**Teaching-focused University–Industry Collaborations: Determinants and impact on graduates’ employability competencies**

**ABSTRACT**

Although teaching is a core mission of universities, we know little about industry’s input into universities’ teaching activities. This paper advances research on teaching-focused university–industry collaborations (UICs) by studying the determinants of universities’ participation in these collaborations as well as the impact of teaching-focused UICs on graduates’ employability competencies. We designed a three-staged mixed-methods approach in the context of Indian Higher Education Institutes (HEIs). In the first stage, we conducted nine case studies through 53 interviews with Indian HEIs and their industrial partners to understand what factors facilitate or hinder an HEI to engage in teaching-focused UICs. In the second stage, we tested the influence of these factors on HEIs’ propensity to form teaching-focused UICs using data gathered from the websites of 2,280 Indian HEIs. In the third stage, we studied the impact of these collaborations on graduates’ employability competencies on the subset of 486 HEIs for which data on graduates’ employability competencies are available. Our results show that among institutional factors, location, the academic autonomy of an HEI and government-supported intermediary organizations facilitate HEIs’ participation in teaching-focused UICs, whereas the HEI’s public ownership inhibits such collaborations. Among HEI-level factors, we found that an HEI’s size, discipline variety, academic embeddedness and industrial embeddedness facilitate its participation in teaching-focused industrial collaborations. Lastly, our results demonstrate that graduates from HEIs collaborating in teaching-focused UICs are able to acquire better employability competencies, particularly domain-specific employability competencies.

**Keywords:** Teaching, university–industry collaborations, employability, mixed methods

## Introduction

Teaching is widely recognized as a core mission of universities, along with research and social impact (Bellucci and Pennacchio, 2016). Teaching revenues constitute a significant percentage of universities’ income. In 2017-2018, the income generated from tuition fees and education contracts contributed to about half of the total income of UK universities (HESA, 2019). The contribution of teaching to universities’ annual income is even higher in less-developed economies, where teaching is the only activity of most universities, and, at the same time, academics are less research-active (Shin and Jung, 2014) and less oriented to engage in research and technology commercialization (Guimón, 2013). Good teaching performance also plays a fundamental role on enhancing a university’s quality, reputation, as well as positively affecting the socio-economic environment, delivering effective students’ learning experience, and in turn attracting high-quality prospective students and employees. Through appropriately designed teaching curricula, universities can ensure that graduates are appropriately trained for industry, thus improving their employability (Khare, 2014; Plewa et al., 2015), and are able to engage in knowledge generation, acquisition, sharing and utilization in their employment (Brown et al., 2003; Shapira et al., 2006). On the other hand, research-oriented teaching and the inclusion of entrepreneurship and sustainability modules in education allow universities to impart important research and entrepreneurial competencies in graduates as well as augment their awareness about sustainability and community engagement (Böttcher and Thiel, 2018; Muñoz et al., 2020; Sánchez-Carracedo et al., 2019). Thus, through teaching, universities can also improve their performance in the other two missions– research and social impact. Lastly, through teaching, universities can instill fundamental institutional and cultural norms and values in graduates that are imperative to build a healthy and inclusive civil society (World Bank, 2002).

Therefore, universities must formulate strategies to support their teaching performance and impact. One such strategy is to develop teaching-focused university–industry collaborations (UICs), which refer to collaborations between universities and corporations for teaching activities, and include curriculum development, training students and academics, and setting up labs (Borah et al., 2019; Orazbayeva et al., 2019; Samuel et al., 2018). Despite the importance of teaching for universities, and the wider socio-economic environment, little research has been conducted on teaching-focused UICs. Instead, university–industry linkages have been predominantly discussed in the context of collaborations for joint research, contract research, consulting, technology transfer, and creating spin-offs (Ankrah and Omar, 2015; Perkmann et al., 2013). In this paper, we refer to these collaborations as research and commercialization-focused UICs. Scholarly attention towards examining teaching-focused UICs remains scant. Ankrah and Omar (2015), drawing on a systematic review of 109 studies on university–industry collaborations published during the period 1990-2014, reported that “none of the reviewed studies has addressed the consequences of this engagement on teaching and learning experience of students affiliated to universities that engaged with the industry” (p. 402). This research lacuna was also highlighted by Perkmann et al. (2013).

Recent studies have analyzed the dynamics of teaching-focused UICs (see Borah et al., 2019; Cavallone et al., 2019; Davey et al., 2018; Kunttu, 2017; Kunttu et al., 2018; Plewa et al., 2015; Rossano et al., 2016; Samuel et al., 2018; Sin and Amaral, 2017). However, they have predominantly focused on either exploring the incentives for universities and companies to engage in teaching-focused UICs, or describing how and in what forms teaching-focused UICs are organized. These studies offer only limited understanding of the determinants of teaching-focused UICs. The examination of the determinants of teaching-focused UICs can help unearth the institutional, university-level and company-level conditions under which universities and companies would show greater propensity to engage in teaching-focused UICs. Knowing these factors is critical for advising universities, companies and policymakers on building a supportive institutional and organizational environment for such collaborations.

Moreover, the extant literature on teaching-focused UICs does not provide comprehensive empirical insights on the impact of these collaborations on graduate outcomes. For example, Orazbayeva et al. (2019) documented improving graduates’ employability as one of the primary reasons why universities tend to form teaching-focused UICs particularly around curriculum design and delivery. However, there is diminutive empirical evidence demonstrating whether universities with teaching-focused UICs provide more employable graduates, thereby limiting our understanding of the actual value of teaching-focused UICs for human capital development. Without such understanding, it would be problematic to motivate policymakers and universities to consider why they should promote teaching-focused UICs in the first place.

To address this lacuna, we ask the following research questions: a) what are the determinants of universities’ participation in teaching-focused UIC? And b) what is the impact of universities’ participation in teaching-focused UICs on graduates’ employability competencies? To answer these research questions, we adopted a three-stage mixed-methods approach in the context of Indian Higher Education Institutes (HEIs) in four engineering disciplines – computer engineering, information engineering, electronics engineering and telecommunication engineering. In the first stage, we conducted case studies on nine Indian HEIs through 53 interviews with the HEIs and their industrial partners in teaching to understand the potential factors that may affect HEIs’ participation in teaching-focused UICs. In the second stage, we tested the influence of the factors identified in the first stage on HEIs’ propensity to form teaching-focused collaborations with industry by estimating negative binomial regression models on data gathered from the websites of 2,280 Indian HEIs. In the third stage, we studied the impact of these collaborations on graduates’ employability competencies, on the subset of 486 HEIs for which data on graduates’ employability competencies are available.

India offers an appropriate institutional setting to study the role of teaching-focused UICs in improving graduates’ employability competencies. Although it is one of the leading countries in terms of the number of engineering graduates produced each year, the quality of the graduates is questionable (Loyalka et al., 2014), with reports showing that more than 70% of engineering graduates lack employability competencies (e.g., Aspiring Minds, 2016; Khare, 2014). These reports have urged the government to find solutions to improve the industrial relevance of engineering education. Therefore, the discussion on initiatives such as teaching-focused collaborations between industry and HEIs, which have the potential to improve graduates’ employability competencies, is of high policy relevance in the Indian context. We consider teaching-focused UICs in four engineering disciplines (computer engineering, information engineering, electronics engineering and telecommunication engineering) because these disciplines prepare engineering graduates for the information and communication technology (ICT) industry, one of the most important sectors in the Indian economy. The examination of teaching-focused UICs in these four engineering disciplines could help understand whether such collaborations are a plausible strategy to meet the urgent need for developing skilled workers in emerging fields such as artificial intelligence, the internet of things and big data analytics (Alharthi et al., 2017), and if so, what conditions are necessary for universities to develop such collaborations.

In this paper, we make several contributions. By studying the university-level and institutional factors facilitating and hindering universities’ participation in two forms of teaching-focused UICs, we address Borah et al.’s (2019) call to “examine the determinants of teaching-focused industry-academia collaborations to advise how to develop a favorable environment for implementing these collaborations” (p. 14). In doing so, we identify some new and context-specific determinants of UIC, whose influence has not been studied on any form of UIC so far. This should help to strengthen the literature on the facilitators and barriers to UICs (Bruneel et al., 2010). Comparison of our results with the extant UIC literature suggests that several factors that influence universities' participation in teaching-focused UICs are the same as those that determine research and commercialization-focused UICs. This result provides clear, practical advice to universities and policymakers on how universities can simultaneously engage in teaching-focused UICs and research and commercialization-focused UICs and improve their performance in the three missions, i.e., teaching, research and social impact (Bellucci and Pennacchio, 2016), thus contributing to the literature on the interconnectedness between the three missions of universities (Artés et al., 2017; Degl’Innocenti et al., 2019; Sánchez‐Barrioluengo, 2014). Our findings also advance research on graduates’ employability by providing large-scale empirical analysis, currently absent in the literature, to corroborate the notion that teaching-focused UICs can help universities to develop employable graduates. Specifically, we examine the role of two forms of teaching-focused UIC: *course-based* and *project-based teaching collaborations*, in enhancing two distinct types of employability competencies: *generic* and *domain-specific employability competencies*, offering a more nuanced understanding of the impact of teaching-focused UICs. These findings should be beneficial for countries that have identified ensuring that graduates are equipped with the necessary employability competencies a key policy priority. In 2012, the European Commission made enhancing the employability of 20–34-year-olds a priority and urged its member countries to work together towards achieving a collective 82% employability rate by 2020 (European Commission, 2016). A similar pledge to improve graduates’ employability has also been displayed by countries in other regions such as the Asia-Pacific region (Cameron et al., 2017).

The rest of the paper is structured as follows. The next section presents a review of literature on teaching-focused UICs and graduates’ employability. Next, we discuss the data collection and analysis methods. The subsequent sections present the results and discuss their implications for research and practice. Lastly, we suggest some promising avenues for future research.

## Literature Review

In this section, we review the existing literature on teaching-focused UICs, their determinants and their role in developing graduates’ employability competencies.

### Teaching-focused UICs

Teaching-focused UICs refer to initiatives facilitating industry’s participation in universities’ teaching activities. They include the development and delivery of curriculum (Davey et al., 2018; Plewa et al., 2015), industrial value-added courses (Cavallone et al., 2019), student projects and internships (Rossano et al., 2016), setting up labs with industrial tools at the university campus for students’ use (Watson-Capps and Cech, 2014), and training academics with industry-relevant competencies (Orazbayeva et al., 2019). Borah et al. (2019) categorized teaching-focused UICs as *course-based teaching collaborations* aimed at developing and teaching tailored degree programs as well as jointly organized courses as a part of the curriculum or value-added[[1]](#footnote-1) courses, and *project-based teaching collaborations* aimed at developing student projects which can be pursued as dissertation or value-added projects. Kunttu (2017) proposed a more nuanced categorization of four different forms of teaching-focused UIC: a) student projects, which are part of the UG curriculum and are co-supervised by academics and industry staff; b) thesis projects, which are co-supervised by academics and industry staff and are related to MSc and PhD dissertations; c) tailored degree programs, which are co-designed and taught by academics and industry staff around competencies which are wanted by the industry partner, and d) jointly organized courses, which are co-designed and taught by academics and industry staff around the research foci of their collaboration.

The onus of developing, teaching and supervising courses or projects is usually shared between academics and the collaborating company’s managers (Kunttu, 2017; Rossano et al., 2016). If industrial supervisors struggle to dedicate time to these activities, due to their regular job commitments (Samuel et al., 2018), they can train academics from partner universities to augment their capability to teach industry-relevant courses and supervise projects to students (Healy et al., 2014).

The main incentive for universities to involve companies in their teaching activities is to enhance the industrial relevance of education, which can boost students’ experiences and their job prospects (Plewa et al., 2015). Academics can benefit from participating in teaching-focused UICs, because it might lead to receive funding/financial resources from the industry partner as well as develop better reputation in the university (Orazbayeva et al., 2019). Meanwhile, companies pursue teaching collaborations with universities mainly for recruitment purposes to select graduates with industry-specific and firm-specific competencies (Plewa et al., 2015). Importantly, this helps companies save time and costs associated with providing on-the-job training (Borah et al., 2019).

Thus, existing studies on teaching-focused UICs offer in-depth analysis on: a) the organizational aspects of such collaborations, i.e., how these collaborations occur (Kunttu, 2017; Rossano et al., 2016; Samuel et al., 2018; Sin and Amaral, 2017); and b) the incentives for both industry and universities to develop such collaborations (Cavallone et al., 2019; Orazbayeva et al., 2019). However, we know little about the determinants of teaching-focused UICs, i.e., the institutional, university-level and firm-level factors/conditions, under which a university is more likely to engage in teaching-focused UICs, as well as the actual impact of these collaborations on enhancing the teaching performance of universities, and in turn improving graduates’ employability competencies.

### 2.2 Determinants of universities’ participation in UICs

The decision for a university to engage in teaching-focused UICs normally requires university-level and/or institutional approval, because any change in the content of the curriculum may have implications for the wider student community of a university (Borah et al., 2019; Samuel et al., 2018). University-level factors refer to the resources and capabilities of the university involved in the UIC such as the university size, discipline variety, quality, status, academic research and industrial networks/embeddedness (Perkmann et al., 2013). On the other hand, institutional factors refer to the elements of the institutional framework in which the UIC operates (Giuliani et al., 2010; Perkmann et al., 2013) such as location (Mawdsley and Somaya, 2016), government policies and support mechanisms available to the university involved in the UIC (e.g. public grants and government-supported intermediary organizations). Therefore, it is expected that university-level and institutional factors will affect universities’ engagement in teaching-focused industrial collaborations.

To the best of our knowledge, only one study (Plewa et al., 2015) has studied the determinants of universities’ participation in teaching-focused UICs. However, Plewa et al. (2015) studied only two determinants, i.e., universities’ resource investments and industrial ties, measured using four variables: alumni network, external promotion, academics of company board and business on university board. Thus, research is still needed to explore what other university-level and/or institutional factors may determine a university’s participation in teaching-focused UICs. Also, Plewa et al. (2015) studied the influence of the two determinants on their participation in course-based teaching collaborations only. Thus, there is no understanding on the determinants of universities’ participation in project-based teaching collaborations.

As the literature on the determinants of teaching-focused UICs is scant, below we discuss the key university-level and institutional factors identified in prior studies as the predictors of universities’ engagement in research and commercialization-focused UICs. These predictors were then used as reference to formulate questions for our interviews to explore if the same factors could also influence universities’ propensity to participate in teaching-focused industrial collaborations, and how.

**2.2.1 University-level determinants of universities’ participation in UICs**

Among university-level factors, the size of the department/university has been established as a key determinant of research and commercialization-focused UICs. For example, Schartinger et al. (2001) report a U-shaped relationship between a department’s size and its propensity to develop industrial collaborations, with small and large departments being more likely to engage in industrial collaborations compared to medium-sized ones. Small departments might be attractive for UICs in niche research fields, whereas larger departments might be attractive due to a higher variety of subject-areas and faculty, as well as benefit from higher visibility and social capital within the industry (Muscio et al., 2013).

Universities’ discipline variety is often seen as an attractor for research and commercialization-focused UICs. Most problems that exist in today’s socio-economic environment are complex and multifaceted; their solutions often require the integration of expertise from multiple disciplines (Bruce et al., 2004; Rijnsoever and Hessels, 2011). A university with a high degree of discipline variety can offer a single platform for companies to access and collaborate with researchers from multiple disciplines, reducing the need for developing collaborations with multiple universities, thereby reducing transaction costs.

Universities’ quality and status also affect the probability that a university will collaborate with industry. Abramo et al. (2011) identify a university’s scientific excellence as a prerequisite for UICs. The presence of ‘star scientists’ in a department could also help to attract private funding, particularly within the physical and engineering science disciplines (Perkmann et al., 2011). From the collaborating firm’s perspective, high-quality universities can offer capabilities and resources to achieve the objectives of an industrial project.

High engagement in academic research and extensive production of academic publications and patents within a specific field indicate high-quality of a university’s knowledge and expertise in that field and helps the university to establish legitimacy in the academic and industrial community (Karlsson and Wigren, 2012), which might attract industry collaborators. Mamun and Rahman (2015) report a two-way relationship between universities’ research publications and research collaborations i.e., high research publications contribute to improving universities’ propensity to form research collaborations and vice versa. Further, universities highly engaged in academic research are likely to possess advanced laboratories, which can be attractive for resource-constrained companies such as SMEs (Massa and Testa, 2008).

Universities’ industrial embeddedness, i.e., prior experience of engaging with industry, also enhances the probability of forming further collaborations, as they signal trust by industrial partners (Hong and Su, 2013) and ability of overcoming possible conflicts arising from differences in institutional logics (Bruneel et al., 2010; Llopis and D’Este, 2016). Moreover, prior experience in collaborating with industry allows individual academics to develop extensive relational networks in the industry (Giuliani et al., 2010) which may be valuable for forming industrial collaborations (Steinmo and Rasmussen, 2018).

**2.2.2 Institutional determinants of universities’ participation in UICs**

Institutional support for university–industry joint projects often come in the form of funding. Universities are increasingly pushed to become entrepreneurial and to generate income through external funding such as public grants (Degl’Innocenti et al., 2019; Sánchez‐Barrioluengo, 2014). Many public grants require the universities to collaborate with industry. For example, under the Knowledge Transfer Partnership scheme, the UK government provides about £25 million annually in grants to support university-industry knowledge transfer. University graduates are placed at the company as knowledge transfer agents and are supervised by the university (Wynn and Turner, 2013).

Governments may also establish intermediary structures such as research parks, consortia, university research centers and incubation centers (Hayter, 2016; Kodama, 2008; Suvinen et al., 2010). These intermediary organizations act as boundary spanners (Wright et al., 2008), linking universities with potential industry partners and vice versa, and thereby contribute towards reducing search and bargaining costs for both universities and companies (Kodama, 2008). They also offer a common geographical space to industrial and academic organizations to work together on research and commercialization projects (Massa and Testa, 2008; Suvinen et al., 2010). Thus, having access to such government-supported intermediary organizations may improve universities’ propensity to form collaborations with industry.

The location of universities also plays a central role in developing research and commercialization-focused UICs (Youtie and Shapira, 2008). Finding industrial partners for research collaborations and an investor for university spinouts becomes easier if the university is located in an industrial cluster (Storey and Tether, 1998). Furthermore, geographical proximity offers the necessary continuous and frequent interactions between the involved partners, enabling the partners to develop trust and overcome barriers posed by differences in institutional logics (Llopis and D’Este, 2016).

Thus, in the extant literature, public grants, government-supported intermediary organizations and university location have been identified as influential institutional factors driving universities’ participation in industrial research and commercialization projects. Among university-level factors, university size, discipline variety, academic research intensity, status and industrial embeddedness have been recognized as the main predictors. In this study, we examine if any of these university-level and institutional predictors of research and commercialization-focused UICs also determine universities’ involvement in teaching-focused UICs.

### 2.3 Graduates’ employability competencies and the role of teaching-focused UICs

Graduates’ employability competencies refer to the "set of attributes, skills and knowledge that all labor market participants [graduates] should possess to [find jobs as well as to] ensure they have the capability of being effective in the workplace" (Confederation of British Industry, 2007, p. 6). Employability competencies can be categorized as *generic competencies* and *domain-specific* *competencies* (Zlatkin-Troitschanskaia et al., 2015). Generic competencies are those competencies required at most workplaces irrespective of the industry and the employer; these include analytical, reasoning, communication and interpersonal skills (Succi and Canovi, 2019). In contrast, domain-specific competencies refer to the core technical competencies required to work in a specific industry (Samuel et al., 2018). For instance, for a computer engineering graduate, the ability to write computer programs and algorithms, and develop applications and software, are examples of domain-specific competencies.

Graduates are expected to develop both generic and domain-specific employability competencies during university education. However, universities may fail to impart such competencies or develop graduates with competencies incompatible with the needs of industry if there exists an information mismatch between universities and industry regarding the specific skill requirements in the industry (Sin and Amaral, 2017). Teaching-focused UICs could help universities reduce this information mismatch by offering opportunities to understand present and future competencies needs and discuss action plans to develop these competencies (Healy et al., 2014; Plewa et al., 2015). For example, universities could invite companies to participate in course-based teaching collaborations and review universities' curricula to analyze whether the curricula adequately cover the required type and level of conceptual/theoretical understanding of industry-relevant technologies (Borah et al., 2019). If needed, companies may collaborate with the university to co-design and deliver new courses to meet the industrial needs (Davey et al. 2018; Plewa et al., 2015; Samuel et al., 2018).

On the other hand, universities and companies can collaborate in project-based teaching-focused UICs to offer students the opportunity to work on real-world industrial projects, which are often designed in line with the collaborating companies’ current and future research projects (Borah et al., 2019; Kunttu, 2017). Participating in such projects allows students to observe the practical relevance of their conceptual understanding as well as to apply such knowledge to solve industrial problems (Kunttu et al., 2018). Also, often companies provide relevant industrial technologies (e.g., software) to the university so that students could use such technologies in their projects (Kunttu, 2017), which could further strengthen the practical side of their domain-specific competencies. Participating in project-based collaborations could also help students to develop important generic competencies such as problem-solving skills and team working capabilities (Rossano et al., 2016).

Most previous studies have focused on the ‘process’ of how teaching-focused collaborations could help developing graduates with necessary employability competencies. To our knowledge, very few studies (e.g., Ishengoma and Vaaland, 2016; Samuel et al., 2018) have examined the ‘outcome’ of these collaborations, i.e., whether they are successful in improving graduates’ employability competencies. Samuel et al. (2018), based on a survey, reported that 53% of the graduate cohort that participated in a teaching collaboration between Brunel University London and the Welding Institute felt that the program imparted them with the necessary employability competencies. However, Samuel et al.’s (2018) findings are mostly based on course-based teaching collaborations only; it is still unknown whether project-based teaching collaborations are effective in improving graduates’ employability. On the other hand, Ishengoma and Vaaland (2016) bring evidence from two universities in Tanzania and report a positive relationship between teaching-focused UICs and graduates’ employability without making clear distinctions between generic and domain-specific employability competencies, thus, making it difficult to recognize whether teaching-focused UICs equip students with better generic competencies or domain-specific competencies or both. Further, the findings from both of these studies are drawn from a few specific cases, which raises questions over the generalizability of their results, thereby pointing towards the need for conducting large-scale empirical analyses on the role of teaching-focused UICs on enhancing graduates’ employability competencies. In this paper, we address these research gaps.

## Research Design and Methods

### 3.1 Methodological framework

In this study, we adopted a mixed-methods approach. Greene et al. (1989) suggest that mixed-methods designs can be implemented to fulfil five purposes: triangulation, complementarity, development, initiation, and expansion. In this paper, the main driver for adopting a mixed-method approach was ‘expansion’, which refers to extending the scope of an investigation by using different methods for different parts of an investigation (Greene et al., 1989), e.g. research questions (Tashakkori and Teddlie, 2009); the study also fulfilled a development purpose, as we explain below. We used two different methods: ‘sequential mixed-methods’ (Molina-Azorin et al., 2012) for addressing the first research question (RQ1) and quantitative methods for addressing RQ2.

For RQ1, a purely quantitative study would have been suitable considering that it is a ‘what’ and relationship-explaining research question (Onwuegbuzie and Leech, 2006). Ideally, the literature review should have informed the independent variables and dependent variables for the quantitative study. However, in this paper, identifying the independent variables, i.e., the potential determinants of HEIs’ participation in teaching-focused UIC, from the literature review was difficult because the extant literature on teaching-focused UICs is scant. Our literature review did allow us to identify some HEI-level factors (HEIs’ size, status, discipline variety, involvement in academic research and industrial embeddedness) and institutional factors (public grants, government-supported intermediary organizations and HEIs’ location) which have been previously reported as the determinants of HEIs’ participation in research and commercialization-focused UICs. However, before including these factors as the independent variables in the quantitative model in Stage 2, we wanted to verify whether these factors are actually relevant to teaching-focused UICs. Hence, for RQ1, instead of a purely quantitative study, we designed a sequential mixed-method study, where a qualitative study involving nine case studies (also referred to as Stage 1 in this paper) was conducted before the quantitative study (Stage 2) (Molina-Azorin et al., 2012) to fulfil the ‘development’ purpose (Greene et al., 1989), i.e., to identify the independent variables for the quantitative study. Thus, the qualitative study in Stage 1 and the quantitative study in Stage 2 jointly helped to address RQ1.

The research setting is Indian Higher Education Institutes (HEIs) and the qualitative study involving case studies on nine HEIs helped to answer two inquiries. First, we asked whether, how and to what extent the above-mentioned HEI-level and institutional factors also influence HEIs’ participation in teaching-focused UICs. This inquiry, which is ‘explanatory’ in nature (Yin, 1981), contributed towards explaining the nature of the relationship (positive, negative or no relationship) between the factors and an HEI’s participation in teaching-focused UICs, and the motivations for developing such a relationship. As a result, we were able to eliminate factors that have previously been reported as the determinants of HEIs’ participation in research and commercialization-focused UICs but are not relevant to teaching-focused UICs (e.g., public grants)[[2]](#footnote-2).

Second, we asked whether any other factor influences HEIs’ participation in teaching-focused UICs and if there was, how. This ‘exploratory’ inquiry (Yin, 1981) helped to reconnoiter if other factors (e.g., context-specific factors) may influence HEIs’ participation in teaching-focused UICs but have not been previously reported as the determinants of HEIs’ participation in research and commercialization-focused UICs. The interviews led us to identify an additional HEI-level factor – HEIs’ academic embeddedness[[3]](#footnote-3) – and two institutional factors – HEIs’ academic autonomy and public ownership[[4]](#footnote-4)– as the potential determinants of HEIs’ participation in teaching-focused UICs. An HEI’s academic embeddedness refers to how well connected the HEI is to the rest of the academic network in the country. Interviewees suggested that high academic embeddedness of HEIs is a facilitator of teaching-focused UICs, because highly academically embedded-HEIs are able to use the partner HEIs’ industrial networks to develop teaching-focused UICs as well as their resources, such as academics and labs, for carrying out the activities in teaching-focused UICs. According to interviewees, an HEI’s academic autonomy, which refers to the degree of autonomy granted to the HEI to change curricula, is also a facilitator of teaching-focused UICs because autonomous HEIs can design their own curriculum and involve industry in the curriculum design process without permission from government authorities. On the other hand, interviewees suggested that an HEI’s public ownership, which refers to whether the HEI is owned and managed by the government, can be a barrier to teaching-focused UICs because high levels of bureaucracy in public HEIs creates difficulties in initiating the collaborations and fulfilling their objectives on time.

As both inquiries have a ‘how’ component, we adopted a case study design for the qualitative study because of its suitability to answer ‘how’ questions (Baxter and Jack, 2008; Yin, 2003). In addition, case studies are appropriate to investigate issues embedded in a multifaceted phenomenon, such as UICs, because they allow addressing an inquiry from multiple perspectives (Yin, 2003)[[5]](#footnote-5). Multiple case studies were selected as the preferred method because they allow identifying similarities and differences in findings across cases and thereby facilitate a deeper investigation (Baxter and Jack, 2008). At the end of the case studies (Stage 1), we identified six HEI-level factors - HEIs’ size, status, discipline variety, academic research, academic embeddedness and industrial embeddedness - and four institutional factors - government-supported intermediary organizations, location, academic autonomy of HEIs, and public ownership of HEIs - as the potential determinants of HEIs’ participation in teaching-focused UICs.

These factors were included as independent variables in the quantitative study in Stage 2, where we tested their influence on HEIs’ propensity to form teaching-focused UICs through the estimation of negative binomial regression models. The data on these variables were gathered from the websites of 2,280 Indian HEIs.

The dependent variables from Stage 2, i.e., the propensity of HEIs to form teaching-focused UICs, form the main explanatory variable in Stage 3 and the independent variables in Stage 2 are also included as independent (control) variables in Stage 3. Stage 3 examines the impact of HEIs’ participation in teaching-focused UICs on their graduates’ employability competencies and addresses RQ2. In Stage 3, we used ordinary least square (OLS) regression models on the subset of 486 HEIs for which data on graduates’ employability competencies are available.

Figure 1 shows the interconnectedness between the stages and how they contribute to addressing the research questions.

Figure 1 An overview of the methods and data used in this study



### 3.2 The qualitative study (Stage 1)

#### 3.2.1 Data collection

We conducted case studies on nine HEIs. The main criterion for selecting a case was that the HEI must have been engaged in at least one teaching-focused UICs. Due to confidentiality purpose, we refer to the cases as HEI-I, HEI-II and so on. Within each HEI, we interviewed members of the top leadership team (Directors/Deans), the academics in charge of teaching-focused UICs, as well as current and former students who took the courses and participated in projects organized under these collaborations. In HEI-II and HEI-III, we conducted interviews in focus groups, where all the interviewed academics were invited to join a roundtable discussion on the factors that influence an HEI’s involvement in teaching-focused UICs. The focus groups had three and six participants respectively and lasted 72 minutes on average. In these focus groups, we followed the ‘structured eavesdropping’ approach (Powney, 1988), where the interviewer plays the role of a facilitator and lets the members discuss among themselves in order to converge to consensus (Kitzinger, 1995). For instance, when we raised a question, we asked one person to take the lead to answer the question and others to contribute to the answer by providing additional or alternative arguments. Such conversations helped to accumulate several explanations on how each factor may influence an HEI’s involvement in teaching-focused UICs. Due to scheduling issues, we could not conduct focus group interviews in other HEIs, and we conducted individual interviews with academics.

For each HEI, at least one of its industrial collaborators was interviewed to validate the arguments highlighted by the academics and thereby achieve triangulation (Baxter and Jack, 2008). Since these companies are involved in teaching-focused UICs with several HEIs across India, the interviewees from the companies provided a more holistic picture on the factors influencing HEIs’ participation in teaching-focused UICs. For instance, we asked the company if the factors that influence an HEI’s involvement in teaching-focused UICs vary across different Indian states/regions to recognize any potential institutional determinant that had not been identified during the interviews with HEIs. In addition, we asked the interviewees from companies to reflect on their experience with both successful and unsuccessful teaching-focused UICs so that we could draw clear distinctions between facilitating factors and barriers to HEIs’ participation in teaching-focused UICs. In the companies, we interviewed the managers responsible for teaching-focused UICs.

For HEI-V, we also interviewed a government-supported intermediary organization (which we refer to as Intermediary-X), because the interviewees from HEI-V disclosed receiving support from Intermediary-X to organize teaching-focused UICs. Interviews with Intermediary-X thus helped us to learn more about the range of support they offer to HEIs for teaching-focused UICs and their geographical coverage. These insights were crucial to identify accessing to government-funded intermediary organizations as a determinant of HEIs’ participation in teaching-focused UICs.

In total, 53 participants were interviewed using ‘semi-structured’ and ‘open-ended’ questions. (See the “e-component” for a list of the interviewees.) The semi-structured and open-ended questions helped2 us address the explanatory and exploratory inquiries respectively (as discussed in Section 3.1). On average, the interviews lasted for 48 minutes. 47 interviews were performed in person and six were conducted over the telephone. We retrieved approximately 3,000 pages of secondary data in the form of company reports, collaboration contracts, and content of the courses and projects taught and supervised within the teaching-focused UICs.

#### 3.2.2 Data analysis

To analyze the qualitative data, we performed ‘axial coding’ (Strauss and Corbin, 1998). The raw data was first coded into first-order codes, which outline the facilitators and barriers to HEIs’ participation in teaching-focused UICs. The codes were then grouped together to form the determinants of HEIs’ participation in teaching-focused UICs, e.g., HEIs’ status, size and location, which are our second-order constructs. Finally, these determinants are categorized into third-order constructs: HEI-level and institutional determinants. (See “e-components” for examples of interview quotes from which 1st-order codes were derived.)

Figures 2 and 3 visualize the data structures developed to identify the HEI-level and institutional determinants of HEIs’ participation in teaching-focused UICs. Among HEI-level factors, the interviewees unanimously identified HEIs’ size, discipline variety, academic embeddedness and industrial embeddedness as the facilitator of teaching-focused UICs. We received a mixed response to the question of whether an HEI’s involvement in academic research and HEIs’ status facilitate or hinder its engagement in teaching-focused collaborations with firms. Among institutional factors, HEIs’ location, autonomy and access to government-supported intermediary organization were recognized as facilitators, whereas the interviews suggested the possibility of a negative relationship between the public ownership of HEIs and their participation in teaching-focused UICs. After six cases (i.e., 41 interviews), we achieved a ‘saturation point’ (Järvi et al., 2018) as the remaining three cases did not result in the identification of new codes. Therefore, we stopped gathering new data for the qualitative study at nine cases and 53 interviews.

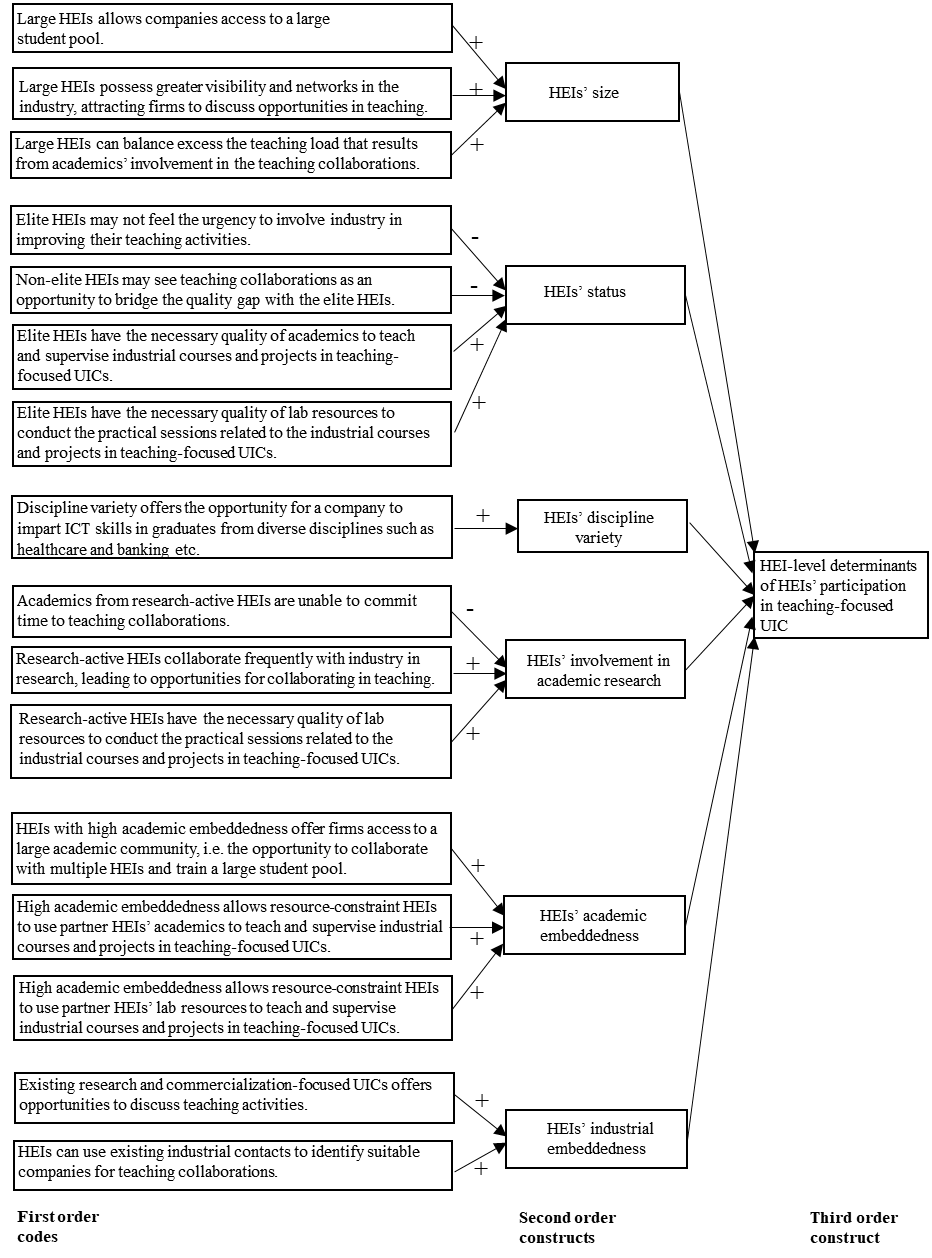


Figure 2 Data structure visualizing the HEI-level determinants of HEIs’ participation in teaching-focused UICs; ‘+’ and ‘–’ denote the facilitators and barriers respectively

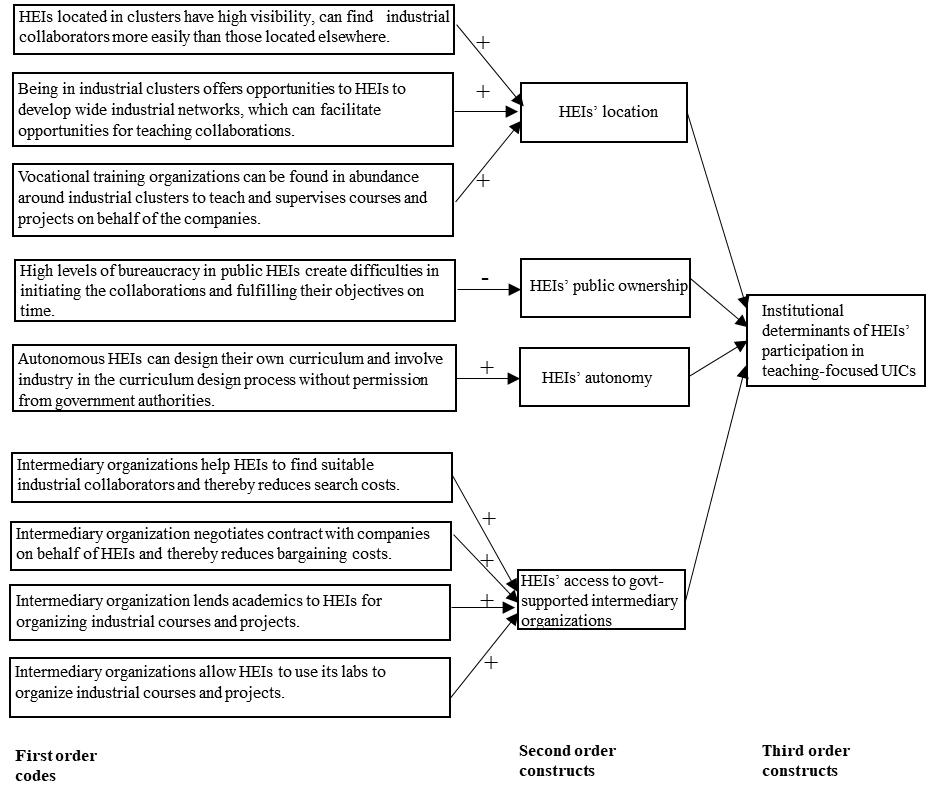


Figure 3 Data structure visualizing the institutional determinants of HEIs’ participation in teaching-focused UICs; ‘+’ and ‘–’ denote the facilitators and barriers respectively

### 3.3 The quantitative study (Stage 2)

#### 3.3.1 Data collection

In Stage 2, conducted in 2017, we collected data from the websites of Indian HEIs on their participation in industrial collaborations in teaching and the potential determinants of such collaborations (identified in Stage 1). Websites are an important communication tool for universities to share details about their programs, faculty, facilities, disciplines, and industrial collaborations to prospective students (Foroudi et al., 2019). Websites are usually the ‘first point of contact’ between prospective students and universities (Lažetić, 2019). Particularly, students, who are unable to visit a university physically or hold limited prior knowledge about the institution, are likely to rely on the information provided on the university website to decide whether to enroll there (Foroudi et al., 2019). Therefore, universities are likely to use websites to provide details about their teaching-focused UICs that are intended to enhance graduates’ employability.

Websites offer a rich data source for collecting data on universities' industrial collaborations because the information on universities' industrial collaborations usually contain the name of the industrial partner, and the company may object and take legal steps if misinformation is conveyed through the website. Prior studies have used information from websites to analyze UICs (e.g., Heimeriks et al., 2008; Li et al., 2018). Data from websites have been used to examine universities’ capabilities, strategies and impact, e.g., intrapreneurial capabilities (Guerrero et al., 2020), partnerships with community organizations (Arrazattee et al., 2013), and contributions to sustainable development (Nejati et al., 2011). These studies support that university websites contain rich and reliable information, which can be used as a data source for academic research.

We checked each webpage of an HEI’s website (e.g., Home’, ‘About’ and ‘Programs’) either manually or using the inbuilt search engines. Moreover, we examined documents such as annual reports, the content of the industrial courses, projects, and memorandum of understanding, for comprehensive data collection. Furthermore, we tracked all the outgoing hyperlinks in the websites (Heimeriks et al., 2008) to examine if the information about the HEI’s teaching-focused UICs had been discussed in external sources such as social media, news reports and collaborating companies’ websites. This helped us achieve triangulation. We considered only those HEIs whose websites were ‘complete’, i.e., contained basic information such as courses offered, disciplines, and the number of enrolled students and were ‘up-to-date’. We considered a website as ‘up-to-date’ if new information was fed into the website in the six months preceding the data retrieval date. Our final sample comprises of 2,280 HEIs.

#### 3.3.2 Operationalization and measurement of variables

**3.3.2.1 Dependent variables**

The dependent variables are an HEI’s propensity to form a specific teaching-focused UICs - course-based or project-based. In order to measure this variable, we counted the number of teaching-focused UICs that an HEI made until 2017 in four engineering disciplines: computer engineering, information engineering, electronics engineering and telecommunication engineering. A collaboration was categorized as teaching-focused if improving the teaching activities of the institute was one of the main objectives. Out of 2,280 HEIs, we found that 958 HEIs participated in teaching-focused industrial collaboration. In total, 2,198 teaching-focused UICs have been recorded, among which 1,667 collaborations were within the computer engineering and information engineering disciplines and 531 collaborations in the electronics engineering and communication engineering disciplines. We distinguished between *course-based* and *project-based* teaching collaborations, finding 1,997 course-based teaching collaborations and 201 project-based teaching collaborations. The process of identifying teaching-focused UICs from HEI websites is presented in more detail in the “e-components”.

**3.3.2.2 Independent variables**

The independent variables are the HEI-level factors and institutional factors that have been identified from Stage 1 as the potential determinants of HEIs’ engagement in teaching-focused UICs. We collected data on these variables from HEIs’ websites.

**HEI-level independent variables**

**HEIs’ size:** The size of an HEI is measured by the number of enrolled students in 2017.

**HEIs’ status**:To measure an HEI’s status (elite versus non-elite), we used the National Institutional Ranking Framework (NIRF, 2019) ranking which lists the top 200 engineering HEIs in India based on performance in five dimensions: teaching resources, research productivity, graduation outcomes, outreach and inclusivity, and perception among employers and academic peers. We considered these 200 HEIs as elite HEIs and assigned a dummy variable ‘1’. The remaining HEIs are considered as non-elite HEIs and were assigned a dummy variable ‘0’.

**HEIs’ involvement in academic research:** We measured an HEI’s involvement in academic research by a) research publication intensity, and b) offering of postgraduate research training programs. Research publication intensity is calculated by dividing the total number of publications by the HEI’s age (years). We retrieved data on HEIs’ research publications from the Scopus database. We created a dummy variable and assigned the value ‘1’ if the HEI offers postgraduate research (i.e., PhD) programs and ‘0’ otherwise.

**HEIs’ academic embeddedness:** This variable measures an HEI’s embeddedness in the academic community. In India, private HEIs are often run by business groups. Similar to firms run by the same business group, same business group-run HEIs are often well connected and share resources and information. Therefore, we considered an HEI to be academically embedded if it belongs to a group of HEIs and assigned to it a dummy variable value of ‘1’, and value ‘0’ otherwise.

**HEIs’ industrial embeddedness:** We measure an HEI’s embeddedness in the industrial community in terms of its engagement in industrial research and commercialization. We define an HEI as highly connected with industry if it has dedicated infrastructure for handling industrial engagement activities such as a ‘technology transfer office’, ‘industrial research center’, ‘entrepreneurship development cell’, etc. Prior studies have confirmed that the presence of such infrastructure on campus greatly contributes towards improving universities’ industrial embeddedness (Hayter, 2016; Perkmann et al., 2013). We created a dummy variable and assigned value ‘1’ to HEIs that possess dedicated infrastructure for industrial research and commercialization activities, and ‘0’ otherwise.

**Institutional independent variables**

**HEIs’ industrial location:** To measure this variable, we created a dummy variable and assigned a value of ‘1’ if an HEI was located in an industrial cluster and ‘0’ otherwise. In line with Sharma et al. (2012), this paper considers the following locations: Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai, and Pune as the industrial clusters in India.

**HEIs’ public ownership:** This variable measures whether an HEI is owned and managed by the government. We created a dummy variable and assigned a value of ‘1’ for public HEIs and ‘0’ for private HEIs.

**HEIs’ academic autonomy**: This variable measures whether an HEI has the academic autonomy to design its own curricula. India’s higher education system mainly comprises two types of HEIs: universities and university-affiliated colleges. Universities include ‘deemed universities’ (public), ‘central universities’ (public), ‘state universities’ (public) and ‘private universities’. All types of universities possess the required academic autonomy to design their curriculum. On the other hand, university-affiliated colleges (unless given the ‘autonomous status’), which are controlled and monitored by the state universities, are required to follow the curriculum designed by the state universities and therefore do not possess academic autonomy. We labelled an HEI ‘autonomous’ if it is either a university or an autonomous university-affiliated college, as reported on the HEI’s website. We created a dummy variable and assigned a value of ‘1’ for autonomous HEIs and ‘0’ otherwise.

**HEIs’ discipline variety:** This variable measures the variety present in an HEI’s disciplines. We created a dummy variable and assigned a value of ‘1’ if the HEI offered courses outside the mainstream engineering disciplines, for instance, courses in humanities and medicine and ‘0’ otherwise.

**HEIs’ access to government-supported intermediary organizations:** The interviewees identified an intermediary organization (Pseudonym: Intermediary-X) set-up by the government of one of the Indian states as influential in promoting teaching collaborations between industry and universities. As Intermediary-X is not a federal policy initiative, the organization offers support only to HEIs and companies operating within that state. This variable measures if an HEI can benefit from Intermediary-X’s support schemes. We considered an HEI to have access to Intermediary-X if it was located in the same state, and we assigned to it a dummy variable value of ‘1’ and ‘0’ for HEIs located in any other state.

**3.3.2.3 The model and control variables**

To explain the determinants of HEIs’ participation in teaching-focused UICs, we used a negative binomial regression model, because the dependent variable in this equation is a count variable and is ‘over-dispersed’[[6]](#footnote-6). The negative binomial model is a more appropriate model than Poisson, which is also suitable for count data, for analyzing dependent variables that are over-dispersed (Gardner et al., 1995).

We included two control variables: HEIs’ age and graduate gender. We controlled for HEIs’ age (years) because older HEIs are more likely to possess higher social capital in the industry than newer ones, which is a prerequisite for most UICs (Hong and Su, 2013). Drawing on Tartari and Salter’s (2015) finding that gender has a role to play in UICs, we controlled for graduates’ gender and assigned a dummy variable value of ‘1’ for female-only HEIs and ‘0’ for mixed-gender HEIs.

### 3.4 The quantitative study on employability of graduates (Stage 3)

#### 3.4.1 Data collection

In Stage 3, we used data on graduates’ employability competencies obtained from Aspiring Minds, an educational consultancy firm in India. This company organizes the AMCAT, a computer adaptive test[[7]](#footnote-7) similar to the Graduate Record Examination (GRE) mainly for new engineering graduates or those in the final year of their degree programs. The test has three components: a) a generic component, which tests the generic competencies of graduates in terms of English language, quantitative aptitude and logical reasoning ability, b) a domain-specific component and c) personality and behavioral component[[8]](#footnote-8). Each generic component includes 16-20 questions, and the candidates are given 25 minutes to answer questions within each section. The domain-specific component for computer engineering graduates comprises three sections of about 25 questions each testing the candidates’ fundamental and advanced computer programming competencies, in the first and second section respectively, and the knowledge of computer architecture, databases, networks and operating systems in the third section. Questions include multiple-choice questions, where a candidate may be asked to read a computer program and choose the correct output of the program among four answers. as well as simulation-based tests called AUTOMATA, where the candidate may be asked to write and compile a computer program. There is no negative marking for wrong answers. Similarly, the domain-specific module for graduates in electronics engineering and telecommunication engineering disciplines test the candidates’ knowledge in digital electronics, analogue electronics and transmission technologies. The minimum and maximum scores a candidate can obtain in any section are 100 and 900. AMCAT measures discipline wise average scores for each HEI. We were given access to these data in 2019.

AMCAT test scores are accepted by a large number of firms in India, and are used to screen applicants, and graduates with higher scores are often given preference in the recruitment process (Krishna, 2014). Therefore, we used its scores as the proxy for graduates’ employability competencies. However, while passing the AMCAT test indicates a high degree of employability competencies possessed by a graduate, it does not guarantee employment. As Clarke (2018) shows, apart from employability competencies, graduates’ employability outcomes are driven by other factors, such as graduates’ work experience, social capital and individual behaviors.

In September 2019, we received the AMCAT test scores from Aspiring Minds of graduates from all the HEIs that participated in the examination following graduation in 2018. We then matched these HEIs against the list of 2,280 HEIs for which we have data on their teaching-collaborations with HEIs to examine the impact of these collaborations on graduates’ employability. We identified 486 HEIs for which information on both teaching collaborations and AMCAT test scores was available[[9]](#footnote-9).

#### 3.4.2 Operationalization and measurement of variables

**3.4.2.1 Dependent variables**

The dependent variables are a graduate’s domain-specific employability competencies. We used AMCAT scores as the proxy for measuring graduates’ employability competencies. The scores for domain-specific component and each section of the generic component (i.e., English language, quantitative aptitude and logical reasoning) in our sample range from 195 to 741[[10]](#footnote-10).

**3.4.2.2 Independent variables**

The independent variables are an HEI’s propensity to form course-based and project- based teaching-focused UICs. Details regarding the operationalization of this variable have been reported in Section 3.3.2.1.

**3.4.2.3 The model and control variables**

To estimate the impact of an HEI’s involvement in teaching-focused industrial collaborations on its graduates’ employability, we used ordinary least squares (OLS) models, due to the linear and continuous nature of the dependent variables (graduates’ competency scores). Before estimating the model, we standardized the independent and dependent variables by mean centering, subtracting the mean from the original value (Kromrey and Foster-Johnson, 1998) to interpret the results for variables with different scales (Wen et al., 2010).

We control for graduates’ gender, HEIs’ age, status, discipline variety, involvement in academic research, industrial research and commercialization. Graduates’ gender is controlled because prior studies (e.g., Knight et al. 2002) report significant differences between male and female engineering students in their ability to acquire generic and domain-specific competencies. We control for HEIs’ age (or experience) because, in line with the organizational learning theory, high experience in organizations (e.g., HEIs) can “lead to more learning and, presumably, to better organizational (e.g., teaching) performance” (Michael and Palandjian, 2004, p. 269). We control for HEIs’ status because elite HEIs are likely to possess the required quality of teaching resources including labs and faculty (Loyalka et al., 2014), which are necessary for imparting domain-specific competencies to students. Besides, elite HEIs are likely to attract high-quality students with better mathematics and science background (Loyalka et al., 2014) and thus, students from elite HEIs are likely to demonstrate better quantitative abilities, which is a key generic competency. We control for HEIs’ academic research involvement. Hattie and Marsh (1996) argue that research-active academics can “construct assignments and examinations that reward deep rather than only surface learning… [and] ensure that students experience the process of artistic and scientific productivity” (p. 534). Thus, research-active HEIs possess the potential to integrate research and teaching, helping HEIs to equip students with a high depth of domain-specific competencies.

HEIs’ discipline variety is controlled here because high variety in disciplines could allow HEIs to design inter-disciplinary training programs. Arujo (2015) showed that inter-disciplinary training programs are effective in developing generic competencies, such as interpersonal and problem-solving competencies, in graduates. An HEI’s involvement in industrial research may offer opportunities for its students to participate in such projects as research assistants (Lee, 2000), which may help students to understand the industrial applications of their theoretical knowledge, thereby improving their domain-specific competencies. On the other hand, students at an HEI with high involvement in commercialization activities are likely to receive more opportunities to engage in venture creation, resulting in the development of domain-specific as well as generic competencies such as problem-solving, resource leveraging, and self-efficacy in students (Morris et al., 2013). Hence, we control for HEIs’ involvement in industrial research and commercialization.

Lastly, we control for the HEIs’ location. Students at HEIs located in industrial clusters are likely to receive more opportunities to attend formal events such as career-related workshops, seminars and to gain part-time work experience at companies as well as engage in informal discussions with industry executives (Richardson, 2013), which may ultimately help students to enhance their employability competencies.

Table 1 reports a summary of the definition and measurement of the variables considered in Stage 2 and Stage 3.

Table 1 Description and measurement of variables

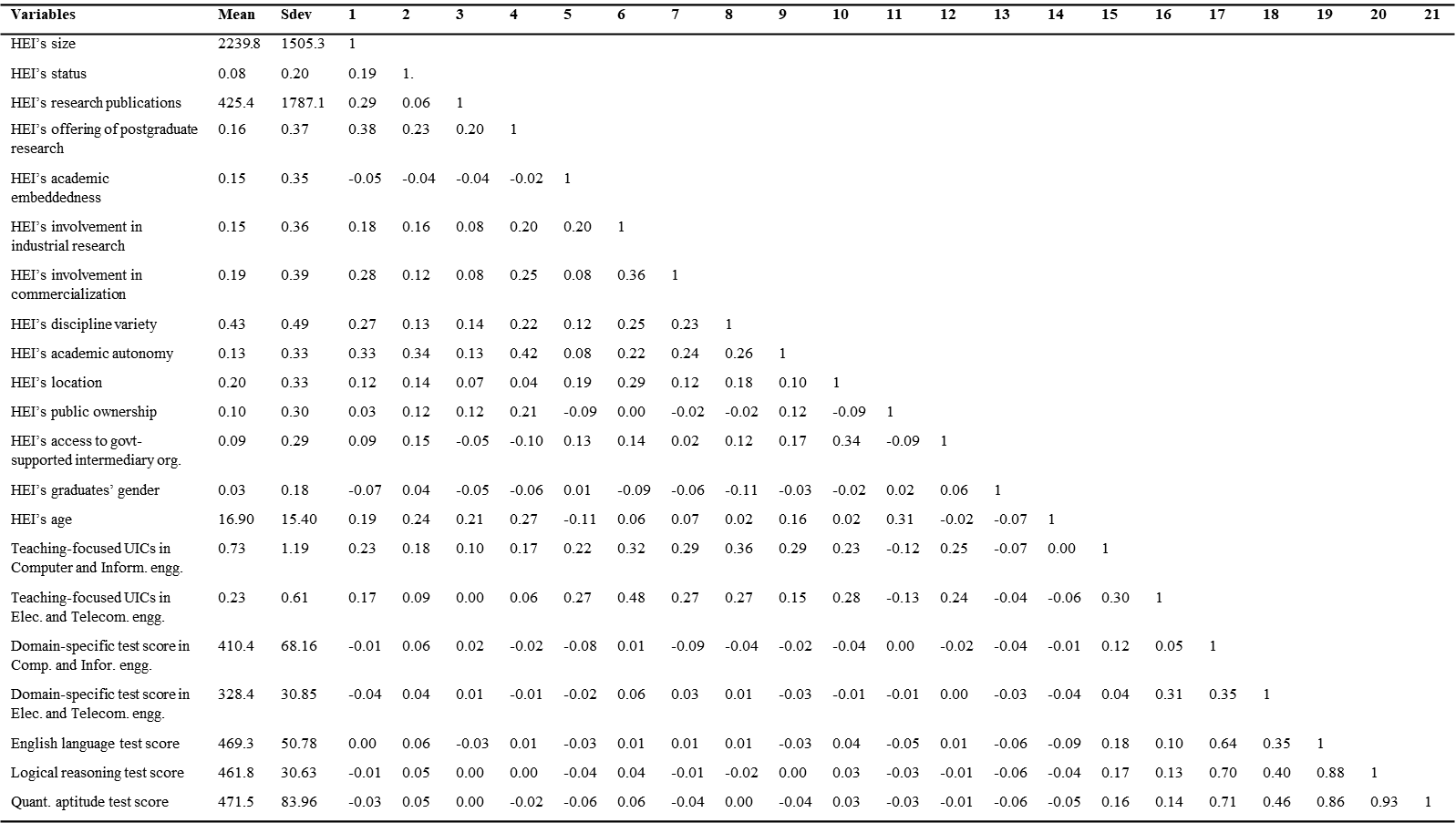


## Empirical Findings

### 4.1 Descriptive statistics

Table 2 reports descriptive statistics and correlation coefficients between the variables. Most correlations are low; however high correlations were observed between some dependent variables (English language, logical reasoning and quantitative aptitude test scores). This indicates that graduates from an HEI scoring high in one generic competence test tend to score high in other generic competence tests. To check collinearly among predictor variables, we further performed the variance inflation factor (VIF) test. The maximum VIF is 1.61, which falls well below the permissible limit (=10), indicating the absence of collinearity among independent variables.

Table 2 Correlation among variables



### 4.2 Determinants of HEIs’ participation in teaching-focused UICs

Table 3 reports the results from the negative binomial regression model addressing RQ1, about the determinants of universities’ participation in teaching-focused UIC. Among HEI-level factors, the coefficient of HEIs’ size is positive and significant (β=0.0001, p<0.01, Model 1) for teaching-focused UICs, suggesting that large-sized HEIs are more likely to form teaching-focused UICs than small-sized HEIs. The discipline variety of an HEI presents a positive and significant coefficient (β=0.29, p<0.01, Model 1) indicating firms’ preference to collaborate in teaching with HEIs with non-engineering disciplines alongside engineering. Results show a negative and significant coefficient of HEIs’ involvement in academic research as proxied by publications intensity (coefficient=-0.0003, p<0.1, Model 1), which suggests that HEIs that engage in academic research tend to form a lower number of teaching-focused UICs. The coefficient of HEIs’ academic embeddedness is positive and significant (β=0.72, p<0.01, Model 1), suggesting that academically embedded HEIs are more likely to form teaching-focused UICs. Both the coefficients of HEIs’ involvement in industrial research (β=0.53, p<0.01, Model 1) and commercialization are positive and significant (β=0.49, p<0.01, Model 1), suggesting that industry embeddedness enhances an HEI’s propensity to develop teaching collaborations with industry. The coefficients of HEIs’ status is not significant for teaching-focused UICs.

Thus among HEI-level factors, our results show that HEIs’ size, discipline variety, academic and industrial embeddedness facilitate HEIs’ participation in teaching-focused UIC, while HEIs’ high degree of involvement in academic research hinders their propensity to form teaching-focused UICs.

Table 3 Determinants of HEIs’ participation in teaching-focused UICs



\*=p<0.1, \*\*=p<0.05 and \*\*\*=p<0.01; standard errors in parentheses.

Amongst the institutional factors, HEIs’ location in industrial clusters holds a positive and statistically significant coefficient (β=0.42, p<0.01, Model 1). Figure 4 visualizes the locations of HEIs with at least one teaching-focused UICs using a heat map. It can be observed that most HEIs with teaching-focused UICs are located in Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai and Pune, which further indicates that HEIs located in industrial clusters are more likely to develop teaching-focused UICs.

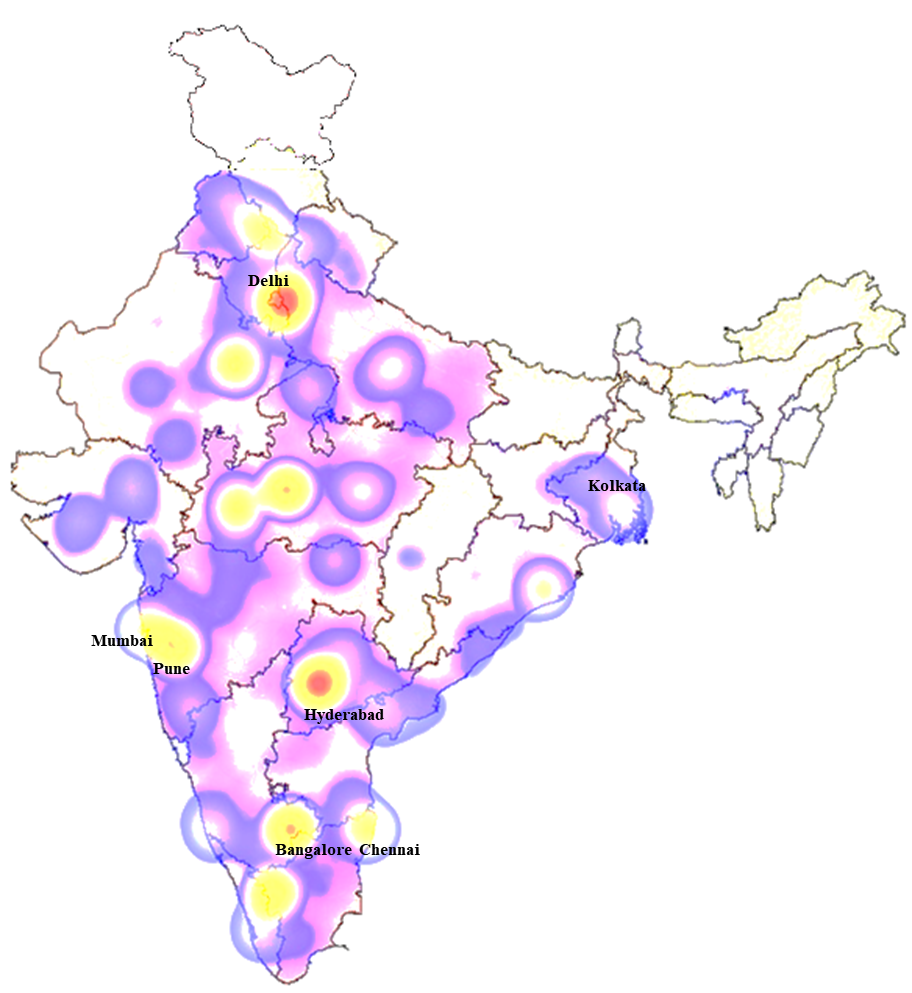


Figure 4 Heat map showing the locations of HEIs with teaching-focused UICs across India (the colours blue, yellow and red denote low (10%), medium (100%) and high (200%) point density) respectively

The coefficient of HEIs’ academic autonomy is positive and significant (β=0.33, p<0.01, Model 1), indicating that autonomous HEIs are more likely to engage in teaching collaborations with industry. The coefficient of HEIs' access to government-supported intermediary organizations is positive and significant (β=0.37, p<0.01, Model 1), offering support for our assumption that HEI with access to government-supported Intermediary-X has a higher propensity to participate in teaching-focused UICs. Finally, the coefficient of HEIs’ public ownership is negative and significant (β=-1.06, p<0.01, Model 1), suggesting that public HEIs are less likely to participate in teaching-focused UICs.

These results are consistent across teaching-focused UICs taking place in the computer engineering and information engineering disciplines, and in the electronics engineering and telecommunication engineering disciplines (see Models 2 and 3 in Table 3). We further examined if the influence of these HEI-level and institutional factors depends on the type of teaching collaborations (course-based vs. project-based). We found the results to be consistent overall. However, the coefficients of HEIs’ academic embeddedness (β=0.73, p<0.01, Model 4) and academic autonomy (β=0.34, p<0.01, Model 4) are positive and significant for course-based teaching collaborations, but they are not significant for project-based teaching collaborations (see Models 4 and 5 in Table 3). Likewise, we found that HEIs’ involvement in academic research in terms of the number of research publications shows a negative and significant effect on UICs for course-based teaching UICs (β=-0.0003, p<0.1, Model 4), but does not affect HEIs’ participation in project-based teaching collaborations.

Among the control variables, the coefficient of HEIs’ age is positive and significant (β=0.004, p<0.1, Model 2) in computer engineering and information engineering disciplines. Finally, as expected, graduates’ gender has a negative and significant effect (β=-0.44, p<0.05, Model 1) on teaching-focused UICs, confirming a gender bias against female only HEIs.

Thus, our results show that, among the institutional factors, HEIs’ location in industrial clusters, academic autonomy and access to government-supported intermediary organizations facilitate HEIs’ participation in teaching-focused UIC, while HEIs’ public ownership reduces their propensity to form teaching-focused UICs.

### 4.3 Impact of HEIs’ participation in teaching-focused UICs on their graduates’ employability competencies

In this section, we report the results of OLS regression models which address RQ2, i.e., whether universities’ participation in teaching-focused UICs affects graduates’ employability competencies. Table 4 shows the impact of HEIs teaching collaborations on its graduates’ employability for domain-specific competencies in Models 6 and 7, and for generic competencies in Models 8, 9 and 10. The coefficients of course-based teaching collaborations are positive and significant for its graduates’ scores in domain-specific competency tests in computer engineering and information engineering disciplines (β=6.90, p<0.05, Model 6) as well as in electronics engineering and telecommunication engineering disciplines (β=11.94, p<0.01, Model 7). Similarly, the results show positive and significant relationships between project-based teaching collaborations and HEIs’ graduates’ scores in domain-specific competency tests in computer engineering and information engineering disciplines (β=33.27, p<0.01, Model 6) and electronics engineering and telecommunication engineering disciplines (β=17.34, p<0.01, Model 7).

These results suggest that graduates from HEIs that engage in a high number of teaching-focused UICs of any type (course-based or project-based) are likely to score higher in domain-specific competency tests. The coefficients of HEIs’ course-based teaching collaborations are positive and significant for all three forms of generic competencies in graduates: English language (β=7.76, p<0.01, Model 8), logical reasoning (β=5.89, p<0.01, Model 9) and quantitative aptitude (β=11.21, p<0.01, Model 10), indicating that graduates from HEIs with course-based teaching collaborations with industry are better able to develop these generic competencies. However, the coefficients of project-based teaching collaborations are not significant for generic competencies. The coefficients of control variables are, overall, non-significant.

Thus, our findings indicate that course-based teaching collaborations help HEIs to improve both domain-specific competencies and generic competencies in graduates, while project-based teaching collaborations contribute towards enhancing domain-specific competencies only.

Table 4 Impact of HEIs’ participation in teaching-focused UICs on their graduates' employability competencies



\*=p<0.1, \*\*=p<0.05 and \*\*\*=p<0.01; standard errors in parentheses.

### 4.4 Robustness checks

In order to test the robustness of our results on the determinants of HEIs’ participation in teaching-focused UICs, we performed separate analyses on the probability of engaging in teaching-focused UICs, regardless of the number of collaborations. We converted the distribution of our dependent variable (number of teaching-focused UICs) into ‘binary distribution’, i.e., all values of the dependent variable that are greater than 1 are considered as ‘1’ and the remainder as ‘0’ and estimated a Probit model. The results are consistent with those obtained with the negative binomial model.

To check the robustness of the results about the impact of HEIs’ propensity of forming teaching-focused UICs on graduates’ employability competencies, we used the un-standardized values of the independent and the dependent variables. The results are consistent with our main results obtained with standardized values.

Furthermore, in both the quantitative studies, we used different proxies for some of the variables. We used the number of courses offered by an HEI as a measure of its size. Additionally, to measure HEIs’ status, we used the definition of elite HEIs by Loyalka et al. (2014), that HEIs admit students only through the Joint Entrance Examination in India. Based on this criterion, we identified 219 HEIs as elite HEIs (instead of 184) and these were assigned a dummy variable ‘1’. The results are consistent with the main results.

Lastly, we conducted additional tests to control for the potential limitation of using website data to build our datasets. One of the main limitations of using website data for research on universities is that the prestige of universities may affect the structure and contents of university websites, which in turn makes it difficult to compile consistent data across less and highly prestigious universities. Based on the website analysis of 150 universities across six European countries, Lažetić (2019) concludes that the websites of less-prestigious universities are more likely to include promotional discourse elements than highly prestigious universities because of the competition that less-prestigious universities face in attracting students. Thus, to avoid possible biases caused by HEIs’ prestige (or status), we conducted additional analyses by splitting the sample into high-status HEIs and low-status HEIs. We found the results to be consistent with the results obtained from the main study when both high and low-status HEIs were considered in the same sample. (See “e-component” for robustness results.)

## Discussion and Conclusion

### 5.1 Determinants of HEIs’ participation in teaching-focused UICs

#### 5.1.1 HEI-level determinants of HEIs’ participation in teaching-focused UICs

The analysis of factors affecting HEIs’ participation in teaching-focused UICs shows that, among HEI-level factors, HEIs’ size, discipline variety, academic embeddedness and industrial embeddedness are the main facilitators. As with research and commercialization-focused UICs (Schartinger et al., 2001), large HEIs also show a high propensity to develop teaching-focused UICs. There are three possible explanations for this result. First, large HEIs are likely to possess greater visibility and networks in the industry (Muscio et al., 2013), attracting firms to discuss opportunities for teaching collaborations. Second, collaborating with large HEIs allows firms to roll out their training programs to a large number of students at a lower marginal cost. Lastly, large HEIs should be better able to balance additional teaching loads (Schartinger et al., 2001) that may arise from several academics’ involvement in teaching-focused UICs. One of the interviewees from the HEIs commented:

*“When we are approached by a company for introducing their courses in our curriculum, we look at one aspect – how big our faculty group in the relevant department is? If we ask a few faculty members to engage in the teaching of these additional industrial courses, can the others take care of the regular courses?”*

Disciplinary variety has long been seen as a factor contributing to improving HEIs’ attractiveness for research and commercialization-focused UICs (Bruce et al., 2004; Rijnsoever and Hessels, 2011). Our results demonstrate that HEIs with high discipline variety are also able to attract teaching-focused UICs. The likely reason is that collaborations with HEIs offering a variety of UG and PG programs allow firms to address interdisciplinary skill needs. In particular, the emergence of Industry 4.0 has resulted in great demand for ICT knowledge across a wide range of sectors, from engineering to banking and healthcare (Manogaran et al., 2017). One of the interviewees from industry noted that:

*“Clients for our computing solutions also include financial and healthcare organizations. We have developed different courses on big data for students studying engineering and other domains such as economics and medicine etc. Therefore, we prefer collaborating with colleges that offer these courses alongside engineering courses so that we can address the skill shortage in multiple areas at one go.”*

Results show that an HEI’s academic embeddedness steer its propensity to engage in teaching-focused UICs. Our findings reveal that academically-embedded HEIs can share academics and lab resources required for delivering industrial courses and projects, and thus are better placed to develop teaching-focused UICs. The industry partner does not object to HEIs integrating resources with other HEIs to deliver their training programs (either courses or projects) to students for two reasons. First, these industrial courses and student projects do not tend to include strictly confidential elements, therefore HEIs are allowed to involve other organizations in the delivery process. Second, industry partners prefer to popularize the courses and projects in as many HEIs as possible so that they can develop a large high-quality pool to recruit from. However, prior studies have not identified academic embeddedness as a factor for research and commercialization-focused UICs.

We found that an HEI’s industrial embeddedness, which has been previously reported as a key determinant of research and commercialization-focused UICs (Bruneel et al., 2010; Hong and Su, 2013), also facilitates HEIs’ engagement in teaching-focused UICs. One possible reason for this is that prior experience with HEIs through research and commercialization-focused collaborations could help to develop cognitive social capital (Steinmo and Rasmussen, 2018) between the company and HEI. Hence, cognitive social capital enables HEIs to develop knowledge and skills to help identify opportunities to collaborate with industry to upgrade labs and the curriculum, and train faculty for the benefit of the students. Our results also reveal that through collaborations in research and commercialization, firms can better appreciate an HEI’s institutional environment, including its organizational structure, culture and leadership, facilitating the development of teaching-focused collaborations. One of the interviewees from industry explained:

*“We had a research partnership with X [the HEI] in 2015. During that period, we learned a lot about the quality of their academics and students, teaching content and processes and helped us to recognize if there is any opportunity or need for our organization to contribute in their teaching.”*

Lastly, we found that an HEI’s involvement in academic research, which has been widely documented as a pull factor for collaborations in research and commercialization (Karlsson and Wigren, 2012; Mamun and Rahman, 2015), negatively affects its engagement in teaching-focused UICs. This is possibly due to the difficulty in balancing time between research activities and teaching-focused UICs activities. “Those who are productive in research tend to spend more time in research and concomitantly less time in teaching” (Hattie and Marsh, 1996, p.508). Organizing courses and projects with industry under teaching-focused UICs demands significant time investment and academics from research-active HEIs may be reluctant to dedicate time and energy in teaching-focused UICs at the expense of their research activities, which are often linked to incentives and promotions in research-active HEIs (Renault, 2006). One of the interviewees from a research-active HEIs commented:

*“Our main issue with collaborating with industry [in teaching] is finding time. Our staff has to contribute to research, which decides their promotion, brings funding to the university as well as improves our ranking”.*

#### 5.1.2 Institutional determinants of HEIs’ participation in teaching-focused UICs

Among the institutional factors, we found that location, HEIs’ academic autonomy and the access to government-supported intermediary organizations facilitate HEIs’ participation in teaching-focused UICs, whereas an HEI’s public ownership hinders such collaborations.

In line with previous studies on the role of the geographical location of HEIs on research and commercialization-focused UICs (e.g., Youtie and Shapira, 2008), this paper recognizes the geographical location of HEIs in industrial clusters as a key factor for teaching-focused UICs, pointing to the possibility that HEIs located in industrial clusters have high visibility (Muscio et al., 2013), which enables them to develop social capital in the industrial community, and vice versa, and therefore allows them to find industry collaborators more easily than those located outside industrial clusters.

We found government-supported intermediary organizations as an influential instrument to teaching-focused UICs. Similar to intermediary organizations for research and commercialization-focused UICs (Kodama, 2008; Wright et al., 2008), the main role of intermediary organizations for teaching-focused UICs is also to link HEIs with potential industry partners and assist HEIs to negotiate contractual arrangements with industrial partners, thereby helping HEIs to reduce search and bargaining costs. Besides, we found that these government-supported intermediary organizations in India help HEIs to overcome resource constraints by lending academics to teach and supervise industrial courses and projects to students at the HEIs, as well as offering HEIs access to its own labs to organize the practical sessions for the industrial courses and projects.

On the other hand, our results show that public HEIs are less likely to form teaching-focused UICs. Public ownership is a challenge because it comes with a highly bureaucratic structure, which slows down setting up collaborative activities. This suggests that public ownership of HEIs in highly bureaucratic countries could also play a vital part in limiting UICs in research and commercialization. For instance, Muriithi et al. (2018), in the context of Kenyan universities, discusses bureaucracy as a key barrier to research and commercialization-focused UICs because it adds additional and unnecessary layers of scrutiny and approvals in the process of releasing project funds and allowing industry’s access to university’ resources. More research could corroborate this argument.

Our findings also indicate that autonomous HEIs are more likely to form course-based teaching collaborations with industry. A possible explanation for this is that developing course-based teaching collaborations with industry requires HEIs making changes to the existing curriculum or introducing a completely new curriculum, and, in the Indian education system, only autonomous HEIs are permitted to make changes or design own curriculum. The effect of academic autonomy of HEIs on their propensity to form research and commercialization focused collaborations have not been investigated.

### 5.2 The impact of HEIs’ participation in teaching-focused UICs on their graduates’ employability competencies

Our results show that graduates from HEIs engaged in teaching-focused collaborations are able to acquire better domain-specific competencies and skills. We find that both course-based and project-based teaching collaborations improve domain-specific competencies in graduates. Course-based teaching collaborations involve classroom training to develop relevant theoretical knowledge as well as practical lab sessions to facilitate hands-on learning and know-how transfer (Borah et al., 2019). Thus, students can receive a better theoretical understanding of industry-relevant concepts and gain expertise in operating industry-relevant technologies and instruments in course-based teaching collaborations. On the other hand, project-based teaching collaborations involve practice-based or case-based learning and are aimed at developing a deeper understanding of the domain-specific competencies through providing an opportunity to apply their theoretical and practical know-how and develop new technologies and products under the supervision of industry staff (Rossano et al., 2016).

In terms of developing generic competencies in graduates, this study reports some interesting results. We find that while course-based teaching collaborations improve generic competencies in graduates, project-based teaching collaborations do not. Several reasons could explain this result. First, our interviewees suggested that some course-based collaborations (e.g. in the case of collaborations developed by HEI-I and HEI-IV) aim to improve all-round employability competencies in students by including modules on generic competencies such as English, communication skills and intrapersonal and interpersonal relationship skills. However, in project-based collaborations, no classroom training is given to students. Occasional 1-2-day practical training may be provided on a technology that is important for the students to use in projects. Thus, in project-based collaboration, there is very little time left for training on generic competencies. Second, course-based teaching collaborations often require an industry partner to review the HEI's curriculum (Plewa et al., 2015), which may lead the company to advise on the type and level of generic competencies that should be offered to students within the curriculum. An interviewee from industry commented:

*“When we develop a curriculum for our university partner, we not only look at the technical modules but also we give a hard look at the soft [generic] skills contents. We share our thoughts on the content and how they should be taught to students”.*

On the other hand, in project-based teaching collaborations, the offering of projects may not require companies to engage in curriculum-related discussions with the HEIs, which could prevent industry partners from offering inputs on the generic competencies. An interviewee from industry commented:

*“The student projects that we offer are often run outside their curriculum. So, there is limited opportunity for us to review the collaborating universities’ curriculum.”*

The third reason relates to the measurement of generic competencies used in this study. We considered only three forms of generic competencies - English, quantitative aptitude and logical reasoning skills. Prior studies have revealed that working in a project-based environment may help individuals to develop other generic competencies, such as critical thinking, problem-solving and teamwork capabilities (Rossano et al., 2016). We could not test if this is the case in the context of our study due to the lack of data on these specific generic competencies.

### 5.3 Implications for research and practice

Employability competencies benefit individual engineering graduates in terms of enhancing their competitiveness in the job market; they can also impact on the growth of knowledge economies (Brown et al., 2003). Engineering graduates enjoying employability competencies enhance a country’s strength in terms of producing qualified human capital who are capable of generating, adapting and diffusing innovations (McGuirk et al., 2015), which is often recognized as a key driver of a country’s economic growth and innovation capability (GII, 2019). Studies have shown that countries with a high stock of qualified engineering human capital can attract greater foreign direct investments in value-adding innovation-related activities, such as research and new product development (Lewin et al., 2009). It is thus of high significance to examine engineering graduates’ employability enhancement strategies and policies. This study helps to establish empirically that teaching-focused UIC is one such strategy that can bolster universities’ capabilities to develop more employable engineering graduates. In contrast to existing studies which are predominantly based on case studies to explain the positive relationship between teaching-focused UICs on graduates’ employability competencies (e.g., Ishengoma and Vaaland, 2016; Samuel et al., 2018), we conducted a quantitative analysis of large-scale data which improves the generalizability of the relationship and should provide support to policymakers when considering teaching-focused UICs as an instrument to strengthen graduates’ employability.

Considering the importance of teaching-focused UICs for graduate employability and thus to the development of a strong knowledge economy, it is also of major interest to researchers and practitioners to study: a) how teaching-focused UICs should be better operationalized so that high graduate employability outcome can be achieved; and b) how a favorable environment can be constructed to support these collaborations. In terms of the operationalization of teaching-focused UICs, by examining the impact of both course-based and project-based teaching-focused UICs on the domain-specific as well as generic competencies of graduates, we contribute towards constructing a nuanced understanding of the impact of teaching-focused UICs on graduates’ employability, which is currently missing in the literature. While we find that course-based teaching collaborations improve both domain-specific and generic competencies, project-based teaching collaborations enhance only domain-specific competencies in graduates. This raises questions on the effectiveness of project-based teaching collaborations and how they should be organized. To address this issue, we propose that instead of using project-based teaching collaborations in isolation, HEIs could combine course-based and project-based teaching collaborations. In doing so, course-based teaching collaborations will facilitate the transfer of both generic competencies and domain-specific theoretical knowledge to students, while project-based teaching collaborations will complement further the development of domain-specific competencies in graduates by offering the opportunity to apply their theoretical knowledge and develop know-how through practice. However, if HEIs and industry decide not to combine project-based teaching collaborations with course-based teaching collaborations, training on generic competencies should be incorporated in project-based teaching collaborations.

On the other hand, barring Plewa et al. (2015), literature explaining how a favorable environment can be constructed to support teaching-focused UICs is almost non-existent. Plewa et al. (2015) studied the influence of only two HEI-level factors- HEIs’ resource investments and industrial ties, which does not offer a comprehensive understanding of the support mechanisms for teaching-focused UICs. We contribute to this literature by examining multiple HEI-level and institutional factors that improve universities’ attractiveness for teaching-focused UICs. Drawing on our findings, we argue that an HEI can develop teaching-focused UICs if it maintains large student enrolments, high discipline diversity, a high degree of industrial embeddedness and location in industrial clusters, and prioritizes teaching over academic research, while policymakers offer academic autonomy to the HEI and support HEIs via intermediary organizations which can help establish and operationalize teaching-focused UICs. Also, policymakers and the HEI (particularly public HEIs) should attempt to mutually develop strategies to reduce bureaucracy, which hinders HEIs’ participation in teaching-focused UIC.

As our research questions demanded, we examined the relationships between the determinants and teaching-focused UICs and between teaching-focused UICs and graduates’ employability competencies separately, and this has allowed us to suggest the existence of an indirect positive relationship between some HEI-level and institutional determinants (HEIs’ size, discipline variety, industrial and academic embeddedness, location in industrial clusters, autonomy and access to intermediary organizations) and graduates’ employability. This is an interesting finding for two reasons. First, the study of HEI-level and institutional determinants of graduates’ employability has drawn little research interest compared to individual determinants such as graduates’ attributes (Alexandre et al., 2009; Alvarez-Gonzalez et al., 2017; Clarke, 2018). Second, among the studies that have discussed the influence of some of HEI-level and institutional factors on graduates’ employability, the majority examined a direct effect (e.g., Alvarez-Gonzalez et al., 2017; Ciriaci and Muscio, 2010) and completely overlooked the possibility of an indirect relationship through the teaching processes (e.g., via teaching-focused UICs, as we show in this paper). The examination and comparison of the direct and indirect effects of HEI-level and institutional factors on graduates’ employability possibly through continuous equation modelling could offer a more nuanced understanding on the determinants of graduates’ employability and their effects, and thus forms a promising avenue for future research.

Our results from RQ1 also allow the identification of two new determinants of UICs- HEIs’ academic embeddedness and academic autonomy, whose influence had not been identified for any form of UIC (see the list of determinants of academic engagement in Perkamnn et al., 2013). We believe that the study of the relationship between HEIs’ academic embeddedness and other forms of UICs such as research and commercialization-focused UICs could form an interesting future research avenue. This is because there exist opposite conceptual arguments about whether or not an HEI’s academic embeddedness can improve its attractiveness for research and commercialization-focused UICs. Arguments behind a positive relationship build on the social capital theory that academically well-embedded universities can arrange complementary external capabilities and resources better (Steinmo and Rasmussen, 2018), which can be useful for managing large, multidisciplinary and complex industrial projects. Drawing upon the knowledge protection perspectives, a counter-argument could be that companies are very protective about their research, development and commercialization activities (Lee, 2000) and therefore, they may not want their university partner to invite academics from other universities to be involved in their research and commercialization projects due to commercial confidentiality concerns. Hence, companies may be less willing to collaborate in research and commercialization activities with universities who are entrenched in strong academic networks. On the other hand, we believe that academic autonomy might not affect an HEI’s ability to collaborate with industry in research and commercialization, because usually, HEIs have the autonomy to choose their research projects, their partners in research as well as to make commercialization decisions. However, further research is required to corroborate this argument.

Among all the determinants studied in this paper, we acknowledge that an HEI’s academic autonomy and public ownership may be context-specific determinants of UICs, i.e., they may influence industrial collaborations in those higher education systems that share governance and structural similarities with those in India. The identification of these factors highlights the importance of considering diverse institutional and geographical contexts while studying collaborative activities between industry and universities. In the extant literature, UICs have mostly been studied against the backdrop of European and North American countries (Muriithi et al., 2018; Perkmann et al., 2013). Our findings suggest that UICs should also be studied in other regions/countries to identify and understand context-specific facilitators and barriers to these collaborations, which is crucial to ensure more nuanced, country-specific policymaking on UICs.

While the influence of these HEI-level and institutional factors have never been examined on HEIs’ propensity to form teaching-focused UICs, some of these factors have been previously identified as the determinants of HEIs’ involvement in research and commercialization-focused UICs (see e.g., Bruce et al., 2004; Bruneel et al., 2010; Perkmann et al., 2013; Wright et al., 2008; Youtie and Shapira, 2008). In particular, we found that HEIs’ size, discipline variety, industrial embeddedness, location in industrial clusters and access to government-supported intermediary organizations are the common facilitators of both forms of UICs whereas public ownership is the common barrier. These findings lead us to argue that the existence of common facilitators and avoidance of common barriers could make an HEI attractive to form both teaching-focused and research and commercialization-focused UICs, helping the HEI to excel in research and commercialization while delivering high-quality teaching and increasing students’ employability.

This is an important finding considering that HEIs are increasingly pressurized to excel in all three missions:1) teaching, 2) research, and 3) to achieve social impact, through knowledge creation, transfer and commercialization (Bellucci and Pennacchio, 2016; Degl’Innocenti et al., 2019). Since the beginning of the entrepreneurial university debate, scholars have explored the interconnectedness between the three missions of universities to suggest how the three missions can be pursued simultaneously (Artés et al., 2017; Degl’Innocenti et al., 2019; Laredo, 2007; Sánchez‐Barrioluengo, 2014). However, there seems to be overall agreement that universities should accept a trade-off between the three missions. Universities that aim at excellence in research and commercialization may have to compromise with the quality of teaching, as studies show a negative relationship between universities’ research and teaching, as well as between commercialization activities and teaching (e.g., Sánchez‐Barrioluengo, 2014). To the best of our knowledge, no study has identified the conditions under which universities can simultaneously contribute to teaching, research and commercialization. Hence our findings contribute to fill this important research gap.

We further observed that HEIs’ academic research intensity is a common determinant of teaching-focused and research and commercialization-focused UICs; however, it shows opposite effects on the two forms of UICs. That is, a high degree of academic research may work as a double-edged sword for HEIs. On one hand, a high degree of academic research improves an HEI’s attractiveness for research and commercialization-focused UICs (Karlsson and Wigren, 2012; Mamun and Rahman, 2015). On the other hand, as our study shows, high degree of academic research leads to a lower number of teaching-focused UICs at the HEI. Although some studies have recognized the research-teaching nexus (e.g., Artés et al., 2017; Hattie and Marsh, 1996; Sánchez-Barrioluengo, 2014), they have only provided limited advice on how HEIs might address this tension. We offer three recommendations. First, HEIs could adopt a ‘contextual ambidexterity’ approach, where incentives can be offered to academics for participating in both research and commercialization-focused UICs and teaching-focused UICs. In many HEIs, academic promotions and financial incentives are awarded to academics for securing external research funding (Renault, 2006). Similar incentive structures might also be developed to encourage academics’ involvement in teaching-focused UICs, as these enhance teaching quality, students’ employability and reputation. Alternatively, HEIs could adopt a ‘structural ambidexterity’ model by forming separate units for research and commercialization-focused UICs and teaching-focused UICs. The research and commercialization-focused UICs unit could comprise ‘star scientists’ (Perkmann et al., 2011), who are highly productive and experienced in research, technology transfer and/or creating spin-offs, while the teaching-focused UICs activities could be assigned to more teaching-oriented academics[[11]](#footnote-11). HEIs who are unable to implement the contextual and structural ambidexterity models could partially outsource the teaching-focused UICs activities to their partner HEIs or government-supported intermediary organizations (where available) so that their own academics can focus entirely on research and commercialization-focused UICs.

### 5.4 Limitations and future research directions

This paper is not exempt from limitations. First, it suffers from context specificity as the study is based on a single country setting. Future studies could investigate the validity of our results in the context of other emerging as well as developed countries. In particular, the institutional factors identified as predictors of HEIs’ participation in teaching-focused collaborations may vary across countries, and their investigation could be an interesting line of enquiry. Second, the data collected on teaching collaborations and their determinants from websites are constrained by the ‘controlled’ nature of the information available on the website and the possibility of human error. Whilst we took all possible measures to mitigate this possibility, some concerns may remain. Third, due to data constraints, we could not retrieve information on other generic competencies such as problem solving, team-work ability, interpersonal communication ability, etc. Future research could examine if such competencies also improve as a result of teaching-focused UICs.

In terms of future research avenues, studies could explore the company-level determinants of teaching-focused UICs. Prior studies (e.g., Fontana et al., 2006) have shown that a number of firm-level factors such as firm size, experience and openness to the external environment can influence the occurrence of research and commercialization-focused UICs. Similar firm-level factors may also influence teaching-focused UICs. Studies could also analyze the determinants and impact of teaching-focused UICs taking place in other engineering and non-engineering disciplines to better articulate the effect of academic discipline. Finally, employability competencies, although improving a graduate’s competitiveness in the labor market, do not guarantee finding a job. Studies could examine the relationship between teaching-focused UICs and the actual employment of graduates, i.e., success in the job market.

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1. Normally value-added courses/projects are not part of the curriculum/dissertation. Students do not receive any credit towards their degree for participating in such courses/projects (Cavallone et al., 2019). [↑](#footnote-ref-1)
2. The interviewees revealed that there are currently no public grants available to Indian HEIs for organizing teaching-focused UICs at the regional/national-level. [↑](#footnote-ref-2)
3. HEIs’ academic embeddedness is a measure of HEIs’ social capital and therefore, it is considered as an HEI-level factor. [↑](#footnote-ref-3)
4. The ‘University Grant Commission’, which is a public governing body for HEIs in India, decides the level of autonomy is granted to an HEI. On the other hand, public HEIs are owned and managed by the government. Due to the high degree of involvement of government in deciding the degree of academic autonomy and public ownership in HEIs, we consider them as institutional factors. [↑](#footnote-ref-4)
5. We also interviewed HEIs’ industrial partners to understand their opinions on what factors affect HEIs’ participation in teaching-focused UICs. [↑](#footnote-ref-5)
6. The variance (2.91) of the dependent variable is significantly greater than its mean (0.97) indicating that a large proportion of HEIs in the sample are not engaged in teaching-focused UIC. [↑](#footnote-ref-6)
7. A computer adaptive test sets the questions according to the candidate's ability level, i.e., when a candidate answers a question, the next question is likely to be tougher. The final score depends on the number of questions answered as well as the difficulty level of the questions. [↑](#footnote-ref-7)
8. However, our dataset contains information on the generic and domain-specific components only. [↑](#footnote-ref-8)
9. Also, we considered only those HEIs, from which at least 10 students participated in the AMCAT test. [↑](#footnote-ref-9)
10. The maximum score a candidate can obtain in any section is 900. [↑](#footnote-ref-10)
11. Similar to academics that are employed on Teaching and Scholarship contracts at some UK universities. [↑](#footnote-ref-11)