Monetary Policy Shocks and Financially Constrained Stock Returns: The Effects of the Financial Crisis

Abstract

This study provides comprehensive evidence on the return response of financially constrained firms listed on London Stock Exchange (LSE) to UK monetary policy shocks extracted from the Bank of England's MPC meetings relative to expectations embedded in interest rate futures prices, during the period June 1999- December 2011. Using a large number of financial constraints proxies, we find no significant evidence that the most constrained firms' returns are more responsive to monetary policy shocks relative to the least constrained ones, as the credit channel of the monetary policy transmission mechanism would suggest. We also show that the inverse relationship between interest rate shocks and UK stock returns reversed its sign and became significantly positive during the recent financial crisis period. Our results show that the Bank of England can affect stock market valuations by modifying interest rates, but this impact is much stronger during periods of tight credit market conditions. Hence, apart from the credit conditions in the wider economy, central banks should also monitor the response of capital and money markets' participants to their policy decisions.

JEL classification: G12; G15.

Keywords: Monetary Policy Shocks, Financial Constraints, Credit Channel, Bank of England, London Stock Exchange.

1. Introduction

The recent global crisis period has demonstrated that financial constraints play a crucial role on all aspects of corporate decisions. Financial constraints are essentially frictions that may prevent firms from funding all desired investments and pose to them restrictions to grow because they affect their financing and investment decisions. The severity of these financial constraints and their impact on corporate policies crucially depend on the macroeconomic environment, and, in particular, on the monetary policy stance by the central bank. The interest rate and credit channels of the monetary policy transmission mechanism imply that in the advent of a tightening monetary policy stance, the most financially constrained firms are expected to experience more severe problems because they are typically characterized by lower interest coverage ratios, lower borrowing capacity, worse credit ratings, lower cash holdings, higher leverage and higher agency costs of debt in comparison to the least constrained firms. Therefore, monetary policy shocks constitute a potential source of risk that may affect differentially the most and the least financially constrained firms.

This potentially differential impact on corporate decisions may also affect differently the cost of capital, and hence the stock prices of the constrained firms relative to the unconstrained ones. As a result, monetary policy shocks may have different asset pricing implications across firms that face different degrees of financial constraints. In this study, we directly test this hypothesis for a large cross-section of UK firms, using a plethora of proxies for financial constraints and a number of alternative proxies for monetary policy shocks.

Given the importance of monetary policy shocks, the financial press and professional investors closely follow monetary policy decisions as well as the statements of central banks' board members in their attempt to extract information with respect to current and future movements in asset prices. The importance of this issue has spurred a growing literature of studies examining the impact of monetary policy decisions on stock market returns (see, inter alia, the seminal studies of Jensen and Johnson, 1995, Thorbecke, 1997, and Bernanke and Kuttner, 2005). The versatility of the literature is reflected in the different methodological approaches and the asset menus that researchers have employed (see Jensen et al., 1997, Sellin, 2001, Ehrmann and Fratzscher, 2004, Bredin et al., 2009, Bredin et al., 2010, and Kontonikas and Kostakis, 2013).

The most obvious way through which monetary policy decisions affect stock price valuations is through the economy-wide interest rate channel. Smirlock and Yawitz (1985), using a standard dividend discount model, argue that an increase in the interest rate raises the discount rate applied to firm's future cash flows, i.e. the opportunity cost of capital, and hence it considerably reduces its cash flows' present value. Moreover, as Bernanke and Gertler (1995) argue, an increase in the policy rate can hamper real economic activity because it reduces current consumer demand and expenditure by increasing the cost of borrowing for consumption and investment. As a result, firms' current net cash flows and expectations over future ones are diminished, leading again to lower stock prices. Another very important channel through which changes in interest rates can affect stock prices is the credit channel of the monetary policy transmission process, as described by Bernanke and Blinder (1992), which affects the "external finance premium", i.e. the wedge between the cost of funds generated internally and the cost of externally raised funds. In particular, this channel consists of two mechanisms: the bank lending channel and the balance sheet channel (see Bernanke and Gertler, 1989 and Bernanke and Gertler, 1995 for a detailed analysis).

According to the balance sheet channel, a monetary tightening can reduce the company's revenues due to lower consumer spending and increase its floating-rate interest payments, leading to a significant reduction in its net cash flows. Moreover, it can reduce the value of its assets and hence the value of the collaterals posted for its loans. This process deteriorates the company's interest coverage ratio and other indicators of its financial health, pulling the trigger of financial accelerator that amplifies the initial negative shock and magnifies the external finance premium due to an increase in the agency cost of debt. The bank lending channel has a more immediate effect. In a restrictive monetary environment, the total supply of intermediated credit is significantly reduced. Therefore, companies face more onerous credit terms or even a dramatic reduction in the level of funds they can borrow either from credit markets or from financial intermediaries and they are hindered from pursuing profitable investment opportunities. Consequently, net cash flows get considerably reduced and profitable projects are abandoned due to lack of funding.

Even though the previously described mechanisms may affect all of the firms in the economy, it is particularly interesting to examine whether and how the magnitude of these effects differs across firms with different capital structure and cash flow characteristics. In particular, the aim of this study is primarily to examine, for the first time in the literature, the impact of monetary policy shocks, as extracted from interest rate futures prices on Bank of England's (BoE) Monetary Policy Committee (MPC) meeting days, across firms listed on London Stock Exchange (LSE) facing different degrees of "financial constraints", i.e. frictions that prevent firms from funding all desired investments (Lamont et al., 2001) and pose to them restrictions to grow at their desirable pace (Whited and Wu, 2006).

The interest rate and credit channels of the monetary policy transmission mechanism imply that financially constrained firms are expected to experience more severe problems due to monetary tightening because they are typically characterized by lower interest coverage ratios, lower borrowing capacity, worse credit ratings, lower cash holdings, higher leverage, higher agency costs of debt and they are less able to raise capital due to their limited ownership base in comparison to the least constrained firms. Fazzari et al. (1988), Kashyap et al. (1994) and Hubbard (1998) have extensively analyzed the impact of financial constraints on firms' financing, investment decisions and net cash flows. Guariglia and Mateut (2006) and Guariglia (2008) provide similar evidence for UK firms. There are few studies in prior literature that have examined the impact of monetary policy on stock returns taking into account the effect of financial constraints. For example, Gertler and Gilchrist (1994), Thorbecke (1997), Perez-Quiros and Timmermann (2000) and Guo (2004), inter alia, differentiate between small and big capitalization stocks, arguing that a monetary tightening should affect more severely small companies because these are typically less well immunized against such an adverse economic condition and they face severe financing constraints. Nevertheless, firm capitalization is only a very rough proxy of these constraints.

To overcome this limitation, some recent studies have suggested a number of more appropriate proxies for firms' financial constraints, examining their relationship with risk-adjusted returns (see Hahn and Lee, 2009, for a review of the literature). As a by-product of their analysis, some of these studies have tested whether the differential return between the most and the least constrained firms is related to monetary conditions among other macroeconomic factors. In particular, Lamont et al. (2001), using size and the composite Kaplan-Zingales (KZ) index as measures, did not find a significant relationship between the spread return of the most minus the least constrained firms and the change in the Fed Funds rate or the growth in real M2. Similar is the evidence provided by Hahn and Lee (2009), who used asset tangibility as a measure of constraints and growth in real M2 as a proxy of monetary conditions. However, such tests are likely to suffer from endogeneity bias because changes in monetary variables measured at monthly or quarterly frequencies are unlikely to be purely exogenous. As Rigobon and Sack (2003, 2004) have convincingly shown, monetary policy decisions may have already incorporated stock market movements, and hence causality may run in both directions.

As a solution to the endogeneity problem, recent studies use the event study approach introduced by Kuttner (2001), relying on daily data to extract the unexpected component of monetary policy decisions. Following this approach, Ehrmann and Fratzscher (2004), Basistha and Kurov (2008) and Jansen and Tsai (2010) have examined the differential impact of US monetary policy shocks on constrained versus unconstrained firms using a number of proxies to classify firms. In particular, Ehrmann and Fratzscher (2004) use cash flows, credit ratings, leverage ratios and Tobin's q as proxies for financial constraints. However, they use only S&P 500 companies, which are probably the least constrained firms in the US market and they rely on survey expectations to extract monetary policy shocks. To the contrary, Basistha and Kurov (2008), who also examine only S&P 500 firms and use credit ratings, trade credit, size and payout ratios as constraints proxies, as well as Jansen and Tsai (2010), who use profitability, payout ratios and debt ratings as proxies, extract unanticipated changes in the Fed Funds rate relative to futures-implied expectations; this is the common practice in the literature since the seminal study of Bernanke and Kuttner (2005). Overall, these US studies find that the most constrained firms are more affected by monetary policy shocks relative to the least constrained ones and that the magnitude of this relationship exhibits state dependence.

Our study contributes to the literature by examining, for the first time, the return response of portfolios constructed on the basis of UK firms' financial constraints proxies to monetary policy shocks on BoE's MPC meetings from June 1999 to December 2011.[1] Following Kuttner (2001), to avoid the potential endogeneity bias discussed in Rigobon and Sack (2003, 2004), we use daily data on interest rate shocks and stock returns. We provide comprehensive evidence on this issue using an exhaustive and survivorship bias-free dataset of firms listed on LSE and utilizing a large number of financial constraints measures that have been suggested in prior literature. We also empirically test whether the most constrained firms respond to monetary policy shocks in a differential manner relative to the least

[1] Bredin et al. (2007), Bredin et al. (2009) and Gregoriou et al. (2009) have also examined the response of stock market returns to monetary policy shocks on BoE's MPC meeting days; however, they examine only aggregate market and sectoral returns.

constrained ones. In doing so, we shed light on the transmission of UK monetary policy decisions through the stock market and we provide evidence on whether investors react to these decisions in accordance to the conjectures made on the basis of the credit channel mechanism. Moreover, we test for the first time in the UK market, whether the relationship between stock returns and interest rate shocks is state dependent by investigating how this relationship is modified across different market phases, credit, volatility and liquidity conditions. Finally, we also examine whether this relationship was affected by the unprecedented global financial crisis of 2007-2009.

Previewing our results, we find that there is a large degree of heterogeneity in the response of the constrained portfolios' returns to monetary policy shocks across the various proxies we use, indicating that these measures capture different dimensions of this elusive concept. Most importantly, with the exception of tangible-to-total assets ratio and KZ-index in some cases, for the remaining proxies there is no evidence supporting the argument that the most constrained firms' returns are more responsive to unanticipated interest rate changes on MPC meeting days relative to the returns of the least constrained firms. Moreover, we find that there has been a reversal in the relationship between UK stock returns and monetary policy shocks during the financial crisis of 2007-2009; the well documented inverse relationship became significantly positive during the crisis period. Finally, our results reveal that this relationship, outside the crisis period, exhibits state dependence. Most significantly, returns' response to interest rate shocks is of much larger magnitude on MPC meetings that took place during periods of tight credit conditions.

This study is structured as follows. Section 2 provides the details for the calculation of monetary policy shocks from interest rate futures prices, the proxies of financial constraints and the construction of the corresponding portfolios. Section 3 contains the main body of the empirical results on the relationship between monetary policy shocks and portfolios' returns, also using various model specifications to reveal potential state dependence of the relationship. Section 4 presents a series of robustness checks, Section 5 examines the impact of alternative economic shocks, while Section 6 concludes.

2. Data and Methodology

2.1. Monetary policy shocks

Following the methodology of Kuttner (2001), we extract monetary policy shocks on BoE's MPC meeting days relative to interest rates expectations that are embedded in futures prices. In this way, we avoid the potential endogeneity bias discussed by Rigobon and Sack (2003, 2004) that could derive from using lower frequency (e.g. monthly) data. It should be noted that there is no futures market instrument that tracks BoE's policy rate, the 2-week repo rate. Therefore, we follow Bredin et al. (2007), Bredin et al. (2009) and Florackis et al. (2014) in utilizing the sterling futures contract that settles on the 3-month British Bankers' Association (BBA) London Interbank Offer Rate (LIBOR) prevailing at 11:00 on the last trading day (third Wednesday of the delivery month). This contract is traded on the London International Financial Futures and Options Exchange (LIFFE) and its settlement price is 100 minus the BBA LIBOR rounded to three decimal places. The price of this futures contract is widely considered to accurately embed market expectations regarding future short-term interest rates and, as Brook et al. (2000) note, it is also used by BoE's MPC for policy purposes.[2] Data on futures prices are obtained from Thomson Datastream.

[2] To be accurate, we actually calculate unexpected short-term LIBOR changes on MPC meeting days and, following Bredin et al. (2007), we consider them to be the best proxy for "monetary policy shocks", given the absence of a futures contract tracking BoE's policy rate. Therefore, we use these two terms interchangeably though, in principle, they are not necessarily identical. Nevertheless, as Lildholdt and Wetherilt (2004) and Joyce et al. (2008) have shown, these LIBOR futures prices reflect market participants' expectations over future interest rates and UK monetary policy quite accurately.

The *unanticipated* (unexpected) interest rate change, Δi_d^u, is defined as the change in the futures-implied 3-month LIBOR rate on MPC meeting day, *d*, relative to the previous day, *d-1*:

$$\Delta i_d^u = f_{m,d} - f_{m,d-1} \tag{1}$$

where $f_{m,d}$ is the implied interest rate, i.e. 100 minus the LIFFE futures contract price, extracted from the corresponding contract with delivery month *m* nearest to the MPC meeting day *d*.[3] On the other hand, the *anticipated* (expected) interest rate change, Δi_d^e, is defined as the difference between the actual change in the 3-month LIBOR on MPC meeting day *d*, Δi_d, and the corresponding *unanticipated* change, Δi_d^u:[4]

$$\Delta i_d^e = \Delta i_d - \Delta i_d^u \tag{2}$$

In contrast to Bredin et al. (2007), who start their sample period from 1994, we consider only meetings that have been publicly announced in advance to ensure that interest rate futures prices actually reflected market participants' expectations regarding monetary policy decisions. In particular, the schedule of BoE's MPC meetings have been publicly announced since June 1997.[5] Nevertheless, our empirical analysis begins from June 1999, since only then 3-month LIBOR futures started settling on a monthly basis. Prior to this date, contracts were settling on a quarterly basis and this lack of correspondence between the frequency of the contract's settlement and MPC meetings could potentially lead to a biased estimate of the unexpected interest rate change. Avoiding this potential problem, we examine

[3] Piazzesi and Swanson (2008) have shown that extracting interest rate shocks using a one-day window is a robust approach because any low-frequency premia embedded in futures prices are effectively "differenced out". Actually, some recent studies have employed even shorter time windows, extracting shocks from futures prices in the interval of 30-minutes around the announcement of the Fed Funds rate (e.g., Wongswan, 2009). Unfortunately, intraday data for interest rate futures and stock prices, which are necessary to calculate portfolios' returns, are not available to us for the UK market.

[4] It should be noted that the 3-month horizons of the LIBOR prevailing on the MPC meeting date and the LIBOR that will prevail on the settlement date of the futures contract do not coincide. We would like to thank an anonymous referee for this remark.

[5] The list of meetings and decisions is available at http://www.bankofengland.co.uk/monetarypolicy.

a total of 152 MPC meetings, from June 1999 to December 2011. Figure 1 illustrates the extracted unexpected interest rate changes along with actual LIBOR changes on MPC meeting days.

-Figure 1 here-

2.2. Financial constraints-sorted portfolios

The concept of financial constraints is rather elusive because a firm may become constrained either due to the size and structure of the assets and liabilities of its balance sheet or due to the level and the variability of its cash flows. Since the aim of this study is to provide comprehensive evidence regarding the return response of stock portfolios constructed on the basis of the degree of financial constraints that firms face, we utilize a number of proxies that have been suggested in prior literature. In particular, the following measures are used: a firm's size proxied by the book value of its assets, its ratio of tangible-to-total assets as a measure of debt capacity, its total debt-to-common equity and total debt-to-market value ratios as measures of leverage, its cash holdings-to-total assets ratio, its interest coverage ratio, the composite KZ-index proposed by Kaplan and Zingales (1997) and the composite WW-index proposed by Whited and Wu (2006).[6] Table 1 presents the list of these measures along with their definitions and the corresponding Worldscope (accounting variables) and Datastream (market variables) codes used to calculate them.[7] Worldscope is the most reliable

[6] As the definition of KZ and WW indices presented in Table 1 indicates, these indices combine in a linear fashion a firm's accounting and market characteristics to measure the strength of its financial constraints. To calculate firms' KZ and WW-index values, we use the coefficients suggested in the original studies by Kaplan and Zingales (1997) and Whited and Wu (2006), respectively. We acknowledge that one would ideally re-estimate these structural models for UK firms and utilize the corresponding coefficients to calculate indices' values. However, we do not have a long enough sample to estimate these coefficients and use them to construct portfolios. Therefore, we opt for the original US-estimated coefficients and we expect that these should also be applicable for UK firms given the similarities in the functioning of these two countries' financial systems and legal frameworks.

[7] It should be noted that when we construct portfolios on the basis of interest coverage ratios, we exclude firms with negative values. We also exclude firms with negative debt-to-common equity ratios, arising from negative values of common equity. Finally, when we construct portfolios using debt-to-common equity and debt-to-market value ratios, the firms with zero leverage are assigned to a separate portfolio, because we cannot identify whether this capital structure is a strategic decision for unconstrained firms or an inevitable situation for highly constrained firms who cannot access external finance.

source of accounting information for a sufficiently large cross-section of UK firms and for a long time period (see also Soares and Stark, 2009).

-Table 1 here-

For the construction of financial constraints-sorted portfolios, we utilize all common stocks listed on LSE from 1998 to 2011. Following common practice in the literature, we include both listed and de-listed firms, so that our dataset is free of any potential survivorship bias. We then exclude unit trusts, investment trusts and ADRs. We impose several screening criteria to our initial sample, excluding firms for which the necessary accounting and market data are not available for a year. We also exclude firms that have market capitalization less than £5 million on a given year. Then, we exclude financial and insurance companies because their capital structure and cash flows definition is fundamentally different and by no means comparable with the other firms. Having applied these filters, we end up with a total of 2,316 firms over the examined period.[8] To ensure that accounting data were publicly available prior to each MPC meeting, and hence they could have been used by an investor in real time to measure firms' financial constraints and construct the corresponding portfolios, we follow Soares and Stark (2009) and lag these data by 6 months.[9]

For every MPC meeting that takes place in month *m*, we calculate each of the financial constraints measures for each firm using market and accounting data that were available to investors at the end of month *m-1*. In this way, we ensure that we use up-to-date information for firms' degree of financial constraints and that this information was publicly available prior to the MPC meeting day. Having calculated these measures, we sort all firms that were listed on LSE on MPC meeting day *d* and assign them to quintile portfolios. The

[8] Arguably, financial constraints may be even more severe for unlisted companies, which are predominantly small and do not have access to credit (Guariglia, 2008). However, here we examine firms' return response to monetary policy shocks, and hence we can only examine listed companies, whose shares are tradable and market prices are observable.

[9] For accounting periods beginning before 2007, firms listed on LSE were allowed by the Financial Services Authority (FSA) to publish their financial reports up to 6 months after the end of their fiscal year. For details see http://fsahandbook.info/FSA/html/handbook/DTR/4/1.

MPC meeting day return of each quintile portfolio *p* is the value-weighted average of the constituent stocks' returns relative to the previous trading day *d-1*. Stock prices inclusive of dividends (datatype RI) are used for the calculation of returns and they are sourced from Datastream.

-Tables 2 and 3 here-

Table 2 reports the descriptive statistics for the most constrained (Panel A) and the least constrained (Panel B) quintile portfolio returns on these 152 MPC meeting days for each of the measures we use as well as the corresponding statistics for FTSE All Share and zero leverage portfolios' returns. Table 3 presents the pairwise correlation coefficients for the returns of the most constrained (Panel A) and the least constrained (Panel B) quintile portfolios along with FTSE All Share returns on MPC meetings. The pairwise correlations among the most constrained quintile portfolio and FTSE All Share returns are quite low, confirming that each of these measures captures a different dimension of the financial constraints concept. These low correlations also indicate that these portfolios' return response to interest rate changes is expected to be considerably different from the commonly studied market return response and to widely vary across the proxies we utilize. The corresponding correlations among the least constrained quintile portfolio and market returns are somewhat higher, but still low if one takes into account that these are daily returns and that the market index mainly consists of big capitalization firms, which are expected to be among the least constrained ones. These low correlations indicate again a potentially large degree of heterogeneity in these portfolios' return response to interest rate changes.

2.3. Proxies for state dependence and other control variables

In our attempt to examine whether the relationship between portfolios' returns and interest rate shocks depends on market and other economic conditions, we use a series of variables to proxy the state of these conditions. In particular, we firstly use the level of FTSE

All Share Index on its own as well as relative to its past moving average to determine whether there is a bull or a bear market phase. To characterize a recession, we follow the technical definition of two consecutive negative real GDP growth rates, using the 2012Q1 vintage of real GDP data compiled by BoE. As a proxy for credit conditions, we use the default yield spread defined as the difference between the long-term corporate redemption yield, extracted from the Bank of America-Merill Lynch UK Corporate Bond Index, and the 10-year UK Government Zero-Coupon Bond yield provided by BoE. As a proxy for financial turmoil and stress, we use FTSE 100 Volatility Index, which is extracted from options on FTSE 100 and it is the UK market equivalent to VIX that is widely used as a gauge of market uncertainty (see Whaley, 2000).[10] To measure stock market liquidity, we use the Return-to-Volume (RtoV) price impact ratio proposed by Amihud (2002). To this end, we calculate for a window of 90 trading days the average ratio of FTSE All Share daily returns (in absolute value) to the total trading volume of the same day.

To estimate in a robust way the effect of interest rate shocks on daily portfolio returns, we also control for other factors that could affect UK stock returns. More specifically, following Bredin et al. (2007), we control for Sterling/ Dollar and Sterling/ Euro daily exchange rate changes as well as for the US market return, proxied by the S&P 500 return.[11] Finally, as a measure of adverse funding conditions and stress in the interbank market, we use in Section 4.4 the spread between LIBOR and BoE's policy rate; this spread is equivalent to the LIBOR-OIS spread that is commonly used in US studies (see Thornton, 2009 and Nyborg and Ostberg, 2010). All of these variables are sourced from Datastream unless otherwise stated. Figure 2 illustrates the values of default yield spread, LIBOR-BoE base rate spread and FTSE Implied Volatility index on the 152 MPC meeting days we examine in our analysis.

[10] FTSE 100 Volatility Index is available on a daily basis from January 2000 onwards.
[11] We use lagged S&P 500 daily returns to account for the lag between UK and US stock market closing times.

-Figure 2 here-

3. Empirical Results

3.1. Portfolio returns and monetary policy shocks: The crisis effect

The benchmark model specification to examine the relationship between anticipated and unanticipated interest rate changes and stock returns, suggested by Bernanke and Kuttner (2005), is given by the following regression model:

$$r_{p,m,d} = \alpha + \beta^{u} \Delta i_{d}^{u} + \beta^{e} \Delta i_{d}^{e} + \varepsilon_{d} \quad (3)$$

where $r_{p,m,d}$ is the value-weighted return of portfolio *p* on MPC meeting day *d* in month *m*, Δi_{d}^{u} is the corresponding unanticipated interest rate change and Δi_{d}^{e} is the anticipated interest rate change.[12] In our attempt to determine the relationship between interest rate shocks and stock returns, we also control for other variables that could potentially affect UK stock returns in a systematic way. To this end, following Bredin et al. (2007), we also control for the Sterling/ Euro and Sterling/ Dollar bilateral exchange rates as well as the lagged S&P 500 return in the following augmented regression model:

$$r_{p,m,d} = \alpha + \beta^{u} \Delta i_{d}^{u} + \beta^{e} \Delta i_{d}^{e} + \gamma ' X_{d} + \varepsilon_{d} \quad (4)$$

where the vector X_d contains the additional control variables.[13]

-Table 4 here-

We estimate this model for each quintile portfolio constructed by sorting all available firms on the basis of each of the eight alternative financial constraints measures that we

[12] It should be acknowledged that if the BoE tends to change its policy rate in a persistent manner, any decisions regarding the current rate may also contain information about the future expected path of short-term rates, and hence affecting longer-term interest rates. In that case, our model specification, which focuses on the stock return response to current unexpected interest rate changes may be not be able to capture the corresponding response to the future path of interest rates (see Jeenas, 2018, for a related discussion). We would like to thank an anonymous referee for this remark.

[13] It should be noted that the relationship between interest rates, FX and stock prices is rather more complex than controlling for bilateral exchange rates in a linear fashion (see, for example, Dua and Tuteja, 2016, and Han et al., 2018). We would like to thank an anonymous referee for this remark.

employ in this study. The benchmark results that we report in this section refer to least squares regressions coefficients and Newey-West standard errors with four lags to take into account the potential autocorrelation structure. For ease of exposition, in Table 4 and the remaining Tables we report the estimated coefficients only for the extreme quintiles, i.e. the portfolios containing the most and the least constrained firms, respectively. Results for the remaining portfolios are available upon request. As a benchmark for comparison, we also report the corresponding estimated coefficients using FTSE All Share Index returns, a proxy for UK market returns. We find that, although negative in most of the cases we examine, the relationship between anticipated or unanticipated interest rate changes and portfolio returns is statistically insignificant. The only exceptions are the most constrained quintile portfolios according to the tangible-to-total assets ratio and WW-index, the zero leverage portfolios and the least constrained quintile portfolio according to the total debt-to-market value ratio, where the inverse relationship between unexpected interest rate changes and returns is significant at the 5% level. The reported lack of statistical significance using portfolios sorted on the basis of financial constraints proxies complements the findings of Gregoriou et al. (2009) for the UK market, showing that this model specification is inadequate to capture the relationship between stock returns and monetary policy shocks when the 2007-2009 crisis period is included in the sample.

The preliminary evidence provided in Gregoriou et al. (2009) for the UK market motivates us to examine whether the relationship between the returns of constraints-sorted portfolios and interest rate changes reversed its sign during the recent financial crisis. As a characteristic example, the unexpected interest rate decrease of 0.4% on the MPC meeting of 6th November 2008, which is by far the greatest in our sample and took place when BoE cut its base rate from 4.5% to 3%, was associated with a dramatic drop in FTSE All Share Index of -5.38%, casting doubt on the conventional wisdom that such a massive interest rate cut would instantaneously boost the stock market. Inspecting the returns of the constraints-sorted portfolios, we find that the quintile portfolio consisted of firms with the lowest interest coverage ratio suffered a loss of -5.61% on that day, while the corresponding portfolio containing the firms with lowest cash holdings experienced a return of -7.8%.

Similarly, BoE's policy rate cut from 5% to 4.5% on the MPC meeting of 8th October 2008 and the corresponding unexpected LIBOR decrease by 0.1% relative to futures-implied expectations, was accompanied by another dramatic fall in stock prices. In particular, FTSE All Share Index suffered a loss of -4.81% on that day, while the corresponding quintile portfolio containing the firms with the lowest interest coverage ratio (cash holdings) experienced a fall of -4.37% (-5.3%). A first indication of the potential reversal in the relationship's sign is provided by scatterplots of FTSE All Share returns versus unexpected rate changes distinguishing between MPC meetings that took place outside and during the crisis period. These two scatterplots are presented in Figure 3, confirming that the negative relationship between unexpected rate changes and market returns has turned positive during the recent crisis period.

-Figure 3 here-

The negative response of the stock market to interest rate cuts during the crisis period also attracted the interest of the financial press.[14] A potential explanation of this paradox is that unexpected interest rate cuts when the global financial system was collapsing were actually perceived as a signal from the central bank that even worse economic conditions lie ahead, forcing market participants to dramatically revise downwards their expectations for asset prices and sell off risky assets in their attempt to "fly to safety", mainly by purchasing government bonds. To formally examine whether this relationship was modified during the

[14] See: "Another paradox of thrift", The Economist, 18th September 2010.

crisis period for the sample of portfolios we have constructed, we utilize the following regression model:

$$r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis}) \Delta i_d^u + \beta_2^u D^{Crisis} \Delta i_d^u + \beta_1^e (1 - D^{Crisis}) \Delta i_d^e + \beta_2^e D^{Crisis} \Delta i_d^e + \gamma' X_d + \varepsilon_d \quad (5)$$

where D^{Crisis} takes the value 1 during the period from August 2007 to December 2009.[15] The choice of the starting period for the financial crisis is motivated by the analysis of Brunnermeier (2009) and it coincides with the bank run of Northern Rock which brought the UK financial system to a near collapse (see Shin, 2009, for a detailed analysis of this episode).

-Table 5 here-

The estimated coefficients for the unexpected rate changes from regression model (5) are reported in Table 5. We find that the inverse relationship between monetary policy shocks and portfolio returns becomes statistically significant when we exclude the 2007-2009 crisis period. Interpreting the reported coefficients, an unexpected interest rate cut of 25 basis points on an MPC meeting day would be associated, for example, with a positive FTSE All Share return of 2.31% on the same day and returns of 1.65% and 2.15% for the most and the least constrained quintile portfolios, respectively, constructed according to interest coverage ratio.

Examining the responses of the most and the least constrained portfolios' returns, we find that across the various proxies we use, there is no particular pattern to indicate that portfolios of the most constrained firms are more responsive to unexpected rate changes. This is only true when the tangible-to-total assets ratio and KZ-index are used as constraints proxies, while the differential response is statistically significant only in the first case. To the contrary, for all of the remaining proxies, this inverse relationship is of higher magnitude for

[15] This and the subsequent model specifications involving dummy variables are chosen to allow the presentation of the dummy coefficients in a direct rather than an additive way, following the practice of Basistha and Kurov (2008).

the portfolios containing the least constrained firms.[16] The large degree of heterogeneity in the estimated return responses among the least as well as among the most constrained portfolios also reflects the fact that each of these measures captures a different aspect of financial constraints. This feature was also indicated by the low pairwise correlations among daily portfolio returns that were reported in Table 3.

The evidence provided in Table 5 is at odds with the hypothesis that the most constrained firms would be more sensitive to monetary conditions, and hence affected by monetary policy shocks to a larger degree relative to the least constrained firms. It also partially contradicts the limited prior evidence for the US market by Basistha and Kurov (2008) and Jansen and Tsai (2010). There are two potential explanations we put forward for this finding. Firstly, investors on LSE may not consider the interaction between financial constraints and monetary conditions to be an important source of risk, especially at very short horizons, and as a result, it does not affect their decision making even when unexpected interest rate changes occur. In other words, according to this line of reasoning, investors do not differentiate across UK listed firms on the basis of their financial constraints or they even altogether ignore this information when reacting to monetary policy news.

Secondly, the most constrained firms are predominantly small capitalization firms, especially according to total assets and WW-index proxies that are by definition related to firms' size. The shares of these firms are usually thinly traded, and hence their prices may not respond to incorporate interest rate shocks as quickly as it would happen with the more liquid stocks of the least constrained and bigger capitalization firms. This argument seems to be valid particularly when total assets and WW-index are used as proxies also because the explanatory power of the regression model for the daily returns of the most constrained

[16] Very similar are the findings when we alternatively classify firms into decile or tercile portfolios on the basis of their financial constraints proxies values. Results are readily available upon request.

portfolios is extremely low, implying that these returns do not respond either to interest rate news or to the other control variables we include in model (5).

With respect to the response of returns to unexpected interest rate changes during the crisis period, we find that this relationship has indeed reversed its sign and it has become positive for the market index as well as the majority of the portfolios constructed on the basis of the constraints proxies. Actually, the estimated coefficients are very large and significant in some cases, e.g. when cash holdings-to-total assets ratio is used, highlighting the economic importance of the direct impact that these unexpected shocks had on stock returns during the crisis. Interpreting the reported coefficients, an unexpected interest rate cut of 25 basis points on an MPC meeting day *during the crisis period* would be associated with a *negative* FTSE All Share return of -3.03% on the same day and returns of -5.83% and -3.1% for the quintile portfolios containing the firms with the lowest and the highest cash holdings ratios, respectively.

Formally testing, via a Wald test, whether a shift in the relationship occurred, we can significantly reject for almost all of the extreme quintile portfolios the null hypothesis that the estimated coefficients of the unexpected interest rate changes are equal outside and during the crisis period. Nevertheless, we do not find again any pattern across the various proxies with respect to the relative magnitude of the most versus the least constrained portfolios' return sensitivity to unexpected interest rate changes. The most constrained portfolio returns are significantly more positively reacting to unexpected rate changes during the crisis period only when the total debt-to-market value, cash holdings-to-total assets and interest coverage ratios are used as proxies.

For Table 5 and the remaining Tables to be legible, we report only the coefficients of the unanticipated interest rate changes. However, it should be mentioned that in most of the cases, the coefficients of the expected interest rate changes are economically and statistically significant, contradicting the evidence provided in Bredin et al. (2007) for an earlier sample period. This highly important finding, which was also reported in the seminal study of Bernanke and Kuttner (2005) for the US market, is at odds with the conjecture that a fully efficient market would have already incorporated expected interest rate changes into stock prices. Moreover, it is important to note that for most of the portfolios, the coefficients of the Sterling/ Dollar exchange rate change and the lagged S&P 500 return are also significant, confirming the importance of adding them to the regression models as control variables, while this is not true for the Sterling/ Euro exchange rate change.[17]

Having reduced its base rate to a record low of 0.5% by March 2009, BoE decided to engage in a series of rounds of asset purchases financed with its reserves, an operation termed as Quantitative Easing (QE), in a further attempt to stabilize the UK economy (see Joyce et al., 2010, for an overview, Martin and Milas, 2012, for a critical analysis, and Mallick et al., 2017, for recent evidence on the effect of QE on stock market volatility). While a detailed examination of the impact of QE on stock returns is beyond the aim of this study, we test here whether the announcements made with respect to QE policies had any effect on the portfolio returns we examine. In particular, we introduce in regression model (5) a dummy variable which takes the value of 1 on the MPC meeting days that an increase in asset purchases was decided.[18]

Unreported results that are available upon request show that there is no significant effect of these QE decisions on the returns of the market index or the constraints-sorted portfolios. The explanation we put forward is that the implementation or extension of QE policies was fully anticipated by market participants each time, and hence this information was already incorporated into stock prices. This is a plausible explanation because even the

[17] The estimated coefficients for expected interest rate changes and the control variables are readily available upon request.

[18] In particular, these are the MPC meetings on 5th March, 7th May, 6th August and 5th November 2009 as well as on 6th October 2011.

actual amounts had been communicated and published in the financial press earlier than the corresponding MPC meeting, probably because BoE did not intend to take markets by surprise with this policy. We have also estimated regression model (5) adding a dummy variable that takes the value 1 on 18th September 2001, which is the only unscheduled MPC meeting in our sample period. The estimated coefficients are very similar to the ones reported in Table 5 and they are available upon request. We have also re-estimated regression model (5) excluding the observations after March 2009 since the policy rate was close to the zero lower bound since then and the unexpected rate changes were very close to zero. Using this shorter time period, the results remain almost identical to the benchmark results presented in Table 5. Finally, we have also re-estimated regression model (4) using data only up to August 2007, i.e. before the beginning of the financial crisis; the derived results confirm the conclusions we previously discussed for the impact of monetary policy shocks on constraints-sorted portfolios' returns *outside* the financial crisis period.

3.2. Portfolio returns and monetary policy shocks: State dependence

This section examines whether the documented inverse relationship between interest rate shocks and portfolio returns outside the crisis period exhibits state dependence, i.e. whether its magnitude depends on the market phase, credit, volatility and liquidity conditions. We follow the dummy variable approach of Basistha and Kurov (2008) to determine each state and estimate the corresponding coefficients of the relationship. We firstly examine whether the portfolios' return response differs across bull and bear markets. Following the definition of Jansen and Tsai (2010, p. 985), a bull market is said to occur when the stock market index is located between the trough and the peak point, including the peak, and a bear market occurs otherwise. We use daily data on FTSE All Share Index to characterize bull and bear market phases.[19] The regression model we use to examine whether the relationship is modified across these two phases outside the crisis period is given by:

$$r_{p,m,d} = \alpha + \beta_1^u (1-D^{Crisis})(1-D^{Bull})\Delta i_d^u + \beta_2^u (1-D^{Crisis})D^{Bull}\Delta i_d^u + \beta_3^u D^{Crisis}\Delta i_d^u + \beta_1^e (1-D^{Crisis})(1-D^{Bull})\Delta i_d^e + \beta_2^e (1-D^{Crisis})D^{Bull}\Delta i_d^e + \beta_3^e D^{Crisis}\Delta i_d^e + \gamma' X_d + \varepsilon_d \quad (6)$$

where D^{Bull} takes the value 1 when the market is in a bull phase on MPC meeting day *d* and zero otherwise. This model specification does not differentiate between bull and bear market phases during the 2007-2009 crisis period, because this period was characterized by a prolonged bear market, and hence such a differentiation would be meaningless. The same approach is followed in the subsequent models with dummy variables, since the crisis period was predominantly characterized by very high default yield spreads, high volatility and low market liquidity (see also Figure 2). Therefore, state dependence is examined *only* outside the crisis period.

-Table 6 here-

The estimated coefficients with respect to unexpected rate changes for the market and the constraints-sorted portfolios are presented in Table 6. We also perform a Wald test for the null hypothesis that the coefficients of the relationship are equal across bull and bear market phases. Overall, the null hypothesis of equality in the coefficients cannot be rejected at the 5% level, apart from the case of KZ-index, where the returns' response is significantly negative only during bull markets.

Setting statistical significance aside, however, we find that the inverse relationship between returns and unexpected rate changes in the UK market existed only during bull market phases. This is true both for market returns and the returns of portfolios constructed on the basis of financial constraints proxies. For example, an unexpected interest rate cut of

[19] Obviously, this is an ex post characterization of bull and bear market phases because one needs to know the subsequent trough and peak points. For robustness, we use an alternative definition in Section 4.3, where a moving average of index values is used and the characterization of bull and bear market phases can be made in real time.

25 basis points on an MPC meeting day during a bull market phase would be associated with a positive FTSE All Share return of 2.16% on the same day, while it would be associated with a positive FTSE All Share daily return of only 0.89% during a bear market phase outside the crisis period. Actually, our results show that during the bear market of September 2000-March 2003, which was the only one in our sample apart from the recent crisis period, there was no particular relationship between portfolio returns and unexpected rate changes for most of the cases we examine. Moreover, there is no evidence suggesting that interest rate shocks had a greater impact on the most constrained portfolios' returns relative to the least constrained ones in either market phase, except when the tangible-to-total assets ratio is used, but still the differential magnitude is not statistically significant.

To examine whether the relationship between stock returns and interest rate changes differs across tight and loose credit conditions outside the crisis period, we estimate the following regression model:

$$\begin{aligned} r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis})(1 - D^{Credit})\Delta i_d^u + \beta_2^u (1 - D^{Crisis}) D^{Credit} \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + \\ \beta_1^e (1 - D^{Crisis})(1 - D^{Credit})\Delta i_d^e + \beta_2^e (1 - D^{Crisis}) D^{Credit} \Delta i_d^e + \beta_3^e D^{Crisis} \Delta i_d^e + \gamma' X_d + \varepsilon_d \end{aligned} \tag{7}$$

where D^{Credit} takes the value 1 when the default yield spread on MPC meeting day d is higher than its sample average value, indicating tight credit conditions, and zero otherwise. The estimated coefficients for the returns' response to unexpected interest rate changes are reported in Table 7. We also report the p-value of a Wald test for the null hypothesis that the coefficients of the relationship are equal across tight and loose credit market conditions.

-Table 7 here-

Overall, the magnitude of portfolio returns' response to interest rate shocks was much greater during tight credit conditions and, according to the Wald test, this differential is significant at the 10% level for half of the cases we have examined. For example, the negative response of FTSE All Share returns was almost four times greater on MPC meetings taking place during tight credit conditions (-27.12) relative to the other meetings (-7.55). This differential magnitude is even more pronounced for portfolios containing the most constrained firms according to KZ-index, tangible-to-total assets, total debt-to-market value and cash holdings-to-total assets ratios. Nevertheless, the response of the most constrained portfolios' returns during tight credit conditions is significantly greater relative to the least constrained portfolios' returns only in the first two cases. According to the other proxies, we find that either the opposite is true, as in the case of total debt-to-common equity, total debt-to-market value and interest coverage ratios or that the differential response is not significant. Finally, the return response to interest rate shocks during the crisis period is very similar to the one reported in the benchmark results of Table 5.

The next step is to examine the differential return response according to market volatility conditions, as proxied by the FTSE 100 Implied Volatility Index, outside the crisis period. The estimated model is given by:

$$\begin{aligned} r_{p,m,d} = {} & \alpha + \beta_1^u (1-D^{Crisis})(1-D^{Vol})\Delta i_d^u + \beta_2^u (1-D^{Crisis}) D^{Vol} \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + \\ & \beta_1^e (1-D^{Crisis})(1-D^{Vol})\Delta i_d^e + \beta_2^e (1-D^{Crisis}) D^{Vol} \Delta i_d^e + \beta_3^e D^{Crisis} \Delta i_d^e + \gamma' X_d + \varepsilon_d \end{aligned} \quad (8)$$

where D^{Vol} takes the value 1 when the implied volatility index on MPC meeting day d is higher than its sample average value, indicating high market volatility, and zero otherwise. The estimated coefficients for interest rate shocks from model (8) are reported in Table 8.

-Table 8 here-

In general, we find that the inverse relationship between returns and shocks outside the crisis period is of greater magnitude on MPC meetings that took place during periods of high market volatility. However, the standard errors of these coefficients are large, rendering them statistically insignificant at the 5% level for most of the portfolios we examined as well as for FTSE All Share. Moreover, the differential magnitude of the return response across low and high volatility conditions is by no means statistically significant, as the p-values for the corresponding Wald test show. Finally, we do not find any evidence supporting the argument that the response of the most constrained portfolios' returns is significantly greater than the response of the least constrained ones, except when the tangible-to-total assets ratio is used as a proxy in low market volatility conditions.

The last potential state dependence that we examine refers to market liquidity conditions, as proxied by the RtoV price impact ratio of FTSE All Share Index, excluding the crisis period. In particular, we estimate the following model:

$$\begin{aligned} r_{p,m,d} = {} & \alpha + \beta_1^u (1-D^{Crisis})(1-D^{Illiq})\Delta i_d^u + \beta_2^u (1-D^{Crisis}) D^{Illiq}\Delta i_d^u + \beta_3^u D^{Crisis}\Delta i_d^u + \\ & \beta_1^e (1-D^{Crisis})(1-D^{Illiq})\Delta i_d^e + \beta_2^e (1-D^{Crisis}) D^{Illiq}\Delta i_d^e + \beta_3^e D^{Crisis}\Delta i_d^e + \gamma' X_d + \varepsilon_d \end{aligned} \quad (9)$$

where D^{Illiq} takes the value 1 when the 90-day moving average of RtoV calculated on MPC meeting day *d* is higher than its sample average value, indicating that the market is in an illiquid state, and zero otherwise. Table 9 reports the estimated coefficients from regression model (9). Overall, we find that, outside the crisis period, the inverse relationship between interest rate shocks and the returns of constraints-sorted portfolios is relatively more pronounced on MPC meetings that took place during illiquid market conditions; this is not true, however, for market index returns. Nevertheless, the p-values of the corresponding Wald tests indicate that the estimated differential magnitude is by no means statistically significant. Moreover, there is no evidence suggesting that the most constrained portfolios' returns are significantly more responsive to unexpected rate changes as compared to the least constrained ones either in liquid or in illiquid market conditions; the opposite is actually true for most of the constraints proxies we examine.

-Table 9 here-

In summary, we find that the inverse relationship between stock returns and interest rate shocks, which was documented outside the crisis period, exhibits state dependence indeed. In particular, the negative response of portfolio returns is more pronounced during bull market phases, tight credit conditions, high volatility and market illiquidity, but this difference is statistically significant only across credit conditions.[20] Furthermore, the results reported in Tables 6 to 9 confirm the main finding of our study, i.e. that the return response of portfolios containing the most constrained firms is not of greater magnitude relative to the response of portfolios containing the least constrained firms, apart from some cases where tangible-to-total assets ratio and KZ-index are used as proxies. In other words, investors on LSE did not seem to differentiate between the most and the least constrained firms when reacting to monetary policy shocks during our sample period and this finding holds true across different market phases and credit, volatility and liquidity conditions.

4. Robustness checks

4.1. Alternative definition of crisis period and robust regression estimates

For the benchmark results reported in Table 5, the crisis period was defined to extend from August 2007 to December 2009, using the bank run on Northern Rock as a starting point. In this section, we examine how robust these results are when a narrower definition of the crisis period is used. In particular, the crisis period is now defined to extend from September 2008 to August 2009 (see also Florackis et al., 2014 for a similar definition), i.e. the period during which the UK economy was officially in recession, using the technical definition of two consecutive quarters with negative real GDP growth. Actually, this is the only UK recession period from 1992 to 2011. Therefore, this narrower crisis dummy variable also serves as a recession dummy variable, enabling us to document at the same time how the interest rate shocks- portfolio returns relationship was modified during this recession period, in light of the US evidence provided by Basistha and Kurov (2008).

[20] It should be noted that, unlike the 2007-2009 crisis period, the bear market phase of September 2000- March 2003 also included periods of low default yield spreads, low market volatility and low RtoV values. Similarly, during the 2010-2011 bull market there were still periods characterized high default yield spreads, high market volatility and illiquidity. Therefore, the estimated coefficients considerably differ across the various regression models used to examine state dependence.

-Table 10 here-

We re-estimate model (5), but now the dummy variable D^{Crisis} takes the value 1 during the period from September 2008 to August 2009 and zero otherwise. The estimated coefficients with respect to the unexpected interest rate changes excluding and during this narrower crisis period are reported in Table 10, along with the p-values of a Wald test for the null hypothesis that the estimated coefficients are equal across the two periods. These results confirm the validity of the benchmark results reported in Table 5. The relationship between portfolio returns and interest rate shocks was negative and statistically significant for most of the cases examined outside the crisis period, while during the crisis period the sign of this relationship became positive and the null hypothesis of equal coefficients across the two periods is rejected. Finally, in line with the benchmark results, there is no evidence that the most constrained portfolios' returns were more responsive to unexpected rate changes relative the least constrained ones, except when the tangible-to-total assets ratio and KZ-index are used as proxies.

Another potential concern for the documented relationships is the impact of outliers, because as Figure 1 shows, large unexpected shocks were extracted on various MPC meeting days. To address this issue, we follow Basistha and Kurov (2008) and Kurov (2010), employing the robust MM weighted least squares procedure introduced by Yohai (1987). This estimation procedure yields robust regression coefficients by minimizing the empirical influence of troublesome residuals. Using this procedure, we re-estimate regression model (5). Unreported results, which are readily available upon request, confirm the reversal of the relationship between returns and interest rate shocks during the crisis period, in accordance to the benchmark results reported in Table 5. Actually, using this procedure the coefficients of the relationship during the crisis period are now larger and more significant relative to the benchmark results.

4.2. Interaction terms to examine state dependence

Section 3.2 examined whether the interest rate shocks- portfolio returns relationship exhibits state dependence using a dummy variable approach. For robustness, in this Section we use the state proxy variables as interaction terms and, following Jansen and Tsai (2010), we examine how the coefficient of the relationship changes with different values of the state proxy. In particular, we interact the anticipated and unanticipated interest rate change with each of the credit, volatility and market liquidity state variables alternatively, leading to the following general model specification:

$$\begin{aligned} r_{p,m,d} = {} & \alpha + \beta_1^u (1-D^{Crisis})\Delta i_d^u + \beta_2^u (1-D^{Crisis}) S_d \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + \\ & \beta_1^e (1-D^{Crisis})\Delta i_d^e + \beta_2^e (1-D^{Crisis}) S_d \Delta i_d^e + \beta_3^e D^{Crisis} \Delta i_d^e + \gamma' X_d + \varepsilon_d \end{aligned} \tag{10}$$

where S_d denotes, alternatively, the value of the default yield spread, FTSE 100 implied volatility index and RtoV price impact ratio of FTSE All Share on MPC meeting day *d*. It should be noted that for the state variables to be used as interaction terms and to have a meaningful interpretation, each of them has been standardized using the average and standard deviation of its full sample daily values.

-Table 11 here-

Since our benchmark results showed that credit conditions significantly affect the interest rate shocks- portfolio returns relationship, we report in Table 11 the estimated coefficients for the unanticipated interest rates changes from regression model (10), using the standardized default yield spread as an interaction term. The coefficient of the interaction term is estimated to be negative for almost all of the cases we examine, confirming our conjecture that the higher the default yield spread is, and hence the tighter the credit conditions are, the more negative the relationship between returns and interest rate shocks becomes outside the crisis period. However, despite the magnitude of the estimated coefficients, the corresponding standard errors are very large, preventing them from being statistically significant at any conventional level.

With respect to the remaining state variables, we find that adding implied volatility as an interaction term in model (10) does not have any particular economic or statistical significance. On the other hand, using our standardized liquidity measure as an interaction term, we find that in line with our benchmark results, the magnitude of the inverse relationship between interest rate shocks and portfolio returns increases considerably as the market becomes more illiquid. However, in most of the cases this effect is too noisy, failing to yield statistical significance. These unreported results are available upon request.

4.3. Alternative proxies for state dependence

In this section, we examine the robustness of our benchmark results in Section 3.2 with respect to the dependence of the shocks- returns relationship on the market phase and market liquidity conditions by using a different approach to determine a bull market phase and a modified price impact ratio to proxy liquidity. In particular, we re-estimate model (6), but now the bull market dummy takes the value 1 if the level of FTSE All Share index is higher than its past 500-day moving average and zero otherwise. Moreover, we use the Return-to-Turnover Rate (RtoTR) price impact ratio for FTSE All Share, which is a modification of the RtoV price impact ratio and it is calculated as the 90-day average ratio of absolute FTSE All Shares daily returns to the corresponding turnover rate of the same day. Using this alternative proxy, we re-estimate model (9) where now the liquidity dummy takes the value 1 when RtoTR on MPC meeting day d is higher than its sample average value, indicating an illiquid market state, and zero otherwise. Overall, the results from these robustness checks are qualitatively very similar to the benchmark results reported in Tables 6 and 9, respectively, and they are readily available upon request.

4.4. LIBOR-BoE base rate spread changes

In this section, we examine how the returns of the financial constraints-sorted portfolios respond to an alternative shock on MPC meeting days, namely the change in the spread between LIBOR and BoE base rate. This spread is equivalent to the LIBOR-OIS spread that is commonly used in US studies (see Thornton, 2009, for an introduction) and it serves as a proxy for funding conditions in the interbank market. Increases in LIBOR-BoE rate spread indicate an increase in the relative cost of funding for financial intermediaries, which eventually leads to an increase in firms' cost of financing through the bank lending transmission mechanism. To examine the response of portfolio returns to changes in this spread on MPC meeting days, we estimate the following regression model:

$$r_{p,m,d} = \alpha + \beta^{spread}\Delta(LIBOR - BoE\ rate)_d + \gamma' X_d + \varepsilon_d \tag{11}$$

where $\Delta(LIBOR - BoE\ rate)_d$ denotes the (daily) change in this spread on MPC meeting day *d*. This model does not include a dummy variable for the crisis period, exactly because this spread was large and exhibited considerable fluctuations mainly during the 2007-2009 crisis period, as Figure 2 shows. Therefore, the crisis effect is inherently taken into account by the behavior of the spread. The estimated coefficients are reported in Table 12.

-Table 12 here-

We find that for almost all of the portfolios we examined, there is an inverse relationship between returns and changes in the LIBOR-BoE rate spread. This negative relationship is statistically significant at the 5% level for half of the cases we report. Regarding the economic significance of the relationship, we find that an increase of 25 basis points in the spread on an MPC meeting day would be associated, for example, with a -0.38% drop in FTSE All Share Index as well as a negative return of -0.80% and -0.47% for the most constrained quintile portfolios according to cash holdings-to-total assets and interest coverage ratios, respectively. These results show that the deterioration of funding conditions for financial intermediaries has a considerable impact on UK stock returns. We also find that this negative impact is stronger for the most financially constrained firms relative to the least constrained ones only when total debt-to-market value, cash holdings-to-total assets and interest coverage ratios are used as proxies, but this differential is significant only for the first two cases. Finally, these results also reveal the large degree of heterogeneity in the response of portfolio returns to changes in the LIBOR-BoE rate spread across the various constraints proxies.

5. The impact of alternative economic shocks

5.1. Interest rate shocks on non-MPC meeting dates

Complementing our benchmark results, this section examines how stock returns respond to daily interest rate shocks on days other than the MPC meeting dates. These interest rate shocks cannot be interpreted as monetary policy shocks because they may have been caused by other macroeconomic news or government policies that may not be necessarily related to monetary policy. To this end, we compute the stock returns of financial constraints-sorted portfolios as well as the expected and unexpected LIBOR changes, computed from LIBOR futures prices, as described in Section 2.1, *on every single trading day* during our sample period. Subsequently, excluding the MPC meeting dates, we regress the daily returns of each portfolio *p* on the corresponding expected and unexpected daily interest rate changes using the model specification (4). The corresponding results are reported in Table 13.

-Table 13 here-

In sum, we find that daily interest rate shocks on non-MPC meeting days do not have a significant contemporaneous impact on stock market returns. This is also true when we examine the impact of daily interest rate shocks on stock returns in the cross-section of portfolios constructed on the basis of firms' degree of financial constraints. Most importantly for our main hypothesis, for almost all of the proxies used, we find no evidence that daily interest rate shocks on non-MPC meeting days have a significantly different impact on the returns of the portfolios containing the most constrained firms as compared to the portfolios containing the least constrained firms. Finally, it should be mentioned that this evidence provides indirect support for the argument that daily stock returns primarily respond to monetary policy shocks on MPC meeting days rather than to daily interest rates shocks in general.

5.2. Fed Funds rate shocks on FOMC meeting dates

The focus of our benchmark results is on UK monetary policy shocks because these are the most relevant ones for firms listed and operating primarily in the UK economy. In this section, we alternatively estimate the return response of financial constraints-sorted portfolios to US monetary policy shocks. This choice is motivated by the conjecture that US monetary policy shocks may affect stock prices internationally (see e.g., Wongswan, 2009) due to the dominant position of the US economy and the fact that other monetary authorities may follow closely the policies of the Federal Reserve.

To this end, we compute the expected and unexpected Fed Funds rate changes on the meeting days of the Federal Open Market Committee (FOMC) and the corresponding daily returns of the financial constraints-sorted portfolios. To compute the expected and unexpected Fed Funds rate changes, we follow the standard approach of Kuttner (2001), which has been extensively used in the literature (see e.g., Bernanke and Kuttner, 2005, Piazzesi and Swanson, 2008, and Bredin et al., 2007) and utilizes the futures contract written on the Fed Funds rate, which is sourced from Thomson Datastream. Moreover, following Bredin et al. (2007) and Wongswan (2009), we utilize the daily portfolio returns on the trading day following the FOMC meeting, since the London Stock Exchange has already closed before the FOMC meeting. We regress the daily returns of each portfolio *p* on the corresponding expected and unexpected Fed Funds rate changes on FOMC meeting days using the model specification (5). The corresponding results are reported in Table 14.

-Table 14 here-

In sum, we find that the UK stock market does not significantly respond to US monetary policy shocks during our sample period, even when we account for the potential structural break in the relationship during the global crisis period. Similarly, we do not find any significant return response to these monetary policy shocks when we examine the cross-section of financial constraints-sorted portfolios. As a result, for almost all of the proxies used, we find no evidence that US monetary policy shocks have a significantly different impact on the returns of the portfolios containing the most constrained firms as compared to the portfolios containing the least constrained firms.

5.3. Shocks from a macro-VAR model

In this subsection, we examine the impact of macroeconomic shocks on the stock returns of financial constraints-sorted portfolios. In particular, we examine the impact of industrial production growth, inflation rate and interest rate shocks on stock portfolio returns at the monthly frequency. To this end, we compute monthly returns for the financial constraints-sorted quintile portfolios. To estimate the impact of these shocks, we utilize a simple macro-VAR system for the UK, similar to the one employed by Kontonikas and Kostakis (2013) for the US.[21]

The endogenous variables vector is $\mathbf{y}_t = [ipn_t, inf_t, libor_t, r_{jt}]'$ where ipn_t is the growth rate of industrial production, inf_t is the inflation rate computed as the growth rate of consumer

[21] The rationale behind the use of a simple macro-VAR framework is to provide results that are directly comparable to previous UK evidence. We acknowledge that an obvious extension of our work is to identify the monetary policy shocks using modern estimation techniques such as the Bayesian Structural Vector Auto-Regression and the Sign-Restrictions VAR. For example, Mallick and Sousa (2013) use these techniques to examine the real effects of financial stress in the Eurozone.

price index (*cpi*), $libor_t$ is the UK 1-month interbank rate and r_{jt} is the monthly return on stock portfolio *j*. The macroeconomic variables have been sourced from Thomson Datastream. Based on the Akaike Information Criterion, the lag order of the estimated VAR is two and a constant is also included. Since it is well-known that the resulting impulse response functions depend upon the ordering of the variables in the VAR (see e.g. Lutkepohl, 2005), our results utilize the Generalized Impulse Response function of Pesaran and Shin (1998), which is invariant to the ordering of the variables in the VAR.

Table 15 presents the contemporaneous generalized impulse return response of the quintile portfolios with the most and the least financially constrained firms, as well as the corresponding response of their spread return, to a one-standard deviation shock to monthly interest rate. Results are reported for the quintile portfolios constructed on the basis of the Kaplan-Zingales (KZ) and Whited-Wu (WW) indices of financial constraints. Results for the other proxies are available upon request.

-Table 15 here-

Figures 4-6 present the multi-period generalized impulse return responses of the quintile portfolios containing the most and the least financially constrained firms to one-standard deviation shocks to monthly interest rate, industrial production growth and inflation rate, respectively. Again, results are reported for the quintile portfolios constructed on the basis of the Kaplan-Zingales (KZ) and Whited-Wu (WW) indices of financial constraints. Results for the other proxies are available upon request.

-Figures 4-6 here-

The main results from this macro-VAR analysis can be synopsized as follows. First, there is no evidence that, even at the monthly frequency, interest rate shocks have a significantly different contemporaneous impact on the stock returns of the quintile portfolio containing the most constrained firms relative to the quintile portfolio containing the least constrained firms. If anything, it is the portfolio with the least constrained firms that exhibits the most negative contemporaneous return response to an adverse interest rate shock. Second, only the contemporaneous return response to an interest rate shock is significant; the impact of this shock on portfolio returns dies out quickly and remains insignificant beyond the first month. Third, a positive shock to industrial production growth causes a positive portfolio return response that seems to persist in the subsequent month too, but again there is no significantly different impact between the portfolios containing the most and the least constrained firms. Finally, these portfolio returns do not significantly respond to an inflation rate shock.

In sum, the evidence from the macro-VAR model estimated at the monthly frequency supports the main conclusions of our benchmark results. Financial constraints-sorted portfolio returns do respond to interest rate shocks, but this response is not significantly different between the portfolios of the most and the least constrained firms.

6. Conclusions

This study examines, for the first time in the literature, the return response of the most and the least constrained firms listed on LSE, as classified according to a series of financial constraints proxies, to monetary policy shocks during the period June 1999- December 2011. Following Bredin et al. (2007) and Bredin et al. (2009), these shocks are extracted on BoE MPC meeting days, relative to expectations embedded in LIBOR futures prices. Using a large number of constraints proxies to provide comprehensive evidence, we derive a series of interesting conclusions.

Firstly, we find no significant evidence that the return response of the most constrained firms is of greater magnitude relative to corresponding response of the least constrained firms, apart from some cases where the tangible-to-total assets ratio and KZ-index are used as proxies. The opposite is actually true for most of the measures we use. This evidence is at odds with the implication of the credit channel of the monetary policy transmission mechanism and the limited existing evidence for the US market (see Ehrmann and Fratzscher, 2004, Basistha and Kurov, 2008 and Jansen and Tsai, 2010). The primary explanation we put forward for this finding is that investors on LSE do not regard the interaction between financial constraints and monetary conditions to be an important source of risk, especially at very short horizons, and hence they do not differentiate across listed firms on the basis of their constraints when reacting to monetary policy shocks.

Secondly, these results also highlight the large degree of heterogeneity in the return response across the proxies we use, revealing that they capture different aspects of the elusive concept of financial constraints. Therefore, relying only on a subset of these measures to derive strong conclusions regarding the effect of financial constraints on the interest rate shocks- stock returns relationship would be rather misleading. Thirdly, our results show that the inverse relationship between monetary policy shocks and stock returns that is documented outside the 2007-2009 crisis period became positive during the crisis. This is true both for the market index and for the majority of the portfolios containing the most and the least constrained firms listed on LSE. This finding remains intact when we use the UK recession period of September 2008- August 2009 to define an alternative, narrower crisis period.

Finally, the reported results reveal that the relationship between stock returns and monetary policy shocks in the UK market exhibits state dependence. In particular, we find that excluding the crisis period, this inverse relationship is of greater magnitude during bull market phases, tight credit conditions, high market volatility and illiquidity periods. However, this differential magnitude is statistically significant only in the case of tight credit conditions.

Our results have direct implications for regulators, investors and corporate financial decision-makers. With respect to regulators and central bankers, we show that the Bank of England can affect stock market valuations via monetary policy shocks and we examine whether this effect may differ across firms with different degrees of financial constraints. Moreover, we show that this impact is not stable across time. These findings are also very important for investors who construct portfolios of stocks with different capital structure and cash flow characteristics because this differential exposure to monetary policy shocks could affect the degree of portfolio diversification and it could inform their risk assessment practices and risk management strategies. Finally, the documented exposure to monetary policy risk has implications for the cost of capital that companies with different degrees of financial constraints face. As a result, this finding could inform the practices of financial decision-makers in their attempt to determine the cost of capital of their corporations, a variable that plays a central role in every aspect of corporate financial management.

References

Amihud, Y. (2002), 'Illiquidity and stock returns: Cross-section and time-series effects', Journal of Financial Markets, Vol. 5, pp. 31-56.

Basistha, A. and Kurov, A. (2008), 'Macroeconomic cycles and the stock market's reactions to monetary policy', Journal of Banking and Finance, Vol. 32, pp. 2606-2616.

Bernanke, B.S. and Blinder, A.S. (1992), 'The Federal funds rate and the channels of monetary transmission', American Economic Review, Vol. 82, pp. 901-921.

Bernanke, B.S. and Gertler, M. (1989), 'Agency costs, net worth and business fluctuations', American Economic Review, Vol. 79, pp. 14-31.

Bernanke, B.S. and Gertler, M. (1995), 'Inside the Black box: The credit channel of monetary policy transmission', Journal of Economic Perspectives, Vol. 9, pp. 27-48.

Bernanke, B.S., Gertler, M. and Gilchrist, S. (1996), 'The financial accelerator and the flight to quality', Review of Economics and Statistics, Vol. 78, pp. 1-15.

Bernanke, B.S. and Kuttner, K.N. (2005), 'What explains the stock market's reaction to Federal Reserve Policy?', Journal of Finance, Vol. 60, pp. 1221-1257.

Bredin, D., Hyde, S. and O'Reilly, G. (2010), 'Monetary policy surprises and international bond markets', Journal of International Money and Finance, Vol. 29, pp. 988-1002.

Bredin, D., Hyde, S., Nitzsche, D. and O'Reilly, G. (2007), 'UK stock returns and the impact of domestic monetary policy shocks', Journal of Business, Finance and Accounting, Vol. 34, pp. 872-888.

Bredin, D., Hyde, S., Nitzsche, D. and O'Reilly, G. (2009), 'European monetary policy surprises: the aggregate and sectoral stock market response', International Journal of Finance and Economics, Vol. 14, pp. 156-171.

Brook, M., Cooper, N. and Scholtes, C. (2000), 'Inferring market interest rate expectations from money market rates', Bank of England Quarterly Review, November, pp. 392-402.

Brunnermeier, M. (2009), 'Deciphering the Liquidity and Credit Crunch 2007-08', Journal of Economic Perspectives, Vol. 23, pp. 77-100.

Dua, P., D. Tuteja (2016), 'Financial crises and dynamic linkages across international stock and currency markets', Economic Modelling, Volume 59, 249-261.

Ehrmann, M. and Fratzscher, M. (2004), 'Taking Stock: Monetary Policy Transmission to Equity Markets', Journal of Money, Credit and Banking, Vol. 36, pp. 719-737.

Fazzari, S.M., Hubbard, G.R. and Petersen, B.C. (1988), 'Financing constraints and corporate investment', Brooking Papers in Economic Activity, Vol. 1, pp. 141-195.

Florackis, C., Kontonikas, A. and Kostakis, K. (2014), 'Stock Market Liquidity and Macro-Liquidity Shocks: Evidence from the 2007-2009 Financial Crisis', Journal of International Money and Finance, Vol. 44, pp. 97-117.

Gertler, M. and Gilchrist, S. (1994), 'Monetary policy, business cycles, and the behavior of small manufacturing firms', Quarterly Journal of Economics, Vol. 109, pp. 309-340.

Gregoriou, A., Kontonikas, A., MacDonald, R. and Montagnoli, A. (2009), 'Monetary policy shocks and stock returns: Evidence from the British market', Financial Markets and Portfolio Management, Vol. 23, pp. 401-410.

Guariglia, A. (2008), 'Internal financial constraints, external financial constraints and investment choice: Evidence from a panel of UK firms', Journal of Banking and Finance, Vol. 32, pp. 1795-1809.

Guariglia, A. and Mateut, S. (2006), 'Credit channel, trade credit channel, and inventory investment: Evidence from a panel of UK firms', Journal of Banking and Finance, Vol. 30, pp. 2835-2856.

Guo, H. (2004), 'Stock prices, firm size, and changes in the federal funds rate target', Quarterly Review of Economics and Finance, Vol. 44, pp. 487-507.

Hahn, J. and Lee, H. (2009), 'Financial constraints, debt capacity, and the cross-section of stock returns', Journal of Finance, Vol. 64, pp. 891-921.

Han, L., Y. Xu, L. Yin (2018), 'Does investor attention matter? The attention return relationships in FX markets', Economic Modelling, Economic Modelling 68 (2018) 644–660.

Hubbard, G. (1998), 'Capital market imperfections and investment', Journal of Economic Literature, Vol. 35, pp. 193-225.

Jansen, D.W. and Tsai, C.L. (2010), 'Monetary policy and stock returns: Financing constraints and asymmetries in bull and bear markets', Journal of Empirical Finance, Vol. 17, pp. 981-990.

Jeenas, P. (2018), 'Monetary Policy Shocks, Financial Structure, and Firm Activity: A Panel Approach', New York University, Working Paper.

Jensen, G.R. and Johnson, R.R. (1995), 'Discount rate changes and security returns in the US, 1962-1991', Journal of Banking and Finance, Vol. 19, pp. 79-95.

Jensen, G.R., Johnson, R.R. and Bauman W.S. (1997), 'Federal Reserve Monetary Policy and Industry Stock returns', Journal of Business Finance and Accounting, Vol. 24, pp. 629-644.

Joyce, M., Lasaosa, A., Stevens, I. and Tong, M. (2010), 'The financial market impact of quantitative easing', Bank of England Working Paper, No. 393.

Joyce, M., Relleen, J. and Sorensen, S. (2008), 'Measuring monetary policy expectations from financial market instruments', Bank of England Working Paper, No. 356.

Kaplan, S.N. and Zingales, L. (1997), 'Do financing constraints explain why investment is correlated with cash flow?', Quarterly Journal of Economics, Vol. 112, pp. 168-216.

Kashyap, A.K., Lamont, O.A. and Stein, J.C. (1994), 'Credit conditions and the cyclical behavior of inventories', Quarterly Journal of Economics, Vol. 109, pp. 565–592.

Kontonikas, A. and Kostakis, A. (2013), 'On monetary policy and stock market anomalies', Journal of Business Finance and Accounting, Vol. 40, pp. 1009-1042.

Kurov, A. (2010), 'Investor sentiment and the stock market's reaction to monetary policy', Journal of Banking and Finance, Vol. 34, pp. 139-149.

Kuttner, K.N. (2001), 'Monetary policy surprises and interest rates: Evidence from the Fed funds futures market', Journal of Monetary Economics, Vol. 47, pp. 523-544.

Lamont, O., Polk, C. and Saa-Requejo, J. (2001), 'Financial constraint and stock returns', Review of Financial Studies, Vol. 14, pp. 529-554.

Lildholdt, P. and Wetherilt, A. (2004), 'Anticipation of monetary policy in UK financial markets', Bank of England Working Paper, No. 241.

Lutkepohl, H., (2005), 'New introduction to multiple time series' Springer, New York, NY.

Mallick, S., Mohanty, M.S. and Zampolli, F. (2017), 'Market volatility, monetary policy and the term premium'. BIS Working Papers No. 606.

Mallick, S.K., and Sousa, R.M. (2013) 'The real effects of financial stress in the Eurozone', International Review of Financial Analysis, 30: 1-17.

Martin, C. and Milas, C. (2012), 'Quantitative Easing: A sceptical survey', Oxford Review of Economic Policy, Vol. 28, pp. 750-764.

Nyborg, K.G. and Ostberg, P. (2010), 'Money and Liquidity in Financial Markets', CEPR Discussion Papers, 7905.

Perez-Quiros, G. and Timmermann, A. (2000), 'Firm Size and Cyclical Variations in Stock Returns', Journal of Finance, Vol. 55, pp. 1229–1262.

Pesaran, M.H., Shin, Y., (1998), 'Generalised impulse response analysis in linear multivariate models' Economics Letters 58, 17-29.

Piazzesi, M. and Swanson, E. (2008), 'Futures prices as risk-adjusted forecasts of monetary policy', Journal of Monetary Economics, Vol. 55, pp. 677–691.

Rigobon, R. and Sack, B. (2003), 'Measuring the reaction of monetary policy to the stock market', Quarterly Journal of Economics, Vol. 118, pp. 639-669.

Rigobon, R. and Sack, B. (2004), 'The impact of monetary policy on asset prices', Journal of Monetary Economics, Vol. 51, pp. 1553-1575.

Sellin, P. (2001), 'Monetary policy and the stock market: Theory and empirical evidence', Journal of Economic Surveys, Vol. 15, pp. 491-541.

Shin, H.Y. (2009), 'Reflections on Northern Rock: The Bank Run that Heralded the Global Financial Crisis', Journal of Economic Perspectives, Vol. 23, pp. 101-119.

Smirlock, M. and Yawitz, J. (1985), 'Asset returns, discount rate changes and market efficiency', Journal of Finance, Vol. 40, pp. 1141-1158.

Soares, N. and Stark, A.W. (2009), 'The accruals anomaly- can implementable portfolio strategies be developed that are profitable net of transaction costs in the UK?', Accounting and Business Research, Vol. 39, pp. 321-245.

Thorbecke, W. (1997), 'On stock market returns and monetary policy', Journal of Finance, Vol. 52, pp. 635–654.

Thornton, D.L. (2009), 'What the LIBOR-OIS spread says', Economic Synopses, Federal Bank of St. Louis, Vol. 24, pp. 1-2.

Whaley, R.E. (2000), 'The investor fear gauge', Journal of Portfolio Management, Vol. 26, pp. 12-17.

Whited, T.M. and Wu, G. (2006), 'Financial constraints risk', Review of Financial Studies, Vol. 19, pp. 531-559.

Wongswan, J. (2009), 'The response of global equity indexes to U.S. monetary policy announcements', Journal of International Money and Finance, Vol. 28, pp. 344-365.

Yohai, V.J. (1987), 'High breakdown-point and high efficiency robust estimates for regression', The Annals of Statistics, Vol. 15, pp. 642-656.

Table 1
Definitions of financial constraints proxies

This Table contains the definitions of eight financial constraints proxies used to classify all of the non-financial firms listed on LSE into quintile portfolios as well as the Datastream and Worldscope data items used to calculate them.

Financial constraints measure	Definition	Data Items used
1. Total Assets	$\text{Book Value of Total Assets}_t$	Worldscope item: WC02999
2. Tangible-to-Total Assets ratio	$\dfrac{\text{Tangible Assets}_t}{\text{Total Assets}_t}$	Worldscope item: WC02501
3. Total Debt-to-Common Equity ratio	$\dfrac{\text{Total Debt}_t}{\text{Book Value of Common Equity}_t}$	Worldscope item: WC08231
4. Total Debt-to-Market Value ratio	$\dfrac{\text{Total Debt}_t}{\text{Market Value}_t}$	Worldscope item: WC03255 and MV
5. Cash holdings-to-Total Assets ratio	$\dfrac{\text{Cash Holdings}_t}{\text{Total Assets}_t}$	Worldscope item: WC02001 and WC02999
6. Interest Coverage ratio	$\dfrac{\text{EBIT}_t}{\text{Total Interest Expense ratio}_t}$	Worldscope item: WC08291
7. Kaplan-Zingales (KZ) index	$\text{KZ}_t = -1.002 \times \dfrac{\text{Cash Flow}_t}{\text{Prop, Plant and Equip}_{t-1}}$ $+0.283 \times \text{Tobin's Q}_t$ $+3.139 \times \dfrac{\text{Total Debt}_t}{\text{Total Capital}_t}$ $-39.368 \times \dfrac{\text{Dividends Paid}_t}{\text{Prop, Plant and Equip}_{t-1}}$ $-1.315 \times \dfrac{\text{Cash Holdings}_t}{\text{Prop, Plant and Equip}_{t-1}}$	Worldscope item: WC01250, WC01151, WC02501, WC02999, WC03501, WC03451, MV, WC03255, WC03998, WC04551 and WC02001
8. Whited-Wu (WW) index	$\text{WW}_t = -0.091 \times \dfrac{\text{Cash Flow}_t}{\text{Total Assets}_t}$ $-0.062 \times \text{Dividend dummy}_t$ $+0.021 \times \dfrac{\text{Long-term Debt}_t}{\text{Total Assets}_t}$ $-0.044 \times \ln(\text{Total Assets}_t)$ $+0.102 \times \text{Industry Sales Growth}_t$ $-0.035 \times \text{Firm Sales Growth}_t$	Worldscope item: WC01250, WC01151, WC02999, WC04551, WC03251, WC01001 and FTAG3 for industry classification

Table 2
Descriptive statistics

Panel A reports the descriptive statistics for the value-weighted daily returns of quintile portfolios with the most constrained firms on BoE MPC meeting days during the period June 1999- December 2011 (152 meetings). Panel B reports the corresponding descriptive statistics for the value-weighted daily returns of the quintile portfolios with the least constrained firms, zero leverage firms and FTSE All Share Index. All of the non-financial firms listed on LSE have been classified into quintile portfolios prior to the MPC meeting day using each of the eight financial constraints proxies defined in Table 1. Panel C contains the corresponding descriptive statistics for expected and unexpected interest rate changes and the values of default yield spread, LIBOR-BoE base rate spread, FTSE 100 Implied Volatility Index and Return-to-Volume (RtoV) price impact ratio for FTSE All Share Index on MPC meetings.

Panel A: Most constrained quintile portfolios

Financial constraints proxy	Mean	Median	Max	Min	St. Dev.
1. Total Assets	0.03%	0.02%	9.51%	-6.27%	1.16%
2. Tangible-to-Total Assets ratio	0.06%	-0.02%	7.20%	-5.39%	1.64%
3. Total Debt-to-Common Equity ratio	-0.17%	0.01%	3.69%	-5.30%	1.19%
4. Total Debt-to-Market Value ratio	-0.08%	0.05%	4.88%	-5.88%	1.37%
5. Cash holdings-to-Total Assets ratio	0.10%	0.05%	6.91%	-7.80%	1.82%
6. Interest Coverage ratio	-0.26%	-0.04%	4.87%	-5.61%	1.39%
7. Kaplan-Zingales (KZ) index	-0.12%	-0.03%	6.74%	-5.69%	1.68%
8. Whited-Wu (WW) index	0.03%	0.01%	10.92%	-5.37%	1.37%

Panel B: Least constrained quintile portfolios, zero leverage portfolios and FTSE All Share

Financial constraints proxy	Mean	Median	Max	Min	St. Dev.
1. Total Assets	-0.10%	-0.09%	4.47%	-5.61%	1.27%
2. Tangible-to-Total Assets ratio	-0.11%	-0.09%	4.45%	-6.77%	1.46%
3. Total Debt-to-Common Equity ratio	0.09%	0.07%	7.45%	-6.88%	1.66%
4. Total Debt-to-Market Value ratio	-0.06%	-0.04%	9.19%	-5.37%	1.64%
5. Cash holdings-to-Total Assets ratio	0.04%	-0.02%	7.93%	-6.64%	1.88%
6. Interest Coverage ratio	-0.12%	-0.08%	5.77%	-6.58%	1.57%
7. Kaplan-Zingales (KZ) index	-0.21%	-0.15%	4.52%	-4.47%	1.28%
8. Whited-Wu (WW) index	-0.10%	-0.09%	4.46%	-5.61%	1.27%
Zero Debt-to-Common Equity ratio	-0.07%	0.01%	9.15%	-5.53%	1.82%
Zero Debt-to-Market Value ratio	-0.06%	0.01%	9.15%	-5.53%	1.81%
FTSE All Share	-0.12%	-0.10%	5.15%	-5.38%	1.31%

Panel C: Interest rate changes and variables for state dependence

	Mean	Median	Max	Min	St. Dev.
Unexpected rate changes	-0.005%	0%	0.26%	-0.40%	0.07%
Expected rate changes	-0.001%	0%	0.23%	-0.39%	0.07%
Default yield spread	1.72%	1.40%	6.11%	0.83%	1.02%
LIBOR-BoE base rate	0.26%	0.17%	2.40%	-0.50%	0.39%
FTSE 100 Implied Volatility	21.61	19.41	56.81	9.50	9.19
RtoV Price impact ratio	1.84	1.76	4.98	0.49	1.02

Table 3
Correlation coefficients

Panel A reports the pairwise correlation coefficients between the value-weighted daily returns of quintile portfolios of the most constrained firms as well as of FTSE All Share Index on BoE MPC meeting days during the period June 1999- December 2011 (152 meetings). Panel B contains the corresponding correlation coefficients between the value-weighted daily returns of quintile portfolios of the least constrained firms as well as of FTSE All Share Index. All of the non-financial firms listed on LSE have been classified into quintile portfolios prior to the MPC meeting day using each of the eight financial constraints proxies defined in Table 1.

Panel A: Correlation coefficients for the most constrained quintile portfolios and FTSE All Share

Financial constraints proxy	1	2	3	4	5	6	7	8	FTSE
1. Total Assets	1								
2. Tangible-to-Total Assets ratio	0.67	1							
3. Total Debt-to-Common Equity ratio	0.34	0.60	1						
4. Total Debt-to-Market Value ratio	0.43	0.63	0.81	1					
5. Cash holdings-to-Total Assets ratio	0.46	0.70	0.72	0.72	1				
6. Interest Coverage ratio	0.42	0.60	0.83	0.84	0.61	1			
7. Kaplan-Zingales (KZ) index	0.47	0.70	0.80	0.77	0.66	0.78	1		
8. Whited-Wu (WW) index	0.89	0.70	0.42	0.48	0.51	0.47	0.54	1	
FTSE All Share	0.44	0.76	0.86	0.83	0.83	0.80	0.83	0.50	1

Panel B: Correlation coefficients for the least constrained quintile portfolios and FTSE All Share

Financial constraints proxy	1	2	3	4	5	6	7	8	FTSE
1. Total Assets	1								
2. Tangible-to-Total Assets ratio	0.92	1							
3. Total Debt-to-Common Equity ratio	0.78	0.69	1						
4. Total Debt-to-Market Value ratio	0.74	0.60	0.81	1					
5. Cash holdings-to-Total Assets ratio	0.82	0.72	0.83	0.91	1				
6. Interest Coverage ratio	0.85	0.77	0.76	0.73	0.79	1			
7. Kaplan-Zingales (KZ) index	0.82	0.66	0.71	0.76	0.76	0.80	1		
8. Whited-Wu (WW) index	1.00	0.92	0.78	0.75	0.83	0.86	0.83	1	
FTSE All Share	0.97	0.89	0.77	0.75	0.82	0.82	0.81	0.97	1

Table 4

Returns response to interest rate changes without accounting for crisis effect

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (4): $r_{p,m,d} = \alpha + \beta^u \Delta i_d^u + \beta^e \Delta i_d^e + \gamma' X_d + \varepsilon_d$. Firms listed on LSE have been classified into quintile portfolios prior to the MPC meeting day using each of the eight financial constraints proxies defined in Table 1. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β^u	β^e	R^2 adj.
1. Total Assets	Most constrained	-2.42	-0.35	1.17%
	Least constrained	-1.98	-2.24	18.05%
	Most-Least spread	-0.44	1.89	8.59%
2. Tangible-to-Total Assets	Most constrained	-9.09**	-5.38	7.13%
	Least constrained	0.75	-1.26	18.06%
	Most-Least spread	-9.83***	-4.12	9.90%
3. Total Debt-to- Common Equity	Most constrained	-2.05	-1.17	18.87%
	Least constrained	-4.88	-3.35	11.85%
	Zero Leverage	-8.71**	-6.07	14.59%
	Most-Least spread	2.83	2.19	-2.22%
4. Total Debt-to-Market Value	Most constrained	0.57	2.23	16.44%
	Least constrained	-6.40**	-4.81**	12.51%
	Zero Leverage	-8.88**	-6.16	15.03%
	Most-Least spread	6.97**	7.04	4.36%
5. Cash holdings-to-Total Assets	Most constrained	-0.03	0.36	7.09%
	Least constrained	-6.92	-4.11	18.16%
	Most-Least spread	6.89**	4.47*	2.95%
6. Interest Coverage ratio	Most constrained	-0.21	0.61	18.73%
	Least constrained	-2.87	-2.22	16.41%
	Most-Least spread	2.65	2.83	-1.58%
7. Kaplan-Zingales index	Most constrained	-5.72	-3.41	12.59%
	Least constrained	-4.24	-2.57	13.59%
	Most-Least spread	-1.48	-0.84	-0.25%
8. Whited-Wu index	Most constrained	-4.20**	-1.70	2.13%
	Least constrained	-1.93	-2.16	17.73%
	Most-Least spread	-2.27	0.46	4.53%
	FTSE All Share	-2.33	-2.14	16.19%

Table 5

Returns response to unexpected interest rate changes accounting for crisis effect

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (5): $r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis}) \Delta i_d^u + \beta_2^u D^{Crisis} \Delta i_d^u + \beta_1^e (1 - D^{Crisis}) \Delta i_d^e + \beta_2^e D^{Crisis} \Delta i_d^e + \gamma ' X_d + \varepsilon_d$, where D^{Crisis} takes the value 1 on MPC meetings from August 2007 to December 2009. p-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes outside and during the crisis period are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	-3.17	-1.48	[0.67]	0.14%
	Least constrained	-8.52***	11.35***	[0.00]	24.20%
	Most-Least spread	5.35*	-12.83***		13.19%
2. Tangible-to-Total Assets	Most constrained	-14.72***	3.82	[0.00]	9.82%
	Least constrained	-6.67**	15.75***	[0.00]	23.94%
	Most-Least spread	-8.05**	-11.93***		10.12%
3. Total Debt-to- Common Equity	Most constrained	-7.22**	8.36**	[0.00]	22.88%
	Least constrained	-14.41***	14.84***	[0.00]	19.67%
	Zero Leverage	-14.45***	4.68	[0.00]	17.00%
	Most-Least spread	7.20**	-6.48		-0.43%
4. Total Debt-to-Market Value	Most constrained	-6.31**	14.97***	[0.00]	22.90%
	Least constrained	-10.06***	-0.88	[0.11]	14.36%
	Zero Leverage	-14.63***	4.54	[0.00]	17.48%
	Most-Least spread	3.75	15.86***		8.27%
5. Cash holdings-to-Total Assets	Most constrained	-11.12***	23.31***	[0.00]	16.17%
	Least constrained	-16.18***	12.39***	[0.00]	23.70%
	Most-Least spread	5.07	10.92***		2.13%
6. Interest Coverage ratio	Most constrained	-6.59**	12.73***	[0.00]	23.38%
	Least constrained	-8.59**	7.22	[0.00]	19.71%
	Most-Least spread	2.00	5.51*		-1.61%
7. Kaplan-Zingales index	Most constrained	-10.28**	3.83	[0.01]	13.43%
	Least constrained	-7.59**	2.82	[0.02]	14.30%
	Most-Least spread	-2.69	1.01		-1.24%
8. Whited-Wu index	Most constrained	-4.71	-3.88*	[0.86]	1.05%
	Least constrained	-8.53***	11.43***	[0.00]	23.93%
	Most-Least spread	3.81	-15.31***		9.53%
	FTSE All Share	-9.25***	12.13***	[0.00]	22.78%

Table 6

Returns response to unexpected interest rate changes in bull and bear markets

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (6): $r_{p,m,d} = \alpha + \beta_1^u(1-D^{Crisis})(1-D^{Bull})\Delta i_d^u + \beta_2^u(1-D^{Crisis})D^{Bull}\Delta i_d^u + \beta_3^u D^{Crisis}\Delta i_d^u + ... + \varepsilon_d$ where D^{Crisis} takes the value 1 on MPC meetings from August 2007 to December 2009 and D^{Bull} takes the value 1 when FTSE All Share Index is in a bull phase and zero otherwise, using the bull market definition of Jansen and Tsai (2010). p-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes in bear and bull markets are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	β_3^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	1.37	-3.95	-1.47	[0.19]	-0.18%
	Least constrained	-1.87	-8.56**	11.28***	[0.22]	26.43%
	Most-Least spread	3.23	4.61	-12.75***		12.77%
2. Tangible-to-Total Assets	Most constrained	-12.46*	-12.51***	3.61	[0.99]	10.14%
	Least constrained	1.76	-8.26**	15.79***	[0.09]	25.12%
	Most-Least spread	-14.22	-4.25	-12.18***		9.82%
3. Total Debt-to-Common Equity	Most constrained	-0.59	-7.78**	8.33**	[0.23]	24.70%
	Least constrained	-13.05*	-11.64**	14.59***	[0.86]	20.20%
	Zero Leverage	-12.46***	-13.47**	4.58	[0.89]	16.30%
	Most-Least spread	12.47	3.86	-6.26		-0.98%
4. Total Debt-to-Market Value	Most constrained	-2.51	-6.17**	14.92***	[0.59]	22.94%
	Least constrained	-0.99	-11.09**	-0.90	[0.08]	16.29%
	Zero Leverage	-12.43***	-13.79**	4.45	[0.85]	16.78%
	Most-Least spread	-1.52	4.92*	15.82***		8.11%
5. Cash holdings-to-Total Assets	Most constrained	-0.13	-11.33***	23.21***	[0.10]	19.17%
	Least constrained	-15.21**	-13.17**	12.13***	[0.80]	23.96%
	Most-Least spread	15.08*	1.84	11.08***		3.21%
6. Interest Coverage ratio	Most constrained	1.62	-8.06**	12.76***	[0.22]	24.75%
	Least constrained	1.69	-9.75*	7.21	[0.06]	22.27%
	Most-Least spread	-0.07	1.69	5.56*		-2.55%
7. Kaplan-Zingales index	Most constrained	7.04	-14.80***	4.01	[0.00]	18.07%
	Least constrained	3.84	-10.19**	2.91	[0.00]	17.89%
	Most-Least spread	3.21	-4.61	1.10		-1.05%
8. Whited-Wu index	Most constrained	1.93	-6.64	-3.79*	[0.14]	0.85%
	Least constrained	-1.95	-8.39**	11.35***	[0.23]	26.31%
	Most-Least spread	3.87	1.76	-15.14***		9.22%
	FTSE All Share	-3.54	-8.63**	12.02***	[0.35]	24.82%

Table 7

Returns response to unexpected interest rate changes in tight and loose credit conditions

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (7): $r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis})(1 - D^{Credit})\Delta i_d^u + \beta_2^u (1 - D^{Crisis}) D^{Credit} \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + ... + \varepsilon_d$, where D^{Crisis} takes the value 1 on MPC meetings from August 2007 to December 2009 and D^{Credit} takes the value 1 when the default yield spread is higher than its full sample average daily value and zero otherwise. p-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes in loose and tight credit market conditions are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	β_3^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	-1.49	-22.99	-1.51	[0.26]	1.27%
	Least constrained	-7.11**	-24.24**	11.33***	[0.12]	24.69%
	Most-Least spread	5.62*	1.25	-12.85***		12.03%
2. Tangible-to-Total Assets	Most constrained	-10.71***	-69.68***	3.67	[0.00]	15.93%
	Least constrained	-6.47**	-9.64	15.74***	[0.82]	22.89%
	Most-Least spread	-4.24	-60.03***	-12.07***		17.85%
3. Total Debt-to-Common Equity	Most constrained	-6.53**	-12.50	8.37**	[0.50]	22.41%
	Least constrained	-10.16***	-75.16***	14.66***	[0.00]	27.00%
	Zero Leverage	-12.00***	-54.13*	4.54	[0.14]	18.74%
	Most-Least spread	3.63	62.65***	-6.29		9.30%
4. Total Debt-to-Market Value	Most constrained	-4.50	-25.74**	14.96***	[0.04]	24.25%
	Least constrained	-7.54**	-43.46***	-0.96	[0.02]	16.58%
	Zero Leverage	-12.28***	-53.70***	4.39	[0.14]	19.17%
	Most-Least spread	3.03	17.72**	15.92***		7.88%
5. Cash holdings-to-Total Assets	Most constrained	-8.49**	-41.18**	23.28***	[0.07]	17.56%
	Least constrained	-14.26***	-42.35*	12.32***	[0.23]	23.91%
	Most-Least spread	5.77	1.17	10.96***		1.44%
6. Interest Coverage ratio	Most constrained	-6.33**	-2.29	12.80***	[0.78]	23.22%
	Least constrained	-5.53	-46.41***	7.15	[0.00]	23.12%
	Most-Least spread	-0.79	44.12***	5.64**		3.66%
7. Kaplan-Zingales index	Most constrained	-7.14**	-48.63**	3.76	[0.06]	16.41%
	Least constrained	-5.49*	-29.06**	2.81	[0.11]	16.73%
	Most-Least spread	-1.65	-19.57**	0.95		-0.94%
8. Whited-Wu index	Most constrained	-2.80	-26.30	-3.90*	[0.27]	2.07%
	Least constrained	-7.03**	-25.08**	11.42***	[0.11]	24.59%
	Most-Least spread	4.23	-1.22	-15.32***		8.39%
	FTSE All Share	-7.55***	-27.12**	12.12***	[0.10]	23.92%

Table 8

Returns response to unexpected interest rate changes in high and low volatility conditions

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (8): $r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis})(1 - D^{Vol}) \Delta i_d^u + \beta_2^u (1 - D^{Crisis}) D^{Vol} \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + ... + \varepsilon_d$, where D^{Crisis} takes the value 1 on MPC meetings from August 2007 to December 2009 and D^{Vol} takes the value 1 when the FTSE 100 Implied Volatility Index is higher than its full sample average daily value and zero otherwise. p-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes in low and high market volatility conditions are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	β_3^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	-4.05***	-5.88	-1.76	[0.87]	-0.91%
	Least constrained	-6.35*	-12.63	11.36***	[0.48]	23.67%
	Most-Least spread	2.30	6.75	-13.12***		12.38%
2. Tangible-to-Total Assets	Most constrained	-11.99***	-25.02*	3.58	[0.38]	9.78%
	Least constrained	-5.86	-5.94	15.94***	[0.99]	23.76%
	Most-Least spread	-6.14**	-19.08	-12.35***		11.28%
3. Total Debt-to-Common Equity	Most constrained	-3.86	-11.35	8.68**	[0.33]	22.44%
	Least constrained	-10.35***	-28.39**	14.62***	[0.12]	20.78%
	Zero Leverage	-10.33**	-23.64*	4.63	[0.23]	16.76%
	Most-Least spread	6.48*	17.04**	-5.94		0.69%
4. Total Debt-to-Market Value	Most constrained	-3.88	-14.48*	14.93***	[0.20]	23.72%
	Least constrained	-6.39*	-16.45	-0.62	[0.37]	13.66%
	Zero Leverage	-10.74**	-23.40*	4.50	[0.40]	17.10%
	Most-Least spread	2.52	1.97	15.55***		8.97%
5. Cash holdings-to-Total Assets	Most constrained	-5.70	-16.57	23.78***	[0.37]	15.35%
	Least constrained	-10.49**	-31.68**	12.03***	[0.10]	25.04%
	Most-Least spread	4.79	15.11**	11.76***		4.18%
6. Interest Coverage ratio	Most constrained	-3.13	-13.55	12.69***	[0.27]	22.70%
	Least constrained	-6.59	-15.27	6.94	[0.42]	20.15%
	Most-Least spread	3.46	1.72	5.75*		0.10%
7. Kaplan-Zingales index	Most constrained	-9.70***	-10.81	4.18	[0.95]	11.87%
	Least constrained	-5.46	-12.48	2.80	[0.52]	13.60%
	Most-Least spread	-4.23	1.67	1.38		-1.32%
8. Whited-Wu index	Most constrained	-4.75**	-11.10	-4.14**	[0.66]	1.24%
	Least constrained	-6.32*	-13.05	11.40***	[0.46]	23.52%
	Most-Least spread	1.56	1.95	-15.54***		9.23%
	FTSE All Share	-8.01**	-13.21	12.14***	[0.60]	22.41%

Table 9

Returns response to unexpected interest rate changes in liquid and illiquid market conditions

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (9): $r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis})(1 - D^{Illiq})\Delta i_d^u + \beta_2^u (1 - D^{Crisis}) D^{Illiq} \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + ... + \varepsilon_d$, where D^{Crisis} takes the value 1 on MPC meetings from August 2007 to December 2009 and D^{Illiq} takes the value 1 when the 90-day moving average of RtoV price impact ratio for FTSE All Share is higher than its full sample average daily value and zero otherwise. p-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes in liquid and illiquid market conditions are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	β_3^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	-2.87	-3.99	-1.64	[0.89]	-0.70%
	Least constrained	-7.91**	-9.46**	11.41***	[0.78]	23.21%
	Most-Least spread	5.04	5.47	-13.05***		12.78%
2. Tangible-to-Total Assets	Most constrained	-13.36**	-16.65**	4.02	[0.73]	9.04%
	Least constrained	-6.58	-6.75	15.79***	[0.98]	22.89%
	Most-Least spread	-6.78	-9.91	-11.77***		9.31%
3. Total Debt-to-Common Equity	Most constrained	-4.90	-10.99***	8.46**	[0.22]	22.46%
	Least constrained	-12.56**	-17.61**	14.82***	[0.61]	18.73%
	Zero Leverage	-9.60**	-23.27***	4.41	[0.12]	17.76%
	Most-Least spread	7.66	6.62	-6.36		-1.62%
4. Total Debt-to-Market Value	Most constrained	-5.43	-7.35*	15.21***	[0.70]	22.78%
	Least constrained	-7.11	-15.43**	-1.06	[0.25]	14.25%
	Zero Leverage	-9.86**	-23.34***	4.26	[0.12]	18.25%
	Most-Least spread	1.69	8.08*	16.27***		11.04%
5. Cash holdings-to-Total Assets	Most constrained	-8.70*	-15.26**	23.31***	[0.39]	15.25%
	Least constrained	-10.41**	-26.17***	12.34***	[0.13]	24.08%
	Most-Least spread	1.71	10.91	10.97***		1.71%
6. Interest Coverage ratio	Most constrained	-4.02	-10.32***	13.08***	[0.24]	24.38%
	Least constrained	-8.45*	-9.14*	7.05	[0.92]	18.93%
	Most-Least spread	4.44	-1.18	6.03**		1.85%
7. Kaplan-Zingales index	Most constrained	-7.44	-14.81**	4.00	[0.33]	12.84%
	Least constrained	-5.70	-10.75**	2.86	[0.40]	13.41%
	Most-Least spread	-1.75	-4.06	1.15		-2.09%
8. Whited-Wu index	Most constrained	-2.97	-8.30	-4.19**	[0.61]	1.54%
	Least constrained	-7.88**	-9.53**	11.48***	[0.76]	22.93%
	Most-Least spread	4.92	1.23	-15.67***		10.74%
	FTSE All Share	-9.45**	-8.67**	12.24***	[0.89]	21.92%

Table 10

Returns response to unexpected interest rate changes using an alternative crisis period

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (5): $r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis}) \Delta i_d^u + \beta_2^u D^{Crisis} \Delta i_d^u + \beta_1^e (1 - D^{Crisis}) \Delta i_d^e + \beta_2^e D^{Crisis} \Delta i_d^e + \gamma' X_d + \varepsilon_d$, where D^{Crisis} takes now the value 1 on MPC meetings from September 2008 to August 2009. p-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes outside and during the crisis period are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	-2.76	-2.29	[0.91]	0.04%
	Least constrained	-7.20**	10.49***	[0.00]	22.55%
	Most-Least spread	4.45	-12.78***		12.18%
2. Tangible-to-Total Assets	Most constrained	-13.43***	2.07	[0.01]	8.20%
	Least constrained	-5.49	15.39***	[0.00]	23.02%
	Most-Least spread	-7.94**	-13.31***		9.67%
3. Total Debt-to- Common Equity	Most constrained	-5.83**	6.95**	[0.00]	21.09%
	Least constrained	-13.79***	17.45***	[0.00]	20.11%
	Zero Leverage	-13.09***	3.85	[0.00]	15.91%
	Most-Least spread	7.96**	-10.50***		1.69%
4. Total Debt-to-Market Value	Most constrained	-5.00	14.99***	[0.00]	21.39%
	Least constrained	-8.99**	-3.02	[0.22]	14.72%
	Zero Leverage	-13.29***	3.73	[0.00]	16.39%
	Most-Least spread	4.00	18.01***		10.58%
5. Cash holdings-to-Total Assets	Most constrained	-9.90**	24.96***	[0.00]	15.59%
	Least constrained	-15.48***	14.46***	[0.00]	23.82%
	Most-Least spread	5.57	10.50***		1.94%
6. Interest Coverage ratio	Most constrained	-5.06	11.78***	[0.00]	21.62%
	Least constrained	-7.36*	5.45	[0.02]	19.79%
	Most-Least spread	2.30	6.33**		-0.01%
7. Kaplan-Zingales index	Most constrained	-9.02**	2.77	[0.02]	12.68%
	Least constrained	-6.40*	0.98	[0.07]	13.33%
	Most-Least spread	-2.62	1.78		-1.08%
8. Whited-Wu index	Most constrained	-4.43	-4.16*	[0.95]	0.87%
	Least constrained	-7.20**	10.56***	[0.00]	22.30%
	Most-Least spread	2.76	-14.72***		8.18%
	FTSE All Share	-7.88**	11.38***	[0.00]	20.96%

Table 11

Returns response to unexpected interest rate changes with default spread as interaction term

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on BoE MPC meeting days during the period June 1999- December 2011, according to model (10): $r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis}) \Delta i_d^u + \beta_2^u (1 - D^{Crisis}) S_d \Delta i_d^u + \beta_3^u D^{Crisis} \Delta i_d^u + ... + \varepsilon_d$ where D^{Crisis} takes the value 1 on MPC meetings from August 2007 to December 2009 and S_d is the value of the default yield spread on MPC meeting day *d*, standardized with respect to its full sample daily values. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β_1^u	β_2^u	β_3^u	R^2 adj.
1. Total Assets	Most constrained	-4.84	-3.56	-1.49	-1.12%
	Least constrained	-15.82**	-14.96	11.24***	24.19%
	Most-Least spread	10.97	11.40	-12.73***	12.55%
2. Tangible-to-Total Assets	Most constrained	-27.11**	-25.21	3.61	10.27%
	Least constrained	-8.74	-3.80	15.67***	23.20%
	Most-Least spread	-18.37	-21.40	-12.05***	10.87%
3. Total Debt-to-Common Equity	Most constrained	-13.38**	-12.82	8.29**	22.86%
	Least constrained	-31.09**	-33.75*	14.54***	21.58%
	Zero Leverage	-32.50***	-36.27*	4.33	18.94%
	Most-Least spread	17.71	20.93	-6.24	0.51%
4. Total Debt-to-Market Value	Most constrained	-12.76*	-13.33	14.89***	22.66%
	Least constrained	-20.90**	-22.05	-1.07	14.73%
	Zero Leverage	-32.09***	-34.99*	4.19	19.30%
	Most-Least spread	8.14	8.72	15.96***	7.46%
5. Cash holdings-to-Total Assets	Most constrained	-23.26**	-24.92	23.14***	16.42%
	Least constrained	-27.57**	-23.08	12.19***	23.73%
	Most-Least spread	4.32	-1.84	10.95***	0.95%
6. Interest Coverage ratio	Most constrained	-6.19	0.52	12.77***	22.47%
	Least constrained	-16.94*	-17.33	7.13	19.66%
	Most-Least spread	10.75	17.85	5.65**	-1.60%
7. Kaplan-Zingales index	Most constrained	-21.49*	-22.80	3.64	13.55%
	Least constrained	-12.30	-9.92	2.78	13.81%
	Most-Least spread	-9.20	-12.88	0.86	-1.03%
8. Whited-Wu index	Most constrained	-8.07	-7.10	-3.90*	0.01%
	Least constrained	-16.03**	-15.41	11.32***	23.98%
	Most-Least spread	7.96	8.31	-15.23***	8.60%
	FTSE All Share	-16.27**	-14.53	12.04***	22.73%

Table 12
Returns response to changes in the LIBOR-BoE base rate spread

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on changes in the LIBOR- BoE base rate spread on MPC meeting days during the period June 1999- December 2011, according to model (11): $r_{p,m,d} = \alpha + \beta^{spread} \Delta(LIBOR - BoE\ rate)_d + \gamma' X_d + \varepsilon_d$. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β^{spread}	R^2 adj.
1. Total Assets	Most constrained	-0.19	0.65%
	Least constrained	-1.51***	22.45%
	Most-Least spread	1.32**	11.03%
2. Tangible-to-Total Assets	Most constrained	-0.63	4.17%
	Least constrained	-1.91***	22.99%
	Most-Least spread	1.28**	4.58%
3. Total Debt-to- Common Equity	Most constrained	-1.35***	22.87%
	Least constrained	-1.77**	14.82%
	Zero Leverage	-0.43	12.58%
	Most-Least spread	0.42	-1.77%
4. Total Debt-to-Market Value	Most constrained	-1.89***	22.38%
	Least constrained	0.27	11.06%
	Zero Leverage	-0.42	12.90%
	Most-Least spread	-2.17***	9.73%
5. Cash holdings-to-Total Assets	Most constrained	-3.21***	19.24%
	Least constrained	-1.35*	20.64%
	Most-Least spread	-1.86***	8.45%
6. Interest Coverage ratio	Most constrained	-1.42***	22.30%
	Least constrained	-0.87	17.52%
	Most-Least spread	-0.55	-1.02%
7. Kaplan-Zingales index	Most constrained	-0.52	11.95%
	Least constrained	-0.82**	13.98%
	Most-Least spread	0.29	0.40%
8. Whited-Wu index	Most constrained	-0.14	22.16%
	Least constrained	-1.52***	1.17%
	Most-Least spread	1.37**	6.89%
	FTSE All Share	-1.52***	20.41%

Table 13

Returns response to interest rate changes on all trading days excluding MPC meeting days

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected interest rate changes on all trading days over the period June 1999 –December 2011 excluding the BoE MPC meeting days, according to model (4): $r_{p,m,d} = \alpha + \beta^u \Delta i_d^u + \beta^e \Delta i_d^e + \gamma' X_d + \varepsilon_d$. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

Financial constraints proxy	Portfolio	β^u	β^e	R^2 adj.
1. Total Assets	Most constrained	-0.11	-0.36	11.16%
	Least constrained	1.08	-0.96	8.41%
	Most-Least spread	-1.19	0.60	0.88%
2. Tangible-to-Total Assets	Most constrained	0.68	-1.80**	11.00%
	Least constrained	1.71	-0.39	9.11%
	Most-Least spread	-1.03	-1.42**	2.29%
3. Total Debt-to- Common Equity	Most constrained	0.48	-1.16*	6.27%
	Least constrained	0.54	-1.46	10.64%
	Most-Least spread	-0.06	0.30	4.33%
4. Total Debt-to-Market Value	Most constrained	0.54	-1.15	7.84%
	Least constrained	0.69	-1.56	9.60%
	Most-Least spread	-0.15	0.41	0.66%
5. Cash holdings-to-Total Assets	Most constrained	-0.07	-1.37	7.30%
	Least constrained	-0.07	-1.96**	11.02%
	Most-Least spread	0.14	0.59	0.07%
6. Interest Coverage ratio	Most constrained	1.20	-1.02*	7.54%
	Least constrained	1.80	-0.95	9.92%
	Most-Least spread	-0.59	-0.07	2.30%
7. Kaplan-Zingales index	Most constrained	0.44	-1.45	8.86%
	Least constrained	0.05	-1.85***	8.04%
	Most-Least spread	0.38	0.40	1.95%
8. Whited-Wu index	Most constrained	-0.16	-0.75*	12.28%
	Least constrained	1.09	-0.95	8.49%
	Most-Least spread	-1.25	0.20	0.91%
	FTSE All Share	1.18	-1.02	9.76%

Table 14

Returns response to US monetary policy shocks

This table presents the estimated coefficients from least squares regressions of daily value-weighted returns of quintile portfolios with the most and the least constrained firms on expected and unexpected Fed Funds rate changes on Federal Open Market Committee (FOMC) meeting days during the period June 1999- December 2011, according to model (5):

$$r_{p,m,d} = \alpha + \beta_1^u (1 - D^{Crisis}) \Delta i_d^u + \beta_2^u D^{Crisis} \Delta i_d^u + \beta_1^e (1 - D^{Crisis}) \Delta i_d^e + \beta_2^e D^{Crisis} \Delta i_d^e + \gamma' X_d + \varepsilon_d ,$$

where D^{Crisis} takes the value 1 on FOMC meeting days from August 2007 to December 2009. *p*-values for the Wald test of the null hypothesis that the coefficients of unexpected rate changes outside and during the crisis period are equal, $\beta_1^u = \beta_2^u$, are presented in square brackets. The corresponding estimates for the spread return between the most and the least constrained portfolios, zero leverage portfolio returns and FTSE All Share returns are also reported. ***, **, * indicate statistical significance at the 1%, 5% and 10% level, respectively, for the estimated coefficients using Newey-West standard errors.

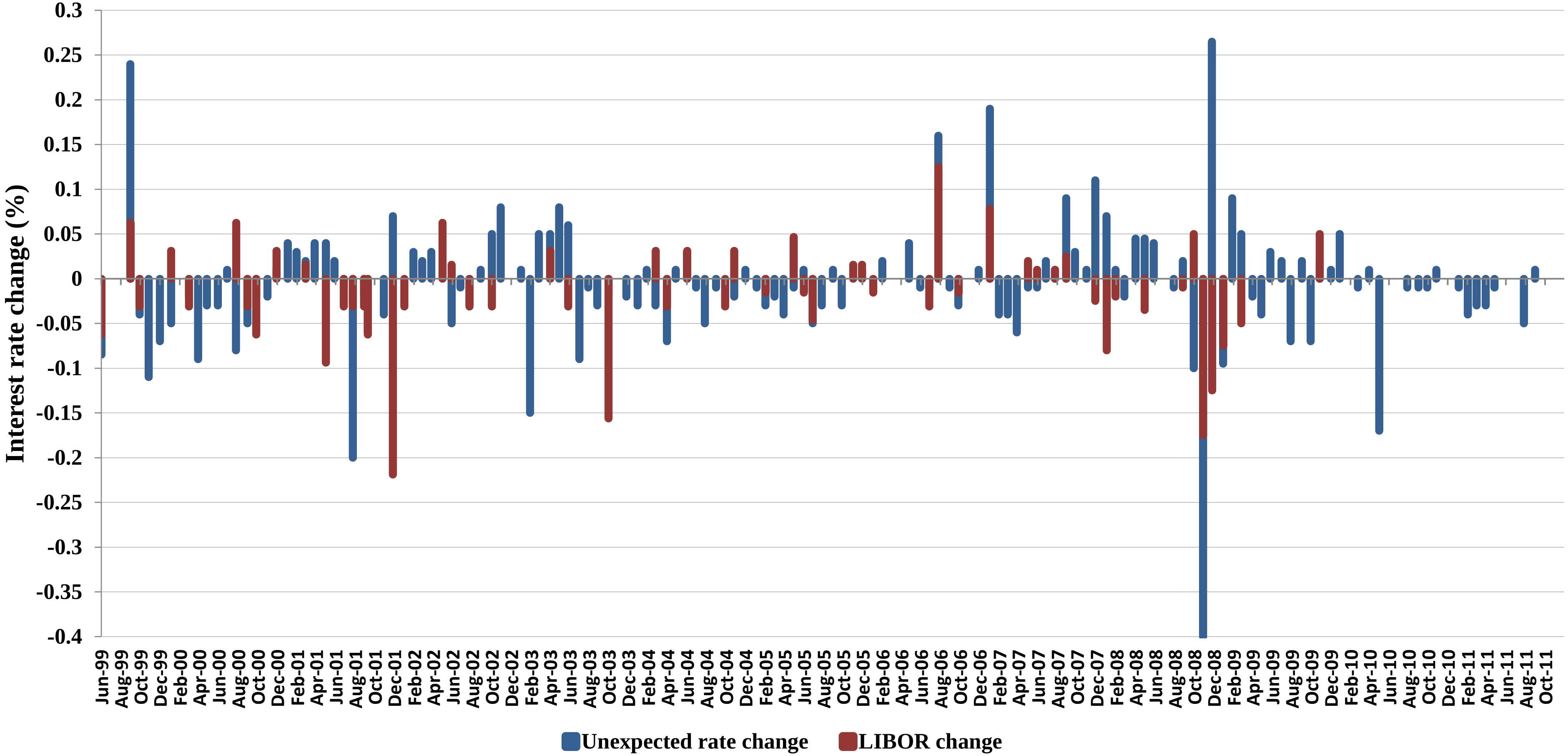
Financial constraints proxy	Portfolio	β_1^u	β_2^u	$\beta_1^u = \beta_2^u$	R^2 adj.
1. Total Assets	Most constrained	-1.13	-1.63	[0.16]	11.17%
	Least constrained	-1.27	-0.54	[0.72]	0.07%
	Most-Least spread	0.13	-1.09		4.46%
2. Tangible-to-Total Assets	Most constrained	-2.18	-1.02	[0.51]	1.51%
	Least constrained	-1.19	-1.17	[0.66]	3.52%
	Most-Least spread	-0.99	0.15		7.22%
3. Total Debt-to- Common Equity	Most constrained	-1.58	0.75	[0.47]	3.76%
	Least constrained	-2.27	-1.27	[0.54]	-0.26%
	Most-Least spread	0.68	0.53		7.03%
4. Total Debt-to-Market Value	Most constrained	-4.37***	-1.82	[0.02]	10.24%
	Least constrained	0.95	-0.002	[0.91]	1.70%
	Most-Least spread	-5.32***	-1.82***		7.59%
5. Cash holdings-to-Total Assets	Most constrained	-2.15	-1.03	[0.57]	0.56%
	Least constrained	-4.59	-2.47	[0.06]	9.59%
	Most-Least spread	2.44	1.44***		5.97%
6. Interest Coverage ratio	Most constrained	-2.35	-0.54	[0.34]	4.30%
	Least constrained	1.93	0.001	[0.64]	0.99%
	Most-Least spread	-4.29*	-0.54		15.35%
7. Kaplan-Zingales index	Most constrained	-1.29	-1.26	[0.65]	6.50%
	Least constrained	-1.54	0.15	[0.69]	-1.22%
	Most-Least spread	0.25	-1.41		9.82%
8. Whited-Wu index	Most constrained	-1.69	-0.90	[0.35]	2.56%
	Least constrained	-1.25	-0.48	[0.73]	-0.07%
	Most-Least spread	-0.44	-0.42		2.28%
	FTSE All Share	-2.13	-0.64	[0.42]	1.72%

Table 15
Impulse responses of portfolio returns to one-standard deviation shock to the monthly interest rate

This table shows the generalized impulse responses of stock portfolios' returns to a one-standard deviation shock to the monthly interest rate. Results are reported for quintiles portfolios containing the most and the least constrained firms, as classified according to the Kaplan-Zingales and the Whited-Wu indices of financial constraints. The endogenous vector is $y_t = [ipn_t, inf_t, libor_t, r_{jt}]$, where ipn_t is the growth rate of industrial production, inf_t is the growth rate of the consumer price index (*cpi*), $libor_t$ is the UK 1-month interbank rate, and r_{jt} is the return of stock portfolio *j*. The lag order of the estimated VAR is two and a constant is also included. The frequency of the variables is monthly and the sample period extends from January 1991 to December 2011. Standard errors for the impulse responses are shown in parentheses. ** stands for statistical significance at 5% level, while *** stands for statistical significance at 1% level.

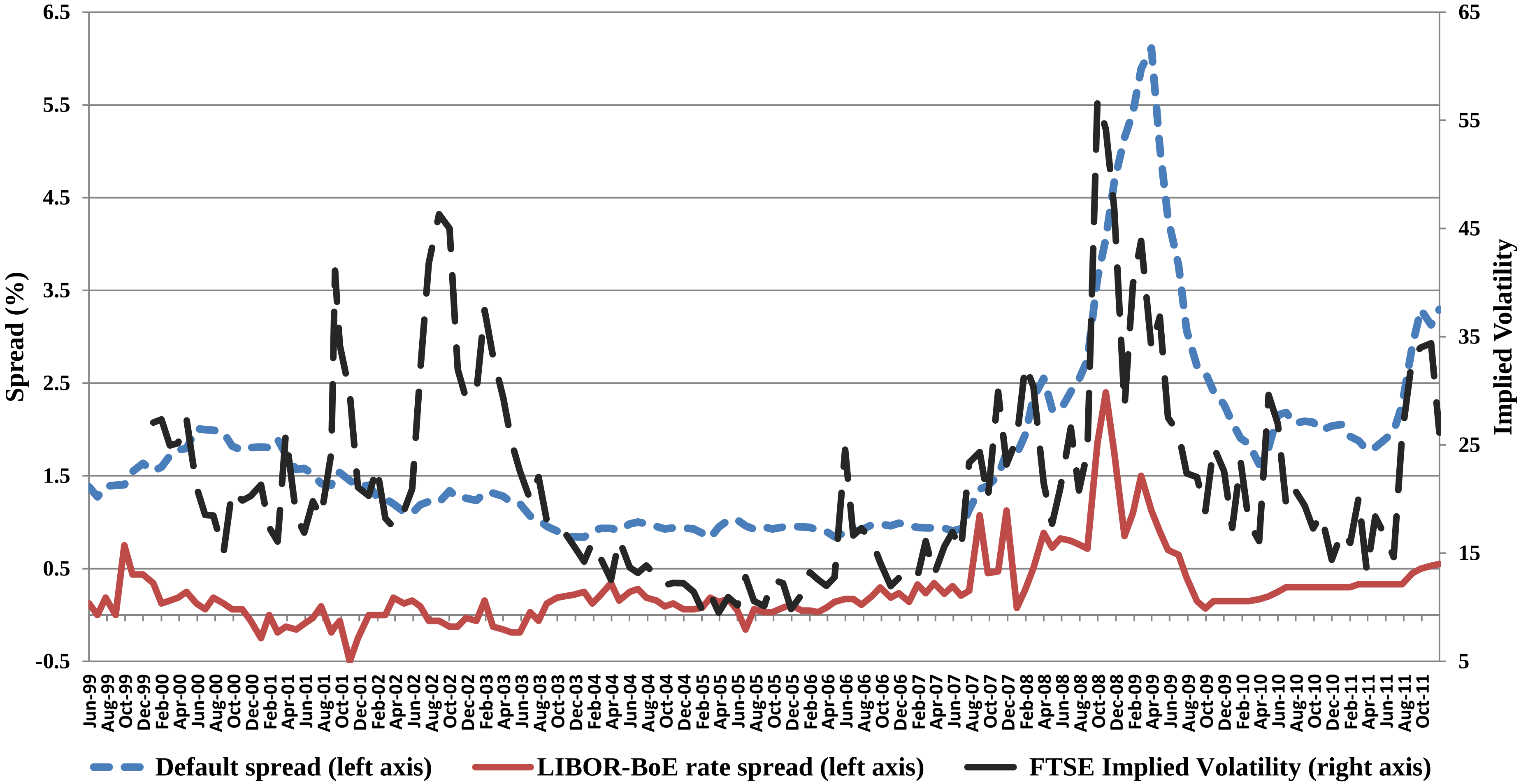
		Portfolio	
Financial constraints proxy	Most Constrained	Least Constrained	Most-Least spread
1. Kaplan-Zingales index	-0.0035	-0.0057**	0.0025
	(0.0035)	(0.0027)	(0.0027)
2. Whited-Wu index	-0.0042	-0.0073***	0.0056
	(0.0044)	(0.0025)	(0.0041)

Figure 1
Changes in LIBOR and unexpected interest rate changes



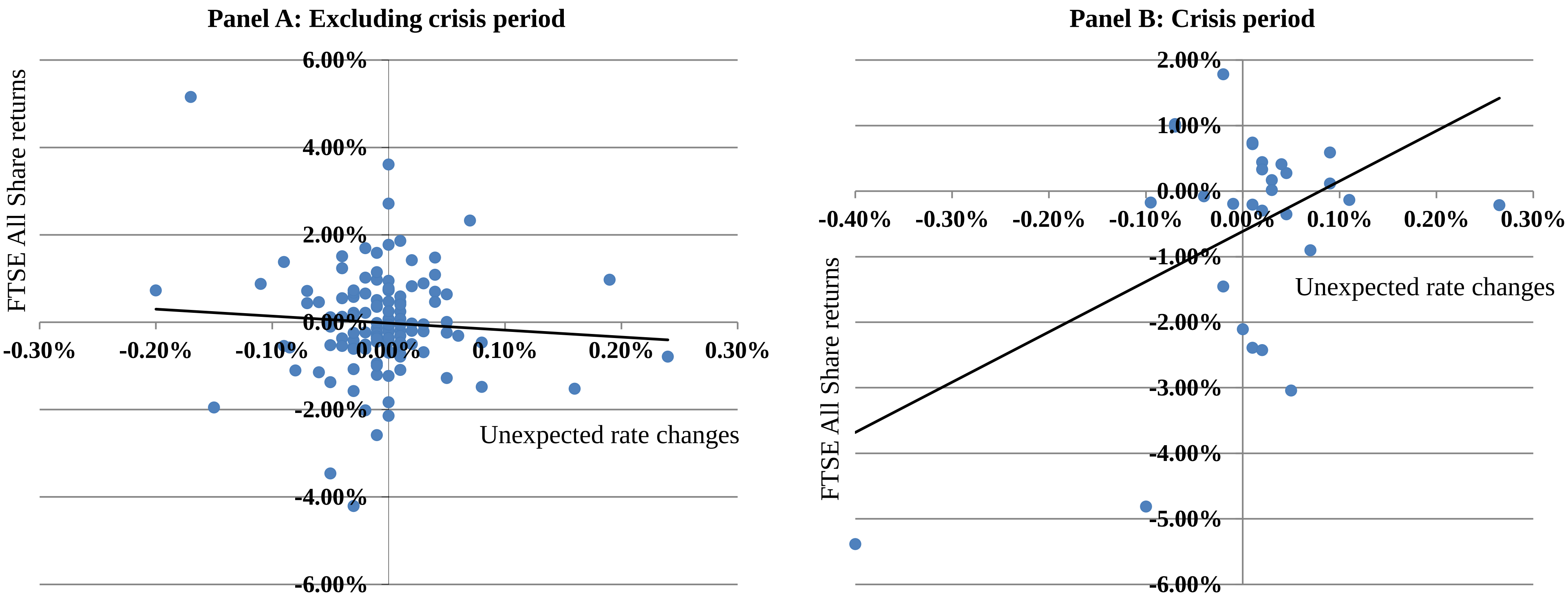
Notes: This Figure presents the daily changes in 3-month LIBOR as well as the corresponding unexpected interest rate changes, relative to expectations embedded in 3-month LIBOR futures prices, on BoE MPC meeting days during the period June 1999- December 2011 (152 meetings).

Figure 2
Default yield spread, LIBOR-BoE base rate spread and FTSE 100 Implied Volatility Index



Notes: This Figure presents the values of the default yield spread and LIBOR-BoE base rate spread (left axis) as well as the values of the FTSE 100 Implied Volatility Index on BoE MPC meeting days during the period June 1999- December 2011 (152 meetings).

Figure 3
Unexpected interest rate changes and FTSE All Share returns

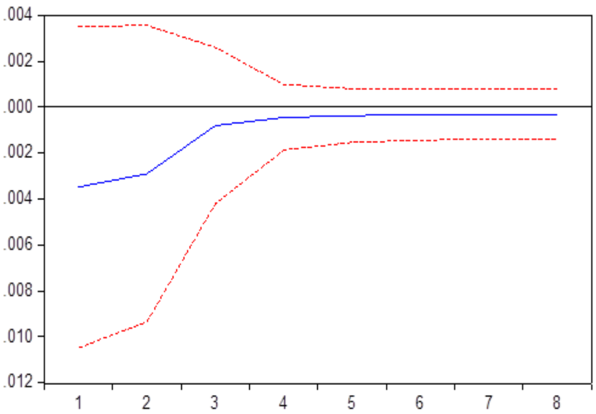


Notes: This Figure presents the combinations of daily unexpected interest rate changes, relative to expectations embedded in 3-month LIBOR futures prices, and daily FTSE All Share Index returns on BoE MPC meetings. Panel A presents these combinations for MPC meetings that took place during the periods June 1999-July 2007 and January 2010- December 2011, i.e. excluding the crisis period. Panel B presents the corresponding combinations for MPC meetings that took place during the crisis period, i.e. August 2007- December 2009. In both panels, a linear fit extracted from a univariate regression of FTSE All Share returns on unexpected interest rate changes is also drawn.

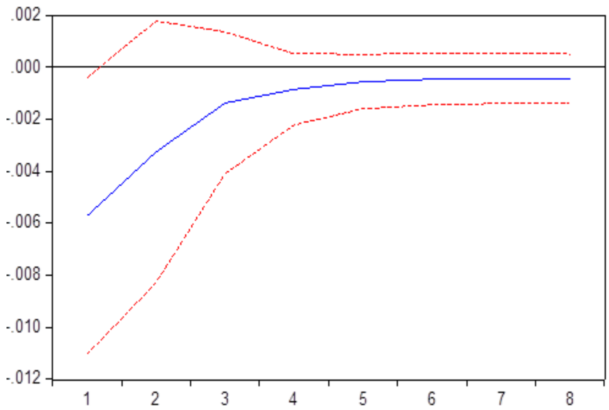
Figure 4
Generalized impulse responses of portfolio returns to one-standard deviation shock to the monthly interest rate

This figure shows the generalized impulse responses (solid curves) of the most constrained (Panels A and C) and least constrained (Panel B and D) portfolios' value-weighted excess returns to a one-standard deviation shock to the monthly interest rate. Firms are classified into quintile portfolios according to the Kaplan-Zingales and the Whited-Wu indices of financial constraints. The dashed curves are 95% confidence intervals calculated from standard errors. The endogenous vector is $y_t = [ipn_t, inf_t, libor_t, r_{jt}]$, where ipn_t is the growth rate of industrial production, inf_t is the growth rate of the consumer price index (*cpi*), $libor_t$ is the UK 1-month interbank rate, and r_{jt} is the return of stock portfolio *j*. The lag order of the estimated VAR is two and a constant is also included. The frequency of the variables is monthly and the sample period extends from January 1991 to December 2011.

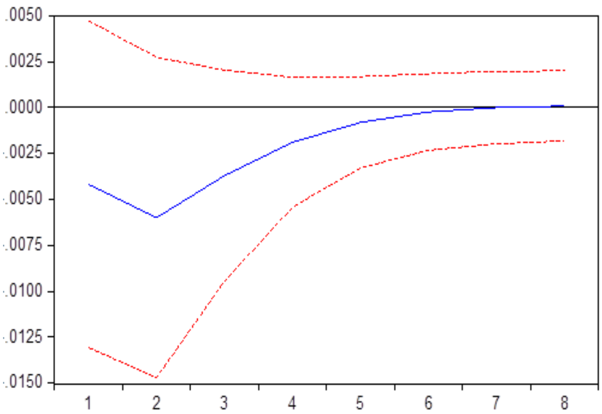
Panel A: Most Constrained Firms
(Kaplan-Zingales index)



Panel B: Least Constrained Firms
(Kaplan-Zingales index)



Panel C: Most Constrained Firms
(Whited-Wu index)



Panel D: Least Constrained Firms
(Whited-Wu index)

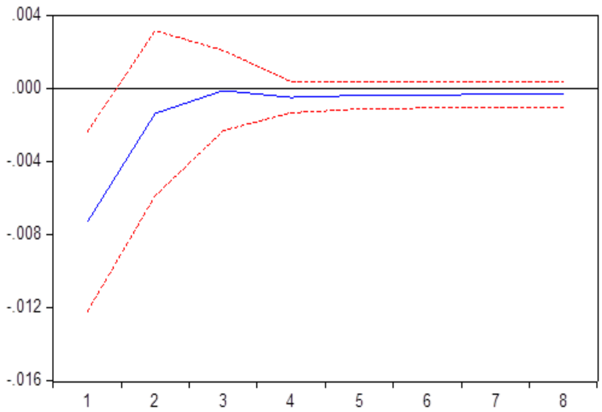
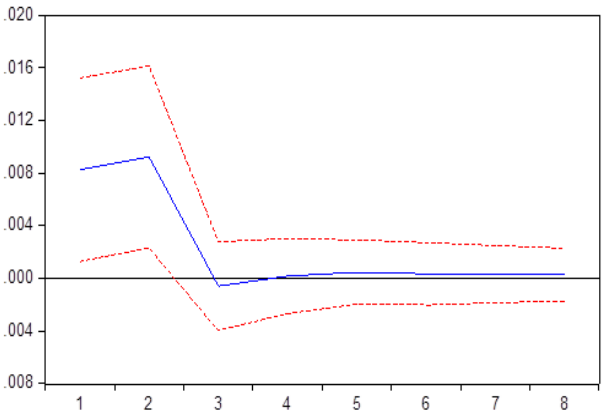


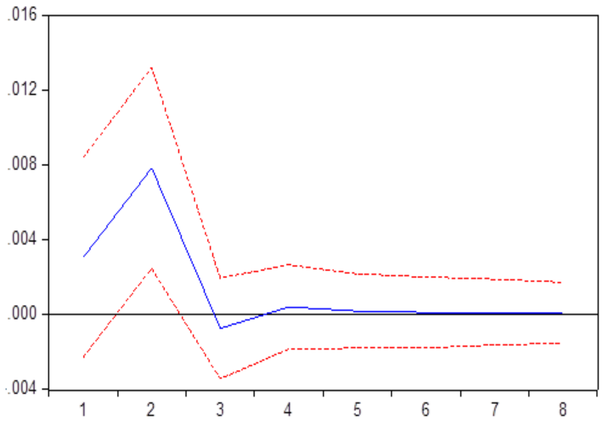
Figure 5
Generalized impulse responses of portfolio returns to one-standard deviation shock to the industrial production growth

This figure shows the generalized impulse responses (solid curves) of the most constrained (Panels A and C) and least constrained (Panel B and D) portfolios' value-weighted excess returns to a one-standard deviation shock to the industrial production growth. Firms are classified into quintile portfolios according to the Kaplan-Zingales and the Whited-Wu indices of financial constraints. The dashed curves are 95% confidence intervals calculated from standard errors. The endogenous vector is $y_t = [ipn_t, inf_t, libor_t, r_{jt}]$, where ipn_t is the growth rate of industrial production, inf_t is the growth rate of the consumer price index (*cpi*), $libor_t$ is the UK 1-month interbank rate, and r_{jt} is the return of stock portfolio *j*. The lag order of the estimated VAR is two and a constant is also included. The frequency of the variables is monthly and the sample period extends from January 1991 to December 2011.

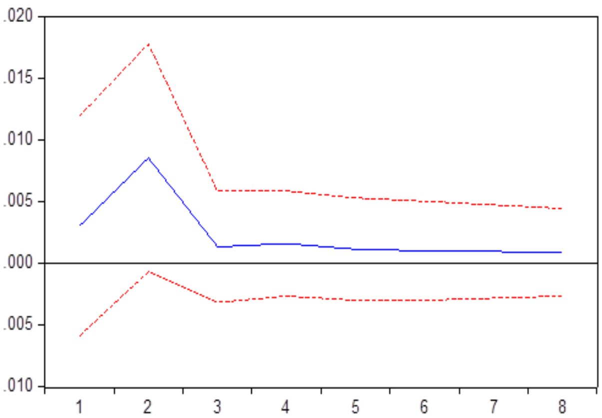
Panel A: Most Constrained Firms
(Kaplan-Zingales index)



Panel B: Least Constrained Firms
(Kaplan-Zingales index)



Panel C: Most Constrained Firms
(Whited-Wu index)



Panel D: Least Constrained Firms
(Whited-Wu index)

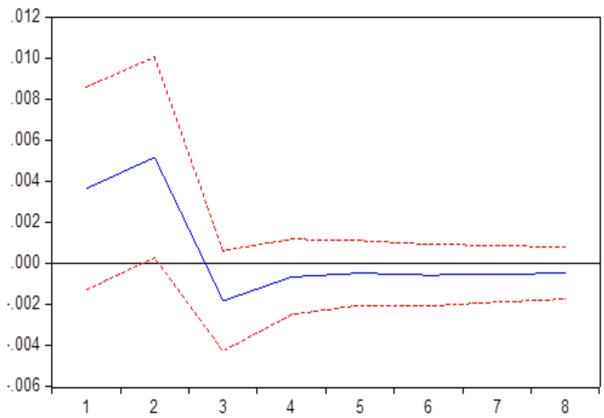
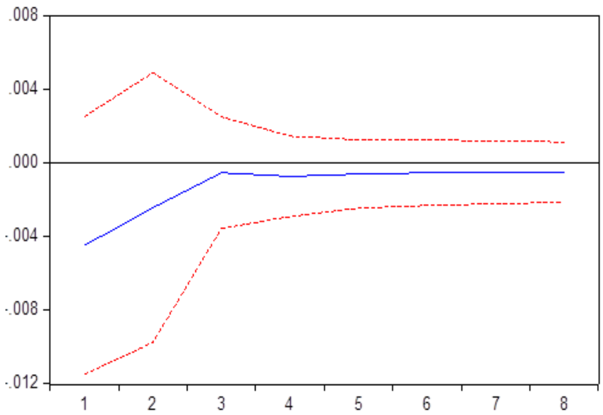


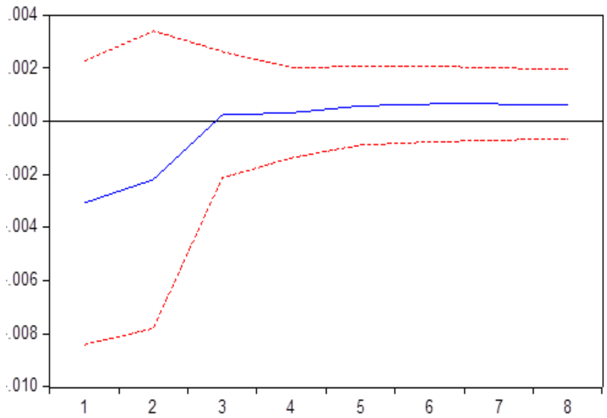
Figure 6
Generalized impulse responses of portfolio returns to one-standard deviation shock to the inflation rate

This figure shows the generalized impulse responses (solid curves) of the most constrained (Panels A and C) and least constrained (Panel B and D) portfolios' value-weighted excess returns to a one-standard deviation shock to the inflation rate. Firms are classified into quintile portfolios according to the Kaplan-Zingales and the Whited-Wu indices of financial constraints. The dashed curves are 95% confidence intervals calculated from standard errors. The endogenous vector is $y_t = [ipn_t, inf_t, libor_t, r_{jt}]$, where ipn_t is the growth rate of industrial production, inf_t is the growth rate of the consumer price index (*cpi*), $libor_t$ is the UK 1-month interbank rate, and r_{jt} is the return of stock portfolio j. The lag order of the estimated VAR is two and a constant is also included. The frequency of the variables in our dataset is monthly and the sample period extends from January 1991 to December 2011.

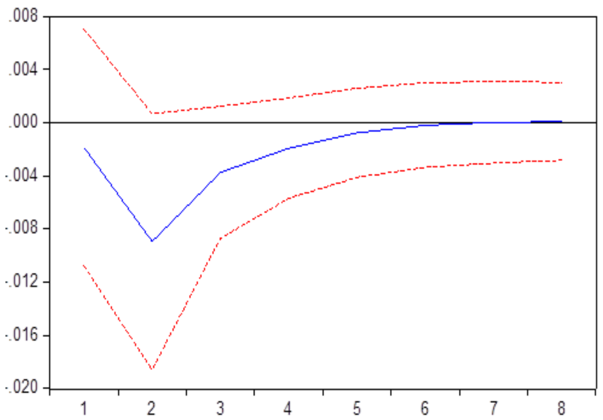
Panel A: Most Constrained Firms
(Kaplan-Zingales index)



Panel B: Least Constrained Firms
(Kaplan-Zingales index)



Panel C: Most Constrained Firms
(Whited-Wu index)



Panel D: Least Constrained Firms
(Whited-Wu index)