business growth and development provide a ground for firms to connect. Overall, consultants play a crucial role as middle ground brokers in connecting knowledge from exploration with firms who can then exploit, as well as providing platforms through conferences for parts of the ecology to informally come together and extend their connections and create a shared common project around the industry.

6.3 Situating Two Ecologies within One City

The chapter has outlined the anatomy of city in relation to two ecologies that are situated with Liverpool. The ecologies have received varying levels of support from the city infrastructures and institutions operating at multiple scales over the last decade. On a broad level, it has become apparent that the life sciences anatomy is far more developed in terms of physical infrastructures and processes towards creating spaces for further research and development. The video game anatomy is built into the broader remit towards the creative and digital industries in Liverpool. Specific institutional supports have tended to be led by the firms rather than collective agencies aimed at supporting their activities. The processes of learning differ considerably too. Cohendet *et al's* (2010) original framework is aimed at creative industries. Typically the industries require less formal qualifications and validation over new innovations. Whereas in the life sciences, due to the nature and application of the product, formal education and strict validation of knowledge and innovation are not only imposed, but essential. The framework fails to take this into account when actors such as universities play a role in almost all three metaphoric layers of the anatomy of a science city. Ideas cannot be found or explored on the streets or art galleries but instead come from years of personal achievement in educational training and validation of creditability and hard science. Table 30 has compared both the general characteristic of each type of city as well as the difference between the two ecologies.

Table 30 Comparison of the two anatomies

	Creative Industry General	Life Sciences General	Liverpool Video Games	Liverpool Life Science
Upper – focus on exploitation	<ul style="list-style-type: none"> • Capacity to finance • Innovative firms specialised in difference fields • Firms that unite different expressions • Integration of different types of knowledge • Test new forms of creativity on the market • Launch new products to the market • Project based production involving different communities of specialist 	<ul style="list-style-type: none"> • Capacity to finance • Science based infrastructure with innovative firms • Firms that can assist in the commercialisation of ideas • Universities who can develop concepts that are peer reviewed and attract star scientists • Launch new products into the market or develop ideas ready for licencing or acquisition • Firms that are focused in one particular area of the production process given the rigidity in the business model 	<ul style="list-style-type: none"> • The upper ground does not have the presence of larger multinational firms, who have greater capacity to finance new ideas and take products to the market. • Instead firms have been innovative in the business model, reducing entry barriers and working on application developments. • Flexible working and project based working is the norm and brings together specialists but most connections stem beyond the ecology rather than within it. 	<ul style="list-style-type: none"> • The upper ground has a limited ability to finance new innovations within it. Instead money is usually drawn from outside the ecology from regional, national and supranational institutions. • There is a strong and developing science based infrastructure. The development of the NBC and the forthcoming Biocampus are testament. • There are only a small number of innovative firms engaged in R&D. As previous chapters have highlighted, some firms are by definition active but not actively producing outputs. • There are three research lead universities and institutions providing the potential to validate and spin out new firms.
Middle – brokering	<ul style="list-style-type: none"> • Focused on the physical and 	<ul style="list-style-type: none"> • Focused on the physical and 	<ul style="list-style-type: none"> • The Baltic triangle is a 	<ul style="list-style-type: none"> • Of the two ecologies, the

	<p>institutional environment</p> <ul style="list-style-type: none"> • Act as a means to explore and elicit exploitation mechanism • Progressively codifies new knowledge • Facilitates a two way process of creative ideas: bottom up through epistemic communities and a top down process through communities of practice. 	<p>institutional environment</p> <ul style="list-style-type: none"> • Key role of industrial specialist consultants • Progressively codifies new knowledge • Knowledge generation is a systematic process of validation, approval and economic market mechanism. The middle ground helps to mediate and provide assistance to drive innovations to commercialisation and the market. 	<p>development targeted at the general creative industries but widely used by video game firms.</p> <ul style="list-style-type: none"> • Provides spaces for informal interaction, the idea validation. • Provides the grounds in which potential synergies and creative idea processing can be achieved. • There is a lack of industry bodies or development agency lead initiatives in this sector. • A virtual space through North West Indies exists for firms to advertise for expertise and also float ideas among local members. • The UTC Studio School is an example of a space where knowledge is progressed and enriches the labour market. Provides a potential ink between the underground and upper ground for sourcing and testing new ideas, especially to young people. 	<p>life sciences have the largest and most noticeable institutional presence with universities, economic development agencies and collective groups organising to ensure its growth and development.</p> <ul style="list-style-type: none"> • There are several consultancy firms working as brokers to many new start-up firms and are fundamental to the collective organisation of the ecology. These firms are also integral in providing commercialisation based knowledge and can mediate firm through the wider processes. • There are still many connections that go beyond the city in order to get many aspects of product development completed. Customers, potential licences and acquirers reside outside
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				the ecology.
Under – focus on exploration	<ul style="list-style-type: none"> • By definition invisible but focused on the people • Proximity and frequent interactions necessary for it to grow and become viable. • Underground culture who seek out new ideas • Shared deep interest in the culture and art • Includes gamers, graffiti artists, and extreme sports aficionados. • Share tacit norms outside the corporate logic of exploitation 	<ul style="list-style-type: none"> • Focused on the labour market and availability of start scientist and high skilled workforces. • Universities provide the space for ideas to be explored free of the corporate world 	<ul style="list-style-type: none"> • Liverpool has been the European Capital of culture and embarked on a creativity and culture lead regeneration programme. • There exists a vast labour pool of talent; creative individuals who can express their culture through the UTC Studio school and other creative space in the city. • The closure of the MNE Studios has led many people at the start to search and explore what it is they want to do as part of setting up a firm 	<ul style="list-style-type: none"> • Universities and research lead organisations are fundamental to the underground of a life science city. They facilitate knowledge exploration free of the commercial world. • Validation of new ideas can be achieved through peer review • The labour market is dependent on the training where knowledge must first be learned then applied.
	Creative Industry General	Life Sciences General	Liverpool Video Games	Liverpool Life Science
Upper – focus on exploitation	<ul style="list-style-type: none"> • Capacity to finance • Innovative firms specialised in difference fields • Firms that unite different expressions • Integration of different types of knowledge • Test new forms of creativity on the market • Launch new products to the market 	<ul style="list-style-type: none"> • Capacity to finance • Science based infrastructure with innovative firms • Firms that can assist in the commercialisation of ideas • Universities who can develop concepts that are peer reviewed and attract star scientist • Launch new products into the market or develop ideas ready for licensing or acquisition 	<ul style="list-style-type: none"> • The upper ground does not have the presence or larger multinational firms who have greater capacity to finance new ideas and take products to the market. • Instead firms have been innovative in the business model reducing entry barriers and working on application developments. • Flexible working and project 	<ul style="list-style-type: none"> • The upper ground has a limited ability to finance new innovations within it. Instead money is usual drawn from outside the ecology from regional, national and supranational institutions. • There is a strong and developing science based infrastructure. The development of the NBC

	<ul style="list-style-type: none"> • Project based production involving different communities of specialist 	<ul style="list-style-type: none"> • Firms that are focused in one particular area of the production process given the rigidity in the business model 	<p>based working is the norm and brings together specialist but most connections stem beyond the ecology rather than within it.</p>	<p>and the forthcoming Biocampus are testament.</p> <ul style="list-style-type: none"> • There are only a small number of innovative firms engaged in R&D. As previous chapters have highlighted some firms are by definition active but not actively in producing outputs. • There are three research lead universities and institutions providing the potential to validate and spin out new firms.
Middle – brokering	<ul style="list-style-type: none"> • Focused on the physical and institutional environment • Act as a means to explore and elicit exploitation mechanism • Progressively codifies new knowledge • Facilitates a two way process of creative ideas: bottom up through epistemic communities and top down process through communities of practice. 	<ul style="list-style-type: none"> • Focused on the physical and institutional environment • Key role of industrial specialist consultants • Progressively codifies new knowledge • Knowledge generation is a systematic process of validation, approval and economic market mechanism. The middle ground helps to mediate and provide assistance to drive innovations to commercialisation and the market. 	<ul style="list-style-type: none"> • The Baltic triangle is a development targeted at the general creative industries but widely used by video game firms. • Provides spaces for informal interaction the idea validation. • Provides the grounds in which potential synergies and creative idea processing can be achieved. • There is a lack of industry bodies or development agency lead initiatives in this sector. • A virtual space through North 	<ul style="list-style-type: none"> • Of the two ecologies the life sciences has the largest and most noticeable institutional presence with universities, economic development agencies and collective groups organising to ensure its growth and development. • There are several consultancy firms working as brokers to many new startup firms and are fundamental to the collective organisation of

			<p>West Indies exists for firms to advertise for expertise and also float ideas among local members.</p> <ul style="list-style-type: none"> • The UTC Studio School is an example of a space where knowledge is progressed and enriches the labour market. Provides a potential link between the underground and upper ground for sourcing and testing new ideas especially to young people. 	<p>the ecology. These firms are also integral in providing commercialisation base knowledge and can mediate firm through the wider processes.</p> <ul style="list-style-type: none"> • There are still many connections that go beyond the city in order to get many aspects of product development completed. Customers, potential licenses and acquirers reside outside the ecology.
Under – focus on exploration	<ul style="list-style-type: none"> • By definition invisible but focused on the people • Proximity and frequent interactions necessary for it to grow and become viable. • Underground culture who seek out new ideas • Shared deep interest in the culture and art • Includes gamers, graffiti artists, and extreme sports aficionados. • Share tacit norms outside the corporate logic of 	<ul style="list-style-type: none"> • Focused on the labour market and availability of start scientist and high skilled workforces. • Universities provide the space for ideas to be explored free of the corporate world 	<ul style="list-style-type: none"> • Liverpool has been the European Capital of culture and embarked and creativity and culture lead regeneration program. • There exists a vast labour pool of talent creative individuals who can express their culture through the UTC Studio School and other creative space in the city. • The closure of the MNE Studios has led many people at the start to search and explore 	<ul style="list-style-type: none"> • Universities and research lead organisations are fundamental to the underground of a life science city. They facilitate knowledge exploration free of the commercial world. • Validation of new ideas can be achieved through peer review • The labour market is dependent on the training where knowledge must

	exploitation		what it is they want to do as part of setting up a firm	first be learned then applied.
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(Adapted from Cohendet *et al*, 2010)

Institutional thickness complements the anatomy of the city framework. Developing the ideas in Table 31 and the analysis done in this chapter, we have to acknowledge a level of institutional thinness in relation to the video games sector. Henry and Pinch (2001) argue that as well as institutional thickness, institutional thinness can also be effective in particular places. Institutional thinness is contrasting to the four key components and process of institutional thickness. Table 31 combines both the institutional thickness and thinness concepts to the life science and video game industry (Henry and Pinch, 2001; Amin and Thrift, 1994, 1995).

Table 31 Institutional thickness and thinness

	Characteristics	Life Science
Institutional Thickness	<p>Strong institutional presence</p> <p>High levels of interaction amongst institutional networks</p> <p>Structures of domination and patterns of coalition</p> <p>Mutual awareness of a common enterprise of industrial purpose amongst participant and institutions</p>	<p>Has a growing institutional presence showing many of the outcomes of the favourable institutional conditions.</p> <p>The life science ecology has been in the process of coordinated institutionalisation for a decade, involving institutions from multiple scales but with the ability and a desire at the city level to continue growing a competitive life science ecology.</p> <p>There is a balance of institutional and firm lead initiative as well as co-ordination between both.</p>
		Video Games
Institutional Thinness	<p>Low institutional presence</p>	<p>The video games industry is lacking many of the co-ordinated institutional processes and components.</p>

	<p>Low levels of interaction with institutions but high among firms</p> <p>Collective structures that emerge through inter-firm co-ordination rather than from institutional efforts</p> <p>More of a process of institutionalisation rather than the presence of institutional infrastructures</p>	<p>However, there is an effort that stems from collective action from the firms themselves that is achieving many of the outcomes of favourable institutional thickness conditions.</p> <p>There are collective structures that are emerging through the pro-activeness of firms. The Indie Showcase and the North West Indies are two firm lead initiatives with no public sponsorship showing a collective representation, as well as a mutual awareness of enterprise and industrial purpose.</p>
	Characteristics	Life Science
Institutional Thickness	<p>Strong institutional presence</p> <p>High levels of interaction amongst institutional networks</p> <p>Structures of domination and patterns of coalition</p> <p>Mutual awareness of a common enterprise</p>	<p>Has a growing institutional presence showing many of the outcomes of the favorable institutional conditions.</p> <p>The life science ecology has been in the process of coordinated institutionalisation for a decade involving institutions from multiple scales but with the ability and a desire at the city level to continue growing and competitive life science ecology.</p> <p>There is a balance of institutional and firm lead initiative as well as co-ordination</p>

	of industrial purpose amongst participant and institutions	between both.
		Video Games
Institutional Thinness	<p>Low institutional presence</p> <p>Low levels of interaction with institutions but high among firms</p> <p>Collective structures that emerge through inter-firm co-ordination rather than from institutional efforts</p> <p>More of a process of institutionalisation rather than the presence of institutional infrastructures</p>	<p>The video games industry is lacking many of the coordinated institutional processes and components.</p> <p>However, there is an effort that stems from collective action from the firms themselves that is achieving many of the outcomes of favorable institutional thickness conditions.</p> <p>There are collective structures that are emerging through the pro-activeness of firms. The Indie Showcase and the North West Indies are two firm lead initiatives with no public sponsorship showing a collective representation as well as a mutual awareness of enterprise and industrial purpose.</p>

(Adapted from Amin and Thrift, 1994, 1995 and Henry and Pinch, 2001)

As determined from Chapters Four and Five, video games firms in Liverpool are seeing increasing control over the entire production process as they change their strategy to smaller application based development. Whereas in the life sciences there is still a tendency to look up to the big players as they hold the capabilities to develop and carry a new innovation through to commercialisation. The

development of an upper ground capable of financing innovations and a middle ground that works for the life sciences is hard to achieve in Liverpool, yet the institutional processes are certainly underway. This is an industry reliant on MNE research laboratories and universities as well as connections to lead firms outside the ecology. It was a similar case in video games ecology in Liverpool but recent changes in the business models, represented a move towards application development; there is increasing control, less financial barriers and less reliance on institutional support to achieve a commercialised product. So, for the life sciences there needs to be more emphasis on the cognitive space and ability to build global pipelines in order to facilitate access to resources that are far from being available in the ecology, notably knowledge specific to their endeavour (Bathelt *et al*, 2004).

For life sciences, Liverpool or the North West has not been seen as a place to do life science, unlike in the video games sector where the big firm names have established a reputation of good game development attracting major events and others to work here.

“There seems to be a lack of awareness of what’s in the North West because when you say life sciences people are drawn to think of London and Oxbridge because of their reputations” (Interview Public organisation 2, 05/08/10)

The big name firms in the Liverpool life science ecology have not given the same gravitas in terms of reputation to attract or spawn new research and development firms. This is simply because of their activities and how the wider industry is organised. For example, life science manufacturing is classed as a different part of the business for the MNE. Internally they have to pitch for work to the headquarters using market mechanisms. For them rivalry is internal and not with the rest of the ecology. Whereas the R&D company’s rivalry is with others in the ecology; primarily on the basis of the need for resources.

In the video games ecology, many of the new owner managers have been free to indulge in the middle ground, finding new ideas and taking advantage of the existing infrastructures here. For the life sciences there isn't enough of a middle ground to foster product specific crossover. Additionally, comparing both ecologies to other studies, part of the problem with a vibrant anatomy of the city is the fact that the critical mass of firms is not large enough. So firms in the early stages of development have limited scope for cross fertilisation or resources to host events and establish large intra-firm projects. The communities that we expect to occupy the middle ground are not developed enough yet – these are like non-profit institutions (Coriat and Dosi, 1998; Cohendet *et al*, 2010). For the life sciences, they did exist at a regional level through organisations such as Bionow (part of NWDA) business link and The Mersey Partnership. These institutions had industry specialists capable of bridging the gaps between the big pharmaceutical firms and the smaller dedicated research firms, again acting as a broker between ties. These have been stripped away with the abolition of the NWDA. Bionow still exists but has a regional focus and no direct policy influence post NWDA. Similar institutions were in place for the wider digital/creative communities in Liverpool, however, post 2010 the video games ecology lost the major players as well as support from NWDA and various city based organisations funded from the NWDA. The firms are on their own with few professional bodies in the ecology to represent them. The video game ecology is too young in its current formation, having lost the big names to establish any new professional communities. However, the studio school is a platform to step forward. The Develop Conference was one of many events that they need to spring board (they organised Indie showcase on the back of it) from to get that fertilisation and coordination.

6.4 Conclusion

Both ecologies have the three layers that compose the anatomy of the city. The middle ground that has emerged in Liverpool is not so much about the creativity or

innovation, knowledge sharing or generation, but about how to survive and overcome day-to-day business issues. Fortunately there are many brokers occupying this middle ground in the form of consultants, public institutions and other associates, providing fundamental access to resources that can't be accessed in the ecology. Grandadam *et al* (2013) concludes that you need the spaces and places to enable a liberation of ideas and creativity, innovation and synergy. In order to have the ability to exploit and explore, an effective middle ground must have brokers or intermediaries to help foster the commercial success but as in Liverpool's case, also have a supportive mechanism in that middle ground for survival.

Cohendet *et al's* (2010) framework does have its draw backs when analysing either Liverpool ecology. For the video games ecology, the framework cannot explain the rise of small businesses and how they explore new ideas after being made redundant from larger MNE. The framework seems to only be able to deal with successful firms that produce successful spin off SME's. There is also an issue of scale in terms of geographical size of Liverpool. The scope to fully explore an underground that is invisible and small is significantly reduced given the existing of all multinational firms that no longer draw in and employ large numbers of skilled workers. The framework has also showed weaknesses to explain the workings of a science city. However, it has been useful to highlight the important role of brokers and the institutionalisation process that is underway in the Liverpool ecology. However, as with the video games ecology, there is an issue over MNE and their role in the upper ground. For Liverpool, the imbalance of actors to form a complete internal ecology production network within an upper ground compromises the framework making it harder to incorporate variations in the upper ground. Equally, the framework does not account for actors or institutions that could sit in all three layers. This is the case for universities in the life science city anatomy. Universities and other research lead organisations are the only place where knowledge exploration of this kind can be done. Institutional thinkness' focus on formal

institutions has complimented the framework by giving theoretical insight into such formal institutions found in the middle ground, particularly for a life science ecology. What we can observe in the life science ecology is a more typical institutional thickness typology given the rigidity in many of the structures and project network. Indeed, the Cohendet *et al* (2010) framework is a metaphor through which we can understand the processes of creativity and learning within cities and how the people and the built environment enable or constrain that. The relevance of institutional thickness can help extend that to a life science ecology. It has not been the aim of this chapter nor of the original framework to propose new layers or a scale dichotomy. The framework has been complimented through the use of institutional thickness (Amin and Thrift, 1994, 1995).

It would be advantageous for Liverpool to think about a middle ground that is able to help with securing vital resources before it can be a middle ground of creativity and innovation. Securing firms and allowing them to prosper should then follow through to a middle ground that matures into a creative or innovative playground (Cohendet *et al*; 2010; Grandadam *et al*, 2013). Given the youth of the current composition of the video game industry in Liverpool, there are signs of firms taking it upon themselves to engage in a creative playground. As firms grow and they secure the correct human, social and physical resources, they can then focus on the middle ground places and spaces. For the life sciences, the pathway to an effectively connected co-working middle ground maybe much longer, given the characteristics of the wider industry. Challenging this pathway is the high diversity, highly specialised knowledge required and the organisation of production, typically expanding beyond the Liverpool ecology. Although there might be an institutionally thin middle ground at the moment, we can conclude that there are processes of institutionalisation and strong physical spaces within the middle ground, filled with the individuals needed to support the two ecologies. Therefore, the ecologies are situated in a developing anatomy of the city of Liverpool.

Chapter Seven

Conclusion

7.0 Firm Ecologies in Liverpool

This thesis has analysed the life science and video game industries in Liverpool. It has examined the institutional and economic environment of the city of Liverpool using an ecological perspective, underpinned by Grabher's (2001) heterarchy framework and the anatomy of the city framework by Cohendet *et al* (2009; 2010). In so doing, this thesis has posed three research questions that were derived from the theoretical framework outlined in Chapter Two. This thesis first proposed the question: how have the life science and video game industry ecologies emerged in Liverpool? Equally, the thesis has sought to address the need for further understanding of how firms are integrating into wider production processes from Liverpool. This generated the second research question: how are the ecologies organised and connected beyond Liverpool? The ecological perspective places emphasis on 'projects' and enabled this research to explore levels of connectedness and rivalry across multiple scales. Lastly, the thesis analyses the role of the city and institutions. It explores how the cities institutions, people and physical infrastructures can be an enabling or even constraining factor on the two industries situated within them. The research posed the final question of how are the two ecologies situated in the anatomy of the city?

There are three gaps in the literature that this research contributes towards. Firstly, agglomerations of firms are not a new phenomenon and have been noted in academic literature for many years, most notable is the work of Marshall (1920) and subsequent work of Markusen (1996) and the highly cited work in both academia and policy of Porter (1990, 1998, 2000). Cluster analysis has been the point of reference as a theory and analytical tool over the last two decades, but it has drawn

substantial criticism from economic geographers and business scholars alike (Martin and Sunley, 2003; Malmberg, 2003, 2006; Cook and Pandit, 2008; Krätke, 2010; Pitelis, 2012; Swords, 2013). Hence, there has been a gap in the literature. This has led to a requirement in the advancement of the theoretical and analytical tools used in order to study the dynamic and diverse agglomerations of economic activity that from modern knowledge economies.

Secondly, much of the literature on western knowledge economies has focused on life sciences related activity and creative industries, in places that are epicentres for such activity, such as London, Paris, San Diageo. What is understudied, in particular, is the video games industry at a local level and especially in the city of Liverpool; a UK northern city. Equally, literature on life science agglomeration tends to focus on 'mega centres' (Cooke, 2004) and neglects how agglomerations of this activity emerge in smaller cities, such as Liverpool. It would be wrong to suggest that the literature is not forthcoming with evidence of agglomeration. However, a gap exists focusing on UK cities beyond the larger and well established agglomerations such as London, Cambridge or Birmingham.

Thirdly, Liverpool is a place where two highly differentiated and dynamic industries are situated. Not only are the industries dynamic and different, but the city itself is also a highly diverse and vibrant place, having undergone significant economic and physical change over the last decade. Coupled with a need to understand changing agglomerations of firms in new ways and the understudy of these industries outside of established centres, this research has contributed to the critique and development of how we can further understand a place as a dense or sparse anatomy of parts; conditioning the environment for industries to emerge and survive.

This chapter will consider some of the key findings from empirical observations of this research. The remainder of this chapter aims to clarify, reaffirm and then

explain the answers to the research questions posed in Chapter Two, as well as highlight some of the limitations that may have constrained some analysis. Following this, the chapter will outline future research that can provide a more complete picture in Liverpool, building on the work of this thesis and future research agendas that have emerged during the course of this project. Alongside this, the chapter will draw on the implications of this research for theory, policy and future trends.

7.1 Emergence of industry Ecologies

The emergence of the two industries examined in this thesis can be found in the relational processes of path dependence, contextuality and contingency (Bathelt and Glückler, 2011). Using the ecological perspective embedded in the relational approach, Chapters Four and Five have provided a global outlook on the industries, outlining contingent processes that have been affecting the path dependent processes and contextuality in which the ecologies have emerged. The ensuing analysis has revealed a number of chance events and institutional infrastructures that firms have been able to utilise in order to emerge as established businesses. From the analysis, based on the theoretical framework in Chapter Two, there are several significant points to raise in relation to their emergence. Each will be discussed in turn.

In order to understand how a place specific ecology has emerged and is currently composed an overview of the global industry was presented. This showed the structure and influence of the wider industry actors through the contingent processes conditioning the local ecology (Bathelt and Glückler, 2011). The analysis shows that the influence of actors in the wider industry varies in the two ecologies. For the life sciences, Chapter Four uncovered much greater rigidity and standardisation in the broader industry business model. Large firms were a source

of financial support for new firm start-ups, resulting in many mergers and acquisitions as well as licencing deals. Kleppers (2010) argued that successful firms breed successful spinouts in areas where venture capital is also readily available. For Liverpool, we see something completely different. Rather than placing the importance on venture capital, the ecology has developed into its recent composition through government and supra-regional intervention that in a way has left little room for a natural emergence of venture capital. The vacuous manufacturing entities owned by leading multinational corporations have limited interest in the research base of the ecology. The level of investment into the institutionalisation in the ecology has aided the emergence of a number of younger firms that are engaged in research commercialisation (Henry and Pinch, 2001).

For the video games industry, the Liverpool ecology has not been immune to the influences and activities of the larger studios and has undergone many changes since its early conception in 1980. There has been an attraction by predominantly American based third party publishers over the years, most notably Infogrames, Activision and THQ. Only SCEE retains a presence in the Liverpool ecology. It can be argued that Liverpool's direct connections in regards to multiplatform console publishing have been significantly reduced as the third party publishers have all left, leaving only London based offices in the UK. A new wave of firms emerges out of the ashes of the restructuring and closure of three multinational studios post 2010. Some have changed their business models in order to focus on small application development for mobile devices whilst still using their existing skills on triple A games in order to fulfil contractual work for short-term capital. The emergence of the current video games ecological composition is pre-empted on decisions made elsewhere in order to close leading studios and enforce redundancies. However, the video game ecology in Liverpool shows a level of resilience to shocks, as the evolution of the sector has been predominantly based on entrepreneurial firms reinventing themselves. Here, Klepper's (2010) argument does stand up, in that the

current firms have inherited successful working patterns and norms from the parent firms; being left to their own abilities in order to seize opportunities. Given the shorter timelines and project based working patterns (Grabher, 2004), the firms within the ecology have been able to reinvent themselves with limited barriers to entry and are able to transfer their skills across multiple platforms. Developments in mobile platforms have played a key role in the ecologies' ability to reinvent (Mason, 2010). The emergence of the video game ecology is in-line with Scott's (2000) argument, that close proximity to other creative industries facilitates external economies and creativity. In fact, it was found that the firms in the ecology do have limited interconnectivity within the ecology. Hence the need to locate was born more out of a relationship to place or a social embeddedness (Hess, 2004).

However, the study can be widened further to include much more of the creative industries within Liverpool. This research has focused on the video game ecology and only firms that have been used in parts of the production. A wider study into music, film and television, art and animation could unearth a much broader picture of creative ecologies and interconnectivity (Howkin, 2010). Using Grabher's (2001) heterarchy informed ecological approach, the research is able to trace back this ecology to its conception and investigate the current ecological structure and connectivity.

7.2 Organising and Connecting Beyond Liverpool

Further to the points raised above, this thesis was not only concerned with the emergence of the ecologies but also with how they are currently organised and connected into wider production networks. Chapters Four and Five outlined the compositions of both industries and in doing so, we are able to draw some striking differences between them. The differences that stand out the most are the timeline and resource requirements for firms in the two ecologies. This affects the

organisation and the connectivity of the ecologies. Hence, this section will discuss each in turn before drawing some broader conclusions from the analysis.

The life science ecology in Liverpool has undergone some significant changes. Predominantly a manufacturing centre for pharmaceuticals firms, the ecology has grown to include a wide range of activities but a low diversity of organisational forms. There has been an increase of discovery led firms over the last ten years, as these firms take advantage of life science related institutional assets, supporting services and a wider governmental remit to increase the UK's science base (BIS, 2013). However, given the diversity and highly specialised activities of the heterarchy, there are few connections between the firms and their projects (Grabher, 2001, 2004). Rivalry is low due to several key factors that are unique to this industry, such as long commercialisation cycles and privileged IP protection for new products. This has reduced the number of trading zones where firms can showcase their business models and where organisational philosophies can be examined and evaluated, then later changed if needed (Grabher, 2001; Malmberg, 2006). The majority of firms are relying on external connections in order to complete their production process and also as an end market for the product. The main reason holding firms and attracting them to be in the Liverpool ecology is funding criteria, pinning the firm to this location without choice. In addition, there is the recent recognition of Liverpool as a place where life sciences are 'happening', by national policy makers and wider industry. The need for stability and predictability, driven by the long commercialisation processes and rigid regulatory environments, dampens the mechanisms of diversity and rivalry. Rivalry sparks the mechanisms needed to spawn new organisational forms and enriches the genetic pool or diversity within the ecology. This creates a mechanism for reflexivity and adaptability within the ecology. As a result, the lack of cooperation on a cognitive and organisational level through tags and projects respectively, means there are less shared norms and values as well as trading zones to again keep rivalry and

diversity from being polarised in periods of rigid order to excessive disorder (Grabher, 2001). What seems to be apparent here is the ecology is in a period of rigid order, limiting the ability to change or even adapt quickly.

On the other hand, the video game ecology diversity has reduced, although the number of firms has increased. Firms are coordinating activities based on their internal capabilities. Inputs were then subjected to a time, cost and quality matrix that determined how the input would be met. Whether that input could be met within the ecology or whether it has to leave and be produced by firms in other places. This goes against much of the reasoning behind creative industry co-location based on external economies (Scott, 2000; Cook *et al*, 2011). The practices of the video games' firms have been inherited from the parent companies and deemed best practice (Klepper, 2010). Therefore, common day practices of a MNE being able to source from around the world based on the demands could be transferred to the SMEs. From the analysis, it was also shown that the new owner managers of firms previously held high-level managerial positions in the parent companies. They had privileged access to the connections of the company and have subsequently transferred those relationships into their own new venture, maintaining and extending connectivity outside the ecology. Previous ways of working are thus inherited in line with what Klepper (2010) argues about success breeding success. The ecology rivalry between firms is reduced, as there is a sense of community or neighbourhood pulling the ecology together like that of a wholly functioning organism, where people feel as if they are 'in the same boat'. This gives firms in the ecology a sense of shared identify and social embeddedness. However, firms are increasingly working online in order to reduce the barriers of geographical distance. This is despite the advances in technology, argued to be showing an increasing trend towards co-location and inter-firm relationships due to the highly technological complexities of such inputs (Balland *et al*, 2013). Online mediums are enabling firms to pay to upload their products onto a faceless application store.

Although the interactions within the development process have stayed the same, with the importance of face-to-face contact still asserted. The relationships between developer and publisher are also changing. Johns (2006) and Cadin and Guerin (2006) argued that the publishers are key players in the industry and developers have to maintain relationships with them. The empirical data has shown that developers are increasing governance over the entire production process and bypassing large publishers by developing for smart phone devices. At the same time, firms do not ignore the need in some cases to involve a publisher in order to deal with promoting the game, but they have more control and influence over the initial development and inclusion of publishers. They have become less dependent also on the big ten publishers, as outlined at the start.

Both of the ecologies suffer from a lack of internal connectivity. The fully functioning mechanisms built into the heterarchy outlined by Grabher (2001) apparent in the advertising industry, are not transparent in either ecology. However, the reflexivity of both ecologies is an important feature, as both ecologies are responding not only to changes in the local environment but also at a wider industry scale. This thesis acknowledges that this research needs to further interrogate the project ecologies of both industries in much more depth in order to gain a more holistic picture of the connectivity in and beyond the ecologies. Surprisingly, the project ecologies' literature is somewhat sparse on application to the life sciences. The major strength of the ecological perspective, underpinned by the heterarchy framework, is its ability to be holistic in its analysis of two highly contrasting and diverse industries at a broader and localised level.

7.3 Ecologies in the Anatomy of the City

From the beginning of this thesis, there has been an emphasis on place and how important that is to the emergence and development of industries (Bathelt and

Glucker, 2011). Both ecologies have the three layers that compose the anatomy of the city. The middle ground that has emerged in Liverpool is not so much about the creativity or innovation, knowledge sharing or generation, but about how to survive and overcome day-to-day business issues. Fortunately, there are many brokers occupying this middle ground in the form of consultants, public institutions and other associates; providing fundamental access to resources that can't be accessed in the ecology. Grandadam *et al* (2013) concludes that you need the spaces and places to enable a liberation of ideas and creativity, innovation and synergy. In order to have the ability to exploit and explore an effective middle ground one must have the brokers or intermediaries to help foster the commercial success but as in Liverpool's case, have supportive mechanism in that middle ground for survival.

It would be advantageous for Liverpool to think about a middle ground that is able to help with securing vital resources before it can be a middle ground of creativity and innovation. Securing firms and allowing them to prosper, should then follow through to a middle ground that matures into a creative or innovative playground (Cohendet *et al*; 2010; Grandadam *et al*, 2013). Given the youth of the current composition of the video game industry in Liverpool, there are signs of firms taking it upon themselves to engage in a creative playground. As firms grow and they secure the correct human, social and physical resources they can then focus on the middle ground places and spaces. For the life sciences, the pathway to an innovative middle ground maybe further away, given the characteristics of the wider industry. Challenging this pathway is the highly diverse, highly specialised knowledge that is required and the organisation of production typically expanding beyond the Liverpool ecology. Although there might be an institutionally thin middle ground at the moment, we can conclude that there are processes of institutionalisation and strong physical spaces within the middle ground filled with the individuals needed to support the two ecologies (Goddard *et al*, 2011, 2012).

Therefore, the ecologies are situated in a developing anatomy of the city of Liverpool.

The framework seems to only be able to deal with successful firms that produce successful spin offs SME's. There is also an issue of scale in terms of the geographical size of Liverpool. The ability to fully explore the underground is limited, given that it is invisible and now much smaller, given the existing of all multinational firms. These large firms are no longer drawing in and employing large numbers of skilled workers, increasing the probability of spin out firms (Edminson, 2007; Glaser, 2010, Kleppers, 2010). The framework has also shown weaknesses in explaining the workings of science ecology. The framework's concepts of an upper, middle and under ground cannot account for the actors that work across more than one ground. This was particularly noticeable for universities who are seen to have several roles within a life science ecology. However, the framework has been complimented through the use of institutional thickness (Amin and Thrift, 1994, 1995). Reinvigorating the use of institutional thickness within the framework has allowed the thesis to develop further the comparison of a place with two constraining industries with an institutionally thick and institutionally thin environment. The Cohendet *et al* (2009, 2010) framework, as mentioned above, was unable to fully imagine the life science ecology in the city because of the structure and function of many institutions working across multiple layers. However, with the use of institutional thickness theory, the analysis was given much more depth behind the interventions of public bodies in the emergence, growth and situatedness of the ecology.

7.4 Future Research

As the literature on the creative and life sciences industries grows and focuses more so on the larger agglomeration of activity, we cannot neglect the smaller concentrations that are apparent in the UK. This thesis has contributed towards

filling this gap and raising further research agendas for a more complete picture of the issues surrounding the study of the ecologies of firms and their impacts upon a local environment (Pitelis, 2012). It is a key interest of policy makers to understand better their local industries in order to react and implement strategies accordingly and when appropriate (Florida, 2004). Not only has this research shed light on two of the four knowledge economy cornerstones for Liverpool, it has disseminated these findings to the local development agency Liverpool Vision. In regards to the life sciences, there have been several publications citing the conditions and path dependent processes leading to the emergence and growth of an agglomeration of science relation firms (Zucker and Darby, 1998; Feldman and Francis', 2003; Cooke, 2004, Lowe and Gertler, 2007; Gertler and Vinadrai, 2009). As the Liverpool ecology has shown, there have been intensive interventions into the development of the ecology, but what has been the drawback of the interventions? A longitude investigation into the life science ecology development would be best practice, given the lengthy timelines of production, linked with a firm population census to see if the ecology can sustain itself in the long term.

The research presented in this thesis is still only a snapshot of the broader industrial environment in Liverpool. Following Toulmin (1990) it is still the belief of the researcher that every environment, niche or habitat is one of its own kind, requiring investigation into the history and trajectories of firms, institutions and individuals occupying that space. Hence, there is more to know about both industries and the other industries that are a part of the knowledge economy within Liverpool. Going forward, the researcher would include an investigation into the financial services and advanced manufacturing sectors in Liverpool to understand the holistic development and fulfilment of a Liverpool knowledge economy strategy. At the same time, the structural changes due to government imposed austerity measures are yet to be assessed with regards to the key sectors of the Liverpool knowledge economy. This research can be taken further to seek the views and transformations occurring in the ecologies. If Liverpool is to be successful in four key sectors, surely

further impact related investigation is warranted. Theoretically, the ecological perspective needs further refining and clarity in regards to its increasing use across the social sciences. This leads us to consider the following points.

Within the video games ecology there are a high number of newly established entrepreneurial firms that are self-organising and becoming increasingly concentrated among other creative actors. There is an emerging literature, particularly in entrepreneurship, with a clear cross over with economic geography. It has begun to develop the concept of place based ecosystems (Jacobs, 2004; Mason, 2010; Mason and Brown, 2013; Vogel, 2013). Ecosystems have recently been cited in regards to sustained economic development. Ecosystems focus on a plethora of actors, including entrepreneurs, firms, universities and governments. In addition to what roles they have in developing adaptive, reflexive and effective economic environments for high growth firms (HGF) and entrepreneurs. Existing contributions from economic geography can supplement the interest in ecosystems such as learning firms and regions (Ashiem and Gertler 2006), institutional thickness (Amin and Thrift, 1994, 1995) and project ecologies (Grabher, 2004). We can pose geographical and strategic management questions with policy application such as:

- What are the conditions necessary to foster and promote an enterprising/entrepreneurship ecosystem?
- What might an enterprising/entrepreneurship ecosystem look like and how do we measure it?
- What is the role of the Public Sector and institutions in developing such ecosystems?
- What is the role of Multinational firms in such ecosystems?

Equally, there are many more questions we can ask about the two ecologies locally and internationally. There have been several publications in regards to the video games industry, in economic geography and management studies, looking into focal firms and the industry as a whole at an international scale (Cadin and Guerin, 2006; Johns, 2006; Balland *et al*, 2013; De Vaan *et al*, 2013; Marchand and Hennig-Thurau, 2013). Given the economic significance of the industry in the UK and in parts of Europe, there is limited but growing analysis of video game agglomerations with avenues to explore changes in production and distribution networks, cross-fertilisation and processes of creative learning in these firms and regions. There is potential to utilise, critique and develop further existing frameworks such as the Anatomy of the City used in North America, developed by Codendet *et al* in order to analyse specific agglomerations of video game activity (2009; 2010). Finally, the industry is seeing significant shifts in terms of production, composition and geography; arguably different to other creative industries, requiring academics to revisit some of the existing literature on an international and local basis.

Appendices

A-1 Interview Questions for Private Firms

Interview Schedule for Private Firms

PARTICIPENT SUMMARY
Name (Company): _____ _____
Previous Names (if any): _____ _____
Name (Respondent): _____ _____
Position: _____ _____
Job Description: _____ _____ _____ _____
Time with Company: _____ _____
University Attended: _____ _____

COMPANY SUMMARY
Primary Role: _____ _____
Other Functions: _____ _____
Annual Turnover: _____ _____
Ownership Status: _____

Year Established: _____

How was the Company Formed:

If Merger/Acquisition how much did it cost:

Other Locations and their Function:

HQ Location: _____

Relationship to HQ: _____

No of Employees (Company): _____

No of Employees (on site): _____

No Maximum Employment/Date: _____ / _____

No Male/Female: _____ / _____

Required Skills/Qualifications (if any): _____

Recruitment Methods:

Location Choice/ Local Cluster

1. Why was this location chosen to start the business?

- a. What do you see as an advantage/disadvantage to being located here?
- b. Does being located here make you feel you are a part of a wider business community, network or cluster: Yes or No?
- c. Why?

Local/Global Connections

- 2. How many business related connections do you have?
- 3. Would you say your links are mainly with small medium or large firms?
- 4. Thinking about all your links to other firms, are most of these local to Liverpool?
 - a. If no – what are you going to non local firms for?
 - i. Where are the firms you are linked to outside of Liverpool?
 - ii. Why are they there?
 - iii. How dependent are you on maintaining these links?
 - b. If Yes - What do these local businesses do for you?
 - i. Are all your business needs satisfied by local business?
 - ii. If no – why not and where do you have to go to satisfy that business need?
- 5. Are any of your connections affected by distance?
 - a. What’s the nature of these connections?
 - b. How and why must they be maintained?
- 6. Does your company have any links to [other] large companies in the industry?
 - a. Why do you need this link?
 - b. How did you form this link and maintain it over time?
- 7. Are there any particular companies you have made strong efforts to connect?
 - a. Who are they?
 - b. Where are they?
 - c. Why have you made this effort?

Production Network

- 8. Think about your products. Does this diagram represent the various stages your product goes through before it reaches the consumer?
- 9. Open discussion here...

Investment (Aimed at Specific firms – Management consultants, DA’s)

- 10. Do you or have you played any role in attracting investment into Liverpool?
 - a. Could you tell me any details of your most recent investment?

Type of Investment	Origin	New firm or production	Amount
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(Following questions aimed at all businesses)

11. Looking at the production system, at what point(s) (if any) did you seek external investment?
12. Have you used any of your above connections to facilitate inward investment into Liverpool?
 - a. If so which ones and why?
 - b. If not how do you source funds for new projects or existing ones?
13. Have you invested outside of Liverpool?
 - a. If so where?
 - b. Why that location?
 - c. What is the benefit to this location?

Development Agencies

14. Are you aware of the local development agencies?
 - a. Have they played any role in your company's success?
 - b. Do you feel you have a relationship with them and what is it like?
 - c. How beneficial are they to you and Liverpool?
 - d. Have you attended any networking events organised by government agencies?
15. What has been the most significant policy intervention(s) that has helped your business? (locally, regionally or nationally)
16. What policies have you come up against that have constrained your business development? (locally, regionally or nationally)
17. Overall does a government agency have any role to play in the production system? (use diagram here)
 - a. If so where and how
 - b. If not why not

Future

18. Where do you see your company in 5 years time?

A-2 Interview Questions for Other Institutions

Interview Schedule for Institutions

PARTICIPENT SUMMARY
Name (Organisation): _____ _____
Previous Names (if any): _____ _____
Name (Respondent): _____ _____
Position: _____ _____
Time with Organisation: _____ _____

ORGANISATION SUMMARY
Primary Role: _____ _____
Other Functions: _____ _____
Year Established: _____ _____
Other Locations and their Function:
No of Employees (Organisation): _____ _____
No of Employees (on site): _____ _____
No Maximum Employment/Date: _____ / _____ _____
Recruitment Methods:

Warm up

1. Can you briefly tell me about your current role and why you chose to do it?

Public Organisation

2. When did the [Public Organisation] become involved in the development of life sciences/ digital sector
3. What is [Public Organisation] role in the development of life sciences/Digital clusters?
4. Who looks after the sector?
 - a. Where are they located
 - b. Would they be willing to speak to me?
5. What other public agencies do you have contact with? What level of government?
6. What's [Public Organisation] strategy for the industry?

Geography and Scale

7. What do you find enabling and restricting about Liverpool in regards to the industries?
8. What is being done to help bring together universities and private sector in Liverpool?
9. Are there any skills gaps in Liverpool? How are they being addressed?

Liverpool

10. Where does Liverpool feature, in regards to digital and life science, in the North West and UK?
11. Why did Liverpool develop a life science/digital sector, who was involved and at what scale were they involved?
12. Incubators – what was the thinking behind these and what policy drove them?

Problems and future policy

13. How does the [Public Organisation] market Life sciences?
14. How close do you think the state, industry and academia are in regards to the life sciences/digital?
15. What is the future of [Public Organisation]?
16. Where do you plan to be in 5 years time in regards to the development of these sectors?

Thank you for your time and participation in this research.

A-3 Interview Schedule (Cited in Text)

Firm	Date of Interview
Online Publisher 1	30/11/11
Outsourcing Firm 1	11/01/12
Developer 3	16/07/12
Developer 4	13/12/11
Developer 5	07/12/11
Developer 6	01/02/12
Developer 7	07/12/11
Developer 8	30/11/11
Developer 9	13/12/11
Developer 10	13/11/12
Developer 11	14/02/12
Developer 13	16/07/12
Developer 17	07/12/11
Developer 20	13/12/11
Former SCE Manager	16/07/12
Discovery Firm 1	10/08/12
Discovery Firm 2	23/10/12
Discovery Firm 3	23/10/12
Discovery Firm 4	12/10/12
Discovery Firm 5	15/08/12
Diagnostic Firm 1	31/07/12
Diagnostic Firm 2	31/07/12
Drug Manufacturer 1	16/08/12
Drug Manufacturer 3	29/10/12
Drug Manufacturer 5	10/09/12
Consultancy Firm 1	26/06/12
Consultancy Firm 2	30/04/12
Consultancy Firm 3	09/05/12
Public Organisation 1	02/08/10
Public Organisation 2	05/08/10
Development Agency 1	21/06/13
UTC	29/10/12

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