Bank Loan Supply, Quantitative Easing and Corporate Bond Issuance: Evidence from the UK

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List of abbreviations

AIC- Akaike Information Criterion

ADF- Augmented Dickey and Fuller test

APF- Asset Purchase Facility

BOE-Bank of England

ECB-European Central Bank

EU-European Union

FCA- Financial Conduct Authority

FEVD-Forecast Error Variance Decomposition

FLS- Funding for Lending Scheme

FTSE-Financial Times Stock Exchange

GDP- Gross Domestic Product

HMG- Her Majesty's Government

HMT-Her Majesty's Treasury

HQ- Hannan Quinn information criterion

IMF- International Monetary Fund

LTCM-Long Term Capital Management

LSAP – Large Scale Asset Purchases

NW-Newey West

PP- Phillip and Perron test

QE- Quantitative Easing

S.D.-Standard Deviation

SBC- Soft Budget Constraint

SVAR-structural vector autoregressive model

SVECM-structural vector error correction model

VAR-vector autoregressive model

VECM-vector error correction model

UK- United Kingdom

US- United States of America

ABSTRACT

This thesis makes two main contributions to the literature. The first is to establish the existence of a capital supply channel, in particular a bank lending channel of monetary policy transmission in the UK using a clean measure of bank loan supply. In this study we exploit the revealed debt preferences of debt issuing firms by using the Becker and Ivashina (2014) fixed effects framework to isolate the impact of credit supply. By conditioning the sample on non-financial firms whose debt issuance is observed, we are able to eliminate the effects of credit demand and to isolate a clean measure for bank loan supply. In this thesis, we find that the tendency by unconstrained, non-financial firms to substitute corporate bonds for bank loans at different points of the financial cycle reflects changes in bank loan supply. We also find that the patterns of substitutability are consistent among more granular classifications of heterogeneous debt. Our results reveal that among unconstrained firms, the proportion of new bank loan issuance declines, while the proportions of corporate bonds and program debt issuance tend to increase, when faced with unfavourable credit market conditions.

We then create a loan to bond substitution measure based on observed substitution behaviour of unconstrained firms. We find that this measure explains the out of sample bank loan issuance behaviour of constrained firms. As a result we conclude that the measure is able to cleanly capture changes in bank loan supply. We extend the study to examine the impact of bank loan supply on the financing, hiring and investment decisions of UK non-financial corporations. We find that bank loan supply disruptions significantly and disproportionately affect the hiring and inventory investment decisions of bank dependent firms relative to those of non-bank dependent firms. The propensity to invest or hire among bank dependent UK non-financial firms declines relative to non-bank dependent firms when bank loan supply deteriorates. Moreover, the fixed investment decisions of non-bank dependent firms tend to decline following adverse bank loan supply shocks. These results confirm the existence of a bank lending channel among UK non-financial firms, and the findings are in line with the narrow credit view of monetary policy transmission.

Our second central contribution is to analyse the impact of orthogonal QE shocks, credit supply shocks, credit demand shocks, and monetary policy shocks on the aggregate debt issuance behaviour of UK non-financial firms. Using structural vector error correction models (SVECM), we show that QE shocks increase corporate bond issuance and compress term spreads, but have no effect on the policy rate. Moreover, we observe that unexpected increases in the monetary policy rate lead to a decline in corporate bonds in the short term. While credit supply shocks move aggregate bank lending and aggregate corporate bond issuance in the same direction, corporate bond issuance responds with a lag to fluctuation in credit supply. This implies that adverse credit supply shocks may produce amplified negative effects on capital supply as both corporate bonds and bank loan decline.

We also establish a counterfactual for corporate bonds and bank loan issues based on our structural model. We find that the QE policies result in the Bank of England averting a decline in corporate bond issuance of between 3% and 10% during the QE period. Our findings in this thesis point towards the existence of a portfolio balance channel of QE that operates in the UK corporate bond markets during the QE period.

DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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DEDICATION

To my late grandfather, J. Bvirindi, whom I wish had lived to share my success.

CHAPTER 1

INTRODUCTION

During the global financial crisis period (2007-2008), increases in counterparty risk in the interbank market, coupled with bank balance sheet restructuring, spur a drastic decline in liquidity, a sharp increase in term spreads, credit spreads and liquidity premiums, propelling a decline in debt issuance in the UK. These challenges in the banking sector are transmitted to non-financial corporations through progressive tightening of lending standards, increases in lending costs and an increase in credit rationing. Non-financial companies which are traditionally heavily dependent on bank loan finance witness a drastic decline in investment and output, suggesting the existence of a capital supply channel of monetary policy transmission in the UK.

In the UK, the Bank of England's response to the financial crisis is to use a number of unconventional monetary policy measures, in particular quantitative easing and credit easing, in a bid to rejuvenate debt issuance and to stimulate investment and spending. Kaya and Wang (2014) and Bank of England (2010) report an increase in corporate bond issuance during the quantitative easing (QE) phase, 2009-2012. However, prior to QE and during the 2007-2008 financial crisis period, a number of non-financial corporations shift the composition of their debt from bank loans towards market debt securities despite the high cost of market debt at this time. Adrian, Colla and Shin (2012) suggest that while bank loan issuance declines during the crisis, corporate bond issuance increases to make up for the decline in bank loan issuance. This finding implies that corporate bonds act as a substitute for bank loans during periods where bank loan supply declines.

However, it is not clear whether the increase in corporate bond issuance is a result of a decline in bank loan supply, a change in firm's financing preferences or due to quantitative easing policies. Second, it is not clear whether the observed decline in the investment during periods of adverse credit shocks is directly related to bank loan supply.

In this study we exploit the structure of corporate debt and its behaviour over the business cycle in order to identify and isolate a measure for bank loan supply, and examine the effects of bank loan supply on the real decisions of firms in the United Kingdom (UK). We also study the effects of quantitative easing (QE) policies on the debt issuance behaviour of UK non-financial firms.

This study contributes to both monetary policy literature and debt issuance literature by examining the impact of the credit supply and quantitative easing policies on debt issuance. Furthermore, the thesis examines the micro level real effects of bank loan supply which help to uncover the non-neutrality of monetary policy effects. Our study also extends the literature on quantitative easing policies by analysing the impact of quantitative easing policies on debt issuance and establishing counterfactuals for corporate bond and bank loan issuance during the QE period. This allows us to understand whether the portfolio balance channels of QE transmission translate into an increase in corporate bond issuance by non-financial companies.

We are not aware of another study examining the UK that; (i) examines the substitution between bank debt and corporate bonds, (ii) studies the impact of various bank loan supply measures on debt heterogeneity in the UK, and (iii) creates a measure for bank loan supply and examines the impact of bank loan supply on the real decision of the firms under the same umbrella.

The three key questions we seek to answer in this thesis are the following. First, can observed substitution between corporate bonds and bank loans tell us anything about bank loan supply? Second, do changes in bank loan supply affect the debt issuance, employment and investment behaviour of UK bank dependent firms? Third, are the observed increase in aggregate corporate bond issuance a direct result of quantitative easing policies, or are they driven by other credit market shocks that are independent of quantitative easing policies, or some combination of both?

The study employs both panel data and time series analysis techniques to examine the debt issuance behaviour in the UK. Panel data analysis techniques are employed to isolate the bank loan supply movements and to create an index for bank loan supply, as well as to examine the real effects of bank loan supply on the real decisions of bank dependent firms. Examining the impact of bank loan supply on the real decisions of the firm allows us to determine whether a bank lending channel of monetary policy transmission exists in the UK.

The time series techniques we adopt seek to isolate QE shocks, credit supply shocks, credit demand shocks, monetary policy rate shocks and bond market specific shocks, and to analyse the impact of these shocks on aggregate corporate bond and bank loan issuance behaviour. Furthermore, our time series techniques enable us to establish counterfactual

results for UK corporate bond issuance during the QE period (2009-2012). This allows us to examine whether a portfolio rebalancing channel of QE transmission was in operation during the QE period. Given that QE policies have become an essential component in the central banks' monetary policy toolkit since the global financial crisis of 2007/08, understanding the transmission channels of QE policies, as well as their pass through effects, is critically important for policy makers and is also essential for the construction and refinement of theoretical models for policy transmission.

The results in this thesis supports the findings of both Becker and Ivashina (2014) and Adrian, Colla and Shin (2012) that the substitution between corporate bonds and bank loans observed through the debt issuance behaviour of unconstrained firms reflects changes in bank loan supply. This implies that an empirical measure for bank loan supply that is clean from credit demand effects can be extracted from the debt issuance behaviour of unconstrained firms. Furthermore, the results also suggest that non-bank dependent firms tend to be protected from adverse credit fluctuations while bank dependent firms are not. Our findings also reveal that the investment, hiring and debt issuance behaviour of bank dependent firms tends to move in tandem with changes in bank loan supply. In periods where bank loan supply deteriorates, bank dependent firms scale back on hiring, inventory and real fixed investment. These results suggest that there exists a bank lending channel of monetary policy in the UK and that monetary policy has non-neutral effects on the real decisions of the firm.

Our results also establish that quantitative easing (QE) polices tend to induce an increase in corporate bond issuance. We find that QE policies engender an increase in corporate bond issuance but have no effect on real bank loan issues and real equity prices. QE shocks also tend to depress the term spread but have no effects on the UK base rate. These results suggest that a portfolio rebalancing channel is in effect in the UK during the QE period. Furthermore, our findings reveal that credit supply shocks have transitory effects on corporate bond issuance and permanent effects on bank loan issuance. In contrast, contractionary monetary policy shocks result in a decline in corporate bond issuance in the short term and result in an increase in loan issuance in the very short term. Credit demand shocks seem to have only transitory effects on loan issuance but have no apparent effect on corporate bond issuance. However, the base rate increases to counteract the increase in loan issuance following positive credit demand shocks.

The result of our counterfactual analysis in Chapter 5 indicate that by embarking on QE policies, the Bank of England manages to avert a 3% to 10% decline in corporate bond issuance by UK non-financial corporations between 2009 and 2014. Furthermore, our findings also establish that quantitative easing policies that target a compression of the term spread are ineffective in stimulating aggregate bank lending. This finding provides evidence to support the claims of Fisher (2010) and Joyce et al. (2011) that UK quantitative easing policies targeting a reduction in the term risks would not translate to an increase in bank loan issuance. Our panel results in Chapter 3 suggest that the propensity to issue corporate bonds increases during the QE period, even when controlling for fluctuation in bank loan supply and aggregate credit supply. The likelihood of issuing corporate bonds is particularly high during the first phase of the QE program (QE 1). The results of both the panel and the time series estimations support the existence of a portfolio balance channel of quantitative easing which operates through public debt markets.

The study is organised as follows. Chapter 2 provides a brief review of the literature on debt choice and the heterogeneity of different debt components. This Chapter also provides a brief review of the literature on monetary policy transmission mechanisms, focusing upon the bank lending channel, and the so-called broad and narrow lending views of monetary policy transmission. In Chapter 3 we test the hypothesis that the observed substitution between corporate bond and bank loan issuance of firms with access to the corporate bond markets is reflective of changes in bank loan supply. We examine whether substitutability is observed among granular measures of debt by testing whether the heterogeneous debt components with differing cash flow and control rights, and information asymmetries, respond differently to changes in credit supply. In this Chapter we also test the hypothesis that QE policies drive the increase in corporate bond issuances during the QE period. We proceed to create an empirically implementable measure for bank loan supply that is clean from credit demand effects. Chapter 4 examines and tests for the existence of a bank lending channel of monetary transmission among UK non-financial firms. We explore whether the firm's investment, hiring and financing behaviour respond to changes in bank loan supply. In Chapter 5 we examine the effects of QE shocks of UK corporate bond issuance in a time series framework. We isolate the impact of QE using two structural identification techniques. Chapter 6 concludes.

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CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature on corporate debt issuance and is divided into two sections. The first part explores and evaluates the determinants of a firm's debt choice between issuing corporate bonds and bank loans, with a particular focus on the exploration of the firm level factors that drive debt choice. This section of the literature review provides the theoretical base that informs our choice of control variables in later chapters of the thesis. In the second section, we provide an exposition and evaluation of monetary policy transmission channels in particular, the bank lending channel.

2.1 Determinants of debt structure choice

The literature on the external debt financing identifies four factors as primary drivers of the choice between bank and nonbank debt. These factors are: (i) issue costs or floatation costs; (ii) the agency costs of debt such as bankruptcy costs and the adverse effects of financial distress such as Myers (1977) underinvestment and asset substitution problems; (iii) the value of secondary market liquidity; and (iv) the resolution of information problems through the presence of covenants and other optionality elements. The relative importance of these factors in the bond versus bank loan choice vary, depending on the characteristics of the borrowing firms and associated information asymmetry costs.

2.1.1 Information asymmetries and agency costs

In many cases borrowers have more information about the outcomes of the projects than lenders and hence potentially possess an information-related advantage which they can exploit to expropriate value from lenders. Although to some extent lenders can protect themselves from exploitation through contracts, their inability to write complete contracts covering the behaviour of borrowers in every eventuality leaves them open to exploitation, giving rise to agency problems between borrowers and lenders, as discussed in Aghion and Bolton (1992), Davis and Ioannidis (2003), Davis and Mayer (1991), Jensen and Meckling (1976).

Asymmetric information about the firm often takes one of two forms. Adverse selection problems (Akerlof (1970) and Levin (2001)), which are the difficulties associated with ex ante screening and separation of good from bad quality borrowers, and moral hazard problems where the contractual terms are such that ex post, borrowers have an incentive to act in a manner that increases their private benefits while causing losses to the lender. These are manifest in both asset substitution and underinvestment problems. The greater

the information asymmetries between borrowers and lenders, the higher the likelihood of not realising profits from intermediating in debt markets.

The pecking order theory of capital structure maintains that debt is the most preferred source of external finance over equity. Although the theory does not discriminate among the various sources of debt financing, it provides some important insights concerning the demand for externally sourced finance. In particular, a firm's preference over financing sources depends on the agency problems associated with the choice of finance, and the sensitivity of the instrument to information asymmetry problems existing between borrowers and lenders. As a result, the instruments that are least sensitive to information problems are issued first and are deemed less costly. The same analogy can be applied to the relative ordering of debt in the capital structure. Gomes and Phillips (2012) and Rauh and Sufi (2010) both claim that the information sensitivity of security issuance choice is significantly lower for private relative to public debt issues.

Bank and non-bank debt carry different agency and information asymmetry costs. Differences in the dispersion of ownership and the flexibility of restructuring, or renegotiating debt when confronted with a default event, play a key role in the optimal financial structure decision and impose differences in the costs associated with different types of debt (Detragiache (1994) and Houston and James (1996)). According to Detragiache (1994), two agency problems arise with debt i.e. ex-post underinvestment problems which can be resolved through debt renegotiation; and ex-ante asset substitution problems when a renegotiation option is present.

The existence of a renegotiation option introduces a soft budget constraint that makes ex-ante asset substitution attractive for managers.[1] In the presence of limited liability, incentives for excessive risk taking arise. This is because equity values are truncated at zero in insolvency or renegotiation states and shareholders cannot lose more than their equity in the firm. The fact that equity holders can bargain for debt renegotiation or debt

[1] Boot (2000) argues that the flexibility of bank loans in allowing borrowers to renegotiate terms in times of financial distress can create ex ante perverse incentives on the part of the borrower, what he terms a soft budget constraint. The soft budget constraint (SBC) problem arises when the link between earnings and expenditure is violated because some institution, the state or otherwise, will take over the excess of expenditure over earnings thereby altering the managers investment behaviour ex ante (Kornai (1986) and Kornai et al. (2003)) The SBC syndrome breeds irresponsibility and disdain of risk, and opens the way to excessive investment hunger and expansion drive among managers. Detragiache (1994) notes that renegotiation can lead to managers engaging in asset substitution ex-ante. However, giving banks some bargaining power in the form of collateral and seniority could resolve the soft budget constraint problem.

forgiveness in order to increase the going concern value of the firm, means they can capture some of the going-concern surplus. This makes the payoffs for shareholders strictly positive in insolvency or bankruptcy states. As a result, incentives to undertake risky suboptimal investments increase, unless the lender has strong bargaining power. In this case, a potential solution to limit the asset substitution problems is to issue debt with no renegotiation options or debt that is difficult to renegotiate in insolvency states (Bolton and Freixas, 2000), albeit, at the cost of introducing ex ante underinvestment problems.

In practice, the renegotiation of debt is partially influenced by the bankruptcy regimes that exist in different countries such that the choice of capital structure that is ultimately chosen by the firm and the efficiency of its investment decisions are also in part affected by the extant bankruptcy regime (Detragiache (1994)). Often, the restructuring or renegotiation of public debt in the event of a default event is complicated, expensive and fraught with coordination problems, (Gertner and Scharfstein (1991) and Brunner and Krahnen (2001, 2008)).[2] This makes public debt unattractive in bad states of nature. As a result firms faced with high default risks or nearing bankruptcy will prefer bank loans to public debt. However, (Altman 2007) argues that recent innovations in credit risk mitigation and the introduction of option elements in bond covenants may lower the cost of reorganising troubled companies, which may result in the agency costs of debt losing some of its relevance in the corporate bond versus bank loan choice.

The extent to which debt holdings are dispersed across lenders impacts on the monitoring efficiency of the lender and the extent of control that the lender may have over the affairs of the borrower. Ordinarily corporate bonds are widely held, and as a result there are reduced incentives for the individual lenders or bondholder to engage in costly information production and monitoring. Information gathering by individuals in this case is costly, inefficient and monitoring efforts are unnecessarily duplicated. This gives rise to free rider problems in the sense that payoffs to bondholders failing to undertake costly state verification will be no different to those that do. Furthermore, bondholders that do not incur costs in relation to the information gathering process will benefit from their inaction. As a result, incentives to monitor the actions of borrowers are weakened. This implies that

[2] Detragiache (1992) notes that the main obstacle to renegotiation is the dispersion of clients. (Brunner and Krahnen 2008) find evidence that when firms are facing financial distress there can be serious coordination challenges between lenders. They find that the existence of small pools of debt owners increases the probability of workout success and the effect reverses when the debt ownership is widely distributed.

public debt has higher information asymmetry problems and agency costs relative to bank debt. Knowing this to be the case, markets will be more inclined to provide public debt to financially sound companies of good repute that are deemed to have very little information asymmetry problems. Mizen et al. (2008) find evidence to suggest that a good reputation increases the likelihood of a firm issuing public debt. In a related study of debt issuance in Asian countries Mizen and Tsoukas (2012) suggest that good financial health increases the likelihood of bond issuances and lowers the external finance premiums at which bond finance is obtained.

In contrast, information asymmetry and agency cost problems are greatly mitigated with bank lending, since banks are relatively efficient at monitoring (Fama, 1980, 1985, and Boot and Thakor (2008)) and screening customers (Boot 2000). They can also influence borrower behaviour while the loan is outstanding (Bolton and Scharfstein (1990) and Bolton and Freixas (2000)). In Holmstrom and Tirole (1993, 1997, 1998), the ability of banks to resolve moral hazard problems through monitoring enables them to provide loans to small firms with a lower credit quality that would otherwise be completely cut out of the credit markets.

Naturally, this creates a pecking order in which small firms and companies that are financially constrained and have little or no access to public debt markets obtain bank loans, and larger firms with dual access to credit markets choose bond finance. Bolton and Freixas (2000) point out that firms which face information dilution costs by issuing equity try to reduce these costs by issuing bonds or taking out bank loans. Since bank lending is more flexible in distress periods but is more expensive than bond financing due to intermediation costs, only those firms with a high demand for flexibility will choose bank lending over bond issuance. Smaller firms that have high information asymmetries and financial distress costs will rely on bank lending because banks provide them with flexibility in renegotiation. However, Bolton, Freixas and Shapiro (2004) also conjecture that mature firms that have good reputations and have cost advantages in accessing both the capital markets and bank lending will often rely on bond financing when credit supply diminishes.

Another advantage associated with bank loans is that monitoring costs of bank debt are fixed and banks as delegated monitors can split the monitoring costs among a wider base of lenders to benefit from economies of scale in monitoring. This improves their monitoring efficiency since they are able to spread the cost to a wider base of individual depositors or

lenders (Diamond, 1991). In addition, the information obtained from monitoring is reusable, and helps in building borrower profiles which may lower future borrowing yields for firms. Therefore, firms with high agency problems can tap into the monitoring prowess of banks to ensure that managers invest efficiently and devote a reasonable amount of managerial effort towards shareholder value maximisation (Myers (1984) and Easterwood and Kadapakkam (1991)).

However, information gathering is expensive and bank lending is laced with implicit taxes that require banks to set aside capital for every new loan granted and to set aside additional reserves for the ongoing performance of the loan. It is also true that bank lending is fashioned with restrictive covenants that may prohibit firms from taking new investments, contracting further debt or distributing cash-flows. The information acquired as part of the ongoing relationship with the borrower creates some information monopolies and holdout problems for the borrower that makes it expensive and difficult for borrowers to switch between lenders (Rajan (1992), and Houston and James (1996)). Furthermore, any violation of debt covenants by the borrower may result in a sharp and persistent decline in net debt issuance, lead to an increase in interest rates and a reduction in the future availability of credit to the firm (Roberts and Sufi (2009)).

2.1.2 Issue costs

Apart from the information costs highlighted above, external debt sources have different cost structures associated with them. Public debt has high fixed costs of issuance which often make it inaccessible for small firms or firms with smaller issue sizes, since they cannot fully exploit issue economies of scale. Public debt offerings are also associated with higher floatation costs such as registration of the issue, listing requirements, preparation and printing of the prospectus, roadshows by investment bankers which make public debt very expensive for small firms (Blackwell and Kidwell (1988)). However, larger firms with large issues can exploit the fixed costs of public debt by spreading them over a large issue size. As a result we would expect firms with large issue sizes to opt for public debt relative to bank debt since public debt is cheaper than bank loans for large size issues.

2.1.3 Secondary market liquidity

Furthermore, public offerings have higher liquidity than private offerings because public offers can be resold in the secondary markets. This tradability of public debt provides essential liquidity securities for the lenders. And where liquidity carries value on lender balance sheets, lenders are willing to give up a portion of their yield for liquidity risk which

ultimately lowers the costs of issuing bonds. But, where the debt is thinly issued the yield savings on public debt may be very low. However, in the US (so of less relevance for the present study) the advent of securitisation and the introduction of Rule 144A debt[3] has significantly lowered the costs of bond issuances and improved their liquidity thereby placing corporate bonds within the reach of small issuers (Amihud et al. (2005)). Arena (2011) argues that Rule 144A issues provide an avenue for cheap finance for companies with poor credit quality.

2.1.4 Resolution of corporate agency problems

Corporate governance literature states that information asymmetry problems between managers and shareholder increase with the dispersion of control rights. If a company is thinly held, monitoring incentives decline and agency problems increase. In order to mitigate against these agency costs, Bolton and Scharfstein (1996), Dewatripont and Maskin (1995) and Myers (1977) proposes that firms should contract private debt. Lin, Ma, Malatesta and Xuan (2013) claim that the relative composition of a firm's debt, between bank debt and public debt, is in part driven by the ownership structure of the firm. Firms with dispersed ownership will prefer bank debt, whereas firms with a few large owners or a single block holder prefer public debt more than bank debt so at to avoid the close scrutiny of banks.

2.1.5 Proprietary information

Other studies such as James (1987) and Houston and James (1996) also note that firms with proprietary information tend to issue privately to avoid mandatory information disclosures associated with public debt. This implies that companies with very high levels of intangible assets and high investments in research and development would prefer bank debt over public debt. As such we would expect to find a negative relationship between intangibility, research and development costs and the bond issuance decision.

In the next section we provide a brief exposition of monetary policy literature, in particular the bank lending channel. This literature is important in uncovering the real effects of bank loan supply disruptions.

[3] In the US, Rule 144A issues are not subject to the same disclosure and listing requirement of traditional public debt. This regulation was crafted to increase the liquidity of privately placed securities and to allow private issues to be listed on the retail bond markets. Issuers have the liberty to issue debt in the private markets and later list it for public trading. However, a drawback of Rule 144A issued securities is that trade of these securities is limited to a select group institutional investors which may hinder the liquidity and yield benefit of these issues.

2.2 Monetary transmission and credit allocation-bank credit

In the credit issuance and monetary policy literature, two dominant views explain lending over the business cycle, namely the lending view and the money view or the traditional interest rate view (Oliner and Rudebusch (1995) and Hubbard (1994)).[4] However, it is the former view that has been more dominant in recent years.

The recent financial crisis and the ensuing policy innovations crafted in its wake have rejuvenated interest in the lending view of monetary policy transmission. The lending view consists of two central propositions. The first proposition is that there exists a group of borrowers who are largely dependent upon bank loans and whose investments are disrupted when bank loan availability is impeded (Bernanke and Blinder (1988), Bernanke (1995) and Kashyap et al. (1993)). The second proposition is the claim that monetary policy shocks shift the supply of bank loans relative to other credit types (Meltzer (1996)). However, these channels are not mutually exclusive (Hubbard (1994)).

2.2.1 The lending view

According to the lending view, a decline in bank loan supply has distributional consequences and often results in efficiency losses. This is because in the case of a quantitative decline in bank credit, access to credit will largely depend on borrower characteristics which reflect potential adverse selection and moral hazard problems, but are unrelated to the social returns of the proposed investment projects in question (Cecchetti (1995)). In cases where credit rationing is an equilibrium phenomena, such declines in bank credit will worsen credit rationing for low credit quality firms (Stiglitz and Weiss (1981)). Bernanke (1995) classifies this channel as a balance sheet channel.

2.2.1.1 Broad credit view

Two versions of the lending view address both demand and supply factors in the lending process. The broad credit view (Oliner and Rudebusch (1995)) is based on the existence of credit market frictions, while the narrow credit view is often associated with bank loan supply variations. In the broad credit view, market imperfections namely information asymmetries, moral hazard problems and bankruptcy risks imply that the health of firms' balance sheets affect both their ability to access finance and the cost at which it is obtained

[4] The money view is concerned with aggregate changes in the level of real interest rates and interest rate sensitive spending. In the money view monetary policy shocks have no distributional consequences. In this view, monetary contractions increase default risks which lowers the desired investments by households and firms. The resulting increase in interest rates following a monetary contraction results in a reduction in capital by households and firms on least socially productive investments since their internal rates of return are forced to fall below the required rates of return.

(Bernanke et al. (1999), Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Mizen et al. (2008, 2012) and Bougheas et al. (2006)). According to the Bernanke et al. (1999) financial accelerator mechanism, increases in interest rates cause a deterioration in the firm's networth, and reduce the expected value of future cash flows. These factors adversely impact the firm's networth, thereby increasing debt burdens, lowering its credit worthiness, and increasing incentives to misrepresent risk. As a result, potential lenders will increase the risk premium they require when lending. If follows that these information asymmetry problems related to risk taking incentives induce a wedge between the costs of internal finance and external finance that makes internal finance cheaper than external finance. This narrative implies that the increase in borrowing costs following an adverse shock to networth will reduce the demand for external finance and will make it harder for firms whose creditworthiness is diminished to secure loans.

2.2.1.2 Narrow credit view

As an alternative, the narrow credit view argues that business cycle and policy changes have a direct impact on the supply of loans. Shocks that increase the level of bank reserves in the economy or the banking systems' capacity to lend, lead to an increase in the volume of loans, while shocks or policies that lower the level of bank reserves or bank capital are assumed to lower credit supply (Meh and Moran (2010), Gertler and Kiyotaki (2010)). More recently, Brunnermeier (2009) proposes that shocks that increase bank losses result in a decline in bank credit supply which affects both the capital expenditures and net debt issuances of bank dependent firms. Credit is then considered to be highly pro-cyclical, increasing in good times and declining in bad times. However, the cyclicality of lending may also depend on the relative demand for loans at different points of the business cycle.

A second claim of the narrow lending view is that there exists a set of borrowers that are dependent on bank loan finance who primarily finance their activities through bank loans. This class of borrowers suffer when the credit supply shocks lower the volume of bank lending.

These two perspectives of the lending view imply that demand and credit supply shocks differ in terms of the channels through which they are transmitted, as well as in their welfare effects. In particular, credit supply shocks are deemed to have cross-sectional effects that disproportionately affect bank dependent firms (Leary, 2009). Bernanke and Blinder (1988) and Kashyap and Stein (1996) argue that for the lending channel to operate,

bank dependent firms must be unable to substitute between bank loans and other forms of finance without costs when bank loan availability deteriorates.

However, supply and demand factors are notoriously difficult to identify separately, since observed levels of lending are an equilibrium outcome where supply and demand factors interact. Moreover, the sources of demand and supply variations, though different, may operate at the same time. According to Mishkin (1996) the dominant drivers of credit cyclicality include, on the supply side, savings squeezes and credit crunches; and on the demand side, collateral squeezes. All of these can occur at the same time.

2.3 Complementarity versus substitutions of debt components

Corporate bond markets tend to have high agency problems associated with them. As a result, corporate bond investors may require some evidence of bank monitoring for firms that seek bond finance. In this case, bond finance will act as a complement to bank loan finance. To the extent that this is true, a decline in bank loan supply will lead to an amplified decline in aggregate credit. This has important implications for financial stability, in that complementarity will tend to compromise the stability of the financial sector and its resilience to shocks. James (1987) claims that some firms tend to issue a portion of their debt privately and disclose the terms of their financing in order to signal the firm's true value to the market. In this case, bond financing also tends to complement bank loan financing as banks serve to provide a public good to the bond markets by certifying the true value of the firm. Datta et al. (1999) find that the extensive monitoring that arises from the existence of bank loans helps to reduce at issue yield spreads for initial public debt offerings. Where bank lending serves to complement the corporate bond issuance decision, we should then expect to see a positive relationship between bank lending and the corporate bond issuance decision. Diamond (1991), Song and Thakor (2008) and Hoshi et al. (1993) analyse the complementarities between capital market funding and bank loan financing.

CHAPTER 3

BANK LOAN SUPPLY AND CORPORATE BOND ISSUANCE: EVIDENCE FROM THE UK

Introduction

In this chapter we seek to identify and isolate the effects of bank loan supply on the debt issuance decisions of firms in the United Kingdom. We study the effects of bank loan supply on the financing choices and investment decisions of UK corporations using firm level data for the period 1994 to 2013, and examine whether there is evidence of a bank lending channel or the narrow credit view in the UK. We adapt the model of Becker and Ivashina (2014) to a UK context, and expand the analysis to incorporate different debt components, quantitative easing period effects and real investment effects.

Considering the differences in the financial structure of the US and the UK economies and the increased dominance of small to medium enterprises in the UK (Afme (2012), FCA (2016)), extending the Becker and Ivashina (2014) study to a UK context allows us to examine whether the Becker and Ivashina (2014) findings can be generalised to other market based economies with nascent and relatively underdeveloped bond markets (Breedon (2012)). Furthermore, our analysis considers both the public and private firms in the analysis as well as privately placed security issues by private non-financial firms.

In an analogous fashion to Becker and Ivashina (2014) we exploit the substitutability between bank loans and corporate bonds issues for rated firms with access to both markets, conditional on firms' issuing new debt, to proxy for changes in bank loan supply. We assume that firms that issue corporate bonds when they would otherwise have issued bank loans do so when bank loan supply declines.[5] Therefore, the observed substitution or change in the composition of debt issuance between corporate bonds and bank loans is indicative of bank loan supply conditions, as our methodology ensures these firms have a positive demand for accessing credit.

Unlike Kashyap et al. (1993) and Calomiris et al. (1996), the Becker and Ivashina (2014) fixed effects approach we adopt controls for changes in the composition of issuing firms, so the results cannot be explained away using arguments based on the heterogeneity of credit demand. Other studies that exploit changes in the composition of debt to isolate credit

[5] Adrian, Colla and Shin (2012) state that substitution between debt types reflect changes in bank loan supply and that it is the less constrained firms with access to bond markets that can easily substitute between loans and bonds.

supply effects include Kashyap, Stein and Wilcox (1993), Oliner and Redebusch (1996) and Calomiris et al. (1996). However, a major criticism of these studies is that the results are driven by changes in the composition of firms issuing debt, and as a result can be explained away using demand based arguments. Secondly, the fixed effects approach isolates movements in bank loan supply, controlling for demand effects by revealed preferences, as a firm that issues debt must have a positive demand for debt finance.

In this study we find that the substitutability between bank loans and corporate bonds in the debt structure of firms reflects changes in both aggregate credit conditions and in bank loan supply. We find that measurable substitutability between bank loans and corporate bonds exists during 2007-2009 the financial crisis and the subsequent quantitative easing period. This supports the assertion that the loan to bond substitution index we utilise captures changes in bank loan supply. Results also reveal that changes in bank loan supply have proportionately different effects across financially constrained and unconstrained firms. We define financially constrained firms as those firms appearing in the lower decile of the firm size portfolio. In particular, constrained bank dependent firms' inventory investment is significantly affected by changes in credit supply. As a result, bank dependent firms may face inventory and working capital challenges when bank loan supply declines.

For bank dependent firms, we find the decline in bank loan supply results in approximately twice as much of a decline in business inventory investment as compared to non-bank dependent firms. However, there are significant differences in the business fixed investment of both constrained and unconstrained firms following certain changes in bank loan supply.

The study proceeds in a number of steps. Initially, we estimate the impact of aggregate measures for credit supply on the propensity to issue bank loans relative to corporate bonds for firms with access to corporate bond markets. We test the prediction that rated firms with corporate bond market access issue bank loans relative to corporate bonds when bank loan availability is high, and issue corporate bonds relative to bank loans when bank loan availability is low. If shifts in aggregate proxies for credit supply explain the substitution between bank loans and corporate bonds for financially unconstrained firms, it strongly suggests that the observed substitutability is reflective of variations in bank credit supply.

Subsequently, we construct a measure for movements in bank credit supply based on the substitability between corporate bonds and bank loans for large firms with access to corporate bond markets and then use this measure to predict the debt issuance behaviour and financial policy of bank dependent firms. In particular, we investigate whether our bank loan to corporate bond substitution measure can predict investment, employment, and net debt issuance of constrained, bank dependent firms. We find that bank loan supply has a disproportionate effect on the investment behaviour of bank dependent firms relative to non-bank dependent firms, and the impact of bank loan supply on investments and employment is larger for bank dependent firms.

Our contribution arises from the fact that we are not aware of another paper in the UK that simultaneously: (i) examines the substitution between bank debt and corporate bonds, (ii) examines the impact of QE on debt issuance, (iii) studies the impact of various bank loan supply measures on debt issuance heterogeneity in the UK, and (iv) creates a clean measure for bank loan supply and examines the impact of bank loan supply on the real financing decision of the firms.

3.1.0 Literature review

An important feature of debt financing decisions is that they are jointly determined as a function of the firms' characteristics and their financial contracting environment (Cantillo and Wright (2000)). Firm characteristics reflect demand for debt as well as reveal information concerning borrower quality or credit worthiness and potential information asymmetry problems (Faulkender and Petersen (2006)). Firm characteristics also impact both price and non-price terms of debt financing. Collectively, these terms influence the rationing of credit and hence debt supply to firms, in particular, when monetary policy conditions tighten and credit rationing is severe (Bougheas et al. (2006) and Bernanke (1995)).[6] Mizen and Tsoukalas (2012) find that firms with good financial health face lower external finance premiums in the debt markets and have a high likelihood of obtaining public finance. Mizen et al. (2008) maintain that credit worthiness increases the likelihood of obtaining public debt. This evidence supports Blinder and Stiglitz's (1983) assertion that

[6] An important point to note is that even though markets tend to be informationally segmented and rationing in the credit markets is an equilibrium phenomenon, firms of high quality can access credit at high prices when credit conditions tighten while firms of low quality are completely rationed out of the market at every available interest rate. Firms in the middle of the credit spectrum may face quantity constraints (Stiglitz and Weiss, 1981). This rationing phenomena worsens during recessions where even firms of high repute are faced with increasing probabilities of default.

lenders view borrowers as imperfect substitutes, and as a result lenders may specialise in funding certain borrower groups. Similarly, borrowers have the same opinions about their lenders and thus fashion their demand for credit by factoring in differences in lenders and lending contracts.[7] For small and medium firms, bank lending plays a significant role in external financing since these firms may not be able to access alternative sources of external finance, and this gives rise to a bank lending channel (Bernanke and Blinder (1988)). Shifts in bank loan supply will, therefore, disproportionately affect small and medium sized firms that are largely dependent on bank loan financing.

3.2. Do changes in the contracting environment affect debt issuance?

Changes in the financial contracting environment affect banks' willingness to provide lending and through endogenous channels, affect both the future cash-flows from investments and the value of borrower collateral. In turn, this will affect firms' demand for finance. Leary (2009) finds that the introduction of the market for commercial deposits and the removal of the interest rate ceiling in 1961 in the US results in an increase in bank loan issuance while the credit crunch of 1966 results in a contraction in bank lending and an increase in corporate bond issuance. In a related study, Kaya and Wang (2014) find that an increase in banks' balance sheet constraints and increased risk perceptions leads to a reduction in bank loan supply, and propels an increase in corporate bond issuance. Both DeFiore and Uhlig (2012) and Bloom (2009) assert that an increase in banks' capital requirements enhance inefficiencies in bank lending, driving firms to seek market finance.

Observed debt issuance decisions and debt levels are thus an equilibrium outcome of demand and supply factors. As such, if demand and supply factors are difficult to isolate, then the transmission mechanisms of monetary policy may not be cleanly identified. In this study, we exploit the firm's revealed debt preference and employ the Becker and Ivashina (2014) fixed effects methodology to control for debt demand in the debt issuance decision. A detailed description of the fixed effects methodology applied in this study is presented in section 3.3.0. We examine whether bank loan supply fluctuation affect the propensity to issue bank debt relative to corporate bonds and in turn exploit firms' revealed debt preference to extract a clean measure for bank loan supply.

[7] This implies that capital structure, in particular, debt component structure matters for the borrower. Small firms with highly volatile cash-flows may value the renegotiation option of bank loans and thus may prefer intermediated debt to market finance.

3.2.1 Do fluctuations in bank loan supply affect corporate investment?

The outpouring of academic research on the role of bank credit in the macro economy since the global financial crisis seems to suggest that bank capital shortfalls, whether due to loan losses or regulatory changes, tend to reduce bank loan supply and to impact real output (Adrian and Shin (2009, 2010), Brunnermier and Sannikov (2009), Brunnermier (2009), Danielson et al. (2009) and Meh and Moran (2010)). Walsh and Wilcox (1996) in their paper on the role of bank credit in the macro economy find that reductions in bank lending tend to be correlated with reduced output. Bank loan supply shocks distort the distribution of credit within the economy in a manner that disproportionately affects bank dependent firms. The implication is that capital expenditure and net debt issuances of bank dependent firms will fall by a larger magnitude relative to their peers (Kahle and Stulz (2013)). Thus, bank dependent firms will not be able to switch between debt types without cost when bank loan supply declines. In the most extreme cases, bank dependent firms will not be able to raise any external debt finance. As a result, constrained bank dependent firms will suffer a decline in investment.

Since borrowers are heterogeneous and default rates differ between borrowers, the markets for low credit quality and high credit quality borrowers tend to be segmented. High credit quality borrowers have an ability to substitute between debt markets and the main form of rationing faced by these firms is through price. Low credit quality firms are completely rationed out of the credit markets by being declined credit altogether.[8] Because banks have unique information production technologies and monitoring capabilities, they can specialise in serving firms that would otherwise be completely cut out of the credit markets (Holmstrom and Tirole (1993, 1997)). Thus, when bank loan supply declines, bank dependent firms will find it expensive or difficult (or both) to replace bank finance. This is because alternative institutional sources of finance might not have information about the firms' credit worthiness. Blinder and Stiglitz (2001) find that due to information segmentation in credit markets, bank and non-bank finance are not close substitutes, and that most firms with no access to non-bank financial markets suffer the brunt of a decline in credit supply.

[8] Information is cheaply acquired for high credit quality firms and there are very little or negligible information asymmetries between investors and managers for these firms. As a result high credit quality firms have easy access to both bank and non-bank finance, and can offset a reduction in bank credit by increasing non-bank debt issuance. Consequently, the investments of unconstrained firms are not adversely affected by movements in bank loan supply.

Studies such as Lemmon and Roberts (2011), Leary (2009) and Kahle and Stulz (2013) exploit exogenous upheavals in the credit market to identify the impact of credit supply on the bank loan issuance and investment decisions of constrained versus unconstrained firms. These studies highlight that small firms that are dependent on banks suffer significant declines in investment when bank credit supply declines.

Vermoesen et al. (2012) in a study of the investment behaviour of Belgian SMEs in the period around the financial crisis find that SMEs with long term debt maturing around the time of the financial crisis fail to renew their loans during the crisis period, which results in an adverse spill over effect on the investments of SMEs. They highlight that the reduction in bank loan supply has significant real effects for Belgian SMEs which results in low aggregate investment.

In a related study, Duchin et al. (2010) while examining the credit supply effects of the recent global financial crisis on the investment behaviour of US firms find that the decline in bank loan supply during the financial crisis has significant adverse effects on the investments of constrained firms during the crisis. They find that the impact of the supply shock was greatest for firms with low cash reserves, high short term debt and which operate in industries that have high external finance dependence.

For unconstrained firms with very little information asymmetries, syndicated bank loans and corporate bond finance are close substitutes. Altunbas et al. (2009) find that syndicated loans are the most powerful substitute of corporate bonds in terms of funds and maturity provided. These unconstrained firms face very low external financing premiums for both bank loan financing and corporate bonds since information is readily available for these firms and information asymmetry problems are minor (Becker and Ivashina (2014)). Altunbas et al. (2009) note that in the EU, firms that issue syndicated loans and corporate bonds have similar characteristics in that they have high credibility and profitability but have fewer growth options. A prediction that proceeds from this theory is that investments of unconstrained firms and those firms that fund themselves internally remain unaffected by movements in bank loan supply. In this study we extract a clean measure for bank loans supply by exploiting the revealed debt preference of debt issuing firms to extract a clean measure for bank loan supply and then analyse whether this measure for bank loan supply can predict the debt issuance behaviour and investment and hiring decisions of UK non-financial firms (Chapter 4).

3.3.0 Methodology

In this study we adopt a recent methodology proposed by Becker and Ivashina (2014) to isolate time series movements in bank loan supply and analyse the link between bank loan supply and bank loan to corporate bond substitution. The equation we estimate is of the following form:

$$D_{it} = c_i + \beta B_t + \gamma X_{it} + e_{it} \quad (1)$$

Where the dependent variable D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond in a given time period, t, c_i represents firm fixed effects (which are within firm, time invariant effects); B_t is a time series measure capturing bank's willingness to lend or bank credit conditions; and X_{it} is a set of time variant controls specific to the firm i. The coefficient of interest in the regressions is β. Although the time series variable B_t for credit supply may correlate with aggregate bank loan issuance, reflecting the time series variation in either credit demand or credit supply, including only firms that have a positive debt demand in the sample allows us to extract the effect of bank loan supply. A key enabler to the identification of bank loan supply is the inclusion of c_i, the firm fixed effect. Data employed in the study is measured at a quarterly frequency. Firm-quarters where the firm does not issue debt or where both corporate bonds and bank loans are issued are excluded from the sample.

Becker and Ivashina (2014) argue that the inclusion of firm fixed effects is central to the identification of bank loan supply. This is because including the firm fixed effects demeans the firm level variables and the implicit dependent variable reduces to $\ddot{D}_{it} = (D_{it} - \overline{D}_i)$, where $\overline{D}_i$ is the firm level mean. As a result, the firm average is not used to identify coefficients in the regression model. If a firm only issues corporate bonds ($D_{it} = 1, \forall\, t$), or only issues bank loans ($D_{it} = 0, \forall\, t$) then $\ddot{D}_{it} = 0, \forall\, t$. This implies that firms that only issue one form of debt effectively do not add identification power to the estimated coefficient β in the model. Therefore, the coefficient of interest, β, can only be identified using firms that switch between debt types. In addition, the sign and magnitude of β is driven by firms that switch between debt types. More importantly, a firm that appears only once in the sample does not affect the identification power and the economic magnitude of β as it will be eliminated by the fixed effects model.

The identification mechanism in Becker and Ivashina (2014) is that in times when bank credit supply is restricted, firms issue bonds because bonds are either cheaper or more

accessible than bank loans.[9] They use the revealed preference for a certain debt type as a proxy for variation in credit supply. However, some firms may either be unconstrained or unaffected by changes in the loan supply so that they do not change their debt type. Including these firms in the fixed effects regression as well as firms that never have access to the bond market biases the β coefficient towards zero, since their debt choice is invariant to changes in bank loan supply. In order to reduce this downward bias on the β coefficient, we limit the sample to firms that issue debt within the last 10 years of its most recent issue. Although this filter reduces the bias in the estimated β coefficient, it removes a significant number of firm without access to the corporate bond markets and some firms that do not switch between different debt types. As part of the robustness tests we further restrict the sample to firms that issued debt within 5 years of their most recent issue.[10] The use of a 5 year filter further reduces the sample but does not eliminate the bias in the regression equation.

Secondly, the sample is made up of firms with a positive demand for debt. The procedure excludes the impact of funding constraints on weak firms that in previous years issued bank loans or corporate bonds but did not issue debt during periods when credit conditions were severely tight. Since the demand for debt by these firms is not observable, we do not know whether these firms do not issue debt for demand or supply reasons. However, if some of the weak firms that previously issued debt had non-zero demand for debt but were not able to obtain credit during a recession, excluding the firm quarters where these firms did not issue debt will result in us ignoring periods where credit constraints were severe and credit supply is low, and during which some firms are rationed out of the market. As a result, dropping the quarters in which firms that previously issued debt have no debt issues also biases the coefficient β towards zero. In order to limit the effect of this bias, we also limit the sample to firms that issue debt within 10 years of its most recent issue, as above.

For a firm to be included in the regression, the firm must issue debt at some point between 1994 and 2013. Each observation corresponds to a new issue of bank loans or corporate

[9] Colla, Ippolito and Li (2013) find that firms tend to specialise in their debt issuances. That is, once a firm issues one form of debt they stick to that form of debt. They can only be induced to switch to another debt type when credit conditions change.

[10] We recognise that the fixed effects assumption over a 20 year period is a very strong assumption as demand effects may no longer be time invariant over this time period. As a result, we employ the 10 year filter and the 5 year filters for our samples in order to test the sensitivity of this fixed effects assumption. Results of these filters are presented in the robustness section of this paper.

bonds (public debt). We exclude observations for which a firm issued both a loan and a bond within the same quarter.[11] If a firm did not issue either a loan or a bond in a given quarter, the firm-quarters for which the firm has no new debt issues are excluded from the regressions. Firms that have no debt issues are excluded from the sample. It is not clear whether firms with no debt issues had no demand for debt or were simply rationed out of the debt markets. If these firms have positive demand for debt during a market downturn but have no access to the debt markets, excluding these firms biases the β coefficient towards zero. However, since the debt demand of non-issue firms is unobservable, we exclude these issues altogether.

In line with the Blinder and Stiglitz (2001) and Adrian et al. (2012) we argue that it is only firms that have access to both markets that are able to substitute between debt types. We maintain that for firms with access to both debt markets, bank loans and corporate bonds are close substitutes and these unconstrained firms aggressively switch between debt types when credit market conditions change. We exploit the switching between bank debt and corporate bonds by firms with access to both debt markets to trace changes in bank-loan supply.

In the first part of the regression we investigate the substitution hypothesis using a linear probability model and proxies for changes in bank loan availability or supply. Angrist and Piscke (2008) highlight that while non-linear models may fit the population conditional expectation function better than linear models, this matters little when it comes to marginal effects. Furthermore, the estimated β coefficient are easily interpretable (Hellevik (2007)). Since the probabilities of issuance are not extreme, that is very close to zero or very close to one for the switching firms, we expect the linear probability model to fit the data equally well. More-so, since our interest is primarily on the marginal effects, we make use of the linear probability model.[12] Moreover, the fixed effects model we employ in this study allows us to control for heteroskedasticity and thus to obtain fairly reliable t statistics (Long (1997)).

We employ the non-performing loans ratio, the Libor-base rate spread, FTSE Banks index, aggregate lending growth and survey based credit conditions measures as proxies for bank

[11] Adrian et al. (2012) and Becker and Ivashina (2014) also exclude firms with mixed debt issues during the same quarter.

[12] However, if the true probabilities of issuance are extreme, the linear probability model can yield probabilities that are greater than 1 or less than 0.

loan availability. In the second stage we create our substitutability measure as a proxy for bank loan supply and examine whether our bank loan supply measure can predict the debt issuance behaviour of constrained bank dependent firms. In chapter 4 we test whether bank loan supply affects the decisions of UK non-financial companies.

3.4.0 Firm level data

3.4.1 Firm level debt issuance data

The new debt issuance data utilised in the study is sourced from the SDC platinum and the LPC databases for the period 1994 to 2013. All new debt issues by financial companies (US SIC codes 6000 to 6799), not for profit enterprises, parastatals and non UK companies are excluded from the sample.[13] For a firm to be included in the multivariate analysis we require the firm to have issued new debt at least once between 1994 and 2013. For every firm quarter in our sample, we set the new-debt-issue equal to one if the firm issued a bank loan and zero if the firm issued a bond.

We conduct our analysis at the deal level and rather that the debt facility level. As such we aggregate facilities of a similar nature that are issued by the same firm in the same quarter. However, Maskara (2010) notes that facilities may be used as a diversification device for which firms with higher risks may take loans with different facilities. As a result, these may mask the impact of financial frictions on debt choice when aggregate measures are used.

Firms for which total assets are missing or are negative are dropped from the sample. Data is winsorised at the 1% and 99% levels. The characteristics of the firm that issue bank loans or corporate bond are presented in Table 1 below.

[13] Managers of not for profit organisations and government entities may be constrained by government regulation and policies and may not have discretion or influence over the firm's investment and financing decisions.

Table 1: Firm and Issue Characteristics

The definition of the variables in this table are provided in Table 2. The table presents the minimum, mean and maximum values for firm and debt characteristics by debt type. The student t-statistic provides the statistical significance of the differences in means between bank loan and corporate bond issuers. The asterisks *, **, *** represent statistical significance at the 10%, 5% and 1%, respectively.

	Bank loan issuers			**Bond Issuers**			**Student t-statistics**
	Min	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Differences in Means**
Firm characteristics							
Total assets (Th)	51,388	5,200,460	11,107,000	52,054	7,779,716	157,000,000	3.0280***
Tangibility	0.0540	0.3400	1	0.050	0.2680	1	-6.0045***
Net leverage	-0.5260	0.2440	0.9900	-0.2890	0.2120	0.9810	-2.2303**
Leverage	0	0.4150	0.9600	0.050	0.3850	0.9990	-1.7400*
Cash ratio	0	0.0780	0.7420	0	0.1290	0.7080	9.6190***
Capital investments	0	0.0580	0.6000	0	0.0780	0.8220	3.2746***
Employees	1	18,823	639964	1	26,098	648254	3.0236***
Issue characteristics							
Issue size (£Th)	29,848	1,294,153	5,500,000	1,000	836,819	11,700,000	-4.6410***
Maturity (Years)	1	4.661	23	1	4.428	35	-1.3028
Average spread (basis points)	84	227	1043	84	237	1590	-15.8030***

The average bond issuing firm in this sample has approximately £7.8 billion in total assets, of which 26.8% of those assets are tangible. Bond issuers, on average, maintain a leverage ratio of about 38.5% and hold approximately 12.9% of their assets as cash and cash equivalents. The average bank loan issuer has £5.2 billion in total assets of which 34% of those assets are tangible. Compared to bond issuers, bank loan issuers have leverage ratios of approximately 41.5%, and cash ratios of about 7.8%. The t-statistics on the difference in means between the two samples of firms reveal that bond issuers and bank loan issuers have different characteristics, and that these differences are statistically significant.

An examination of the average issue characteristics reveal that although the bank loans and corporate bond that were issued during the sample have equal average maturity periods. This is consistent with Faulkender and Petersen (2005) who claim that syndicated loans and corporate bonds are comparable across a range of maturities. However, bonds generally tend to have longer maturities than loans (Barraza, Civelli and Zaniboni (2016)). The average bank loan has a spread of approximately 227 basis points while the average bond in the sample has spreads of approximately 237 basis points. This finding is consistent with the findings of Rauh and Sufi (2008) on the US market who finds that non-bank debt has higher interest spreads. Secondly, the syndicated loans in the sample tend to be very large relative to corporate bond issues. The average syndicated loan issue is £1.3 billion compared to an average corporate bond issue size of £837 million.

However, we note that the Dealscan database has a wider coverage of syndicated loans relative to bilateral loans (Ivashina (2009)). As a result, our loan issuance results are likely to be biased towards syndicated loans. But since these loans are close substitutes for corporate bonds for large firms, this is unlikely to be a major issue in our identification of bank loan supply. Faulkender and Petersen (2005) and Johnson (1997) indicate that syndicated loans and corporate bonds are treated the same during bankruptcy proceedings and tax computations, can be compared for different ranges of maturities and characteristics for repayments, as well as securitisation and covenant structures.

Below we summarise the frequency of UK non-financial firms' debt issuance in the sample over the period 1994 to 2013.

Bonds database SDC platinum	
Total Observations	27312
Matched to accounting data	3969
Unmatched to accounting data	23343
Bank loans (LPC DataStream)	
Total issues	7462
Matched to accounting data	3662
Unmatched to accounting data	3840

The combined dataset contains 6703 observations including dissolved institutions and firms that are currently under liquidation or recuperative care. We remove firms for which the total assets are negative or missing.

Following Erel et al. (2011) and Gomes and Phillips (2007), issues of a similar type but with different terms by the same firm in the same quarter are aggregated and the terms of issue are weighted by the amount raised from the debt issue. Perpetual bonds are excluded from the sample since perpetual bonds are similar to equity in nature albeit they are senior to equity in bankruptcy.

We employ the Bank of England credit conditions survey data on six major components of the credit conditions survey, namely; changes in credit availability, changes in risk appetite, changes in macroeconomic outlook, tightening in lending standards, sector risks and market pressure. The changes in credit availability variable captures lender's willingness and ability to provide credit, holding bank loan demand constant. Similarly, changes in risk appetite measure changes in banks' lending behaviour that are attributable to changes in the lenders' risk preferences, holding credit demand constant.

Changes in economic outlook refer to changes in the outlook for output, employment and inflation as well as any other significant economic factors that are deemed to affect credit supply. Tightening in lending standards measure changes in the lender's willingness and ability to provide credit that are linked to a tightening of funding conditions on wholesale funding market. A tightening of wholesale funding conditions inhibits the capacity of banks to engage in maturity transformation and thus lowers the willingness of banks to extend credit. This effect is deemed to have first order effects on bank loan supply.

The sector specific risks variable measures the impact of sector specific developments that may make lending attractive to those sectors. This variable captures developments that are significant enough to affect the risk reward relationships of lending to various sectors.

Lastly, the market pressures variable reflects changes in loan supply that are driven by changing competitive objectives and behaviour of banks as opposed to changes in the underlying fundamentals that drive lending. These include changes in spreads that are related to competition or product promotion, relative to other lenders in the market.[14]

The Bank of England's credit conditions survey data is relevant in studying the impact of credit supply in that the questionnaire for the banking industry contains questions that are directly linked to factors affecting bank's willingness to provide finance. An examination of the issuance behaviour of firms with access to both debt markets gives us further indication of whether observed substitutability is reflective of changing supply conditions rather than a mere shift in firm's financing preferences that are unrelated to credit supply conditions. A detailed description of the measurement methodology applied by the Bank of England in measuring the six components of the credit conditions survey is provided in section 3.6.1.

3.4.2 Accounting information

Public firms are required by the Financial Conduct Authority (FCA), under the powers conferred to it by the Companies Act 2006, to publish quarterly interim results. For most public firms in our sample, we obtain quarterly reports from the Bureau Van Djirk Orbis and Osiris databases. Quarterly reports are available consistently on the Orbis and Osiris databases for the period 2004 to 2012 when the FCA disclosure and transparency rules (DTR 4.3) are in effect.[15] The regulations, introduced as part of the EU transparency directive, are designed to improve the quality and flow of information available to investors. Selected interim financial statements for the periods before 2004 are sourced directly from company's quarterly management accounts submissions in the Bureau Van Dijk Orbis database listed companies' additional section. End of year financial results are obtained from FAME and DataStream. Selected interim and quarterly financial statements for private issuer firms are obtained from company quarterly submissions and issue prospectus. Firms for which total assets are missing or negative are dropped from the sample. A summary of the descriptive statistics is provided in Table 1.

A list of variables, definitions and data sources is provided in Table 2 below.

[14] Banks take different approaches to lending when market pressures increase. Some banks scrap arrangement fees, others offer guaranteed discounted borrowing costs whilst others offer cash back schemes.

[15] In 2015, the Financial Conduct Authority scrapped rule DTR4.3 and other consequential amendments (e.g. 6.3.5 R(3)C) requiring public companies to publish quarterly results. The removal of the rule was done to encourage more long term thinking in the stock markets.

Table 2: Data sources and Variable definition

The table presents the variable definitions, the source of the data used to generate the variables and the previous studies that have employed the same variable in their analysis.

Variable	Definition	Source	Other studies
Assets	Total assets	FAME and Orbis	
Cash ratio	(bank deposits + short-term investments)/ Assets	FAME and Orbis	Detragiache (1994),
Leverage	(Short term debt+ Long-term debt)/ Assets	FAME and Orbis	Mizen et al. (2007), Erel et al. (2011), Leary (2009)
Net Leverage	(Short term debt+ Long-term debt- Cash- short term investments)/ Assets	FAME and Orbis	Adrian et al. (2012)
Short-term debt	Debt in current liabilities/ Assets	FAME and Orbis	Duchin et al. (2010), Diamond (1991) Denis and Mihov (2003)
Dividend Payer	Dummy equal to one if dividends>0, and zero otherwise	FAME and Orbis	Adrian et al. (2012)
Size	Log(1+Total Assets)	FAME and Orbis	Faulkender and Petersen (2006), Becker and Ivashana (2014), Adrian et al. (2012)
Sales growth	Growth rate in annual sales	Orbis	Childs et al. (2005), Johnson (2002)
Capex	Total capital expenditures/ Assets	FAME and Orbis	Adrian et al. (2012)
Bonds			
Loans			
Loan spread			
Bond spread			
ROA	EBIT/Assets	FAME and Orbis	Denis and Mihov (2003)
Tangibility	Tangible assets (PPE)/ Assets	FAME and Orbis	Becker and Ivashana (2014), Rajan and Zingales (1995), Pulvino (1998) Faulkender and Petersen (2006)

3.5.0 Benchmark hypothesis

In this section we test whether the observed substitutability between bank loans and corporate bonds captures movements in credit supply for firms with access to corporate bond markets. We predict that bank loan issuance is positively associated with increases in credit availability, and that corporate bond issuance increases during periods when bank credit supply is low. We employ a number of time series variables namely the non-performing loans ratio, aggregate bank loans growth, Libor-base rate spread, term spreads and survey based measures as controls to capture environments of limited bank intermediation.

The first variable is the non-performing loans ratio, which measures realised losses from lending. Increases in the volume of non-performing loans commonly occur when macroeconomic conditions and business profitability deteriorate. A high level of non-performing loans is associated with a tightening of lending conditions and a decline in bank loan supply (Berger and Udell (2004)).[16] As a result, we expect the level of non-performing loans to be negatively correlated with bank loan issuance. Data for the non-performing loans is obtained from the Bank of England.

The second variable is the aggregate bank loans growth rate. This is measured as a four quarter rolling window growth in total banking sector loans compiled by the Bank of England. We predict a positive relationship between bank loan issuance and bank loan growth since an increase in bank loan growth is associated with an increase in bank loan supply.

The LIBOR-Base rate spread is used as a measure of stress in the banking sector. This spread is measured using the 3 months LIBOR and 3 months overnight rates on unsecured lending by the Bank of England. This measure is the UK equivalent of the LIBOR-OIS spread, and acts as a proxy for stress in the interbank markets and perceptions of bank risk stress. An increase in the spread reflects an increase in risk in the banking sector, and thus a decline in bank loan supply.

[16] Non-performing loans represent a real constraint on bank lending since banks are required to provide capital for non-performing loans. An increase in non-performing loans implies higher capital provisions or write offs and thus real losses from lending. However, banks' response to changes in non-performing loans may differ depending on whether the ratio is above or below the prudential requirements.

The bank risk appetite measure is obtained from the Bank of England's credit conditions survey report. A positive risk appetite index reflects an average increase in the number of banks reporting an increase in their risk appetite, and thus their lending business in the last quarter. A negative index implies that banks reduced their risk taking in the last quarter. The bank risk appetite index is used to proxy for bank risk taking and thus bank loan supply. Adrian, Estrella and Shin (2009) and Adrian and Shin (2010) argue that there is a direct relationship between bank balance sheet conditions and bank risk taking, where a deterioration in lender balance sheets decreases the willingness of banks to supply credit. Therefore, we predict that there is a positive relationship between bank loan issuances and our bank risk appetite measure from the credit conditions survey.

We also employ the logarithm of the FTSE 350 Bank stock index to measure changes in banking sector performance. The index is comprised of banking stocks on the FTSE 350 index. Unlike the non-performing loans ratio which is a backward looking measure, the bank stock-index is a forward looking measure of banking sector performance (Becker and Ivashina, 2014). An increase in the index reflects an improvement in banking sector performance, and therefore an expansion of bank lending.

The term spread captures changes in the yield curve and is used to proxy for credit supply and market timing incentives. A widening of the term spread implies a tightening of credit conditions while a narrowing of the term spread indicates an increase in aggregate credit supply. We expect bank loan issuance decision to be negatively related to term spreads. The spread is calculated as the difference between the yields of 10 year UK Government bonds and 1 year UK Treasury securities and data is collected from the Bank of England. Note that the term spread measures changes in aggregate credit conditions and hence may not adequately capture fluctuations that are specific to the banking sector.

Finally, we also test the hypothesis that the quantitative easing policies of the Bank of England result in an increase in corporate bond issuance over and above the substitution effects triggered by changes in bank loan supply. We conjecture that asset purchases by the Bank of England spur an increase in corporate bond issuance through a number of channels. However, in this study we do not seek to differentiate between the different transmission channels of QE but we conjecture that debt issuance occurs through the portfolio rebalancing activities of economic agents. QE is measured in two ways, first as a period level dummy equal to one for the period March 2009 to December 2012 and zero

otherwise, and second as two separate period level dummies where QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, and QE2 is also a binary variable equal to one for the period October 2011 to December 2012 and zero otherwise.

3.6.0 Benchmark Results using measure of credit supply in bank lending

We present our results in Table 3. The first finding is that an increase in non-performing loans, which reflects a reduction in bank loan supply, increases firm's preference to issue corporate bonds relative to bank loans. This result supports the hypothesis that firms issue corporate bonds when bank loan supply declines following an increase in nonperforming loans. It also supports the view that observed substitutability between corporate bonds and bank loan issuance reflect changes in bank loan supply. This is consistent with the findings of Leary (2009) who observes that firms with access to public debt markets substitute from private debt to public debt when bank loan supply deteriorates. However, results on the FTSE350 Bank Index and the Libor-Base rate spread do not reveal any significant relationship between bank loan issuance behaviour and changes in bank performance and money market conditions, respectively.

Contrary to Becker and Ivashina (2014), the coefficient on bank loan growth in column 2 indicates that an increase in bank credit availability increases the propensity to issue corporate bonds relative to bank loans. The negative correlation between bank loan issuance and bank loan growth may capture a general increase in demand for corporate bonds. The changes in aggregate bank loan growth may also reflect a shift in the capital supply schedule that may affect all capital markets.

The results for the credit conditions survey data show that an increase in bank's risk appetite which reflects an increase in bank loan supply would result in firms issuing more bank loans relative to corporate bonds. Table 3 reveals that variations in the debt mix tend to capture movements in bank credit availability.

The statistical insignificance of the term spread in the bank loan to corporate bond issuance decision is consistent with the findings of Barry et al. (2008) that term spreads are not significantly associated with debt issuance. This insignificance of the term spread may reflect the fact that the variation in debt mix is driven by market timing incentives. However, one weakness of the term spread as a proxy for market timing effects is that the measure is not free of duration effects. Moreover, the negative relationship between the

term spread and bank loan issuance supports the view in Adrian, Colla and Shin (2012) that an increase in spreads will result in a contraction of bank loan supply, and a decline in the proportion of bank loans in firms' debt structures as firms substitute away from bank loans.

Results on the quantitative easing period level dummy variables reveal significant differences in the period effects of the quantitative easing program on the bank loan versus corporate bond issuance decisions. The results show that the first phase of the quantitative easing program (QE1) from March 2009 to December 2009, results in an increase in corporate bond issues while the second phase of the quantitative easing program (QE2) from October 2011 to December 2012, is positive but insignificant in influence debt issuance. The evidence of an increase in corporate bond issuance in the first phase of quantitative easing is consistent with Fisher (2010) and Joyce et al. (2011) who report that net corporate bond issuance in 2009 was stronger than had been recorded during the 2003 to 2008 period. This result provides evidence that the initial phase of the quantitative easing policy may have helped spur corporate bond issuance by UK non-financial firms during this period, thereby fulfilling the Bank of England's original policy intention. The Bank of England (2009) asserts that the Asset Purchase Facility (APF) is designed to increase the availability of corporate credit by easing credit conditions in the corporate debt markets. In particular, that the APF is designed to lower risk and liquidity premiums in the corporate bond markets, and to bolster secondary market activity in this market, in order to stimulate primary market issuance (Joyce et al. (2011) and Fisher (2010)) .

Table 3: Bank loans vs bond issuance

The dependent variable is equal to 1 if a firm issues a bank loan and 0 if it issues a bond. The results are estimated using OLS and control for firm fixed effects. The regression is estimated using a fixed effects regression model of the following form:

$$D_{it} = c_i + \beta B_t + \gamma X_{it} + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively. The model is estimated for the period 1994 to 2013. For a firm to be included in the sample it must have issued either a bond or a bank loan at some point between 1994 and 2013. QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, while QE2 is a dummy variable equal to one for the period October 2011 to December 2012.

Mean (Bond issues)	0.401	0.385	0.385	0.295	0.401	0.385	0.318	0.401	0.401
				2007-2013	QE1&2			QE1	QE1 &QE2
Non-performing loans	-10.4730**								
	(-2.08)								
Bank loan growth		-0.2474*							
		(-1.77)							
Term spread			-0.0084						
			(-0.93)						
Credit conditions survey- Risk appetite				0.0022*					
				(1.82)					
QE1 (Level Dummy)					-0.2772			-0.0700***	-0.0632***
					-1.20			(2.92)	(-2.41)
QE2 (Level Dummy)									0.0219
									(0.92)
Libor-Base rate spread						0.0109			
						(0.59)			
Log FTSE350 Bank Index							0.0095		
							(0.38)		
Size	0.0191	0.0035	0.015	0.0454	0.0259	0.0024	0.0019	0.0066	0.0035
	(0.73)	(0.14)	(0.6)	(0.98)	(0.18)	(.19)	(0.13)	(0.10)	(0.23)
Tangibility	0.3200**	0.3570***	0.310**	-0.226	0.157**	0.2072**	-0.0201	0.1549**	0.173**
	(2.36)	(2.88)	(2.46)	(-1.09)	(2.07)	(2.47)	(-0.24)	(2.17)	(2.30)
Roa	0.0216	0.0046	-0.0009	-0.0282	-0.0518	-0.0360	-0.0850**	-0.0347	-0.0542

Table 3: Bank loans vs bond issuance

The dependent variable is equal to 1 if a firm issues a bank loan and 0 if it issues a bond. The results are estimated using OLS and control for firm fixed effects. The regression is estimated using a fixed effects regression model of the following form:

$$D_{it} = c_i + \beta B_t + \gamma X_{it} + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively. The model is estimated for the period 1994 to 2013. For a firm to be included in the sample it must have issued either a bond or a bank loan at some point between 1994 and 2013. QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, while QE2 is a dummy variable equal to one for the period October 2011 to December 2012.

Mean (Bond issues)	0.401	0.385	0.385	0.295	0.401	0.385	0.318	0.401	0.401
				2007-2013	QE1&2			QE1	QE1 &QE2
	(0.24)	(0.05)	(-0.01)	(-0.28)	(-1.04)	(-0.78)	(-2.05)	(-0.83)	(-1.08)
Lev	0.0004	-0.0165	-0.0068	-0.0033	-0.0161	-0.0446	-0.0530	-0.0186	-0.0057
	(0.01)	(-0.47)	(-0.21)	(-0.05)	-0.036	(-0.92)	(-0.76)	(-0.92)	(-0.13)
Divpayer	-0.1750***	-0.1940***	-0.1960***	-0.0825	-0.0990***	-0.0120***	0.0062	-0.0990***	-0.103***
	(-2.61)	(-2.96)	(-3.05)	(-0.85)	-2.80	(3.06)	(0.18)	-2.81	(-2.87)
_cons	0.1870	0.3620	0.2020	-0.1950	0.6404***	0.6820***	0.5376*	0.7353***	0.710***
	(0.53)	(1.06)	(0.6)	(-0.31)	(3.23)	(3.63)	(1.78)	(3.79)	(3.49)
N	2174	2285	2285	1225	2285	2020	1336	2285	2285
Rsqr	0.6809	0.6936	0.6897	0.5998	0.6845	0.6808	0.6643	0.69005	0.6927
F statistic (prob)	0.0045	0.0009	0.0025	0.0000	0.0022	0.0004	0.5912	0.0000	0.0016
Companies (Fixed effects)	728	738	738	490	738	697	546	738	738

The coefficient on the QE2 period level dummy variable indicates that the propensity to issue bank loans relative to corporate bonds increases during the second phase of the quantitative easing program (QE2).[17] However, the coefficient is not statistically significant and has no economic effect in the model. This finding is in line with the claim by Borio and Disyatat (2009) that the second phase of the quantitative easing program does not translate into an increase in lending since banks are not reserve constrained. However, the result is inconsistent with Fisher (2013) who reports that corporate bond issuance increase during the second phase of the quantitative easing program, driven by an intensification of the search for yields on the lower end of the credit spectrum as investors driven by return targets, mandates and benchmarks sought higher returns. Overall, the results indicate that the two phases of the quantitative easing program had different effects on debt issuance decisions of UK non-financial firms. However, these preliminary results on quantitative easing do not account for debt substitution arising from countercyclical shifts in corporate bond issuance following adverse changes to bank loan supply. We further examine the interaction effects of the quantitative easing program in section 3.7 of this chapter.

The results of the control variables reveal that firms with more tangible assets are more likely to issue bank loans relative to corporate bonds. This result supports the view that financially constrained firms that have high information asymmetries issue bank loans and use collateral to increase the bargaining power of banks in liquidation. Consistent with Becker and Ivashina (2014), the results in Table 3 also reveals that dividend payers are more likely to issue corporate bonds relative to bank loans since companies that issue dividends are less financially constrained. However, the coefficients on the remaining control variables are not statistically significant.

3.6.1 Credit conditions survey based measures-Bank of England data

The data we use to capture credit conditions is obtained from the Bank of England credit conditions survey and is available from quarter two of 2007 on the Bank of England online data repository. The credit conditions survey requests UK banks to respond to a set of questions that detail the credit conditions in the last quarter, and their expectations of credit conditions in the quarter in which the survey is completed. The results of the survey are based on lenders' responses. Each lender's response is given a score based on

[17] It is possible that the relative increase in bank loan issuance captured by the QE2 dummy variable relates to the impact of the Funding for Lending Scheme (FLS) that was implemented in June 2012, when QE2 was still in effect, in order to stimulate lending to SMEs and Households. However, the FLS scheme can also be broadly classified as quantitative easing.

subjective criteria. Lenders who report that conditions have changed markedly are given twice the score of those who report that conditions have marginally changed. These scores are then weighed by lenders' market shares and net percentage balances are calculated as the difference between the weighted balances of lenders reporting that lending conditions were tighter versus those reporting that they were looser. The net percentage balances are scaled to lie between +/-100. A positive score indicates that changes in the factor serve to increase credit availability while a negative score indicates that the factor serve to reduce credit availability.

We retrieve survey responses from the lending to nonfinancial companies table of the Bank of England's credit conditions survey responses. In this study we employ the scores on the major six components of the credit conditions survey that are used to inform the monetary policy committee on conditions in the credit markets namely: tightening of credit conditions, bank risk appetite, market pressure, changes in the macroeconomic conditions, changes in credit availability and sector risks.

In this section we examine whether the substitutability between corporate bonds and bank loan issuance captures changes in bank loan supply conditions as reported in the Bank of England's credit conditions survey. We test the hypothesis that a decline in bank loan supply operating either through increased tightening of credit conditions, reduced bank risk appetite, or a deteriorating economic outlook among other factors, increases the likelihood of issuing corporate bonds relative to bank loans for unconstrained firms.

The dependent variable in the regressions is a dummy variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond. The regressions are estimated using a panel linear probability model, controlling for firm fixed effects. The specification of the regression equation is given in equation 1 above. Firm level control variables include firm size, leverage, profitability, tangibility and an indicator for dividend paying firms. The coefficients of the credit supply variables are reported in Table 4 below. Each coefficient in the regressions represents a separate regression equation. The variable Actual represents what the banks provide as the explanation for the realised lending in the last quarter, and the expected variable captures banks responses about their expectations for the next quarter.

Table 4: Effect of credit conditions on bank loan vs bond issuance

The regression is estimated using a fixed effects regression model of the following form:

$$D_{it} = c_i + \beta B_t + \gamma X_{it} + \varphi_i + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The asterisks *,**,*** represent statistical significance at the 10%, 5%, 1% levels, respectively. The results in this table report the β coefficients. Each coefficient represents a separate equation. Coefficients on the X_{it} variables are not reported in this table for the sake of brevity. Each coefficient in panels A and B represent a separate regression equation while panel c presents results of three regression equations. QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, while QE2 is a dummy variable equal to one for the period October 2011 to December 2012.

	Changes in credit availability	**Changes in Risk appetite**	**Changes in macroeconomic outlook**	**Tightening in lending standards**	**Sector risks**	**Market pressures**
			Panel A (All firms(490))			
Actual	-0.0005	0.0022*	0.0004	0.0001	0.0007	0.0008
Expected	-0.0013**	0.0022*	0.0004	-0.0005	0.0002	0.0008
Obs	1225	1225	1225	1225	1225	1225
			Panel B: Rated only (244 companies)			
Actual	-0.0007	0.0006	0.0065**	0.0013***	0.0004	0.0000
Expected	-0.0004	0.0010	0.0074**	0.0008***	0.0005*	0.0005
Obs	780	780	780	780	780	780
			Panel C: Rated only with QE intercept dummies			
Panel C: Coefficients in this panel are for the QE1 and QE2 intercept dummies for Rated firms						
QE1	-0.0428***	-	-0.0516***			
QE2	-	-0.0110	-0.0296**			
Obs	780	780	780			
F stats (prob)	0.0539	0.1016	0.0801			
R sqr	0.5086	0.5025	0.5097			

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Results on the full sample in Table 4 (panel A) reveal that for unconstrained firms, an expected improvement in credit availability increases the likelihood of issuing corporate bonds relative to bank loans. The results also show that the banks' risk appetite, whether current or expected, is significantly correlated with an increase in bank loan issuances relative to corporate bond issues. A one standard deviation increase in bank's risk appetite in the current period (4.386), which implies an increase in bank credit supply, increases the likelihood of a firm issuing a bank loan relative to a corporate bond by 1% (0.00221*4.386). Conversely, a decline in bank's risk appetite increases the probability of issuing corporate bonds by a similar magnitude.

The results for rated firms in Panel B of Table 4 show that when credit conditions loosen by one standard deviation, represented by a positive value for lending standards of 7.99 index points, bank loan issuances increase by 1.04% relative to bond issuances. While an expectation of looser credit conditions in the next quarter increases the likelihood of bank loan issuances by 0.83%. The propensity to issue bank loans relative to corporate bonds increases in response to an improvement in the economic outlook and a reduction in sector risks for rated firms. A one standard deviation expected improvement in future macroeconomic conditions and sector risks increases the propensity to issue bank loans relative to corporate bonds by 6.81% and 0.29%, respectively. This result is consistent with De Fiore and Uhlig (2012) who point out that bank loan issuance behaves in a procyclical manner.

Notably, the results also indicate that changes in credit availability and bank risk appetite have no significant effects on the debt issuance behaviour of rated firms. The results for the sample of rated firms may imply that changes in credit conditions have asymmetric effects on the issuance behaviour of UK non-financial firms. Relative to the full sample, rated firms tend to respond to changes in macroeconomic conditions, sector risks and tightening of lending conditions but are generally unaffected by changes in bank risk appetite and changes in credit availability. Moreover, the corporate bond issuance of rated firms tends to be countercyclical, increasing when macroeconomic conditions and credit conditions tighten and decreasing relative to bank loan issuance when macroeconomic conditions and bank intermediation improves. This finding lends support to the counter-cyclicality of corporate bond issuance documented in Erel et al. (2011) and Contessi et al. (2013). This result supports our hypothesis that observed substitutability between corporate bonds and bank loans reflects changes in credit availability.

Preliminary results in Panel C of Table 4 on the impact of the different phases of the quantitative easing program on the debt issuance behaviour of rated firms reveals that both phases of the quantitative easing program, QE1 and QE2, result in an increase in corporate bond issuance relative to bank loan issuance for the sample of rated firms. These preliminary findings support the claim in Churm et al. (2015) that the quantitative easing policies result in an increase in corporate bond issuance. However, the sign on the coefficient of the QE2 period level intercept dummy for rated firms contradicts that obtained on the full sample in Table 3. The QE2 period level dummy in Panel C of Table 4 indicates that the QE2 increases the propensity to issue corporate bonds for rated firms while the results in Table 3 reveal that QE2 had no significant effects on the debt issuance behaviour of firms in our sample.

We further examine the impact of the quantitative easing on UK debt issuance by interacting our bank loan supply measures from the credit conditions survey with the quantitative easing period dummy variables in section 3.7. This treatment allows us to identify the added effects of the quantitative easing policies on debt issuance in the presence of bank loan supply changes. We introduce an interaction variable of the quantitative easing dummy variable and a continuous bank credit supply variable to capture a change in the slope of the relationship between credit supply and debt issuance. Overall, the results in Table 4 lend support to the hypothesis that the observed substitutability between corporate bonds and bank loans indeed reflects variations in bank loan supply conditions.

We now present a set of robustness tests for our benchmark results before we proceed to examine whether the issuance behaviour of firms in our sample changed significantly during the quantitative easing period in section 3.7.

3.6.2 Robustness tests

In this section we subject our benchmark results in Table 3 and Table 4 to a number of further tests using different filtering techniques and additional controls. The robustness tests indicate that the propensity to issue bank loans relative to corporate bonds responds to movements in bank loan supply measures. The results in Table 5 indicate that the coefficients for non-performing loans, aggregate credit growth and bank risk appetite remain robust and consistent in sign(s) even after including issue characteristics and prior debt issuance filters.

Table 5: Additional filters and robustness tests

The dependent variable is equal to 1 if the firm issues a bank loan and 0 if it issues a bond. The linear probability model results are estimated using OLS. The regression is estimated using a fixed effects regression model of the following form:

$$\mathrm{D_{it}} = \mathrm{c_i} + \beta B_t + \gamma X_{it} + \varphi_i + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to firm i. Each coefficient β in this table represents a separate regression equation. The variables of interest are the time series variables, non-performing loans, the bank loan growth, the term spread that proxy for bank loan supply, and time series variables from the credit conditions survey. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively. The results for each of these regressions are robust to heteroskedasticity.

Explanatory variable	NPLs	Aggregate Lending growth	Term Spread	Tightening conditions	Changing credit availability	Risk appetite	Libor –base rate spread	FTSE 350 Bank index
Benchmark	-10.4730**	-0.2474*	-0.0084	0.0001	0.0005	0.0022*	0.0100	0.0156
Further controls								
Excluding 2007-2009	-14.0463*	-1.0478**	0.0045	0.0010	0.0015	0.0019**	-0.0440**	-0.0180
Maturity	-9.4880**	-0.2509**	0.0060	-0.0002	-0.0004	0.0016**	0.0102	0.0114
Log Amount	-7.6827*	-0.2534*	-0.0009	0.0001	-0.0003	0.0016**	0.0008	0.0009
Yield, Amount, Maturity	-6.1551*	-0.2569**	-0.0022	-0.0001	-0.0004	0.0014**	-0.0102	-0.0257
Prior debt issuance								
Issues before and after 2007/08 crisis	-11.4995*	-0.3167**	-0.0048	0.0004	-0.0004	0.0024***	0.0166	0.0094
Issue before and after QE	-12.3798*	-0.2529**	-0.0062	0.0003	-0.0005	0.0019**	0.0229	0.0153
Any debt in last 5 years	-11.3470**	-0.2512**	-0.0047	0.0001	-0.0004	0.0018**	0.0068	0.0092
Bond in last 5 years	-15.9057*	-0.6212**	-0.0016	0.0005	0.0004	0.0034***	0.0241	0.0514
Bond and loan in last 5 years	-20.6979*	-0.7750**	-0.0038	0.0001	0.0006	0.0043***	-0.0398	-0.1289
Credit ratings								
Investment grade	-18.4827	-0.6003*	-0.0079	0.0016	-0.0006	0.0030*	-0.0157	-0.0066
Non-investment grade	-9.5189**	-0.1226	-0.1150***	-0.0007	-0.0004	0.0012*	-0.0038	0.0011

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As our first step in the robustness tests we examine whether including the characteristics of the debt issue has the potential to affect our results since issue characteristics may also reflect both the firm's changing financial health and capital supply conditions in the bond markets. When the level of risk aversion in the financial markets increase, accompanied by low growth and poor bank health, new debt issues may increasingly become short term and yields may temporarily increase regardless of the financial health of borrowing firms. As a result, switching between debt components may be prompted by changes in the terms of debt contracts that are unrelated to bank loan supply but are driven by countercyclical shifts in bond supply. To control for the impact of changing financing terms that may be unrelated to bank loan supply, we control for debt issue characteristics. Results in Table 5 show that the coefficients for non-performing loans, aggregate lending growth and bank risk appetite remain statistically significant after controlling for issue characteristics, while the coefficients for the term spread, tightening conditions, Libor-base rate spread and the FTSE350 Bank index remain insignificant. However, issue characteristics may also reflect firm specific agency and information asymmetry problems that are unrelated to debt supply.

Moreover, variations in credit supply may differ at different points of the business cycle. Including a period of high credit market upheaval in the sample period may result in reported coefficients being driven by isolated single period events. In order to investigate whether loan to bond substitution is driven by the financial crisis, we remove all observations for the period 2007Q2-2009Q4 when the financial crisis was at its height. We find that the results for non-performing loans remain robust even after excluding this 2007-2009 financial crisis period. Notably, we also find that results for the Libor-base rate spread become significant after excluding the financial crisis period. This implies that an expansion in the Libor-base rate spread during periods of relative calm may result in an increase in corporate bond issuance relative to bank loan issuance.

The inclusion of non-switching firms in the sample may bias the coefficients for our bank loan supply proxies towards zero since it may also include constrained firms that do not have access to the bond markets (Becker and Ivashina, 2014). To reduce the downward bias arising from the inclusion of non-switching firms, we employ a number of filtering techniques and test the sensitivity of our results to sample changes. We find that restricting the sample to firms with a record of debt issuance in the period before and after quantitative easing or the financial crisis of 2007-2009 does not alter the general results of

the benchmark model. The coefficients for bank risk appetite, credit growth and nonperforming loans remain statistically significant despite losing some switching firms with no debt issues after the quantitative easing period. However, the filter allows us to capture some firms with long maturity debts that fall outside the 10 year filter that we employ for our benchmark results. One drawback of this type of filter is that a number of switching firms that only issued debt before the crisis or before quantitative easing period drop out of the sample, which may further bias the results.

To address the downward bias caused by non-switching firms as well as to lower the number of firms with no access to the corporate bond market in the sample, while also capturing the variability arising from changing credit conditions of non-switching firms, we narrow the sample to include firms with a recorded debt issue of at most 5 years from its most recent issue. Although narrowing the filter to 5 years results in a minor improvement in the magnitudes of the coefficients, it does not improve the statistical significance of the coefficients, and it results in a loss of some switching firms with historical debt issues that are more than 5 years from the most recent issue. However, this filter allows us to also test the sensitivity of our results to the fixed effects assumption on debt demand.[18]

As an alternative filter, we include all firms that have issued a corporate bond in the last 5 years since their most recent debt issue. By default, this filter excludes all non-switching loan issuing firms, some of whom may have access to the corporate bond markets but did not issue bonds during the sample period because their relative loan issuance costs were low. However, the filter captures a number of high frequency corporate bond issuers that do not have any recently issued loans. We find that the filter results in an improvement in the magnitudes of our reported coefficients but it does not change our general result. Employing a much stricter filter where we include only switching firms with debt issuance in the last 5 years of their most recent issue we find that magnitudes of the coefficients increase markedly.

We further restrict the sample of firms to rated firms and examine the impact of our proxies for bank loan supply on the debt issuance behaviour of investment grade and non-investment grade firms. Firms with a debt rating are deemed to have access to the

[18] We recognise that debt demand may vary for the firm over a long period of time. In order to eliminate the effects of possible changes in debt demand, we employ a number of filters in order to reduce the period over which debt observations are recorded for the firm. We conjecture that over a relatively short period of time, debt demand is likely to remain unchanged.

corporate bond markets, and thus have the capacity to substitute between bank loans and corporate bonds (Leary (2009)). Our results show that an increase in the growth rate of aggregate bank lending increases the likelihood of issuing corporate bonds by investment grade firms but is not related to the debt issuance behaviour of non-investment grade firms. The results also show that an increase in bank risk appetite increases the propensity to issue bank loans by investment grade firms.

The results also highlight that non-investment grade firms increase their likelihood of issuing corporate bonds when the level of nonperforming loans increase and the term spreads widens. Surprisingly, an increase in bank risk appetite also increases the propensity to issue corporate bonds for these firms. However, restricting the sample to rated firms only, results in other switching firms that do not have available ratings information falling out of the sample. Furthermore, firms that carry a credit rating often solicit for the credit ratings, resulting in some endogenous variations between ratings and debt issuance.

Results in Table 5 show that our results, unlike Kashyap, Wilcox and Stein (1993), are not driven by changes in the composition of firms issuing debt nor by isolated periods of credit market upheavals. Similarly, the results also show that the loan to bond substitutability we capture is not driven by relative increases in the supply of corporate bonds. It is worth reiterating that by design, the methodology employed in this paper automatically controls for changes in debt demand since firms included in the sample all have a positive demand for debt.

However, these results may be driven by changes in the debt markets that seem to drive demand for corporate bonds such as a narrowing of spreads that leads firm to time debt issuance and to move from equity to public debt markets. In order to control for these demand driven effects for corporate bond issuance, we control for long term interest rates, debt maturity and the relative costs between bank loans and corporate bond in the robustness section. We find that our results are not driven by an increase the demand for corporate bonds but are rather a result of shifts in bank loan supply. This result is consistent with Barker and Ivashina (2014).

A caveat that applies to this section is that the residuals of the regression models in the robustness section are estimated based on the assumption that residuals are not correlated across clusters i.e. that the standard errors are heteroskedastic and autocorrelation consistent (HAC). However, we do not account for within cluster correlations between

residuals. As a result, the precision of our estimated results may be overstated since the standard errors are not heteroskedastic and cluster robust (Cameron and Miller (2013)).[19]

3.7.0 Quantitative easing interactions effects and bank loan to bond substitutability

In this chapter, the quantitative easing period actually refers to two time intervals, the first between March 2009 and December 2009 is referred to as the QE1 period, and the second between October 2011 and December 2012, the QE2 period, when the quantitative easing policies of the Bank of England are in effect.

During the quantitative easing period, asset purchases by the Bank of England are documented by others to result in a decline in long term yields and a substantial increase in bank reserves (Joyce et al. (2011)).[20] It was envisaged that the increase in bank reserves would ease liquidity conditions for banks and stimulate lending to private nonfinancial firms (Bank of England (2010)). At the same time, it was believed that lower long term yields would stimulate corporate bond issuances by nonfinancial firms. Chodorow-Reich (2014) find that in the US, quantitative easing policies improved risk taking by financial firms, enhanced the value of legacy assets, and improved market liquidity through searching for yields in the bond markets. Kaya and Wang (2014) report that corporate bond issuances increase significantly both in Europe and in the UK during this period. This empirical literature suggests that the quantitative easing policies may increase bond issuance. In this section we estimate whether there is any evidence of substitutability during this period. If bank loan to bond substitutability captures changes in credit supply, we expect to see some significant coefficients on the QE interacted measures of credit supply.

In Table 6 we present the results for the quantitative easing interacted credit supply variables obtained from equation 2 below.

$$D_{it} = c + \beta B_t + \emptyset(B_t \times QE) + \gamma X_{it} + \varphi_i + e_{it} \text{ ..... (2)}$$

[19] Although the presence of non-issuing firms in the sample does not add to the identification of bank loan supply effects, it induces within cluster serial correlations for firms that do not switch between debt issues. However, the impact of serial correlation is not expected to be severe since there are very few high frequency issuers in the sample and the panel structure is unbalanced (Cameron and Miller (2013 p.5)).

[20] Although the asset purchases of corporate bond by the Bank of England are considered too small to have triggered a significant response in the corporate bond markets, Borio and Disyatat (2010) and Joyce et al. (2010) provide evidence of portfolio balance effects operating through the corporate bond markets that serve to increase corporate bond issuances despite the initial low level of corporate bond purchases by the Bank of England.

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, φ_i represents firm fixed effects, B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation, QE represents a dummy variable for the quantitative easing period and X_{it} is a set of time variant controls specific to the firm i. If the QE period has no effect on debt issuance we expect the coefficient ∅ to be zero. The results in Table 6 are robust to filtering firms based on issuance before and after the crisis as shown in section 6.2.

The full sample results in Panel A of Table 6 indicate that although improvements in credit availability, whether actual or anticipated, generally result in an increase in bank loan issuance, a one standard deviation increase in actual or anticipated improvements in credit availability during the quantitative easing period increases the probability of issuing corporate bonds relative to bank loans by 6.31% and 6.92%, respectively. Similarly, a one standard deviation increase in expected loosening of lending standards and improvement in sectoral risks during the quantitative easing period increases the propensity to issue corporate bonds relative to bank loans by 4.33% (0.00541*8.004) and 5.01% (0.00872*5.745), respectively.

The results for the full sample in Panel A also reveal that although both actual and expected improvements in credit availability result in an increase in corporate bond issuance during the QE1 period (Panel B), it is expected improvements in credit availability which result in an increase in bank loan issuance during the QE2 period (Panel B). Positive developments in general macroeconomic outlook and in bank risk appetite correlate with an increase in bank loan issuance during QE1. However, during the QE2 period, expected improvements in bank risk appetite are associated with an increase in bank loan issuance, while both actual and expected improvement in the macroeconomic outlook result in an increase in bank loan and corporate bond issuance, respectively.

The coefficients on the credit availability measure in Panel D show that an improvement in credit availability, both actual and expected, increases the propensity to issue corporate bonds during the quantitative easing period for rated firms. These effects are stronger for rated firms than for the full sample estimates reported in Panel A. In the rated firms' category, an increase in the market pressure during the quantitative easing period results in increased corporate bond issuance relative to bank loans during the quantitative easing period. A one standard deviation increase in expected market pressures in the next quarter

(5.29 index points) would increase the likelihood of issuing a bond by 1.95%. These results point towards possible substitution during this period.

Actual loosening in credit standards and an expectation that credit standards will be easier in future increases the likelihood of issuing a bank loan relative to a corporate bond during the quantitative easing period for the rated firms. The results in Panel D also show that negative economic outlook with adverse effects on bank loan supply increases the propensity to issue corporate bonds relative to bank loans for the rated firms during the quantitative easing phase.

Table 6: Quantitative easing interacted credit supply measures

The regressions are estimated using a fixed effects regression model of the following form:

$$D_{it} = c + \beta B_t + \emptyset(B_t \times QE) + \gamma X_{it} + \varphi_i + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, φ_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The QE variable is a dummy variable equal to 1 if the period is between March 2009 and December 2009 or between October 2011 and December 2012. The dummy variable excludes the period January 2010 to August 2011 when the quantitative easing program was officially suspended. The asterisks *,**,*** represent statistical significance at the 10%, 5%, 1% levels, respectively. Results in this table report the β and $\emptyset$ coefficients. Each set of coefficients (β and $\emptyset$) represents a separate equation. Coefficients on the X_{it} variables are not reported in this table for brevity. QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, while QE2 is a dummy variable equal to one for the period October 2011 to December 2012. Results are robust to heteroskedasticity.

	Changes in credit availability	**Changes in Risk appetite**	**Changes in macroeconomic outlook**	**Tightening in lending standards**	**Sector risks**	**Market pressures**
			All (Panel A)			
Actual	0.0037**	0.0032**	0.0007	0.0017	0.0023*	0.0045**
QE*Actual	-0.0012***	0.0019	-0.0009	-0.0035	-0.0054	-0.0169**
Expected	0.0042**	0.0010	0.0092	0.0029	0.0019	0.0030
QE*Expected	-0.0013***	0.0032	-0.0014	-0.0054**	-0.0087***	-0.0049
			All firms QE split into 1 and 2 (Panel B)			
Actual	0.0004	0.0014**	-0.0005	0.0002	0.0008	0.0011
QE1*Actual	-0.0065***	0.0068**	0.0063**	0.0010	-0.0010	-0.0167**
Expected	0.0007	0.0017**	-0.0057	0.0004	0.0007	0.0012
QE1*Expected	-0.0058***	0.0059**	0.0111**	0.0016	-0.0030*	-0.0230***
			QE2			
Actual	-0.0006	0.0016**	0.0019**	0.0005	0.0008	0.0009
QE2*Actual	0.0006	0.0040	0.0044***	-0.0038	-0.0059**	-0.0033
Expected	-0.0015**	0.0017**	0.0023*	0.0005	0.0002	0.0005
QE2*Expected	0.0053**	0.0191**	-0.0038***	-0.0016	-0.0063*	0.0015
			QE Intercept dummy- All firms (Panel C)			
			$D_{it} = c_i + \beta B_t + \emptyset(QE) + \gamma X_{it} + \varphi_i + e_{it}$			
			In this panel we report the coefficients β and$\emptyset$. QE in this case is defined as an intercept dummy and each set of coefficients β and $\emptyset$ is a separate regression equation.			
Actual	0.0004	0.0024***	0.0007	0.0015	0.0011*	0.0013

Table 6: Quantitative easing interacted credit supply measures

The regressions are estimated using a fixed effects regression model of the following form:

$$D_{it} = c + \beta B_t + \emptyset(B_t \times QE) + \gamma X_{it} + \varphi_i + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, φ_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The QE variable is a dummy variable equal to 1 if the period is between March 2009 and December 2009 or between October 2011 and December 2012. The dummy variable excludes the period January 2010 to August 2011 when the quantitative easing program was officially suspended. The asterisks *,**,*** represent statistical significance at the 10%, 5%, 1% levels, respectively. Results in this table report the β and $\emptyset$ coefficients. Each set of coefficients (β and $\emptyset$) represents a separate equation. Coefficients on the X_{it} variables are not reported in this table for brevity. QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, while QE2 is a dummy variable equal to one for the period October 2011 to December 2012. Results are robust to heteroskedasticity.

	Changes in credit availability	**Changes in Risk appetite**	**Changes in macroeconomic outlook**	**Tightening in lending standards**	**Sector risks**	**Market pressures**
QE intercept	-0.0547***	-0.0487**	-0.0034	-0.0266	-0.0394	-0.0359
Expected	-0.0004	0.0029***	0.0009	-0.0006	0.0005	0.0016*
QE intercept	-0.0397*	-0.0501**	-0.0040	-0.0299	-0.0311	-0.0446*
Rated Only Firms (Panel D)						
Actual	0.0024*	0.0023	0.0021**	0.0019	-0.0023	0.0032**
QE*Actual	-0.0058*	0.0063**	0.0019**	0.0012**	0.0047**	-0.0067
Expected	0.0026	0.0037**	0.0024*	0.0033**	0.0027**	0.0022**
QE*Expected	-0.0072**	0.0055**	-0.0041	-0.0025	0.0069	-0.0037**
Rated Only Firms QE split into 1 and 2 (Panel E)						
Actual	0.0024**	0.0023**	0.0021**	0.0019**	0.0023**	0.0032**
QE1*Actual	-0.0071**	0.0054*	0.0032	0.0012	0.0047**	-0.0270**
Expected	0.0022**	0.0037**	0.0024**	0.00261	0.0030**	0.0022**
QE1*Expected	-0.0063**	0.0048	-0.0067	-0.0083	-0.0079	-0.0138
Actual	0.0024**	0.0023**	0.0021**	0.0019**	0.00231**	0.0032**
QE2*Actual	-0.0058**	-0.0068	-0.0003	0.0026	0.00231	-0.0120*
Expected	0.0022**	0.0037**	0.0024**	0.0023**	0.0027**	0.0022**
QE2*Expected	-0.0090**	0.0014	-0.0009	0.0025	0.0032	-0.0050

Table 6: Quantitative easing interacted credit supply measures

The regressions are estimated using a fixed effects regression model of the following form:

$$D_{it} = c + \beta B_t + \emptyset(B_t \times QE) + \gamma X_{it} + \varphi_i + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 if it issues a bond, φ_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The QE variable is a dummy variable equal to 1 if the period is between March 2009 and December 2009 or between October 2011 and December 2012. The dummy variable excludes the period January 2010 to August 2011 when the quantitative easing program was officially suspended. The asterisks *,**,*** represent statistical significance at the 10%, 5%, 1% levels, respectively. Results in this table report the β and $\emptyset$ coefficients. Each set of coefficients (β and $\emptyset$) represents a separate equation. Coefficients on the X_{it} variables are not reported in this table for brevity. QE1 is a dummy variable equal to one for the period March 2009 to December 2009 and zero otherwise, while QE2 is a dummy variable equal to one for the period October 2011 to December 2012. Results are robust to heteroskedasticity.

	Changes in credit availability	**Changes in Risk appetite**	**Changes in macroeconomic outlook**	**Tightening in lending standards**	**Sector risks**	**Market pressures**
QE Intercept dummy- All firms (Panel F) $D_{it} = c_i + \beta B_t + \emptyset(QE) + \gamma X_{it} + \varphi_i + e_{it}$ In this panel we report the coefficients β and$\emptyset$. QE in this case is defined as an intercept dummy and each set of coefficients β and $\emptyset$ is a separate regression equation.						
Actual	0.0024**	0.0023**	0.0021**	0.0007	0.0023**	0.0032**
QE intercept	-0.0749*	-0.0752	-0.0540	-0.1170*	-0.0468	-0.0717
Expected	0.0022**	0.0037**	0.0024**	0.0023**	0.0027**	0.0022**
QE intercept	-0.0898	0.0048	-0.0711	-0.0521	-0.0303	-0.0673

An examination of the different phases of the quantitative easing period in Panel E of Table 6 reveals that while actual and anticipated improvements in credit availability during the QE1 period increased the likelihood to issue corporate bonds, actual improvements in bank risk appetite and sector risks would increase the propensity to issue loans relative to corporate bonds for rated firms. During the QE2 period, both actual and anticipated changes in credit availability increase the likelihood of issuing corporate bonds relative to bank loans for the issuing firms. However, actual and anticipated increases in bank risk appetite, tightening conditions and sector risks have no effect on the debt issuance decisions during the QE2 period for the rated firms.

Results on the QE intercept dummies in Panels C and F of Table 6 indicate that, on average, the quantitative easing period results in an increase in the likelihood that firms would issue corporate bonds relative to bank loans for both the rated firms and the full sample firms. However, the effects of the quantitative easing policies on the debt issuance behaviour of UK non-financial firms are largely concentrated in the first phase of the program (QE1) and very little effects were witnessed in the second phase of the program (QE2).

The results in Table 6 provide additional evidence of bank loan to bond substitution during periods of adverse credit upheavals. These results suggests that bank loan to corporate bond substitution may indeed capture movements in bank loan supply. It is also worth noting that the reported effects of the quantitative easing interactions may be capturing the effects of the credit supply shocks of the global financial crisis. But since the crisis and the quantitative easing policies overlap and the later was crafted in order to address the challenges associated with the crisis, the two effects will always be difficult to separate. We investigate this issue later (in chapter 5) using aggregate time series data on debt issuance and structural vector error correction models to separate the effects of the different structural shocks on debt issuance, particularly QE shocks, credit supply shocks, credit demand shocks and monetary policy rate shocks.

3.8.0 The effects of bank loan supply movements on individual debt components

The results of the robustness analysis in Table 5 provide evidence that the patterns of substitution between bank loans and corporate bonds to movements in credit supply are invariant to changes in the sample definition and inclusion of additional issue-specific controls. In this section we further disaggregate the two broad debt categories (namely corporate bonds and bank debt) into their constituent debt types and test whether the

observed patterns of substitution are consistent across different debt types and across time. Understanding the impact of credit supply on the individual debt components allows us to comprehend how firms form their indebtedness patterns at different points of the financial cycle.

Aggregating debt into two broad categories can mask the specific effects of credit supply, firm characteristics and macroeconomic forces on the debt instruments; and may distort the effects that heterogeneous debt instruments have on a firm's financing patterns. Rauh and Sufi (2010) and Gomes and Phillips (2012) find evidence to suggest that aggregating different debt types and treating them as a homogeneous group induces a risk of establishing inaccurate causal relationships. They find that the relationship between leverage rates and firm characteristics vary significantly when debt components are analysed separately.

In order to uncover evidence of substitutability and/or complementarity between different debt types, we study the impact of the aggregate credit availability measures on the movements in heterogeneous debt instruments in the firm's capital structure. Since different types of debt instruments differ in terms of transaction costs, cash flow claims, control provisions, sensitivity to information and their incentive properties for managers (Bolton and Freixas (2000), Rauh and Sufi (2010) and Gomes and Phillips (2012)), and covenant structures (Bradley and Roberts (2015), Lou and Otto (2016)), we expect different debt instruments to respond differently to changes in credit supply.

We test the prediction that the new issue proportions of different debt types in the firm's debt structure change at different rates in response to credit supply shocks. In particular, that the proportion of new bank loan issues in the debt structure increases (decreases) at a faster rate than other debt components when credit is readily available (difficult to obtain) and credit conditions are lax (tight). Following the debt classification in Rauh and Sufi (2010) and Colla, Ippolito and Li (2013), we disaggregate the debt components into five categories namely bank debt, bonds, program debt, private placements and other debt. The new debt issue categories are expressed first as a proportion of total capital[21] and then as a proportion of total debt. Using the classifications and debt type descriptions in the LPC

[21] Total capital is defined as total debt plus the book value of equity.

Dealscan and SDC platinum origination databases, we categorise the new debt issues into five categories as follows:

1. Bank debt comprises of revolving bank debt, including lines of credit or committed revolving credit facilities and term bank debt which includes term loans, bank overdraft facilities and borrowings on uncommitted lines of credit.
2. Bonds consist of public debt issues, industrial revenue bonds and Euro 144A private placements.[22]
3. Program debt includes debt that is exempt from registration namely commercial paper, shelf registration debt and medium term notes.
4. Private placements consists of non-Euro 144A privately placed debt, debentures and other unclearly classified notes and debentures in SDC.
5. Other debt: includes acquisition notes, capitalised leases, unclassified debt, mortgage bonds, mortgage loans, equipment trust certificates and other equipment based debt.

Kwan and Carleton (2010) claim that private placements are more likely to carry restrictive covenants than public debt issues. Both monitoring and renegotiation are carried out in different ways between public issued bonds and private placements. Private placements are also very different from loans which tend to have higher seniority in liquidation. Furthermore, they are likely to be issued by smaller and much riskier firms. However, while banks are subject to bank regulation and supervision, private placement lenders are not. As a result, their responses to changes in credit supply may differ significantly from those of other debt components.

We exclude any debt that is clearly marked as convertible debt in the SDC platinum and LPC databases and debt with embedded option elements. The regressions are estimated using a panel Tobit model of the following form:

$$Y_{it} = c + \beta B_t + \gamma X_{it} + \varphi_{it} + e_{it} \quad \text{....(3)}$$

We employ a panel Tobit model in our analysis because a significant proportion of observations in our debt type regressions sample are clustered at zero. For example if a

[22] Gomes and Phillips (2007), Rauh and Sufi (2010) and Gomes and Phillips (2012) claim that Rule 144A private placements are closer to bonds than private placements which tend to be held by one or two insurance companies. They find that the majority of Rule 144A private placements are subsequently registered as public bonds. Rule 144A securities are unregistered securities that are traded between institutions. They are designed to allow for secondary market trade of privately placed securities (Kwan and Carleton (2010)).

firm issues bonds and private placed debt in period 1 and then issues only private debt in period 2, corporate bond issues in period 2 are recorded as 0. Moreover, data on the repayments and renegotiation of debt are not observed in our sample. As a result the true values of the variables are not known. Furthermore, the proportion of the debt component is bounded between 0 and 1, and is not continuous. The inability to observe debt repayments and renegotiations in the origination database may induce timing differences in that total debt measured at the end of the quarter may distort the observed proportions of new debt issues. However, such instances are very rare and would likely occur in the presence of short term debt, and since we eliminate debt with a tenure less than one year, such observations are highly unlikely. Given these issues with the data, a Tobit model is deemed more fitting. We control for the influence of information asymmetry problems in the regressions using firm size, tangibility, return on assets and a dummy variable for dividend payers.

3.8.1.1 Results

The results in Table 7 show that the different debt components respond differently to changes in bank credit availability. In panel A, the findings indicate that an increase in term spreads results in an increase in the proportion of new corporate bond issues and a decline in the proportion of new bank loan issues in the firm's debt structure. Panel B indicates that an increase in bank loan growth results in a decline in the issuance of corporate bonds in the debt structure of the firm. Other debt components do not seem to exhibit such sensitivity to changes in aggregate credit growth. However, the reason for observing insignificant coefficients might be that aggregate credit growth may be too coarse a measure of credit supply for the granular debt types defined in this section.

The results in panel C reveal that an increase in non-performing loans in the banking sector tends to increase the overall level of corporate indebtedness but reduces the proportion of new bank debt issues in the firm's debt structure. Increasing non-performing loans result in higher corporate leverage and the effect is statistically significant at the 1% level of significance.

A challenge that arises is that these results may be distorted by changes in total capital that are driven by increases or decreases in equity rather than changes in the different debt instruments in the firm's capital structure. If adverse changes in credit supply induce firms to issue more equity then a reported decline in a given debt instrument following a credit

supply shocks may be driven by changes in equity rather than by a firm reducing the proportion of new debt issue of this debt instrument in its debt structure. As a robustness check, we also report our results with each debt component scaled by total debt rather than by the total capital in panel B of Table 8. This allows us to eliminate the possibility that our reported coefficients on the credit availability measures are influenced by changes in total capital that are driven by changes in equity.

The first 3 rows of panel B of Table 8 show that results for bank loan growth, non-performing loans and term spread measures remain qualitatively similar for bank loans and corporate bond issues following a rescaling of our dependent variables. However, results based on total debt reveal that new private placements as a proportion of total debt decline following a widening of term spreads, and that program debt responds positively to bank loan growth and declines with an increase in bank loan losses.

Results in Table 7 and Table 8 show that there are heterogeneous changes in issuance of different debt types in the firm's capital structure when credit availability changes. These result points towards a possible substitution between different debt types in the firm's capital structure as credit supply changes.

The coefficient on the control variables in panels A to C of Table 7 confirm the heterogeneity of the debt components documented in Rauh and Sufi (2010). Consistent with Rauh and Sufi (2010) and Rajan and Zingales (1995), the coefficients for tangibility and profitability in panels A and B reveal that the total debt or leverage decreases with profitability and increases with tangibility. The negative relationship between profitability and leverage supports the traditional pecking order theory of capital structure. However, coefficients on the individual debt components reveal that debt instruments have differential responses to firm level determinants of capital structure and to changes in credit supply. This implies that there is a more substantial variability and heterogeneity in capital structure than perhaps is suggested by traditional capital structure theory.

The results in Table 7 show that the contributions of the corporate bonds, programme debt and other debt components in the firm's debt structure decline by the largest magnitudes as firm size increases, while the proportion of bank loans and private placements in the firm's debt structure increase by a larger proportion as firm size increases. Moreover, asset tangibility results in an increase in both corporate bonds and bank loan issuance, while reducing the issuance of program debt, private placements and other debt. These results

reflect the fact that the different debt components carry different cash-flow and control rights which impact differently on the firms' incentive structures. However, the result for firm size on debt issuance is inconsistent with issue cost and information asymmetry theories of debt issuance, which suggest that larger companies with less information asymmetries issue more corporate bonds.

The positive relationship between firm size and bank loans and the negative relationship between size and corporate bond issuance are consistent with Yosha (1995) who states that large firms may prefer to issue debt because the onerous information requirements of corporate bond issuance may force issuers to disclose proprietary information to competitors, and may incite undesirable competitive responses from rival companies. Lucinda (2004) concurs with this assertion and reports that bank debt involves less publicity about the firm's investments and operations, is more flexible in terms of funding volume, and above all presupposes a long term relationship with the financier.

These results on the control variables tend to confirm the existence of debt heterogeneity in our sample. We proceed to examine the impact of bank loan supply on the heterogeneous debt components in the next section.

Table 7: Leverage regression by debt type

The dependent variable in the regressions is the amount of debt issued in the quarter for a given debt component scaled by total book capitalisation (total debt + total book equity). The regressions are estimated using a panel Tobit model with random effects of the following form:

$$Y_{it} = c + \beta B_t + \gamma X_{it} + \varphi_i + e_{it}$$

Where Y_{it} amount of debt issued at time t scaled by the total debt stock at time t, c represents the sample specific average; B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; X_{it} is a set of time variant controls specific to the firm I; φ_i is a firm specific random effect; and e_{it} is the error term. The last column of each panel presents the leverage regression. The results are estimated for the sample period 1994 to 2013. The Rho statistic provides the percentage contribution to total variance of the panel variance component and indicates whether the panel Tobit estimator is a better fit than the pooled Tobit estimator.

	Bank	**Bonds**	**Program**	**PP**	**Other**	**Leverage**
			Panel A			
Spread	-0.0261**	0.4580***	-0.0297	-0.0297	0.5861***	0.0012
	(-4.66)	(3.69)	(-0.62)	(-1.00)	(3.47)	(0.59)
Size	0.0265***	-0.6620***	-0.4290***	0.0616***	-4.5440***	0.0045
	(3.07)	(-4.04)	(-10.54)	(3.95)	(-6.43)	(1.30)
Tangibility	0.2530***	4.3850***	-1.5300***	-0.3108**	-7.0440**	0.1360***
	(4.06)	(3.86)	(-4.23)	(-2.24)	(2.06)	(5.48)
ROA	0.1090**	2.1330*	0.0034	-0.0081	-0.5818	-0.1060***
	(2.02)	(1.90)	(0.01)	(-1.06)	(-1.48)	(-5.481)
Dividend payer	-0.0795***	-0.7860	0.6970***	0.2535***	2.0640***	-0.0076
	(-3.26)	(-1.37)	(3.28)	(3.24)	(2.61)	(-0.81)
	13.75	40.42	176.92	30.39	69.84	63.72
Wald Chi Sqr	0.0175	0.0000	0.0000	0.0000	0.0000	0.0000
Rho	0.90	0.802	0.8078	0.5257	0.961	0.70
			Panel B			
Banklg	0.8160***	-1.3520***	3.6030	0.3184	2.8960	0.0410
	(3.75)	(-2.90)	(1.51)	(0.65)	(0.78)	(0.71)
Size	-0.0040*	-0.1080***	-0.0270	0.0499***	-0.7360***	0.0050
	(-1.81)	(-5.44)	(-0.13)	(3.13)	(-4.42)	(1.46)
Tangibility	0.3907***	-0.0590	0.2870	-0.4064	-6.9670***	0.1320***
	(4.12)	(0.762)	(0.27)	(-3.19)	(-5.05)	(5.35)
Roa	0.1256	0.2480**	-0.5870	0.0051	0.4090	-0.1060***
	(1.57)	(2.10)	(-1.29)	(0.03)	(0.48)	(-5.53)

Table 7: Leverage regression by debt type

The dependent variable in the regressions is the amount of debt issued in the quarter for a given debt component scaled by total book capitalisation (total debt + total book equity). The regressions are estimated using a panel Tobit model with random effects of the following form:

$$Y_{it} = c + \beta B_t + \gamma X_{it} + \varphi_i + e_{it}$$

Where Y_{it} amount of debt issued at time t scaled by the total debt stock at time t, c represents the sample specific average; B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; X_{it} is a set of time variant controls specific to the firm I; φ_i is a firm specific random effect; and e_{it} is the error term. The last column of each panel presents the leverage regression. The results are estimated for the sample period 1994 to 2013. The Rho statistic provides the percentage contribution to total variance of the panel variance component and indicates whether the panel Tobit estimator is a better fit than the pooled Tobit estimator.

	Bank	**Bonds**	**Program**	**PP**	**Other**	**Leverage**
Divpayer	-0.1150***	-0.0960	0.8850**	0.2470***	2.7060***	-0.0074
	(-3.39)	(-1.35)	(1.98)	(3.52)	(2.72)	(-0.80)
	49.86	42.15	8.74	32.14	43.11	63.89
Wald Chi sqr	0.000	0.000	0.1197	0.000	0.000	0.000
Rho	0.760	0.89	0.96	0.001	0.89	0.70
			Panel C			
Npls	-40.27***	-899.9	54.58	-8.8320	356.6	13.49***
	(-3.73)	(-1.56)	(0.57)	(-0.38)	(1.16)	(2.36)
Size	0.0239*	-0.4190	-1.0380***	0.0598***	-5.0530**	-0.3970**
	(-1.89)	(-0.40)	(-21.45)	(3.74)	(-20.53)	(-9.13)
Tangibility	0.3777***	-1.6730	-2.6820***	-0.3940***	-6.6080***	-0.5820**
	(4.06)	(0.255)	(-6.44)	(-3.13)	(2.84)	(-2.01)
ROA	0.1850***	-22.1200***	-1.0820**	-0.0021	-3.0100	-0.0550
	(2.31)	(-5.07)	(-2.00)	(-0.01)	(-0.21)	(-0.29)
Divpayer	-0.1160***	1.8750	0.3010	0.2080***	2.5280***	0.3850***
	(-3.31)	(0.92)	(1.08)	(3.04)	(2.16)	(2.84)
Rho	0.595	0.8023	0.978	0.00215	0.8199	0.6301
Wald Chi sqr	33.36	43.30	8.78	42.15	40.34	32.14
Prob	0.0000	0.00	0.1210	0.0000	0.0000	0.0000

3.8.1.2 Credit conditions survey components and debt type substitution

We further investigate the heterogeneity in debt components and potential substitutability between the different debt components in the debt structure by examining the response of debt compositions to movements in survey based measures of bank credit supply, the libor-base rate spread, and the FTSE350 Bank Index.

The results in Table 8 indicate that an increase in credit availability increases bank loans while reducing corporate bond issuances in the debt structure. A decline in the availability of credit would result in a reduction in bank debt and an increase in corporate bonds in the firm's debt structure. Similarly an increase in bank's risk appetite results in an increase in bank loan issuance and a decline in corporate bond issuances in the firm's debt structure.

An improvement in the economic outlook results in an increase in bank loan issuances, while reducing the issuance of corporate bonds and program debt in the firms' debt structure. However, the changes in economic outlook have no significant effects on the leverage of the firms. This result is perhaps not surprising once we recognise that the corporate bond issuance pattern of unconstrained firms is countercyclical.

A reduction in sectoral risks results in an increase in bank loan issuance and a reduction in the marginal contributions of corporate bonds and program debt to the firm's debt structure. However, sector risks have no significant effects on the firms' leverage.

A tightening of credit standards seems to increase the issuance of other corporate debt instruments and to reduce the overall level of corporate indebtedness. The results in Table 8 imply that firms increase bank loans relative to corporate bonds in their debt structures when credit conditions improve and vice versa. The proportion of bank debt in firm's debt structure rises when the economic outlook improves, sectoral risks decline, bank risk appetite increases and bank credit availability is generally relaxed. On the other hand, corporate bond holdings in the debt structure increase at a faster rate when credit conditions tighten and bank credit supply declines. Overall, the response of our granular debt types to aggregate measures of bank credit availability confirms the idea that substitution between corporate bonds and bank debt reflect movements in bank credit supply. Furthermore, the results on the overall leverage equation imply that a tightening in lending standards will reduce the overall indebtedness of nonfinancial companies.

Table 8: Credit condition and debt types

The dependent variable is the new debt issued under the debt component scaled by total book capital. The regression model is of the following form:

$$Y_{it} = c + \beta B_t + \gamma X_{it} + \varphi_i + e_{it}$$

Where Y_{it} amount of debt issued at time t scaled by either total debt stock or total debt at time t, c represents the sample specific average; B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; X_{it} is a set of time variant controls specific to the firm I; φ_i is a firm specific random effect; and e_{it} is the error term. Each coefficient represents a separate regression equation for each of the column variables as a function of the row variables and a set of firm specific controls in Table 7. The sample period is 1994 to 2013.

Variable	Bank	Bonds	Program	PP	Other	Leverage
Panel A: Scaled by total capital						
Changing credit availability	0.0036***	-0.0011*	0.0118**	0.0004	0.0059	0.0003
Changing risk appetite	0.0303*	-0.0051*	0.0014	0.0003	-0.0090	-0.0004
Tightening credit standards	-0.0006	-0.0036	0.0175	0.0019	0.0100**	-0.0003*
Changing economic outlook	0.0066*	-0.0018*	0.0085	0.0015	-0.0193	-0.0003
Changing Sectoral risks	0.0105*	-0.0090*	-0.0027**	0.0016	-0.0056	-0.0003
Changing market pressure	-0.0016	-0.0024**	0.0309*	-0.0039	-0.0031	0.0006
Libor Base rate Spread	0.0619*	-0.0319	-0.0636	0.0652	-0.0293	0.0092
FTSE350 Bank Index	0.2423***	-0.1717*	0.5795**	0.0951	-0.2840***	0.0071
Panel B: Scaled by total debt						
Term spread	-0.0889***	0.0030	-0.0257	-0.0626*	0.0846	0.0019
Bank loan growth	52.4900***	-0.9490*	2.0850**	0.8820	2.2620	0.0701
NPLs	-93.8800*	63.6000	-89.9900*	-21.6700	-73.8300	0.9570
Changing credit availability	0.0063**	0.0028	0.0015	0.0009	0.0010	0.0000
Changing risk appetite	0.0069*	-0.0052*	-0.0036	-0.0004	-0.0145	-0.0004*
Tightening credit standards	0.0027	0.0085	0.0023	-0.0013	0.0277*	-0.0002
Changing economic outlook	0.0028*	0.0088*	0.0012	-0.0021	-0.0350***	-0.0004**
Changing Sectoral risks	0.0041	0.0038	0.0071	0.0013	-0.0131*	-0.0004
Changing market pressure	0.0080	-0.0045	0.0000	-0.0059	-0.0311*	-0.0001
Libor Base rate Spread	0.0775	-0.2170	-0.0811	0.2940	-0.2470	0.0044
FTSE350 Bank Index	0.0138	-0.0334*	0.0197*	0.0299	-0.0323	0.0003

The results in Table 8 also highlight that an increase in the Libor-base rate spread increases the proportion of bank loan issuance in the debt structure of the firm, but has no effects on the overall indebtedness of the firm. In contrast, an improvement in banking sector performance, as indicated by an increase in the FTSE350 Bank Index, results in an increase in the proportions of bank debt and program debt while reducing the proportions of corporate bonds and other debt in the firm's debt structure without increasing the firm's overall level of indebtedness.

The findings in this section imply that the substitution between bank loans and corporate bonds for unconstrained firms is cyclical. Debt issuance responds to movements in bank loans supply. In particular, a decline in bank loan availability and a deterioration in aggregate credit conditions both result in an increase in corporate bond issuances.

So far we have established that the bank loan to corporate bond substitution behaviour of firms tend to capture changes in bank loan supply, and that changes in bank loan supply affect debt components differently. The results seem to suggest that there is a possible bank lending channel or capital supply channel in operation in the UK debt markets since corporate debt issuance responds to variations in bank loan supply.

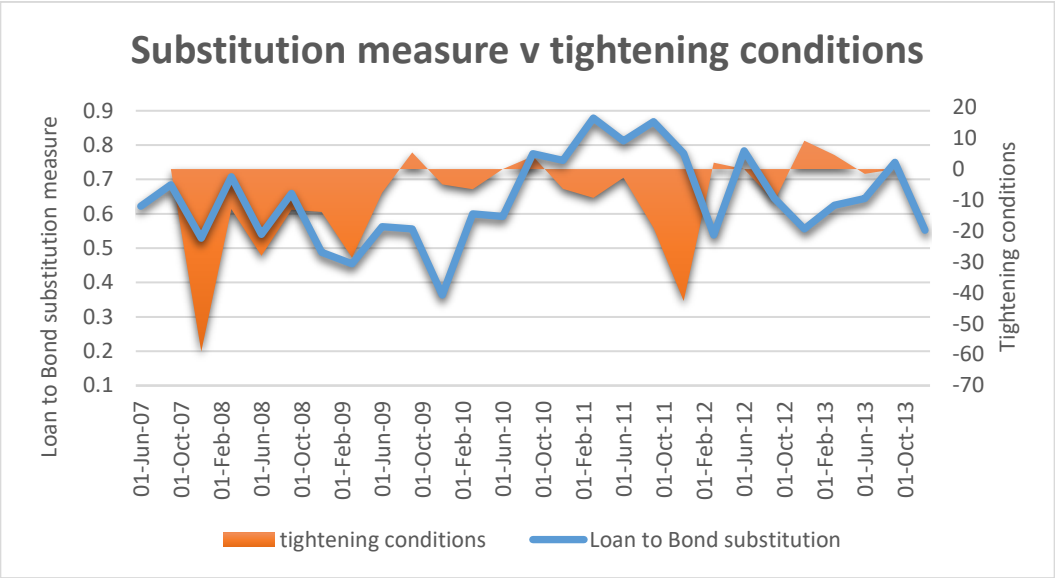
3.9.0 Bank loan availability measure and out of sample predictions of constrained firms' debt issuance

In this section, we construct a measure for bank loan supply which we will employ to analyse the behaviour of constrained firms in chapter 4. Based on the results from the previous section, we construct a bank loan to bond substitution measure as a clean proxy for bank loan supply. Since the substitution between loans and bonds for the unconstrained firms in our sample responds to changes in bank loan supply, we conclude that changes in the debt issuance behaviour of substituting firms is able to inform us about overall conditions of aggregate bank credit supply, Becker and Ivashina (2014).

In this section we use the proportion of firms issuing loans as a proportion of firms that issue debt in that quarter as a measure for bank credit supply. The measure is constructed using the sample of unconstrained issue firms that have access to both markets. If there are 100 firms with access to both markets issuing debt in a given quarter and only 25 firms issue bank loan, the measure for bank loan substitution will be 0.25. The diagrams below show the trend in our credit supply measure and the tightening and bank risk appetite variables from the credit conditions survey.

Figure 1: Substitution measure versus tightening of conditions

The bank loan to corporate bond substitution measure, on the left scale, is constructed using quarterly issuances of debt securities by rated firms with access to both debt markets. Tightening conditions measure is a survey based measure of credit supply obtained from the Bank of England credit conditions survey. Data for the credit conditions survey is only available beginning in the year 2007. Tightening conditions are scaled to lie between +/-100 while the loan to bond substitution measure for credit supply is bounded between 0 and 1.

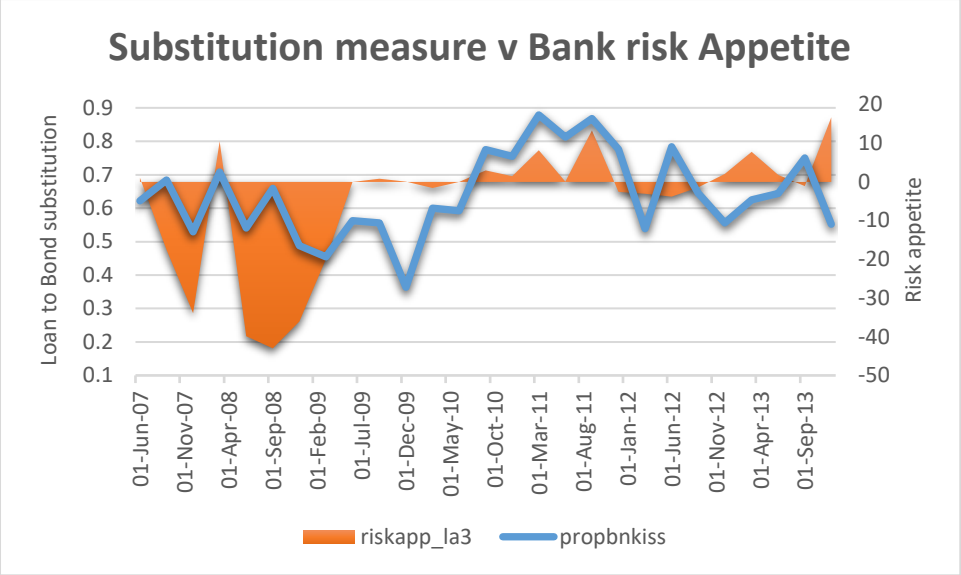


Prior to October 2010, our measure for bank loan supply closely mimics the trends in tightening conditions in the credit markets. During periods when credit conditions were reported to be tight, our substitutability measure indicates that a larger proportion of firms resort to issuing corporate bonds relative to bank loans. An analysis of the correlation between our tightening in credit conditions measure and the loan to bond substitution measure for credit supply reveals a positive ad statistically significant correlation of 0.1402. This implies that bank credit supply increases at the same time that credit conditions loosen, and bank loan supply declines right around the time when credit conditions and lending standards are tightened. However, there is a minor breakdown in this trend between October 2010 and July 2011.[23] This coincides with the period when the asset purchase facilities of the Bank of England were operational and may suggest that these policies may have impacted the debt markets during this period.

[23] By excluding the period between October 2010 and July 2011 the correlation between the substitution measure and tightening conditions marginally increases to 0.1821.

Figure 2: Substitution measure versus bank risk appetite

The bank loan to corporate bond substitution measure, on the left scale, is constructed using quarterly issuances of debt securities by rated firms with access to both debt markets. Bank risk appetite measure is a survey based measure of credit supply obtained from the Bank of England credit conditions survey. Data for the credit conditions survey is only available beginning in the year 2007. Riskapp_la3 represents the risk appetite measure from the credit conditions survey and the propbnkiss represents the loan to bond substitution measure. The Bank risk appetite measure is scaled to lie between +/-100 while the loan to bond substitution measure for credit supply is bounded between 0 and 1.



The substitution measure that is constructed in the study closely mimics the trends in bank risk appetite. The correlation coefficient between our bank loan to bond substitution measure and bank risk appetite measure from the credit conditions survey is 0.379. This suggests that our bank credit supply measure declines when bank risk appetite is low and banks are reluctant to increase credit supply.

The correlations between our bank loan to bond substitution measure for credit supply and aggregate measures for credit supply indicate that the bank loan to bond substitution measure may be able to predict out of sample movements in aggregate credit measures.

3.9.1 Out of sample predictions for bank dependent firms' debt issuance and single issue firms.

To date, we estimate and isolate a measure for bank loan supply that is clean of credit demand effects. In this section we estimate whether our bank loan supply measure is able to predict the debt issuance behaviour of bank dependent firms. According to the narrow credit view (Chapter 2, section 2.2.1.2), the debt issuance and investment behaviour of bank dependent firms moves in tandem with changes in bank loan supply.

A direct prediction that arises from the bank loan to corporate bonds substitution measure for bank loan supply we construct in this paper is that the bank loan supply measure should

be able to forecast the behaviour of bank dependent firms. In particular, the loan to bond substitution measure should be positively correlated with the bank loan issuance relative to the no issue decision of bank dependent firms. This implies that bank dependent firms tend to issue bank loans when credit supply is high and that the propensity to issue bank loans declines when credit supply is low. Therefore, we expect a positive and significant coefficient on the loan to bond substitution measure in the bank loan issuance equation for bank dependent firms. In the ensuing regression, we consider firms that have a record of bank loan issues in the LPC database, but for which a bond issuance record could not be found in SDC platinum, to be bank dependent firms. The dependent variable is a dummy variable equal to one when the firm issues a bank loan and zero otherwise.

The results in Table 9 indicate that changes in the debt mix have independent predictive power for the bank loan issuance of bank dependent firms, holding other determinants of bank loan issuance constant. Our indicator for bank loan supply is positively correlated with the issuance decision for the sample of bank dependent firms. This result implies that the probability of issuing a bank loans increases when bank loan supply increases and declines when bank loan issuance declines. This result is consistent with Becker and Ivashina (2014) and with the out-of-sample predictions of Kashyap, Wilcox and Stein (1995) who find that bank dependent firms suffer a decline in external financing when bank loan availability declines. These bank dependent firms are unable to switch between lenders, largely because lending markets are segmented and that switching between lenders or accessing public debt markets is costly. This result implies the existence of a bank lending channel where the financing and investment activities of bank dependent firms are affected by changes in bank loan supply. We will proceed to estimate the impact of bank loan supply on the real decisions of bank dependent firms in chapter 4.

The out of sample predictions show that the loans to bonds substitution measure and bank risk appetite proxies for bank loan supply are both able to predict the loan issuance decision of constrained firms that have no-access to the corporate bond markets. Furthermore, including the loan to bond substitution measure, together with other aggregate measures for bank credit availability, reveals that only the loan to bond substitution measure remains significant. However, a major weakness of the results in this section is that the regressions do not control for credit demand effects since in the periods where there are no recorded bank loan issues it is not clear whether a firm did not have a positive demand for credit or was completely rationed out of the credit markets.

The results on the loan to bond substitution measure indicate that a one standard deviation increase in the ratio (14.63%) will increase the likelihood of issuing a bank loan relative to the no issue decision by 9.77%. The bank loan to bond substitution measure thus shows strong out of sample predictive capacity for the issuance decisions of bank dependent firms, which strongly suggests that the ratio is a useful proxy for changes in bank loan supply.

In the above regressions we establish that our loans to bond substitution measure captures changes in bank loans supply conditions. A decline in bank loan supply is reflected as an increase in the loan to bond substitution ratio, since relatively less constrained firms switch from bank loans to corporate bonds when bank loans supply conditions deteriorate. Furthermore, we identify that the loan to bond substitution measure also predicts the bank loan issuance decisions of firms that have restricted access to the corporate bond markets. In chapter 4 we test whether the bank loans to corporate bonds substitution measure can help predict firms financing and investment policies.

Table 9: Out of sample prediction of the loans to bonds measure

The dependent variable is equal to 1 if a firm issues a loan in that quarter and 0 otherwise. The linear probability model results are estimated using OLS. The regression is estimated using a fixed effects regression model of the following form:

$$D_{it} = c_i + \beta B_t + \gamma X_{it} + e_{it}$$

Where D_{it} is a binary variable equal to 1 if a firm issues a bank loan and 0 otherwise at time t, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a time series measure capturing bank's willingness to lend or condition of limited intermediation; and X_{it} is a set of time variant controls specific to the firm i. The coefficient β in columns 1 to 8 represents a separate regression equation. This sample period is 1994 to 2013. The loan to bond substitution is the fraction of firms that receive a loan among the firms that issued debt in a given quarter. This measure is based on the sample of firms that have access to both markets. Standard errors are robust to heteroskedasticity. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively. All regressions in this table control for firm size, tangibility, profitability, leverage, dividend payments, and cash holdings.

	1	2	3	4	5	6	7	8	All
Loan to Bond Substitution	0.6680***								0.5992***
Credit availability		-0.0012							-0.0028
Risk appetite			0.0017*						0.0045
Tightening				0.0030					-0.0029
Economic conditions					0.0010				0.0034
Sector risks						0.0008			-0.0030
Market pressure							-0.0014		-0.0024
NPL								-7.851	-12.4030
Bank loan growth									0.5233
GDP									0.0805
Adj R-sqr	0.156	0.112	0.116	0.114	0.115	0.115	0.115	0.111	0.1501
F stat	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.000	0.0065
N	1464	1464	1464	1464	1464	1464	1464	1396	1396

3.10.0 Conclusion

In this chapter we test the hypothesis that the substitution between corporate bonds and bank loans by UK non-financial firms reflects changes in bank loan supply. We examine the relationship between changes in credit supply and the propensity to issue corporate bonds or bank loans. We employ firm fixed effects model in controlling for the effects of debt demand and exploit the firms' revealed preference for a given debt type to expose bank credit supply variations. Thus, if a firm issues corporate bonds when overall credit conditions are tightening or bank risk appetite is weak, we interpret this as due to a contraction in bank loan supply. The fact that a firm issues debt in a given quarter implies that the firm had a non-zero demand for debt. As a result, restricting the sample to firms that receive debt within a given quarter isolates demand effects. We control for different information asymmetry and agency related factors that influence debt issuance and employ different filtering techniques in order to isolate the effects of bank loan supply. We find that corporate bond issuance increases relative to bank loan issues when credit spreads widen, bank loans growth contract and credit availability is weak, and when bank risk appetite wanes. Corporate bond issuance is also found to increase during periods of unfavourable macroeconomic outlook. These results tend to confirm the hypothesis that the substitution between bank loans and corporate bonds reflects changes in bank credit supply and are consistent with the findings of Becker and Ivashina (2014) on the US market.

We also test whether credit supply has varying effects on granular debt components. Our results reveal that debt is heterogeneous, and that substitution between debt components occurs at the granular level when credit conditions change. The debt heterogeneity uncovered in this study implies that changes in the debt structure may mask the variations of firm leverage to changing credit conditions, giving rise to inaccurate causal relationships in capital structure studies. These results are in line with the findings in Erel et al. (2011). Furthermore, our results reveal a countercyclical shift in debt issuance from bank debt to corporate bonds when credit conditions deteriorate and bank loan supply declines. This result supports the view of Contessi et al. (2013) and suggests that a capital supply channel is in operation in the UK.

We find that corporate bond issuance increase significantly during the quantitative easing period over and above the effects of credit supply disruptions. In particular, corporate bond issuance increases significantly during the QE1 period while bank loan issuance increases during the QE2 period for the full sample. However, for rated firms, both phases of the QE

program result in an increase in corporate bond issuance. These results suggest that the QE programs have significantly impacted debt issuance in the primary markets, thereby successfully achieving the Bank of England's policy intentions. Furthermore, the variation in QE2 results for the rated firms sample and the full sample seem to suggest that QE2 may have had a differential impact between rated unconstrained firms and relatively constrained firms in the full sample. Overall the results of our QE interacted credit supply factors point towards a portfolio balance channel of QE operating through the bond markets.

Results on our out of sample predictions reveal that our bank loan to corporate bond substitution measure for bank loan supply is a strong predictor of the bank loan issuance behaviour of constrained firms in the sample. Thus the loan to bond substitution measure is a strong predictor of credit contraction for firms that cannot substitute into corporate bond markets. These results reveal that credit supply may be an important factor in explaining firms' debt issuance behaviour and the business cycle. This result is consistent with the findings of Becker and Ivashina (2014) on the US market and confirm the existence of a bank lending channel in the UK.

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CHAPTER 4:

THE REAL EFFECTS OF BANK LOAN SUPPLY ON UK NON-FINANCIAL FIRMS

4.1.0 Introduction

In this chapter we use our index for bank loan supply developed in chapter 3 to test whether bank loan supply is able to predict a firms' financial policies and real investment decisions. In particular we study whether movements in bank loan supply have any bearing on a firms' fixed and inventory investment, net debt issuances and hiring decisions.

Monetary policy literature has long been interested in the role of bank lending supply in the economy, specifically its impact on firm investment and spending behaviour (Hubbard (1996), Bernanke et al. (1999), Peek and Rosengren (2000)). Recent evidence such as that found in Leary (2009), Lemmon and Roberts (2011) and Chava and Purnanandam (2011) confirms the view that bank loan supply affects corporate activity, and that credit supply has variegated impacts on firms with different levels of access to external capital markets.

In the monetary policy literature, according to the lending view (Bernanke et al. (1999), Kashyap and Stein (1996), Gertler and Kiyotaki (2010) Kiyotaki and Moore (2012)), changes in aggregate loan supply have differential effects for bank dependent firms and for unconstrained firms. Here the argument is that a decline in lending supply results in a reduction in constrained firms' business fixed and inventory investment. This is largely because these financially constrained firms are rationed out of the credit markets when bank loan supply declines (Stiglitz and Weiss (1981)). Kashyap, Lamont and Stein (1994), and Lemmon and Roberts (2011) find evidence to suggest that changes in credit availability have real effects on investment, and that adverse credit supply shocks largely impact constrained firms. This implies that adverse credit supply shocks may amplify a decline in investment, employment and output during the business cycle.

In the next section we test the prediction that the investments of bank dependent firms are closely related to movements in bank loan supply, increasing in periods where bank loan availability is high and decreasing in periods where bank loan supply is low. If this lending view is supported we should observe a significant positive relationship between movements in bank loan supply and the investments of bank dependent firms.

4.1.1 Real effects: Business Fixed Investments

Business investment occurs in the form of fixed investment and business inventory investment. According to the narrow lending view, bank loan supply has different cross-

sectional effects on the real decision of firms. Adverse credit supply shocks are deemed to lower both fixed and inventory investments of bank dependent firms. Since bank dependent firms finance their activities using bank loan financing, an inability to access a bank loan translates directly into a decline in investment. In this section we test the hypothesis that the investments of bank dependent firms are positively related to bank loan supply and that the effects of bank loan supply changes are much more significant on bank dependent firms than on non-bank dependent firms.

We employ our measure for bank loan availability that we construct, following Becker and Ivashina (2014), to study the fixed and inventory investments of constrained firms as well as their employment decisions. We argue that the bank loan to corporate bond substitution measure we construct in Chapter 3 is clean from credit demand effects and is thus able to capture fluctuations in bank loan supply. Kahle and Stulz (2013) argue that if substitution away from bank finance to corporate bonds is a result of changes in credit supply, the economic importance of these effects should be reflected in the financing and investment behaviours of bank dependent firms. Changes in bank loan supply should, therefore, disproportionately affect firms, with the largest impact being upon bank dependent firms.

In this section we predict that an increase in the loan to bond substitution measure, which represents an expansion of bank loan supply, is associated with higher firm investments while a lower ratio (contraction in bank loan supply) is associated with lower investments.

Empirical strategy

In this chapter we employ a fixed effects regression model to estimate the impact of our bank loan supply measure on the real decisions of UK non-financial firms. The fixed effects model allows us to control for unobservable firm specific effects that drive investment and financing decisions. The regression model employed in the study takes the following form:

$$Y_{it} = c_i + \beta B_t + \beta_1 Z \times B_t + \gamma X_{it} + e_{it}$$

Where Y_{it} is the dependent variable for firm i at time t, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a the loan to bond substitution time series measure capturing credit supply, Z is an indicator for financially constrained firms; and X_{it} is a set of time variant controls specific to the firm i. As noted in Chapter 3, the loan to bond substitution measure we employ in this study is clean from demand effects.

We employ firm size, leverage and book to market ratios to proxy for financial constraints. Firms in the upper size decile are considered to be less financially constrained and to have better access to corporate bond markets as compared to firms in the lower size deciles. Furthermore, large size firms are more able to meet the high fixed costs associated with corporate bond issuance (Blackwell and Kidwell, 1988). First, Fama (1985) and Nakamura (1993) argue that small firms rely more on bank debt financing since they are not able to meet the information production costs associated with public debt issues. Second, firm size is considered to be highly correlated with firm age or maturity, analysts' coverage and lower information asymmetries.

We also consider those firms that fall into the highest leverage decile to be more financially constrained as they are deemed to face high financial distress costs and may be more in need of renegotiating their debt. Since banks are more flexible and efficient in renegotiating contracts, and are better able to discern when to liquidate or let the firm continue pursuing its growth options when confronted by temporary financial difficulties, firms with high leverage will tend to prefer bank debt to corporate bond issuance.

Furthermore, firms with high debt levels have lower financial flexibility (Ferrando, Marchica and Mura (2014)) and thus are considered to be more financially constrained and bank dependent. Jensen and Meckling (1976) show that the firms with high leverage have high incentives to invest in risky projects due to limited liability provisions and may require some form of monitoring. Myers (1977) also argues that the firm's underinvestment problems may be resolved by contracting debt with monitoring capabilities. As a result firms with high leverage and potential under investment problems may rely on bank lending to resolve asset substitution and underinvestment problems. Firms with low market to book ratios are also considered to be financially constrained and to have very little access to the corporate bond markets. Low book to market firms generally also have low growth options and are bank dependent.

4.1.2 Results

The regression results in Table 10 indicate the effects of our bank loan supply measure on the real fixed investment decisions of both bank dependent and non-bank dependent firms holding firms' growth opportunities constant. In line with Duchin et al. (2010), we eliminate firms with an asset growth greater than 100% at some point during the sample, since these

firms may have undergone mergers or other significant restructuring which likely tends to skew investment patterns.

For unconstrained (access) firms which are the subset of firms in the highest size decile, the results in Table 10 document a positive contemporaneous relationship between our bank loan supply measure and fixed investments. This implies that the fixed investment behaviour of unconstrained firms respond to changes in bank loan supply, and that companies may immediately cut back on current period investments should credit supply decline. We also include a lag of the loan to bond substitution measure in order to capture the possibility of investments responding with a lag to changes in credit supply. We find that results remain relatively unchanged after including this lagged loan-to-bond substitution measure.

Constrained firms in columns 2 and 3 of Table 10 are those firms that are in the lower deciles of the size portfolios. We regress investments using the contemporaneous and lagged changes in the loan-to-bond substitution measure and interaction factors to capture high leverage firms in column 2 and low book to market firms in column 3. The results in Table 10 indicate that while an increase in bank loan supply results in an increase in investments for the average constrained firms, firms in the top most leverage decile experience a decline in investments. This result is contrary to theoretical prediction of the investment behaviour of bank dependent firms to changes in bank loan supply which predict that the capital expenditure of bank dependent firms is more responsive to changes in bank loan supply than the average firm. One explanation for this result is that bank dependent firms with high leverage are faced with high debt overhang problems, and thus may scale back their investments relative to the average firm following either a current or previous period increase in bank loan supply. Similarly, results for the interaction term for firms in the low market to book ratios deciles reveals that business fixed investment behaviour of such firms does not respond differently compared to the average constrained firm when current period or previous period bank loan supply declines.[24]

In column 4 of Table 10 we consider the impact of bank loan supply on constrained firms characterised by both high leverage and low to market book ratios. The firms in this sample are at the intersection of the top most decile of leverage ratio sorts and the lower most

[24] A point to note here is that firms with low market to book ratios may be mature companies that have strong reputations in the credit markets and thus may not be affected. However, this is unlikely to be the case in the subsample of low decile firms.

decile of the market to book ratio sorts. These firms are considered to be severely financially constrained. The results show that for this set of financially constrained firms, changes in bank loan supply affect the investment behaviour of these firms only at a low level of significance. Moreover, the results for the joint significance of the bank loan to bond substitution measure and the firm-specific control variables reveal that these variables fail to jointly explain the investment behaviour of these firms. As a result, the fixed investment behaviour of severely constrained firms appears unresponsive to changes in bank loan supply. The implication is that for these firms, the evidence of a bank lending channel operating through the fixed investment behaviour of constrained firms is weak and hence the hypothesis of the narrow credit view is not supported. However, the results in Table 10 imply that the frictions that customarily generate debt market substitution do not matter in the firm's fixed investment decisions.

Overall, these results indicate the following. First, that the investment behaviour of both unconstrained and constrained firms responds to changes in bank loan supply, and that the investments of financially constrained firms with high leverage respond differently than those of the average bank dependent firm to changes in bank loan supply. These results are consistent with the existence of a capital supply channel of monetary policy transmission as in Lemmon and Roberts (2011). Second, that although the investment of constrained firms tend to respond to movements in bank loan supply, collateral and profitability, these variables do not jointly explain the investment behaviour of firms with severe financial constraints. As a results there is only weak evidence of a bank lending channel operating via the fixed investment behaviour of severely constrained firms.

Table 10: Real effects of loan supply-Fixed investment

The dependent variables is the change in property plant and equipment scaled by total assets. Data used in this regressions are annual data obtained from data stream for the period 1994 to 2013. The loan to bond substitution is the number of access firms issuing bank loans divided by the total number of firms with access to both market issuing debt in a given quarter. The regression is estimated using a fixed effects regression model of the following form:

$$Y_{it} = c_i + \beta B_t + \beta_1 Z \times B_t + \gamma X_{it} + e_{it} \text{ and}$$

$$Y_{it} = c_i + \beta B_{t-1} + \beta_1 Z \times B_{t-1} + \gamma X_{it} + e_{it}$$

Where Y_{it} is the change in property plant and equipment scaled by total assets, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a the loan to bond substitution time series measure capturing credit supply, Z is a dummy variable equal to 1 a firm's leverage is top 10 decile of the leverage sorts and 0 otherwise or if a firm is in the lowest market to book ratio decile based on the market to book ratio sorts; and X_{it} is a set of time variant controls specific to the firm i.In this regression the annual loan to bond substitution measure is calculated as the average of the quarterly loan to bond substitution measure. High leverage is a dummy variable equal to 1 if the firm is in the uppermost decile of leverage sorts and 0 otherwise. Low market to book is a dummy variable equal to 1 if the firm is in the lower most decile of market to book sorts. Access is a dummy variable equal to 1 if the firm is in top size decile. The regressions results are estimated using OLS and are heteroskedasticity consistent. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively. Firms for which negative asset values are reported are dropped from the sample.

	Limited Access firms (Lower deciles firms)						
	Access firms (1)		High Leverage (2)		Low Market to Book (3)		High leverage and Low market to book (4)
	T	t-1	T	t-1	t	t-1	Severely constrained
Investments	0.0619		0.0758		0.0758		0.0928
Loan to Bond substitution	0.0308**	0.0308**	0.0028*	0.0027*	0.0020**	0.0020**	0.7650*
	(2.38)	(2.38)	(1.71)	(1.71)	(2.10)	(2.10)	(1.73)
Loan to Bond substitution * Leverage			-0.0346***	-0.0346***			
			(-5.11)	(-5.53)			
Loan to Bond substitution * Market to Book ratios					0.0165	0.1654	
					(1.00)	(1.00)	
Tangibility	0.3552***	0.3552***	0.3266***	0.3328***	1.5725	1.5725	1.3795*
	(5.21)	(5.21)	(21.70)	(22.14)	(1.69)	(1.69)	(1.81)
Size	0.0140***	0.0140***	0.0174***	0.0181***	0.1445*	0.1445*	-0.2251
	(3.53)	(3.53)	(10.61)	(11.25)	(1.76)	(1.76)	(-1.11)
Leverage	-0.0021	-0.0021	0.0002	0.0002	0.0010	0.0010	0.5894
	(-1.04)	(-1.04)	(0.83)	(0.84)	(0.41)	(0.41)	(0.70)
ROA	0.0022*	0.0022*	0.0010**	0.0010**	-0.0220	-0.0220	1.5639*
	(5.30)	(5.30)	(2.26)	(2.27)	(-0.48)	(-0.48)	(1.74)

Table 10: Real effects of loan supply-Fixed investment

The dependent variables is the change in property plant and equipment scaled by total assets. Data used in this regressions are annual data obtained from data stream for the period 1994 to 2013. The loan to bond substitution is the number of access firms issuing bank loans divided by the total number of firms with access to both market issuing debt in a given quarter. The regression is estimated using a fixed effects regression model of the following form:

$$Y_{it} = c_i + \beta B_t + \beta_1 Z \times B_t + \gamma X_{it} + e_{it} \text{ and}$$

$$Y_{it} = c_i + \beta B_{t-1} + \beta_1 Z \times B_{t-1} + \gamma X_{it} + e_{it}$$

Where Y_{it} is the change in property plant and equipment scaled by total assets, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a the loan to bond substitution time series measure capturing credit supply, Z is a dummy variable equal to 1 a firm's leverage is top 10 decile of the leverage sorts and 0 otherwise or if a firm is in the lowest market to book ratio decile based on the market to book ratio sorts; and X_{it} is a set of time variant controls specific to the firm i.In this regression the annual loan to bond substitution measure is calculated as the average of the quarterly loan to bond substitution measure. High leverage is a dummy variable equal to 1 if the firm is in the uppermost decile of leverage sorts and 0 otherwise. Low market to book is a dummy variable equal to 1 if the firm is in the lower most decile of market to book sorts. Access is a dummy variable equal to 1 if the firm is in top size decile. The regressions results are estimated using OLS and are heteroskedasticity consistent. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively. Firms for which negative asset values are reported are dropped from the sample.

	Limited Access firms (Lower deciles firms)						
	Access firms (1)		High Leverage (2)		Low Market to Book (3)		High leverage and Low market to book (4)
	T	t-1	T	t-1	t	t-1	Severely constrained
Investments	0.0619		0.0758		0.0758		0.0928
Market to Book	-0.0000	-0.0000	0.0002	0.0003	0.0008	0.0008	-0.2725
	(-0.45)	(-0.45)	(1.58)	(1.58)	(0.48)	(0.48)	(-1.88)
Dividend payer	0.0098	0.0098	-0.0108*	-0.1082	0.0068	0.0068	0.2413
	(1.40)	(1.40)	(-1.70)	(-1.70)	(0.21)	(0.21)	(2.46)
Cash ratio	-0.015	-0.0147	0.0201***	0.0201***	0.3939	0.3939	0.3368
	(-0.44)	(-0.44)	(2.90)	(2.90)	(1.52)	(1.52)	(0.59)
N	3996	3996	4005	3635	3800	3406	2357
Companies	470	470	455	455	455	455	415
F stat(prob)	0.0000	0.0000	0.0000	0.0000	0.0009	0.0009	0.1873
Adj R sqr	0.1142	0.1141	0.0934	0.0933	0.058	0.057	0.0239

4.2.0 Business Inventory investments

Kashyap, Lamont and Stein (1994) note that inventory investments of firms often play a major role in the business cycle fluctuations. Most recessions are preceded by a period of protracted credit shortages (Eckstein and Sinai (1986), Blinder and Maccini (1991), and Borio (2014)). Firms often rely on bank funding in order to meet short term working capital requirements, especially in the case of bank dependent firms. As a result the inventory investments behaviour of bank dependent firms tends to be sensitive to changes in bank loan supply (Peek et al., (2003) and Kashyap, Lamont and Stein (1994)). Therefore, we test the hypothesis that inventories of bank dependent firms are positively related to movements in bank loan supply and that the impact of bank loan supply on the inventory behaviour of bank dependent firms is higher relative to firms with access to public capital markets. We test this hypothesis by regressing the growth rate in total inventories against the loan to bond substitution measure.

Here, as in the previous section, we consider firms in the top most leverage decile and those in the lower most market to book market ratios decile to be financially constrained firms (see section 4.1.1. above). In the first set of regressions, column 1, we estimate the impact of our loan to bond substitution measure on the inventory investments decisions of the unconstrained firm. In this set of results, we find that current period and previous period changes in the loan to corporate bond substitution measure are positive correlated with inventory growth and the results are statistically significant at the 5% level. This result implies that the average unconstrained firm tends to increase business inventories when bank credit is readily available in the financial markets.

Similarly, results in column 2 indicate that constrained firms also tend to increase their inventory investments in line with changes in bank credit availability. However, when we include an interaction term for highly levered firms, the results reveal that among the constrained firms, highly levered firms increase their inventories at rates that are lower than those of the average constrained firm when bank loan supply increases. Similarly, constrained firms with low growth opportunities also increase their inventories at lower rates than the average constrained firm when bank loan supply increases. These results are statistically significant at the 10% level.

When we consider the interplay of leverage and market to book ratios, we find that the inventory investment behaviour of financially constrained firms in both the 10th leverage decile and low market to book firms in the 1st decile of the market to book ratio sort

(column 4) responds to changes in our loan to bond substitution measure. The positive coefficients of the loan-to-bond substitution measure for the constrained firms in column 4 indicates that the inventory investments of constrained firms is more than three times as sensitive to movements in bank loan supply as that for the average unconstrained firm in the sample. This result is consistent with both a priori expectations and also with the theoretical predictions of the narrow credit view on the impact of bank loan supply on inventory investments behaviour of financially constrained firms. As most bank dependent firms rely on bank funding for working capital and investments in fixed assets, this result is perhaps not too surprising. Among the bank dependent firms, those firms that are significantly constrained and (in most cases) have no recourse to alternative markets for finance will suffer significantly when bank loan supply declines. This result suggests the bank lending channel may operate via the inventory investment behaviour of financially constrained bank dependent firms.

The results in column 4 are consistent with Peek et al. (2003), who report that business inventories tend to be very sensitive to changes in bank health and bank loan supply. The results also corroborate the findings of Lemmon and Robert (2011) who find evidence of a capital supply channel that operates through inventory investments. In column 4 we find that the impact of bank loan supply on bank dependent firms' inventory investment behaviour is almost four times that of the average unconstrained firm in the sample.

Table 11: Real effects: Inventory investments and bank loan supply

The dependent variable is the growth rate in total inventories. The regression is estimated a fixed effects regression model of the following form:

$$Y_{it} = c_i + \beta B_t + \beta_1 Z \times B_t + \gamma X_{it} + e_{it} \text{ and}$$

$$Y_{it} = c_i + \beta B_{t-1} + \beta_1 Z \times B_{t-1} + \gamma X_{it} + e_{it}$$

Where Y_{it} is the growth rate in total inventories, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a the loan to bond substitution time series measure capturing credit supply, Z is a dummy variable equal to 1 if a firm's leverage is in the top 10 decile of the leverage sorts and 0 otherwise or if a firm is in the lowest book to market decile based on the book to market sorts; and X_{it} is a set of time variant controls specific to the firm i. The constrained only sample consists of firms with high leverage and low market to book values based on quintile double sorts based on leverage and market to book ratios. Firm level control variables included in the regressions include firm size, tangibility, leverage, market to book ratios, cash ratios, a dummy for dividend payers and return on assets. Standard errors are clustered at the firm level.

	Access firms		Limited Access firms				Severely constrained only
	Access (1)		High leverage (2)		Low Market to Book (3)		High leverage and Low Market to Book (4)
	T	t-1	T	t-1	T	t-1	T
Loan to Bond Substitution	0.1033***	0.0613**	0.2000*	0.1709*	0.2060**	0.1843	0.3827**
	(3.49)	2.09	(1.88)	(1.74)	(1.89)	(1.62)	(2.01)
Loan to Bond Substitution*Leverage			-0.0472**	-0.0161			
			(-2.05)	(1.58)			
Loan to Bond Substitution*Low Mkt to book					-0.0517**	-0.0402**	
					(-2.22)	(-2.05)	
N	4028	3901	4005	3635	3800	3406	1126
Companies	443	429	455	455	455	455	517
R sqrd	0.0612	0.0738	0.0840	0.0900	0.0849	0.068	0.1078
F stat (prob)	0.0014	0.0020	0.0726	0.0789	0.0890	0.0930	0.0008

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4.3.0 Net debt issuance

Consistent with our previous analysis, we estimate the impact of bank loan supply on firm's net debt issuance behaviour. In this section we examine whether bank loan supply can predict the net debt issuance of the average unconstrained firm and that of the financially constrained bank dependent firms. Column 1 of Table 12 reveals that unconstrained firms increase their debt issuance relative to constrained firms when bank loan supply increases and the result is significant at the 5% level. Furthermore, the results also show that firm characteristics, together with the bank loan substitution measure are jointly significant in explaining the net issuance behaviour of UK non-financial firms.

Results in the second column, however, indicate that the subset of constrained firms (those in the low size decile portfolio) tend to reduce their overall indebtedness when bank loan supply increases. In the third column we interact the loan to bond substitution measure with a dummy variable for the high leverage decile firms in the low size decile portfolio. The leverage dummy variable is set equal to 1 if a firm is in the top decile of the leverage distribution and zero otherwise. The result in column 3 indicates that for a small subset of highly levered, size constrained firms, the loan to bond substitution measure is positively correlated with net debt issuance. This implies that among size constrained firms, highly levered firms tend to increase their net debt issues when bank loan supply increases. Considering that these highly levered size constrained firms issue debt when bank loan supply is high and reduce their fixed and inventory investments around periods of high bank loan supply, we can speculate that these firms issue new debt when bank loan supply is high in order to retire old debt or to hold as a cash reserve for a precautionary motive.[25] Our results also indicate that among size constrained firms, low market to book ratio firms also experience an increase in their net debt issuance behaviour following an increase in bank loan supply.

[25] However, we do not directly test this assertion in this study.

Table 12: Real effects: Net debt issuance

The dependent variable is the net debt issuances scaled by total assets. Regressions are estimated using fixed effects and are heteroskedasticity robust. The regression is estimated using a fixed effects regression model of the following form:

$$Y_{it} = c_i + \beta B_t + \beta_1 Z \times B_t + \gamma X_{it} + e_{it}$$

Where Y_{it} is the net debt issuance if firm i at time t, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a the loan to bond substitution time series measure capturing credit supply, Z is a dummy variable equal to 1 a firm's leverage is top 10 decile of the leverage sorts and 0 otherwise or if a firm is in the lowest book to market decile based on the book to market sorts; and X_{it} is a set of time variant controls specific to the firm i. Standard errors are clustered by firm year. Firm level control variables included in the regressions include firm size, tangibility, leverage, market to book ratios, cash ratios, a dummy for dividend payers and return on assets. Asterisks *,**,*** represent statistical significance at the 10%, 5% and 1% level. Firms for which the net debt issuance as a proportion of total asset is greater than 100% are dropped from the sample.

		Limited Access firms			Severely constrained only Low Market to book and high leverage (5)
	Access only (1)	Limited Access(2)	Leverage (3)	Market to book (4)	
Loan to Bond substitution	0.1137**	-0.2068*	-0.3002**	-0.2361**	-0.0578
	(1.96)	(1.66)	(-2.44)	(-0.85)	(-1.32)
Loan to Bond substitution*leverage			0.7209***		
			(12.32)		
Loan to Bond substitution*mkt to book				0.1905***	
				(2.73)	
Rsqrd	0.1502	0.1264	0.2498	0.1342	0.1165
F stat (pro)	0.0000	0.0000	0.0000	0.0000	0.0000
Companies	327	533	533	533	424
N	1473	1473	1473	1473	875

However, for the subset of severely constrained firms located at the intersection of the lowest decile of the market to book ratios portfolio and the top decile of the leverage ratio portfolio of firms, the results in column 5 indicate that changes in bank loan supply have no effect on the net debt issuance behaviour of such severely financially constrained firms. This result is inconsistent with both the narrow credit view of monetary policy and also the bank lending channel.

One possible explanation for the failure of the bank loan to bond substitution measure for bank loan supply to predict net debt issues behaviour of the severely constrained firms may be the existence of credit lines which are drawn down during periods of adverse bank loan supply movements. As a result, net debt issuance may be insensitive to swings in bank loan supply. Ivashina and Scharfstein (2010) find evidence that during the financial crisis, firms continued to drawdown their credit lines at a time when bank loan supply was significantly lower. Kahle and Stulz (2013) also find that bank dependent firms did not experience a decline in net debt issuance in the first year after the crisis, although the net debt issuance of highly levered firms declines significantly during the same period.

The inability of our loan-to-bond substitution measure for credit supply to predict changes in net debt issues of severely constrained firms may also be due to firms substituting one form of debt for another while leaving the net debt issuance ratio unchanged. However, we would not expect to find such substitution behaviour manifest in the subsample of financially constrained firms with high leverage and low growth opportunities. Our failure to identify a significant relationship between net debt issuance and bank loan supply for these financially constrained firms suggests that the narrow credit view may not be sufficient to explain the debt issuance behaviour of financially constrained firms in the UK, and that the bank lending channel operates weakly in the UK.

4.4.0 Employment growth

Quadrini (2011) asserts that a decline in bank loan supply may result in firms cutting back on both spending and hiring which may generate recessionary pressures. This suggests a positive relationship between corporate investment on hiring and bank loan supply and that this relationship may be stronger for bank dependent firms. In this section we estimate the relationship between our bank loan supply measure and corporate hiring. Employment growth is defined to be the year on year growth in an organisations' staff compliment. We use the employee numbers reported in FAME and DataStream.

At the firm level, employment growth is largely driven by the degree of capital intensity in the firm's investments, the firm's size, and competitive pressures in the firm's industry, the level of unionisation and trade union bargaining power, and the ownership style. In this section we employ tangibility as a measure of the firm's capital intensity, since firms with larger plants and equipment are generally considered to be capital intense. We also employ the leverage ratio as a proxy for the degree of unionisation or trade union bargaining power. Matsa (2010) notes that firms may sometimes employ high leverage in order to lower the surplus that workers can extract from the firm when bargaining with unions. Thus, in industries where unions have more bargaining power, the firms may employ higher debt levels. Other controls that we employ in this study include, cash ratios, and a dummy variable that captures whether a firms pays out dividends.

Our variable of interest in these regressions is the loan-to- bond substitution index since we wish to find out whether bank loan supply has effects on firm's hiring and firing decisions. The results of regressing employee growth rates on firm characteristics in Table 13 indicate that firm hiring behaviour is positively associated with capital intensity, firm size, and negatively related to leverage which proxies for unionisation and labour bargaining power.

Table 13: Real effects: employment growth

The dependent variable is measured as the growth rate in the number of employees reported by firms per year. The regression is estimated for the period 1994 to 2013 using a fixed effects regression model of the following form:

$$Y_{it} = c_i + \beta B_t + \beta_1 Z \times B_t + \gamma X_{it} + e_{it}$$

Where Y_{it} employee growth rate of firm i at time t, c_i represents firm fixed effects (which are within firm time invariant effects); B_t is a the loan to bond substitution time series measure capturing credit supply, Z is a dummy variable equal to 1 a firm's leverage is top quintile of the leverage sorts and 0 otherwise or if a firm is in the lowest book to market quintile based on the book to market sorts; and X_{it} is a set of time variant controls specific to the firm i. Our loan to bond substitution is taken as the annual average of the quarterly loan to bond substitution ratio. The regression is estimated using a fixed effects model that includes firm size, return on assets, market to book ratios, a dividend payer dummy variables as controls. High leverage is a dummy variable equal to 1 if a firms is in the top leverage quintile and low market to book is a dummy variable equal to 1 if a firm is in the lowest quintile of the market to book distribution and zero otherwise. The asterisk *, **, *** represents statistical significance at the 10%, 5% and 1% level, respectively.

	Access (1)	Limited Access (2)	High leverage (3)	Low Market to Book (4)	High leverage and Low market to book (5)
Loan to Bond substitution	0.0301***	0.1281**	0.1273***	0.1224***	0.1307**
	(2.83)	(2.27)	(2.63)	(5.47)	(2.30)
Loan to Bond substitution * Leverage			-0.1071**		
			(-2.26)		
Loan to Bond substitution * Market to Book ratios				-0.0833***	
				(-2.69)	
Tangibility	0.1643***	0.346**	0.359**	0.375**	0.0599
	(2.58)	(2.14)	(2.21)	(2.37)	(1.08)
Size	0.0229***	0.0240**	0.0265**	0.0271**	0.0274*
	(2.35)	(2.18)	(2.31)	(2.33)	(1.81)
ROA	0.0127	0.0147	0.0151	0.0148	0.0474*
	(1.60)	(1.02)	(1.04)	(1.03)	(1.69)
Leverage	-0.0555**	-0.0641*	-0.0681*	-0.0642*	0.0063
	(-2.06)	(-1.84)	(-1.88)	(-1.85)	(0.99)
Mkt to book ratios	0.0012***	0.0027***	0.0028***	0.0025***	0.00259*
	(3.53)	(4.03)	(4.15)	(3.57)	(1.73)
Dividend payer	0.0068	0.0696	0.0716	0.0710	0.0030
	(0.46)	(0.71)	(0.72)	(0.72)	(0.09)
Cash ratio	-0.0841***	-0.1241***	-0.1252***	-0.1233***	-0.0134
	(-5.32)	(-3.01)	(-2.99)	(2.79)	(-0.10)
N	1626	1668	1668	1668	494
Adj R sqr	0.323	0.334	0.333	0.341	0.115
F Stat (prob)	0.0248	0.0105	0.0136	0.0177	0.0645
Number of companies	340	636	636	636	279

In Table 13 we estimate the impact of our loan to bond substitution measure for bank loan supply on the hiring decisions of constrained and unconstrained UK non-financial firms. In this section, companies for which employment data is not available are dropped out of the sample for each of the decile portfolios. We therefore maintain the same decile portfolios in our estimation such that the results are not influenced by changes in decile composition. In column 1 we find that our loan-to-bond substitution measure is contemporaneously positively correlated with employment for the unconstrained firms in our sample (top size decile firms). We also find that the increase in employment growth is also consistent for size constrained firms (column 2 to column 5). This implies that an increase in bank loan supply is positively associated with an increase in employment among UK non-financial firms. In columns 3 and 4 we find that among size constrained firms, the hiring behaviour of highly leveraged firms and low market to book firms grows at a slower rate than the average size constrained firm in the sample when bank loan supply increases.

In column 5 we estimate the impact of bank loan supply on a subset of financially constrained firms that are at the intersection of the top most leverage decile and the lowest market to book decile. We consider these firms to have limited access to the corporate bond markets. The results reveal that the loan to bond substitution measure is positively related to employment growth among bank dependent firms. The impact of bank loan supply on these constrained bank dependent firms is higher than that for the average size constrained firm in the sample.

The results also show that the loan-to-bond substitution measure predicts the employment growth in firms that are financially constrained and having no access to bond markets. Our results suggest that while bank loan supply may be significant in predicting the hiring of bank dependent firms, there are no significant differences in the response of employment growth between high leverage and low market to book ratios firms and other size constrained firms in the sample. This result points towards a possible existence of a bank lending channel that operates through firm hiring and firing decisions of non-financial firms. We find that our results are broadly consistent with the narrow lending view of monetary policy transmission since the impact of bank loan supply is higher for constrained firms than for the unconstrained firms in the sample.

4.5.0 Conclusion

In this chapter we sought out to establish the real effects of bank loan supply changes on the financing and investment behaviour of constrained firms. Our objective is to ascertain the possible existence of a bank lending channel in the UK. We employ the loan-to-bond substitution measure as a proxy for changes in bank loan supply, based on Becker and Ivashina (2014), to predict the behaviour of constrained non-financial firms. We find that fluctuations in bank loan supply are directly related to business fixed investment and the inventory investment decisions of bank dependent firms. We also notice that the hiring behaviour of non-financial UK firms is strongly correlated with fluctuations in bank loan supply with adverse changes in bank loan supply being associated with a decline in employment. These findings seem to confirm the existence of a bank lending channel of monetary policy in the UK which operates through the investment and hiring decisions of constrained bank dependent firms.

We find that adverse changes in bank loan supply result in a decline in the inventory investment and hiring decisions of constrained bank dependent firms, while it results in a decline in the fixed investment of unconstrained firms. However, adverse changes in credit supply do not seem to have a significant effect on the net debt issuance and net leverage of constrained firms. Overall, the findings in this chapter reinforce the claim that credit supply has important real effects which affect the business cycle and that there exists a bank lending channel or capital supply channel of monetary policy transmission in the UK.

CHAPTER 5

QUANTITATIVE EASING AND THE AGGREGATE DEBT ISSUANCE BEHAVIOUR OF UK NON-FINANCIAL FIRMS

5.0 Introduction

In this chapter we complement our earlier micro-level analysis of the impact of quantitative easing (henceforth QE) policies and bank loan supply on corporate bond issuance by examining the impact of both QE policies and a variety of credit supply shocks on aggregate corporate debt issuance behaviour in the UK.

To date, a significant amount of work on QE programs examines the impact of QE on US long term government bond yields (Krishnamurthy and Vising-Jorgensen (2011)), equity prices, and the investment portfolios of insurance and pension funds for the UK and US (Joyce, Lui and Tonks (2014), and Chodorow Reich (2014), respectively), inflation and economic growth in the UK (Churm et al. (2015), Kapetanios et al. (2011), Goodhart and Ashworth (2012), Borio and Disyatat (2010)), and bank loan issuance in Japan (Bowman et al. (2015)). Although significant strides have been made in identifying the transmission channels of UK QE and the pass-through effects of QE policies on asset prices (Joyce et al. (2012), Breedon et al. (2009), Hausken and Ncube (2013)), the impact of QE on debt issuance on the primary market issuance is largely implied rather than being the subject of analysis[26]. Notwithstanding this fact, several commentators note and accept that the QE program coincides with a substantial increase in corporate bond issuance in the UK ((Fisher (2010), Bank of England (2010) Kaya and Wang (2014), and Joyce et al. (2011)). However, they do not analyse whether the increase in corporate bond issuance is purely coincidental or a result of QE policies.

This study seeks to close this gap by examining the impact of QE on aggregate corporate bond issuance in the UK. The key question we attempt to answer in this study is whether

[26] In most studies, QE affects interest rates through several channels which in turn change the willingness of companies to issue debt and equity as well as to invest and employ, individuals to spend, banks to lend e.t.c. these changes will then ultimately affect inflation and economic growth.

the observed increase in aggregate corporate bond issuance is a direct result of quantitative easing policies, is driven by other credit market shocks that are independent of quantitative easing policies, or is a result some combination of both. The credit market shocks we examine in this chapter include bond market specific shocks, credit supply shocks, credit demand shocks, QE shocks and monetary policy rate shocks. We contribute by studying the effects of QE on debt issuance in a structural model where short term interest rates are constrained at the zero lower bound (ZLB) and asset purchases by the Bank of England substantially lower long term rates, thereby compressing interest rate term spreads. Given that unconventional monetary policies have become an essential component in the central banks' monetary policy toolkit since the global financial crisis of 2007-2009, understanding the transmission channels of QE policies as well as their pass-through effects is important for policy makers and is also essential for the construction and refinement of theoretical models addressing policy transmission.

A major challenge contributing to the paucity of empirical contributions on debt issuance behaviour is the difficulty in separating the simultaneous effects of QE policies from credit supply and credit demand effects. Since QE policies are designed partly in response to a deteriorating macroeconomic environment and tightening credit supply conditions, the policy effects of QE tend to be confounded by these endogenous interactions. This simultaneous interaction of different shocks makes it incredibly difficult to apply the parametric restrictions necessary to resolve the identification problem. Furthermore, given that plausible counterfactuals for net debt issuance in the absence of a QE program cannot be easily established, assessing the impact of quantitative easing policies on debt issuance is further compounded.

In an attempt to resolve the identification challenges highlighted above, we make use of two identification techniques. The first technique employs a structural vector error correction model (SVECM) to identify the impact of quantitative easing shocks, credit supply shocks, credit demand shocks, monetary policy rate shocks and bond market specific shocks. We impose long run restrictions on the model and take advantage of the permanent and transitory shock decomposition of Pagan and Pesaran (2008) so as to use the lagged error correction terms of the VECM as instruments to identify structural shocks.

In the second approach, we apply a contemporaneous sign restrictions strategy to identify independent structural shocks, thereby isolating the impact of different shocks that would

otherwise occur at the same time (Pagan and Fry (2011), Kilian and Lutkepohl (2016)). This approach allows us to identify structural shocks based on their proposed contemporaneous effects, without needing to identify instrumental variables. As a result, the second identification technique is less strict and has an intuitive appeal, especially in situations where some parametric restrictions may seem questionable or are difficult to design. In related studies, Baumeister and Benati (2013) and Peersman (2011), employ a combination of sign identification and parametric restrictions in order to isolate and examine the impact of quantitative easing shocks on output growth and inflation. In other studies, Peersman (2005) and Grant (2015) use more than one identification strategy, namely zero restrictions and sign restrictions, to examine the causes of the early millennium slowdown in the US economy. Thus, the use of both parametric and non-parametric identification strategies is present in the literature.

This chapter contributes by being the first to estimate the effects of QE on the primary corporate bond market activities of UK firms. We examine the impact of quantitative easing shocks, occurring through a compression of the term spreads, on aggregate corporate bonds and bank loans issuance behaviour of UK non-financial firms using structural VAR (SVAR) time series techniques. Although the term spread compression during the QE period is largely attributable to QE shocks (Joyce et al. (2011), Breedon et al. (2012)), studies have neglected analysing the effects of term spread compression on the primary market activities of UK firms. This paper contributes by approaching the QE question from this perspective. In a similar vein, other papers that attempt to explain corporate debt issuance using aggregated data include De Bondt (2002), Davis (2001); and Bridges and Mizen (2004) who all focus upon loan issuance in UK.

Our main findings are as follows. QE shocks result in an increase in corporate bond issuance but have no effect on real bank loan issues and real equity prices. QE shocks tend to depress the term spread but have no effects on the UK base rate. Furthermore, credit supply shocks have transitory effects on corporate bond issuance and permanent effects on bank loan issuance. In contrast, contractionary monetary policy shocks result in a decline in corporate bond issuance in the short term and an increase in loan issuance in the very short term. Credit demand shocks seem to have only transitory effects on loan issuance but appear to have no impact on corporate bond issuance. However, credit demand shocks result in an increase in real equity prices and the UK base rate. As is expected, the increase in the base rate translates into a mechanical reduction of the term spread.

Our counterfactual results indicate that by embarking on QE policies, the Bank of England manages to avert a 10% decline in corporate bond issuance in the UK, although they appear to have no effects on bank loan issuance.

5.1 QE program operations and subsequent events

During the first phase of the QE program, generally termed QE1 (March 2009 to January 2010), the Bank of England made a £200 billion facility available for the purchase of high quality private sector assets and gilts from the private non-financial sector financed by the creation of bank reserves (Bank of England (2009)). The purchase of high quality private sector assets under the QE program is designed to increase the availability of corporate credit by reducing the illiquidity of the underlying credit instruments, while the broader programme of gilt purchases is targeted to boost money supply growth and nominal demand (Fisher (2010 b)).[27] The belief is that the policy transmission of QE policies operates chiefly through the capital markets, with very little impact expected to emanate directly from the bank lending channel (Fisher (2010 a, b)), Bean et al. (2011)). Bank lending is not expected to increase substantially given that banks are concurrently in the process of deleveraging and recapitalising.

In October 2010, saw the Bank of England extend a further £125 billion facility, commonly termed QE2, to purchase long term gilts. This facility is enhanced with a further £50 billion in 2012. In addition to the purchase of gilts, these facilities also allow for the purchase of corporate bonds and high quality commercial paper, (Fisher, 2010 a).[28] This £175 billion facility is introduced as a response to concerns that the Euro area sovereign debt crisis would lead to the UK undershooting its 2% CPI inflation target (Joyce et al. (2011), and Bean (2011)).

The design of the UK's QE program is such that policy transmission primarily occurs via the capital markets rather than through the banks. As a result, it may not be surprising that the QE1 and QE2 policies appear not to have a substantial impact on banking sector lending (Bank of England (2013)). Churm, Joyce, Kapetanios and Theodoridis (2015) find evidence

[27] Fisher (2010 b) claims that the two immediate aims of the corporate bonds program were to improve the price discovery process and hence improve liquidity in the secondary market, and to encourage private demand for corporate bonds in the primary market.

[28] The asset purchase program of the Bank of England is undertaken using a reverse auction framework and has a self-adjusting mechanism that makes selling gilts and corporate bonds to the Bank of England unattractive once credit markets recover and asset prices begin to rise. Credit spreads are set lower than those prevailing during the crisis but higher than those that would obtain in a normal market. As such, the asset purchase facility is self-liquidating.

to suggest that lending to private non-financial companies and households remained relatively unchanged between 2009 and 2012, despite the monetary loosening brought about by the QE policies and low (near zero) policy rates.

Recognising that the QE program does not have a substantial impact on lending, the Bank of England and the UK Treasury introduce the Funding for Lending Scheme (FLS) in 2012 in order to influence credit creation (Bank of England (2013)).

The FLS is designed to improve bank lending and credit supply in the UK economy by providing funding to banks and building societies at favourable terms. Through this facility, the Bank of England lends funds to banks and building societies for longer periods than usual, and at terms that are linked to the volume of their lending to targeted economic sectors and entities[29]. In April 2013, the period of operation for the facility is extended to January 2015.[30] The initial aim of the extension is to engender confidence in the banking sector and to provide an assurance against a sudden increase in funding costs in light of heightened uncertainty in the Euro zone area. The extension is also meant to encourage lending to small and medium enterprises, since even during the two phases of QE, SMEs do not experience a substantial improvement in credit conditions.[31] However, according to the Bank of England (2013), FLS is not expected to impact capital issuance by nonfinancial corporations.

From the foregoing discussion, it is apparent that the QE policies seem to target the capital market and have no substantial impact on bank loan issuance, thereby necessitating the introduction of FLS. However, in this chapter our focus is upon the impact of QE on debt issuance and do not analyse the role of FLS. In the next section we present a discussion of the transmission channels of QE.

[29] Under the FLS scheme, the Bank of England offers to lend UK treasury bills to banks and building societies for a period of up to 4 years in exchange for loans to businesses and households. Each participating bank is able to borrow up to 5% of its stock of outstanding loans to UK non-financial corporations. The cost of funds to each bank or building society is linked to its net lending. Banks increasing their lending to non-financial corporations face lower funding costs. Banks that reduce their lending face an increase in their fee schedule.

[30] New allowances for drawings in the extension period are calculated on the basis of banks' lending behaviour. For every £1 of net lending to SMEs in 2014, banks are able to draw £5 from the scheme in the extension period. To encourage banks to lend to SMEs sooner rather than later, every £1 of net lending to SMEs during the remainder of 2013 is worth £10 of initial borrowing allowance in 2014. Net lending to other sectors during the remainder of 2013 counts towards the initial borrowing allowance for 2014 pound for pound. Bank of England and HM Treasury announce extension to the Funding for Lending Scheme. Retrieved from http://www.bankofengland.co.uk/publications/Pages/news/2013/061.aspx

[31] Retrieved from http://www.bankofengland.co.uk/publications/Documents/fls/governorletterfls.pdf

5.2 Transmission channels for QE

Two main channels generally dominate the literature on QE transmission mechanisms, namely, the portfolio balance channel and the signalling channel. The Bank of England's monetary policy committee emphasises that the portfolio balance effects channel is the main channel through which UK QE policies are transmitted to inflation and output (Joyce, Lui and Tonks (2014), Joyce et al. (2012), Benford et al. (2009)). The purchases of financial assets from the private sector by the Bank of England aims to bid up asset prices of gilts and other assets that are close substitutes for gilts, as households and firms seek to rebalance their portfolios and transfer into other risky assets. The wealth effects arising from increasing asset prices, lower borrowing costs, softening the terms of borrowing, and strengthening private sector and household balance sheets, are intended to stimulate expenditure by households and investment by firms, thereby helping economic growth (Benford et al. (2009), Joyce and Tong (2012) and Kapetanios et al. (2012)). This implies that the ultimate effects of the QE program is to increase GDP and inflation in the UK through spending, asset price and lending channels.

Kapetanios et al. (2012) and Joyce et al. (2012) claim that the unconventional monetary policies of the Bank of England are partially directed at restoring the credit market function by easing the liquidity situation in the credit market. Yellen (2009) also concurs with this view, asserting that the QE program affects credit availability through a reduction in credit spreads. Theoretical work by Hormann and Schabert (2015) indicates that QE policies operate by reducing liquidity spreads in the credit markets and by stabilising distressed credit markets. Similarly, Arseneau et al. (2015) develop a theoretical model in which they show that QE increases secondary market liquidity, compresses liquidity premia and results in an increase in corporate bond issuance. Benford et al. (2009) claim that the QE policies target reductions in illiquidity premia, and that credit risk premia may be influenced indirectly through the general increase in collateral values and nominal spending that arises through money-financed asset purchases. In support of this claim, Joyce et al. (2012) use event study techniques to establish that the liquidity component of credit spreads narrows following the announcement of UK QE policies.

Krishnasmurth and Vissing-Jorgensen (2011) find similar evidence for the US markets. In a related study, Gagnon et al. (2011) asserts that large scale asset purchases in the US result in a fall in the duration risk premia. They find that there is a contraction in yields on Treasury securities and mortgage backed securities of approximately 90 and 110 basis points,

respectively. Similarly, empirical evidence from Joyce et al. (2011), Joyce and Tong (2012), Meaning and Zhu (2011), Breedon, Chadha and Waters (2012), Christensen and Rudebusch (2012) provide evidence in support of portfolio rebalancing and document a reduction in long term gilt yields (there is consensus in these studies that long term gilt yields decline by almost 100 basis points) and a compression in the term spreads; as well as an increase in the prices of other assets and an improvement in corporate bond and equity issues.

Fisher (2010, p.10) acknowledges the success of the QE program in increasing corporate bond issuance during 2009 and states:

"*….the corporate bond market overall has performed consistently strongly and in line with the original objectives of the scheme: There has been record issuance of sterling corporate bonds; spreads for eligible bonds have halved; bid-offer spreads have narrowed; and the bond-CDS basis has also contracted significantly. These asset purchases do seem to have played their part in improving the access of investment grade corporates to bond market financing…*"

However, the overall impact of the QE policies on the availability of credit to companies is contingent on investor's willingness to provide capital to corporate debt markets. Benford et al. (2009) argue that the Bank of England's asset purchases will serve to stimulate bank lending to lower-quality debt issuers providing that investment-grade companies aggressively take advantage of low yields in the capital market. This leaves banks with more capacity to lend to non-investment grade companies. However, Borio and Disyatat (2010) argue that banks are subject to severe financial stress during this time period, and as a result this bank lending channel is unlikely to work.

As Kapetanios et al. (2012) note, QE has no wide-ranging economic effects unless it affects agent's expectations about the future path of interest rates through a signalling channel.[32] By reference to a feature common to many new Keynesian models, Kapetanios et al. (2012) claim that portfolio balance mechanisms are largely irrelevant. This is because a reduction in private sector risks resulting from central bank asset purchases is counterbalanced by an increase in the riskiness of the public sector portfolio due to the inherent uncertainty associated with future taxes and spending. They deem that this offsetting mechanism makes QE largely ineffective, if not irrelevant in stimulating private sector investment behaviour. Bridges and Thomas (2012) note that the QE effects they identify using the term

[32] Purchasing a large quantity of long term assets and holding these on the central bank's balance sheet may serve as a credible commitment to keep interest rates low, thereby making asset purchases a credible signal through resolving the policy inconsistency problem.

spreads appear to be temporary. Similarly, Churm et al. (2015) document that while QE has a substantial effect on reducing credit spreads and yields in the debt markets, it has no significant effect on UK bank loan issuance.

The literature on the transmission channels of QE highlights that there is an expectation that QE lowers yields through a reduction in risk premium, or an improvement in the collateral values of economic agents. In turn, these low yields make it attractive for economic agents to issue debt and to switch into other higher yielding risky assets. On the basis of the foregoing discussion, we conjecture that QE, through a reduction in yields and spreads, may stimulate firms to issue corporate bonds, particularly at a time when the bank loan issuance is constrained.

5.3 Methodology

The chapter employs a series of steps in its attempt to study the effects of QE policies on UK corporate bond and bank loan issuance. We employ Johansen and Juselius (1990) cointegration techniques to study the long run relationships and the short run dynamics between corporate bond issuance, bank loan issuance, equity prices, term spreads and the policy rate. Since the variables employed in the study are non-stationary and co-integrated (stationarity and cointegration results are presented in section 5.3.2), this implies the presence of temporary and permanent shocks in the data series. Therefore, we employ a structural vector error correction model (SVECM) with long run restrictions in the spirit of Blanchard and Quah (1989) to account for these permanent and transitory shocks, and thus disentangle QE shocks from other credit market shocks. The identification of QE shocks and other related credit market shocks is presented in section 5.6 of this chapter. Throughout the discussion, a particular concern is to establish plausible counterfactuals for the impact of QE[33].

Specifically, we proceed as follows. Initially, we formulate a SVECM model to study the impact of QE and other credit market related shocks on corporate bonds and bank loan issuance in the UK. We employ vector error correction model (VECM) to summarise the data and then build a SVECM using long run restrictions to enable us to give an economic interpretation of our model results. The SVECM model we estimate in this study is of the form:

[33] The VECM model we estimate is used to provide the point estimates we need for counterfactual analysis.

$$B_0 \Delta y_t = \Pi^* y_{t-1} + B(L)\Delta y_{t-q} + \varepsilon_t \quad \ldots\ldots\ldots\ldots (1)$$

where B_0 is an $(n \times n)$ matrix of contemporaneous interactions, Π^* is the structural matrix, $B(L)$ are $(n \times n)$ matrices of short run dynamics parameters, $L = L^1 + L^2 + \cdots + L^q$, q is the appropriate lag length at which all serial correlation is eliminated in the regression equations, and ε_t is an $(n \times 1)$ vector of structural form errors with mean zero and covariance matrix I_k. Δy_t represents the first differences of the I(1) variables in y_t=$[b_t, l_t, f_t, s_t, r_t]$ in equation 1. $y_t = [b_t, l_t, f_t, s_t, r_t]$ is a set of endogenous variables with b_t, l_t, f_t, s_t and r_t being the outstanding corporate bond issues, outstanding bank loan issues, FTSE total return index, UK term spread, and the Bank of England base rate, respectively. The variables are measured at a quarterly frequency.

In order to estimate the summative model, we express equation 1 in reduced form as a VECM of the form:

$$\Delta y_t = \Pi y_{t-1} + \Gamma(L)\Delta y_{t-l} + u_t \quad \ldots. \quad (2)$$

Where $\Pi = B_0^{-1}\Pi^*$, $\Gamma(L) = B_0^{-1} B(L)$, and $u_t = B_0^{-1} \varepsilon_t$. When Π has reduced rank ($rank(\Pi) = \mathrm{r} < \mathrm{k}$), the matrix $\Pi = \alpha\beta'$ with β an $(n \times r)$ matrix of long-run relationships, α an $(n \times r)$ matrix of speed of adjustment coefficients, and u_t is white noise with mean zero and covariance matrix $\sum_u$. In this study we test for cointegration using the Johansen and Juselius (1990) cointegration techniques. Results of the Johansen and Juselius cointegration tests and the ensuing cointegrating relationships are presented in section 5.3.2.

In the second stage, we augment our SVECM results with the use of sign restriction identification strategies. The sign restrictions methodology relates the variable shocks to their impulses responses. The restrictions are based on the expected direction of variable shock effects on impact. We use the sign restricted identification results as a robustness test for the time profile of shocks generated using long run identification strategies. Both Uhlig (2005) and Canova and De Nicolo (2002) claim that sign identification provides more information for the estimation of structural parameters which helps in resolving the structural identification problem often associated with parametric restrictions. This allows us to better identify structural shocks and provide an economic interpretation of the model results.

However, Fry and Pagan (2011) note that identification of impulse responses through sign restricted models may induce a model identification problem. This is because the set of impulse responses identified using sign restrictions is not unique. Consequently, there may be many models with identified parameters that can provide the same fit to the data.[34] In order to balance out the structural identification challenges of parametric restriction and the model identification problems of sign identified models, we apply both identification strategies in this chapter. We present the details of the sign restrictions identification strategy we employ in the study in section 5.10.

5.3.1 Variable definition and justification

In this section we present the variables employed in this study. We obtain the real variables bonds, loans and equity prices by deflating the relevant nominal variables by the consumer price index. All variables are measured at a quarterly frequency and cover the period 1975 to end-2015.

Outstanding corporate bonds (bonds): This Bank of England measure captures aggregate corporate bonds that have been issued and are still outstanding.

Outstanding Bank loans issued (loans): The series, again from the Bank of England, captures the aggregate loans provided by monetary financial institutions to non-financial corporation in the UK.

FTSE total return index/ equity prices (FTSE): The variable is used to measure equity prices.

Term Spread: We estimate this series as the difference between the 10 year UK gilt yields and the 3 month UK Treasury bill rate. Data for the term spread is from the Bank of England. We employ this variable to capture quantitative easing shocks when the policy rate is near the zero lower bound. The term spread allows us to cleanly capture QE shocks, since the measure is free from large and significant liquidity risk premia and default premia.[35] Moreover, shocks to the term spread that we capture using this measure are independent of changes in firm's credit risk premiums, and thus a compression of the term spread is assumed to be caused by QE policies, through asset purchases at the long term end of the yield curve, when the monetary policy rate is at the zero lower bound. Furthermore, only

[34] Fry and Pagan (2011) and Killian and Murphy (2012) assert that sign restricted models are set identified models and as such are inappropriate in providing the point estimates needed for counterfactual analysis.

[35] The term spread measure is not free from duration effects and tends to capture duration risk premia. However, we conjecture that duration premia will not confound the QE effects captured by shocks to the term spread since QE policies targeting the long end of the yield curve are designed to lower risk premiums associated with duration (Bernanke (2006) and Baumeister and Benati (2013)).

the long term end of the yield curve is capable of being adjusted through long term gilt purchases when the base rates are near zero.

UK base rate: we use this variable to capture policy changes in the Bank of England's' monetary policy stance. The base rate is the primary policy tool of the Bank of England and serves as the basis on which all other rates in the credit market are set.

5.3.2 Unit root and cointegration tests

In this study we employ both the Augmented Dickey Fuller (ADF) unit root test and Phillips and Perron stationarity test to establish the order of integration for the time series variables. The ADF test is sensitive to the number of lags included in the Dickey and Fuller regression model (Enders (2004)). Including too few lags in the model may result in serially correlated residuals, while including too many lags may result in a loss of degrees of freedom and reduces the power of the test to reject the null hypothesis of a unit root. The appropriate lag length is chosen using the Schwartz Bayesian Information Criteria (SIC). The model for unit root testing is selected based on the Dickey and Fuller (1981) test procedure. The critical values for the $\emptyset_1, \emptyset_2$ and $\emptyset_3$ statistics are obtained from the Dickey and Fuller (1981) empirical distribution for $\emptyset$.

We summarise the univariate properties of the five variables we employ in the analysis in Table 14. Results of the ADF unit root tests and the Phillip and Perron stationarity tests indicate that: outstanding nominal bank loans, real loans, nominal bond issues, real bond issues, equity prices and real equity prices are unit root processes (at a 5% significance level) over the sample period on the basis of both ADF unit root and Phillips-Perron stationarity tests. These variables are non-stationary and integrated of order one, I(1). The first difference of these variables is stationary and integrated of order zero, I(0). However, term spreads, long term yields, real long term yields and the UK base rate are stationary and integrated of order zero, I(0) and are thus stationary at the 5% level of significance. This implies that outstanding corporate bonds, bank loans and equity prices carry permanent shocks whilst the remaining I(0) variables carry transitory shocks.

The results of the cointegration analysis using the Johansen (1995) cointegration tests, both for the full sample (1975Q3-2015Q1) and the pre-crisis sample (1975Q3-2007Q1), shown in tables 22 and 23 in the appendix to this chapter, indicate that on the basis of the Trace statistic and the maximum Eigenvalue test statistics, we cannot reject the null hypothesis of a single cointegrating relationship in the data series. Trace statistics results for the

reduced sample indicate that there is a single cointegration relation among the data series, while the maximum Eigenvalue statics cannot reject the null of no cointegration. Where the cointegration tests are in conflict, we rely on the results of the Trace statistic as recommended by Lutkepohl et al. (2000). Johansen (1994) also tends to favour the trace statistic largely because the trace tests give rise to a more coherent testing strategy.

The existence of a single cointegration vector among three I(1) variables in the model implies that two permanent shocks exist in the system. Since the term spread and the policy rate are both I(0) processes and therefore carry only transitory shocks, there are three transitory shocks in the system . However, Fisher, Huh and Pagan (2013) and Ouliaris, Pagan and Restrepo (2016) claim that I(0) variables can produce permanent effects in the SVECM system. In this study we allow I(0) variables to produce both transitory and permanent effects.

Table 14: Unit root tests

The table presents results of the Augmented Dickey Fuller (ADF) unit root test and the Phillips and Perron stationarity test. T&I represents trend and intercept model for unit root testing while, I, represents the intercept only model. H0 is the null hypothesis in the test while H1 represents the alternative hypothesis. The asterisks *,**,*** represent statistical significance at the 10%,5% and 1% levels. All variables except the interest rates are expressed in natural logarithms. The general form for the ADF test is given as:

$$\Delta y_t = c + \delta t + \propto y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$$

Where c is an intercept, t is the time trend included in the T&I model, $\propto = -\left(1 - \sum_{i=1}^{p} a_i\right)$ and $\beta_i = -\sum_{j=i}^{p} a_j$. For the I model the time trend is dropped from the equation. While in the None model, both the intercept, c, and the time trend, t, are left out. The null hypothesis under the ADF test is H0: $\propto = 0$. NW lags represent the Newey West bandwidth chosen using the Bartlett kernel by automatic selection in Eviews. The $\emptyset_i = \frac{[SSR_{restricted} - SSR_{unrestricted}]/_r}{[SSR_{unrestricted}/(T-k)]}$ where r is the number of restrictions, T is the number of observations and k is the number of parameters estimated in the unrestricted model. The general ADF model presented above is taken as the unrestricted model. The null hypothesis that $\propto = c = 0$ is tested using the $\emptyset_1$ statistic. The joint hypothesis that $\propto = c = \delta = 0$ is tested using $\emptyset_2$ while the joint hypothesis that $\propto = c = \delta = 0$ is tested using the $\emptyset_3$ statistic. Critical values for $\emptyset_1, \emptyset_2$ and $\emptyset_3$ are obtained from the Dickey and Fuller (1981) empirical distribution.

Variable	H0	H1	Model	ADF	Lags	$\emptyset_1$ *3.86, **4.71 ***6.70	$\emptyset_2$ *4.16, **4.88 ***6.50	$\emptyset_3$ *5.47, **6.49 ***8.73	PP	NW Lags	Conclusion
Loans	I(1)	I(0)	T&I	-1.0909	4	6.4190**	4.2970*	5.4980*	-0.1710	9	I(1)
ΔLoan	I(1)	I(0)	T&I	-7.2638***	4	12.9160***	8.7110***	12.7930***	-3.3751*	3	I(0)
Real Loans	I(1)	I(0)	I	-1.7384	4	4.2260*	3.1450	3.0990	-0.0469	9	I(1)
ΔReal loans	I(1)	I(0)	None	-1.7609*	4	3.9470*	2.6503	3.9730	-5.8501***	6	I(0)
Bonds	I(1)	I(0)	T&I	-0.2389	0	13.8660***	16.9150***	5.2610	-0.4572	2	I(1)
ΔBonds	I(1)	I(0)	T&I	-11.8810***	0	68.9940***	46.0880***	69.0060***	-3.4295*	8	I(0)
Real bonds	I(1)	I(0)	T&I	-1.3790	4	4.1180*	6.1830**	1.2170	-0.1595	3	I(1)
ΔReal bonds	I(1)	I(0)	T&I	-11.3710***	0	64.6710***	43.1210***	64.6790***	-11.3203	4	I(0)
FTSE equity prices	I(1)	I(0)	I	-2.4250	0	5.8530**	3.9370	1.7445	-1.2249	4	I(1)
ΔFTSE equity prices	I(1)	I(0)	T&I	-12.0688***	0	48.0950***	54.7870***	43.5740***	-12.0759***	3	I(0)
Real equity prices	I(1)	I(0)	None	1.1840	0	2.6210	2.3320	2.2620	-2.0041	4	I(1)
Δ Real equity prices	I(1)	I(0)	T&I	-12.6780***	0	80.0140***	53.3430***	80.0150***	-12.1762***	4	I(0)
Term spread	I(1)	I(0)	T&I	-3.5390**	4	6.4710**	4.3140**	6.4520**	-3.3993**	4	I(0)
Long term yield	I(1)	I(0)	T&I	-4.6480***	1	10.8190***	7.8170***	10.8480***	-3.4989**	1	I(0)
UK base rate	I(1)	I(0)	T&I	-4.0557***	2	8.7180***	5.9850**	8.8010***	-3.5858**	4	I(0)
Real long term yields	I(1)	I(0)	T&I	-4.8780***	1	11.9060***	7.9700***	11.9010***	-2.9483**	3	I(0)

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5.4 Reduced-form Cointegration results and weak exogeneity tests

In this section we estimate the reduced form cointegration relations in equation 2 and test the null hypothesis that corporate bond and bank loans are compliments against the alternative that there is no long run complementarity between bank loans and corporate bonds. Results of the cointegrating relationship between real corporate bond issues, outstanding real bank loan issues, real equity prices, term spreads and the base rate are given in Table 15.

The lag length for the VECM is set at 2 to allow for sufficient dynamics to expunge any serial correlation in the residuals.[36] The lag order is based on the Schwarz Information Criterion and the Hannan-Quinn information criterion. However, we also apply a lag order of one based on the Akaike information criterion in order to check the robustness of the VECM. The qualitative results of the VECM do not change if the lag length is set to 1. Diagnostic results in Table 15 and the correlogram of residuals we present in Figure 12 show that the residuals from the VECM models exhibit no serial correlation. The Jacque-Bera normality test reveals that the residuals are not jointly multivariate normal. The inverse characteristic roots of the VECM model in Figure 13 of Appendix D indicate that the roots of the VECM lie within the unit circle, and thus the model is stable.

The Johansen and Juselius cointegrating results in Table 15 reveal that there exists a positive long-run relationship between corporate bond issuance and bank loan issuance. The long run restrictions we impose on the cointegration relation, columns 3 and 5 of Table 15, fail to reject the null hypothesis, at the 1% level of significance, that corporate bonds market and the bank loans market tend to be complementary in the long run. Our results also indicate that this long run relationship between corporate bonds and bank loans is consistent whether we use real or nominal variables. The implication is that bank loan market developments are directly associated with corporate bond market developments in the long run. This finding is consistent with a priori expectations, since credit market developments tend to move in the same direction over time.[37] However, this long run relationship may be a result of common credit shocks that affect corporate bond issues and bank loan issues in the same direction. As such, we test for causality and the existence of weak exogeneity in the data series in the analysis to follow. We present an examination of

[36] Results of the lag order selection criteria are presented in Table 23 in the appendices section.

[37] Improvement in technologies in the credit markets such as securitisation, may result in positive spill-overs between markets in the long-run.

the impact of structural shocks on the corporate bond and bank loan markets in section 5.7 of this study.

Furthermore, the results also show that in the long run, a tightening of monetary policy, an increase in term spreads, and an improvement in real or nominal equity prices, all result in a decline in long-run corporate bond issuance. Increases in the monetary policy rate and in term spreads will both increase issuance costs and thus reduce demand for corporate bonds, consistent with a priori expectations. An increase in real equity prices mean that it may be favourable for firms to issue equity relative to corporate bonds. In this sense, its effect is also consistent with prior expectations, since bond prices often fall as investors switch into equities.

We proceed to test for the existence of weak exogeneity and Granger causality between the variables in the long run equation in order to better understand the structure of the data. We undertake this examination before we identify structural shocks in the data series. Results for both long- and short run Granger causality tests as well as weak exogeneity tests are given in Table 16. They show that we fail to reject the null hypothesis that equity prices and policy rates tend to be weakly exogenous at the 5% level of significance. This result tends to suggest that changes in equity prices and policy rates exhibit a tendency to be determined from outside the VECM system.

Table 16 also reveals that there exists both long- short run bi-directional Granger causality between the bond market and the loans market, and also between the loans market and the equity market. To the extent that an increase in real equity prices represents an improvement in the wealth and the collateral value of economic agents, the existence of Granger causality between real equity prices and bank loan issuance suggests that the Bernanke et al. (1999) financial accelerator effect may be in operation in the UK.

However, an examination of the causal link between real equity prices and real corporate bond issues shows that equity prices do not Granger cause corporate bond issuance, and vice versa. This absence of a causal link between corporate bonds and real equity prices, coupled with the weak exogeneity of real equity prices in the VECM system, tends to suggest that the observed long run relationship between real equity prices and corporate bonds issuance may be partially capturing the common relationship between bonds and loans through real equity prices, since there also exists a bi-directional causal link between equity prices and bank loans.

Table 15: Long run cointegration equation for the bond market

This table presents results for the cointegrating vector, β′, and the error correction terms, α, in the reduced form VECM model presented in equation 2. These equations are estimated using the sample 1975Q3-2009Q1. The long run relationships, β′, are estimated using real and nominal variables, respectively, and are given by:

$$b_{nt} = 0.895bl_{nt} - 1.200f_{nt} - 0.263r_t - 0.745s_t$$ for nominal variables, and

$$b_t = 1.268bl_t - 2.062ftse_t - 0.405r_t - 0.929s_t$$ for real variables.

Where b_t, l_t, f_t, r_t, s_t represent outstanding corporate bonds, bank loans, FTSE index, UK bank of England base rate and the term spread, respectively. Results in Columns 3 and 5 test the null hypothesis that in the long run, corporate bonds issues and bank loans issues are complements i.e. H_0: $\beta_{bankloans} = -1$, for nominal and real variables, respectively. χ_1^2 represents the results of the Wald's Chi squared test for the coefficient restrictions in the cointegration equation. Student t-statistics are presented in the square brackets, []. The model is estimated with an intercept but no trend in the cointegrating equation and with no intercept in the VAR equation.

(1)	(2) Unrestricted equation (nominal variables)		(3) Long run substitutability restriction (norminal variables) H_0: Restriction $\beta_{bankloans} = -1$ $H_{1:}$: $\beta_{bankloans} \neq -1$ χ_1^2=2.2820 probability = 0.13088		(4) Unrestricted equation (real variables)		(5) Long run substitutability restriction (real variables) H_0: Restriction $\beta_{bankloans} = -1$ $H_{1:}$: $\beta_{bankloans} \neq -1$ χ_1^2= 0.078808 probability =0.778919	
Variable	Cointegration equation $\beta, [\ t\ Stat]$	Error correction terms $\propto, [\ t\ Stat]$	Cointegration equation $\beta, [\ t\ Stat]$	Error correction terms $\propto, [\ t\ Stat]$	Cointegration equation $\beta, [\ t\ Stat]$	Error correction terms $\propto, [\ t\ Stat]$	Cointegration equation $\beta, [\ t\ Stat]$	Error correction terms $\propto, [\ t\ Stat]$
Log Bonds	1	-0.0110 [-1.7698]	1	-0.0012 [-1.2659]	1	-0.0030 [-0.5028]	1	-0.0046 [-0.6562]
Log Bank loans	-0.8953 [-1.6926]	-0.0026 [-2.2207]	-1	-0.0004 [-2.2614]	-1.2683 [-1.6821]	-0.0001 [-0.1120]	-1	-0.0004 [-0.2880]
Log FTSE	1.1997 [1.7144]	-0.0118 [-1.3723]	7.1099 [2.1307]	-0.0014 [-1.0712]	2.0624 [1.8428]	-0.0023 [-0.2670]	1.6081 [1.8119]	-0.0022 [-0.2220]
Term spreads	0.7449 [4.2724]	-0.3590 [-4.3693]	4.6866 [3.8355]	-0.0540 [-4.5079]	0.9293 [3.6779]	-0.3714 [-4.6775]	0.8351 [4.3098]	-0.4229 [-4.5028]
Policy rate	0.2630 [2.0463]	0.2456 [2.4138]	1.3710 [1.5580]	0.0389 [2.6179]	0.4046 [2.1089]	0.2925 [2.9505]	0.3891 [2.7392]	0.3213 [2.7429]
Diagnostics results								
Serial correlation-LM test (prob)	26.6206 (0.3751)		31.8746 (0.1617)		29.4587 (0.2458)		29.1909 (0.2560)	
Jacque-Bera [df](prob)	1015.491 [10] (0.000)		1238.72 [10] (0.0000)		714.45 [10] (0.0000)		699.48 [10] (0.0000)	

Table 16: Examining weak exogeneity, and Granger causal structures

In this table we present the results of exogeneity and causality restrictions on the estimated VECM relations $\Delta y_t = \alpha\beta' y_{t-1} + \Gamma(L)\Delta y_{t-l} + u_t$. Each of the columns (2)-(6) represent a separate VECM and the rows present results of the joint restrictions $H_0: \beta_{1,1}\Delta y_{t-1} = \beta_{1,2}\Delta y_{t-2} = \alpha = 0$ for each of the variables in y_t. This restriction is equivalent to a Granger causality test and it tests for the existence of long-run causality between variables in the VECM. The ECM terms present results of the weak exogeneity restriction $H_0: \alpha = 0$ for each of the partial VECMs. The asterisks *, **, ***, represent a rejection of the null hypothesis at the 10%, 5%, and 1%, levels of significance, respectively.

Variable restrictions (1)	**Bonds VECM (2)**	**Loans VECM (3)**	**FTSE VECM (4)**	**Spread VECM (5)**	**Policy rate (6)**
$\boldsymbol{\beta_{1,1}\Delta y_{t-1} = \beta_{1,2}\Delta y_{t-2} = 0}$	χ_2^2 **, (prob)**	χ_2^2 **(prob)**	χ_2^2 **(prob)**	χ_2^2 **, (prob)**	χ_2^2 **, (prob)**
ECM terms[38]	4.332 (0.037)**	7.924 (0.049)**	1.493(0.223)	8.898(0.002)***	3.647(0.06)*
Bonds	-	7.567 (0.048)**	1.911 (0.643)	2.101 (0.717)	2.318 (0.677)
Loans	11.242 (0.024)**	-	11.814 (0.019)**	5.702(0.062)*	1.883 (0.757)
FTSE	0.463 (0.793)	15.475 (0.004)***	-	0.517 (0.972)	1.273 (0.866)
Spreads	1.903 (0.386)	14.632 (0.006)***	1.097 (0.895)	-	6.099 (0.056)*
Policy rates	0.627 (0.731)	10.349 (0.035)**	0.984 (0.912)	0.705(0.095)*	-

[38] The cointegration equation is normalised on the bond issuance series. For the error correction terms (ECMs), the restriction imposed is $\alpha = 0$.

The results also highlight that term spreads, the FTSE total return index and policy rates have no significant causal effects on bond issuance in the estimated equation for the bond market. In contrast, results for the loans market point to the existence of a causal relationship between bank loan issuance and the policy rate, term spreads, bond issues and equity prices. The causal link between bank loans and policy rates is uni-directional and flows from policy rates to bank loans. While the relationship between term-spreads and loans issuance tends to be tenuous and bi-directional (at the 10% level of significance), Granger causality appears to flow strongly from term spreads to loan issuance and weakly from real loan issuance to term spreads. Similarly, the causal relationship between term spreads and policy rates appears to be bi-directional at the 10% level of significance.

The results in Table 16 tend to suggest that the loans market is more responsive to term spread, policy rates and real equity prices in comparison to the corporate bond market.

Having established the existence of a long run relationship between UK corporate bond issuances, bank loan issuances, equity prices, term spreads and the base rate, we proceed to estimate the structural parameters and to disentangle the structural shocks from the estimated VECM. In this study we identify credit supply, credit demand, quantitative easing and monetary policy shocks using a SVECM framework, in a manner similar to Pagan and Pesaran (2008), Gali (1992, 1999) and Ouliaris et al. (2016). Impulse responses and variance decomposition of the corporate bonds and bank loans to the different structural shocks are shown in the sections 5.7 and 5.8.

5.5 Identification of permanent and transitory shocks in the co-integrated system

In order to identify the structural shocks of interest, and to be able to infer the impact of the quantitative easing and other credit market shocks on the debt issuance behaviour of UK non-financial firms, it is essential that the identified structural shocks are independent. In this section we achieve the identification of bond market, credit demand, credit supply, quantitative easing and monetary policy shocks using a combination of restrictions on B_0 and $\Gamma(L) = B_0^{-1} B(L)$, in equations 1 and 2. Since our variable are cointegrated, we achieve identification of structural shocks using long run restrictions strategies. The identification strategy allows both temporary and permanent components in the time series to determine economic outcomes.

Johansen (1995) demonstrates that by applying the Granger representation theorem, the SVAR process for y_t in equation (1) has the following common trends representation:

$$y_t = F\sum_{t=1}^{T} u_t + \sum_{j=0}^{\infty} F^* u_{t-j} + y_0^* \ldots \quad (3)$$

where $F = \beta_\perp\left(\alpha'_\perp\left(I_k - \sum_{i=1}^{p-1}\Gamma_i\right)\beta_\perp\right)^{-1}\alpha'_\perp$ and y_0^* contains initial values, with $\alpha'_\perp\alpha = 0$ and $\beta'\beta_\perp = 0$. The matrix F is, therefore, rank deficient and has rank $(k-r)$, where r is the number of cointegrating vectors and k is the total number of variables. According to Lutkepohl (2005), the long run effects of the structural innovations are captured by $F\sum_{t=1}^{T} u_t$, while the transitory shocks are captured in the second term of equation 3, ($\sum_{j=0}^{\infty} F^* u_{t-j}$), which declines to zero as j approaches infinity. By replacing u_t with its structural equivalent $B_0^{-1}\,\varepsilon_t$, we obtain:

$$F\sum_{t=1}^{T} u_t = FB_0^{-1}\sum_{t=1}^{T}\varepsilon_t \ldots \quad (4)$$

The matrix FB_0^{-1} has rank$= (k-r)$ and B_0 is a non-singular matrix. This implies that there can be at most r zero columns in this matrix. This means that a maximum of r structural innovations have transitory effects, while the remaining $(k-r)$ have permanent effects. As a result, when r cointegration relationships are uncovered, r transitory shocks can be justified, and at most r columns of FB_0^{-1} can be restricted to zero (Pagan and Pesaran (2008), Lutkepohl (2005)). Since the matrix FB_0^{-1} has reduced rank, $(k-r)$, each of the zero columns in FB_0^{-1} stand for $(k-r)$ independent restrictions. Thus, the r transitory shocks represent $r(k-r)$ independent restrictions. These restrictions are imposed on the basis of knowledge of the cointegration rank.

Assuming that the first $(k-r)$ structural shocks are permanent shocks (ε_{1t}) and the remaining r shocks are transitory (ε_{2t}), the Wold decompositions implies we can express Δy_t as:

$$\Delta y_t = C(L)B_0^{-1}\begin{pmatrix}\varepsilon_{1t}\\ \varepsilon_{2t}\end{pmatrix} \ldots \quad (5)$$

$C(L)$ is a polynomial of order q in the lag operator. Estimating a SVECM model in this form enables us to analyse the dynamic responses of the variables to various permanent and transitory shocks by extracting the impulse response functions and undertaking a historical decomposition.

For the shocks to be transitory it requires that the following condition be satisfied:

$$FB_0^{-1}\begin{pmatrix}0_{(k-r)\times r}\\ I_r\end{pmatrix} = F\alpha = 0 \ldots (6)$$

where α is a $(k-r)\times r$ matrix of adjustment coefficients for the non-stationary variables that generate the permanent shocks driving the cointegrating relationships. The result $=0$, therefore, precludes the use of error correction terms in the equations that describe the permanent shocks (Pagan and Pesaran, 2008). This feature enables the lagged error correction terms to be used as instruments when estimating the parameters of the equations with permanent shocks. Pagan and Pesaran (2008) and Ouliaris, Pagan and Restrepo (2013) both assert that restricting the error correction terms in the permanent equations to zero is a necessary and sufficient for identification, and this result holds regardless of whether the transitory shocks are correlated or not. The permanent component of the y_t series can then be expressed as:

$y_t^p = FB_0^{-1}\varepsilon_t$ … (7)

This implies that the structural parameters of the SVECM model in equation 1 can be estimated using an instrumental variables regression model where we use the lagged error correction terms as instruments[39]. To implement the SVECM model as a structural VAR model, we partition the vector $y_t = (\gamma_t^1, \gamma_t^2)$ where γ_t^1 is a $(k-r)\times 1$ vector of variables with permanent shocks and γ_t^2 is an $r\times 1$ vector of variables with transitory shocks. The structural impact multiplier matrix B^0 is also partitioned into $B^0 = \left(\emptyset_{1,1}^0, \emptyset_{1,2}^0\right) = \left(B_{1,1}^o, B_{1,2}^0, B_{2,1}^0, B_{2,2}^0\right)$. The SVECM

$B_0\Delta y_t = \Pi^* y_{t-1} + B(L)\Delta y_{t-l} + \varepsilon_t$

Can then be expressed as:

$B_0\Delta y_t = \propto^* \xi_{t-1} + \varepsilon_t$ … (8)

where $\propto^*$ is an error correction term. This implies that the SVECM can be written as:

$\emptyset_{1,1}^0\Delta\gamma_t^1 + \emptyset_{1,2}^0\Delta\gamma_t^2 = \alpha_1^*\xi_{t-1} + \varepsilon_t$ … (9)

From the cointegrating relation $\xi_t = \beta_1'\gamma_t^1 + \beta_2'\gamma_t^2$

$$\gamma_t^2 = (\beta_2')^{-1}(\xi_t - \beta_1'\gamma_t^1)$$

where β_2' is a non-singular matrix. Substituting for γ_t^2 in equation 9 yields;

[39] Pagan and Pesaran (2008) observe that most studies do not deal with the SVECM directly but rather estimate an SVAR system consisting of the $(k-r)$ element of Δy_t and the r error correction terms $\xi_t = \Pi y_{t-1}$.Fisher and Huh (2012) claim that the two methods are equivalent even though the Γ(L) matrices of coefficients differ between the two systems.

$$\emptyset_{1,1}^{0}\Delta\gamma_t^1 + \emptyset_{1,2}^{0}(\beta_2')^{-1}(\Delta\xi_t - \beta_1'\Delta\gamma_t^1) = \alpha_1^*\xi_{t-1} + \varepsilon_{1t} \ldots (10)$$

This allows us to define $B_{1,1}^{o} = \emptyset_{1,1}^{0} - \emptyset_{1,2}^{0}(\beta_2')^{-1}\beta_1'$ and $B_{1,2}^{0} = \emptyset_{1,2}^{0}(\beta_2')^{-1}$, thereby reducing equation 10 to $B_{1,1}^{o}\,\Delta\gamma_t^1 + B_{1,2}^{0}\Delta\xi_t = \alpha_1^*\xi_{t-1} + \varepsilon_{1t}$ for the first block of the $(k - r)$ equations, the permanent equation. Ouliaris et al. (2016) assert that out of the k variables in the SVECM system, it does not matter which $(k - r)$ variables are chosen to carry permanent shocks as long as β_2' is non-singular. The remaining r equations with transitory shocks become:

$$B_{2,1}^{o}\,\Delta\gamma_t^1 + B_{2,2}^{0}\Delta\xi_t = \alpha_2^*\xi_{t-1} + \varepsilon_{2t} \ldots (11)$$

$$B_{2,1}^{o}\,\Delta\gamma_t^1 + B_{2,2}^{0}\xi_t = \left(B_{2,2}^{0} + \alpha_2^*\right)\xi_{t-1} + \varepsilon_{2t} = B_{2,2}^{1}\xi_{t-1} + \varepsilon_{2t} \ldots (12)$$

Equation 6 indicates that $\alpha_1^* = 0$ for the permanent equations, so implying that the lagged error correction terms are available to be used as instruments, thereby enabling the identification of structural shocks. As such, the SVECM can be estimated as an SVAR consisting of $\Delta\gamma_t^1$ and ξ_t.

On the premise that the time series variables employed in this study consist of both I(1) and I(0) variable series, we make two assumptions in the estimation. First, we treat the I(0) variables as non-stationary, I(1) variables, and then estimate the SVAR using the first differences of these I(0) variables. Gali (1992) and Dungey and Pagan (2009) employ a similar approach and treat the interest rate as non-stationary and capable of carrying permanent shocks. This allowed them to identify permanent monetary policy shocks through the interest rate equation. Second, we consider the stationarity of these I(0) variables and introduce them in the SVAR model in levels and exclude the same I(0) variables from the cointegrating relationship. The results based on the second assumption are presented in Appendix B.

Ouliaris, Pagan and Restrepo (2016) claim that introducing the stationary variables into the SVECM does not create any dependence in the I(0) variables, and thus introducing the first differences of the I(0) variables in the SVAR system will allow the I(0) variables to carry only transitory effects. This implies that SVECM equation will take the form:

$$B_0\Delta y_t + \phi z_t = \propto^* \xi_{t-1} + \varepsilon_t \ldots (13)$$

Which reduces to:

$$B_{1,1}^{o}\,\Delta\gamma_t^1 + B_{1,2}^{0}\Delta\xi_t + \phi_{1,3}\Delta z_t = \alpha_1^*\xi_{t-1} + \varepsilon_{1t} \ldots (14)$$

where z_t is a vector of the I(0) variables. This result implies that our orthogonal structural shocks of interests can be identified using instrumental variable techniques. In order to estimate the parameters in the equations for the I(0) variables in equation 14, we instrument for Δz_t using z_{t-1}. The key advantage of applying this technique is that it allows for data coherence while imposing minimum theoretical restrictions (Dangey and Pagan (2009)).

5.6 Equations for empirical structural estimation.

Following Gali (1992), Gali (1999), Pagan and Pesaran (2008) and Fisher, Huh and Pesaran (2016), we reduce the SVECM model into an SVAR model that is amenable to estimation using instrumental variable techniques. We retrieve the cointegrating vector for the real variables in Table 15:

$$\xi_t = \beta_1 b_t - \beta_2 l_t + \beta_3 f_t + \beta_4 r_t + \beta_5 s_t \dots (15),$$

and express the SVECM model in equation 1 in an SVAR format, consisting of the variables $\Delta b_t, \Delta l_t, \Delta s_t, \Delta r_t \Delta \xi_t$, where these variables represent first differences of real corporate bonds outstanding, real bank loans outstanding, term spreads, the UK base rate, and error correction terms, respectively. Given that we have $k = 5$ and $r = 1$, the implication is that we have four permanent shocks in the system and one transitory shock. We identify the four permanent shocks as being those in the structural equations involving real corporate bond outstanding (b_t), real bank loans outstanding (l_t), term spreads (s_t) and the base rate (r_t). The five shocks we identify in this study are bond market specific shocks (ϵ_{bt}), credit supply (ϵ_{lt}), credit demand (ϵ_{ft}), quantitative easing (ϵ_{st}), and monetary policy (ϵ_{rt}) shocks, respectively. The transitory shocks in the SVECM system thus represent $r(k-r) = 4$ independent restrictions that are needed to identify the permanent shocks.

Unlike Christiano, Eichenbaum and Evans (1999) and Barraza, Civelli and Zabaroni (2016) who identity their structural shocks using recursive ordering techniques, we apply long run identification techniques and leave the short run impact to be revealed by the data. Considering that theoretical models on quantitative easing are largely underdeveloped, the applied restrictions for the identification of quantitative easing shocks are derived from a suit of macro-economic models are empirical results from previous studies.[40] Furthermore,

[40] Bernanke (2010) retorts that quantitative easing policies work in practise but do not work in theory.

since macroeconomic theory generally tends to be long term in nature, imposing long run restrictions for identification of shocks seem a plausible way to proceed.

We decompose our SVECM into SVAR equations of the following forms:

$$\Delta b_t = \alpha^0_{1,2}\Delta l_t + \alpha^0_{1,3}\Delta s_t + \alpha^0_{1,4}\Delta r_t + \alpha^0_{1,5}\Delta\xi_t + \alpha^1_{1,1}\Delta b_{t-1} + \alpha^1_{1,2}\Delta l_{t-1} + \alpha^1_{1,3}\Delta s_{t-1} + \alpha^1_{1,4}\Delta r_{t-1} + \alpha^1_{1,5}\Delta\xi_{t-1} + \epsilon_{bt} \quad \dots (16)$$

$$\Delta l_t = \alpha^0_{2,1}\Delta b_t + \alpha^0_{2,3}\Delta s_t + \alpha^0_{2,4}\Delta r_t + \alpha^0_{2,5}\Delta\xi_t + \alpha^1_{2,1}\Delta b_{t-1} + \alpha^1_{2,2}\Delta l_{t-1} + \alpha^1_{2,3}\Delta s_{t-1} + \alpha^1_{2,4}\Delta r_{t-1} + \alpha^1_{2,5}\Delta\xi_{t-1} + \epsilon_{lt} \quad \dots (17)$$

$$\Delta s_t = \alpha^0_{3,1}\Delta b_t + \alpha^0_{3,2}\Delta l_t + \alpha^0_{3,4}\Delta r_t + \alpha^0_{3,5}\Delta\xi_t + \alpha^1_{3,1}\Delta b_{t-1} + \alpha^1_{3,2}\Delta l_{t-1} + \alpha^1_{3,3}\Delta s_{t-1} + \alpha^1_{3,4}\Delta r_{t-1} + \alpha^1_{3,5}\Delta\xi_{t-1} + \epsilon_{st} \quad \dots (18)$$

$$\Delta r_t = \alpha^0_{4,1}\Delta b_t + \alpha^0_{4,2}\Delta l_t + \alpha^0_{4,3}\Delta s_t + \alpha^0_{4,5}\Delta\xi_t + \alpha^1_{4,1}\Delta b_{t-1} + \alpha^1_{4,2}\Delta l_{t-1} + \alpha^1_{4,3}\Delta s_{t-1} + \alpha^1_{4,4}\Delta r_{t-1} + \alpha^1_{4,5}\Delta\xi_{t-1} + \epsilon_{rt} \quad \dots (19)$$

$$\Delta\xi_t = \alpha^0_{5,1}\Delta b_t + \alpha^0_{5,2}\Delta l_t + \alpha^0_{5,3}\Delta s_t + \alpha^0_{5,4}\Delta r_t + \alpha^1_{5,1}\Delta b_{t-1} + \alpha^1_{5,2}\Delta l_{t-1} + \alpha^1_{5,3}\Delta s_{t-1} + \alpha^1_{5,4}\Delta r_{t-1} + \alpha^1_{5,5}\Delta\xi_{t-1} + \epsilon_{ft} \quad \dots (20)$$

We make the following key assumptions in order to identify our structural shocks:

1. We impose the restriction that bond market specific shocks, credit supply shocks and quantitative easing shocks have no long run impact on the base rate. Quantitative easing policies are adopted by the central bank when the traditional monetary policy tools have become blunt and the monetary policy rate is near its zero lower bound. Once the inflation, output and employment objectives have been achieved, the central banks will tend to unwind QE policies through quantitative tapering. Furthermore, the QE policies are general decoupled from the base rate (Borio and Disyatat (2009, 2010))[41]. As such we do not expect the quantitative easing shocks to affect the base rate in the long run. Similarly, we do not reasonably expect the central bank to respond to bond market specific shocks by adjusting the base rate. Moreover, our results on the long run Granger causality tests and weak

[41]The Central Bank's monopoly over the market for bank reserves ensures that monetary policy rate can be set and implemented with no significant changes in the central bank's balance sheet size, structure and risk profile. This implies that the same level of interest rates can co-exist with very different levels of bank reserves and vice versa. Furthermore, unwinding central bank's balance sheet policy and the central bank's balance size, composition or risk profile cannot be preconditions for raising the base rate. Borio and Disyatat (2010).

exogeneity tests in Table 16, all reveal that the term spreads, credit supply and bond issues do not Granger cause the base rate (at the 5% level of significance).

2. We assume that credit supply shocks and bond market specific shocks have no long run effects on the term spread. This assumption is partly informed by our Granger causality and weak exogeneity results in Table 16.

Our identification strategy reflects the underlying assumption that quantitative easing policies are decoupled from the monetary policy rate and have no long run effects on the policy rate. This implies that the identified quantitative easing shocks are independent of conventional monetary policy rate shocks. In terms of equation 19 of this system, the requirement that bond market specific shocks, credit supply shocks and quantitative easing shocks do not have a long run effect on the UK base rate generates the following restrictions:

$$\alpha_{4,1}^{0} = -\alpha_{4,1}^{1}$$

$$\alpha_{4,2}^{0} = -\alpha_{4,2}^{1}$$

$$\alpha_{4,3}^{0} = -\alpha_{4,3}^{1}$$

By using the Shapiro and Watson (1988) approach, equation 19 can be replaced by:

$$\Delta r_t = \alpha_{4,1}^{0}\Delta^2 b_t + \alpha_{4,2}^{0}\Delta^2 l_t + \alpha_{4,3}^{0}\Delta^2 s_t + \alpha_{4,5}^{0}\Delta\xi_t + \alpha_{4,4}^{1}\Delta r_{t-1} + \alpha_{4,5}^{1}\Delta\xi_{t-1} + \epsilon_{rt} \quad \ldots(21)$$

Similarly, imposing the restriction that bond market specific shocks and credit supply shocks have no long run effect on the term spread implies that:

$$\alpha_{3,1}^{0} = -\alpha_{3,1}^{1}$$

$$\alpha_{3,2}^{0} = -\alpha_{3,2}^{1}$$

These restriction transform equation 18 to:

$$\Delta s_t = \alpha_{3,1}^{0}\Delta^2 b_t + \alpha_{3,2}^{0}\Delta^2 l_t + \alpha_{3,4}^{0}\Delta r_t + \alpha_{3,5}^{0}\Delta\xi_t + \alpha_{3,3}^{1}\Delta s_{t-1} + \alpha_{3,4}^{1}\Delta r_{t-1} + \alpha_{3,5}^{1}\Delta\xi_{t-1} + \epsilon_{st} \quad \ldots(22)$$

In order to estimate equation 22, we instrument for Δr_t using the estimated residuals for equation 21, $\widehat{\epsilon_{rt}}$.

Although the weak exogeneity and Granger causality tests in Table 16 reveal some evidence of bi-directional causality between corporate bond issues and bank loans, we impose the

restriction that in the long run, bond market specific shocks have no effects on bank loan issuance. This implies that $\alpha_{2,1}^{0} + \alpha_{2,1}^{1} = 0$, thereby simplifying equation 17 to:

$$\Delta l_t = \alpha_{2,1}^{0}\Delta^2 b_t + \alpha_{2,3}^{0}\widehat{\epsilon_{st}} + \alpha_{2,4}^{0}\widehat{\epsilon_{rt}} + \alpha_{2,5}^{0}\Delta\xi_t + \alpha_{2,2}^{1}\Delta l_{t-1} + \alpha_{2,3}^{1}\Delta s_{t-1} + \alpha_{2,4}^{1}\Delta r_{t-1} + \alpha_{2,5}^{1}\Delta\xi_{t-1} + \epsilon_{lt} \quad \ldots (23)$$

We solve for Equation 16 using the estimated residuals of the structural equation for the policy rate, term spread and bank loan issues in equations 21, 22 and 23, respectively. This allows us to identify the bond market specific shocks using equation 24 below:

$$\Delta b_t = \alpha_{1,2}^{0}\widehat{\epsilon_{lt}} + \alpha_{1,3}^{0}\widehat{\epsilon_{st}} + \alpha_{1,4}^{0}\widehat{\epsilon_{rt}} + \alpha_{1,5}^{0}\Delta\xi_t + \alpha_{1,1}^{1}\Delta b_{t-1} + \alpha_{1,2}^{1}\Delta l_{t-1} + \alpha_{1,3}^{1}\Delta s_{t-1} + \alpha_{1,4}^{1}\Delta r_{t-1} + \alpha_{1,5}^{1}\Delta\xi_{t-1} + \epsilon_{bt} \quad \ldots (24)$$

Having obtained all the instruments necessary to estimate the structural equations, the structural equation for real equity prices, equation (20), simplifies to:

$$\Delta\xi_t = \alpha_{5,1}^{0}\widehat{\epsilon_{bt}} + \alpha_{5,2}^{0}\widehat{\epsilon_{lt}} + \alpha_{5,3}^{0}\widehat{\epsilon_{st}} + \alpha_{5,4}^{0}\widehat{\epsilon_{rt}} + \alpha_{5,1}^{1}\Delta b_{t-1} + \alpha_{5,2}^{1}\Delta l_{t-1} + \alpha_{5,3}^{1}\Delta s_{t-1} + \alpha_{5,4}^{1}\Delta r_{t-1} + \alpha_{5,5}^{1}\Delta\xi_{t-1} + \epsilon_{ft} \ldots (25)$$

We employ instrumental variable techniques to estimate the system of equations 21-25. Starting with equation 21, the variables Δb_{t-1}, Δl_{t-1}, and Δs_{t-1} are used as instruments for $\Delta^2 b_t$, $\Delta^2 l_t$, and $\Delta^2 s_t$, respectively, as these variables are uncorrelated with the structural shocks, ϵ_{rt}, but are correlated with the variables for which they are being used as instruments. For the remaining variable, $\Delta\xi_t$, the omitted lagged error correction terms, ξ_{t-1}, are used as instruments. The estimated residuals from equation 21 are then used as instruments for Δr_t in subsequent regressions[42]. Similarly the estimated residuals in equation 22, ϵ_{st}, are employed as instruments for Δs_t, and so on.

The next section presents the economic interpretation of the structural shocks we identify in this chapter, namely bond market specific shocks, credit supply shocks, credit demand shocks, quantitative easing shocks, and monetary policy rate shocks.

5.7 Analysis of impulse responses

In this section we present an analysis of the accumulated impulse responses of real corporate bond issuance, real bank loan issuance, real equity prices, term spreads and the UK base rate to a series of orthogonal credit market shocks. The impulse response are

[42] In the second stage of the SVECM estimation results where we employ the actual order of integration for term spreads and policy rates, identification of the structural shocks is simpler since only 2 permanent shocks are to be identified.

estimated for a horizon of 40 quarters. The accumulated structural impulse responses are estimated using equation 5.

5.7.1 Quantitative easing shocks

Figure 3 shows the accumulated impulse responses of real corporate bond issues, real bank loan issuances, real equity prices, term spreads and the UK base rate to quantitative easing policy shocks. The profile of impulse responses in Figure 3 reveal that quantitative easing shocks result in a permanent compression of term spreads which is associated with an increase in corporate bond issuance. Consistent with both our initial expectations and earlier findings based on firm level data (Chapter 3), the results reveal that quantitative easing policy shocks increase corporate bond issuance in the short term. This results also support the findings of Kaya and Wang (2014) that QE increases corporate bond issuance, and the claim by Adrian, Colla and Shin (2012) that a decline in term spreads occasions an increase in corporate bond issuance. However, consistent with Bridges and Thomas (2012), we find that the effects of quantitative easing policy shocks tend to be temporary and wash out after a period of 14 quarters. This implies that quantitative easing policies can potentially work as a short term solution in stimulating bond issuance by UK non-financial corporations. This also suggests that the quantitative easing program is effective in reducing frictions that hamper UK non-financial firms from issuing corporate bonds in the short term, in line with Fisher (2010). As such, we propose that QE policies are effective in stimulating an increase in corporate bond issuance and as such, are successful in achieving the Bank of England's stated policy intentions. However, QE policies also result in a permanent contraction of the term spread.

The results also reveals that quantitative easing policy shocks have a neutral effect on bank loan issuances and real equity prices. Quantitative easing policies that target term spread compression appear to be ineffective in stimulating bank loan issuances and increasing real equity prices. The neutrality of bank lending to quantitative easing shocks is consistent with the findings of Churm et al. (2015) on UK bank lending and the claims by Borio and Disyatat (2010) and findings by Caballero, Hoshi and Kashyap (2006) that quantitative easing policies fail to stimulate bank lending when bank balance sheets are weak.[43] This finding also tends to suggest that the QE policy transmission effects, particularly portfolio substitution effects,

[43] In this study we do not examine the impact of bank balance sheet strength on corporate bond issuance. However, earlier results in chapter 3 reveal that the propensity to issue corporate bonds relative to bank loans increases as bank risk appetite deteriorates. As risk appetite is directly related to balance sheet strength, the impact of risk appetite on debt issuance may reflect balance sheet related factors.

only occur via the bond markets. Another implication of this result is that QE transmission via asset price channels is weak. Consistent with a priori expectations, we also find that quantitative easing policy shocks have no effect on the UK base rate. The lack of potency of quantitative easing policies on bank lending, real equity prices and the base rate seem to support the existence of the Wallace (1981) neutrality.[44]

The results illustrated in Figure 10 of Appendix B for the 3 variable cointegration system reveal that QE shocks have qualitatively similar effects on corporate bond issuance and policy rates. However, identification based on the three variable cointegration system reveal that QE shocks have a temporary effect on the term spread that lasts for a period of 5 quarters after the initial shock. Notably, the QE policies have no effects on the policy rates, bank loan issues and real equity prices.

5.7.2 Credit Supply Shocks

Figure 4 reveals that an increase in credit supply occasions an increase in both real corporate bond and real bank loan issuance. The results also indicate that bond markets are slow to respond to an increase in credit supply, and bond issuance only begins to increase after a period of three quarters. Moreover, the increase in corporate bond issuance following a positive credit supply shock is temporary. The effects of an increase in credit supply on real corporate bond issuance tend to disappear 20 quarters after the initial shock. In contrast, positive credit supply shocks generate a contemporaneous, positive and permanent effect on real bank loan issuance. Analogously, a sudden contraction in credit supply results in a temporary but delayed decline in bond issuance, and an immediate but permanent decline in bank loan issuance. Following a credit contraction, bank loans decline and appear to settle at a new lower equilibrium.

The joint positive response of both corporate bonds and bank loan issues following a credit supply shock seems to suggest that there exists some level of complementarity between corporate bond and bank loan markets. Moreover, the response of both credit markets to a positive credit supply shock confirms the existence of a lending channel in the UK, particularly the narrow credit view. However, the results in Figure 6 reveal that bank loan issuance does not respond to bond market specific shocks. This fact, coupled with the

[44] The Wallace neutrality proposition states that changing the size and the composition of the central bank balance sheet when the policy rate is near or at the zero lower bound has no general equilibrium effects on asset prices, interest rates, or non-financial economic activity.

delayed response of bond markets to credit supply shocks observed in Figure 4 seems to suggest positive developments in the bank loan markets may spill over to the bond markets but not vice versa.[45] Furthermore, our Granger causality results in Table 16 again corroborate this interpretation, with Granger causality appearing to be stronger when flowing from bank loans to corporate bonds. This finding is consistent with the claims of James (1987) that bank loans are used as a certification mechanism that firms use to signal their quality for the purposes of a subsequent corporate bond issue. The observed complementary relationship between corporate bonds and bank loans has important macro-prudential implications, in that adverse credit supply shocks may tend to be amplified, thereby compromising the stability of the financial system.

The insignificance of the increase in the monetary policy rate following a positive increase in credit supply (Figure 4), coupled with the neutrality of contractionary monetary policy shocks on bank lending (Figure 7) suggest that interest rate policy may at best be a blunt policy tool for counteracting excessive credit supply shocks and, conversely, for inducing an increase in bank loan issuance following adverse credit supply shocks.

5.7.3 Credit demand Shocks

Results in Figure 5 show that a one standard deviation increase in credit demand shocks triggers a contemporaneous increases in corporate bond issuance and bank loan issuance. These shocks wash out after a period of two and three quarters for the corporate bond and bank loans market, respectively. Furthermore, a rise in demand for credit occasions a contemporaneous increase in the UK base rate, possibly to counteract the adverse effects of excess credit demand. The effect of credit demand on the UK base rate dissipates 14 quarters after the initial shock. Results also show that a one standard deviation increase in credit demand results in an increase in real equity prices in the UK. Furthermore, an increase in credit demand shocks results in a contraction of the term spreads. The effect of credit demand on the term spread washes out after a period of 12 quarters. Overall, the results reveal that credit demand shocks may indeed have mainly transitory effects.

5.7.4 Bond Market Specific Shocks

The impulse responses from the structural model, Figure 6, reveal that a positive one standard deviation increase in bond market specific shocks, as measured by ϵ_{bt} in equation 16, yields a permanent increase in corporate bond issuance by non-financial firms.

[45] An example of such spill overs is the proliferation of securitisation transactions through the banks' 'create to distribute models' in the period prior to the global financial crisis.

Developments in the corporate bond markets tend to be isolated, and do not transmit to the bank loans market and the equity market.

5.7.5 Monetary Policy Rate Shocks

Figure 7 shows that a tightening of monetary policy rates results in a permanent increase in the UK base rate that is associated with a contraction in the term spread. The results also reveal that following a monetary policy contraction shock, bank loan issuance continues to increase for a period of up to four quarters before the impact of the monetary policy shock on bank loan issuance completely washes out of the system. This result is consistent with Christiano, Eichenbaum and Evans (1994), Den Haans, Sumner and Yamashiro (2007) and Barraza, Civelli and Zaniboni (2016) who find a similar effect in the US. They report that the increase in lending in the period immediately after monetary policy tightening is driven by an increase in draw downs on undrawn, pre-contracted lines of credit by non-financial firms.

One result we find somewhat surprising is that a contractionary monetary policy rate shock has no significant effects on real bank loan issuance by UK non-financial corporations in the medium to long term. The insensitivity of bank loan issuance to changes in the policy rates implies that the interest channel appears to be weak in exerting an influence on UK bank loan issuance.[46]

Consistent with prior expectations, a contractionary monetary policy shock engenders a decline in real corporate bond issuance by non-financial corporations. The results reveal that a one standard deviation increase in the monetary policy rate shock occasions a decline in corporate bond issuance for a subsequent period of up to 26 quarters before its effects dissipate. This finding appears to be inconsistent with the micro-level evidence of Kashyap, Stein and Wilcox (1993) in which non-financial firms substitute away from bank lending and towards non-intermediated forms of credit following a period of monetary policy tightening. Furthermore, the results also reveal that a contractionary monetary policy rate shock initiates a decline in real equity prices for a period of up to three quarters before the effects of the shocks fade away.

[46] Black and Rosen (2016) note that the impact of a contractionary shock may occur via a shortening of maturity rather than and reduction in lending volume. This implies that the bank lending channel of monetary policy may be more complex than what literature suggests.

Figure 3: Accumulated responses to quantitative easing shocks

The figure presents the accumulated impulse responses of the corporate bond issuance, bank loan issuance, equity prices, term spreads and policy rates to structural shocks. The shocks are identified using a SVECM model estimated using the Gali (1999) and Pagan and Pesaran (2008) methodologies, equations 21-25. QE Shocks are expressed as positive one standard deviation shock innovations for all the variables, which represents an expansion of the term spread. However, results are interpreted based on the mirror images of the reported results. The dotted red lines represent the two standard error bands.

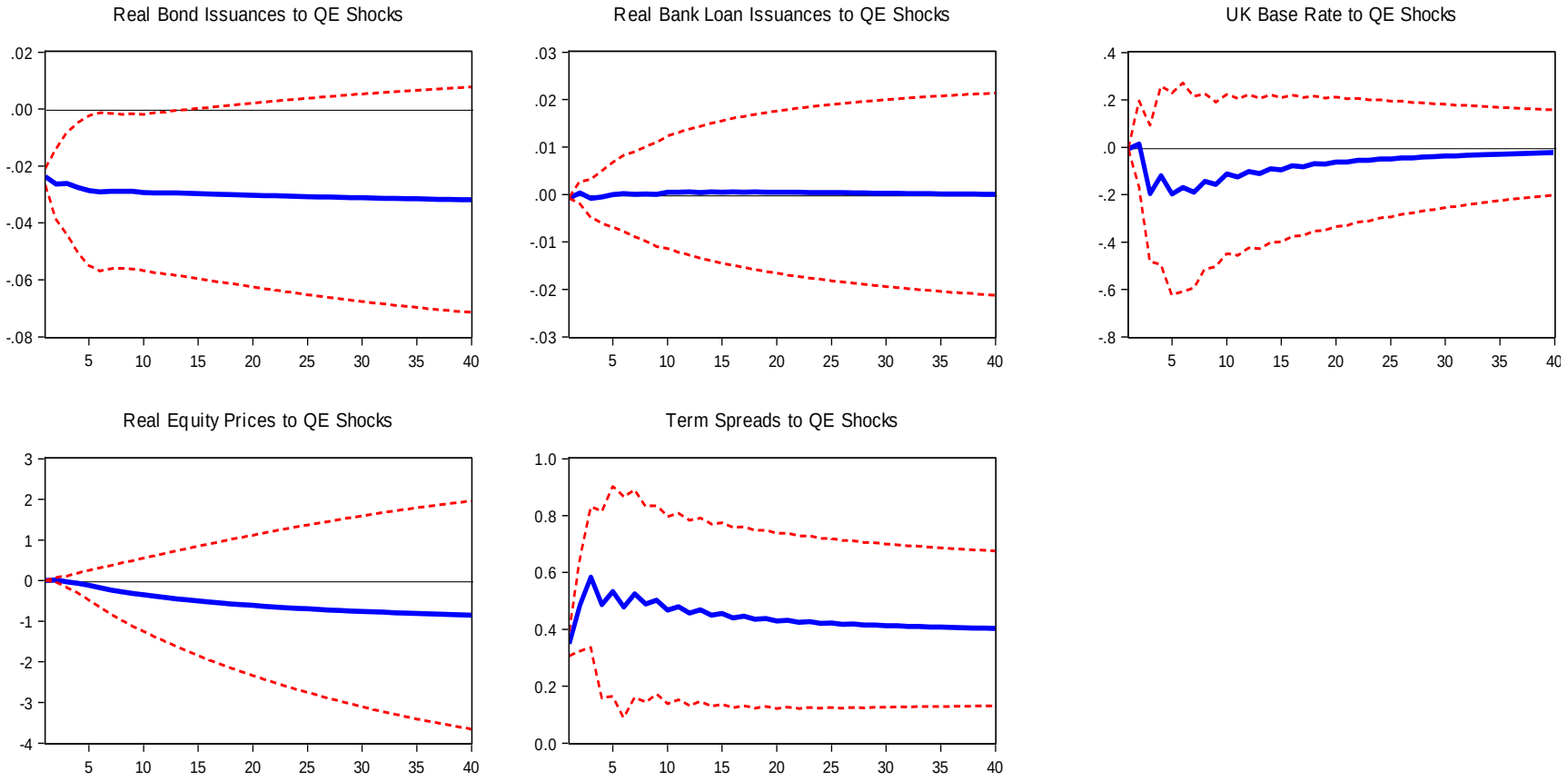


Figure 4: Accumulated responses to credit supply shocks

The figure presents the accumulated impulse responses of the corporate bond issuance, bank loan issuance, equity prices, term spreads and policy rates to structural shocks. The shocks are identified using a SVECM model estimated using the Gali (1999) and Pagan and Pesaran (2008) methodologies, equations 21-25. Shocks are expressed as positive one standard deviation innovations for all the variables. The dotted red lines represent the two standard error bands.

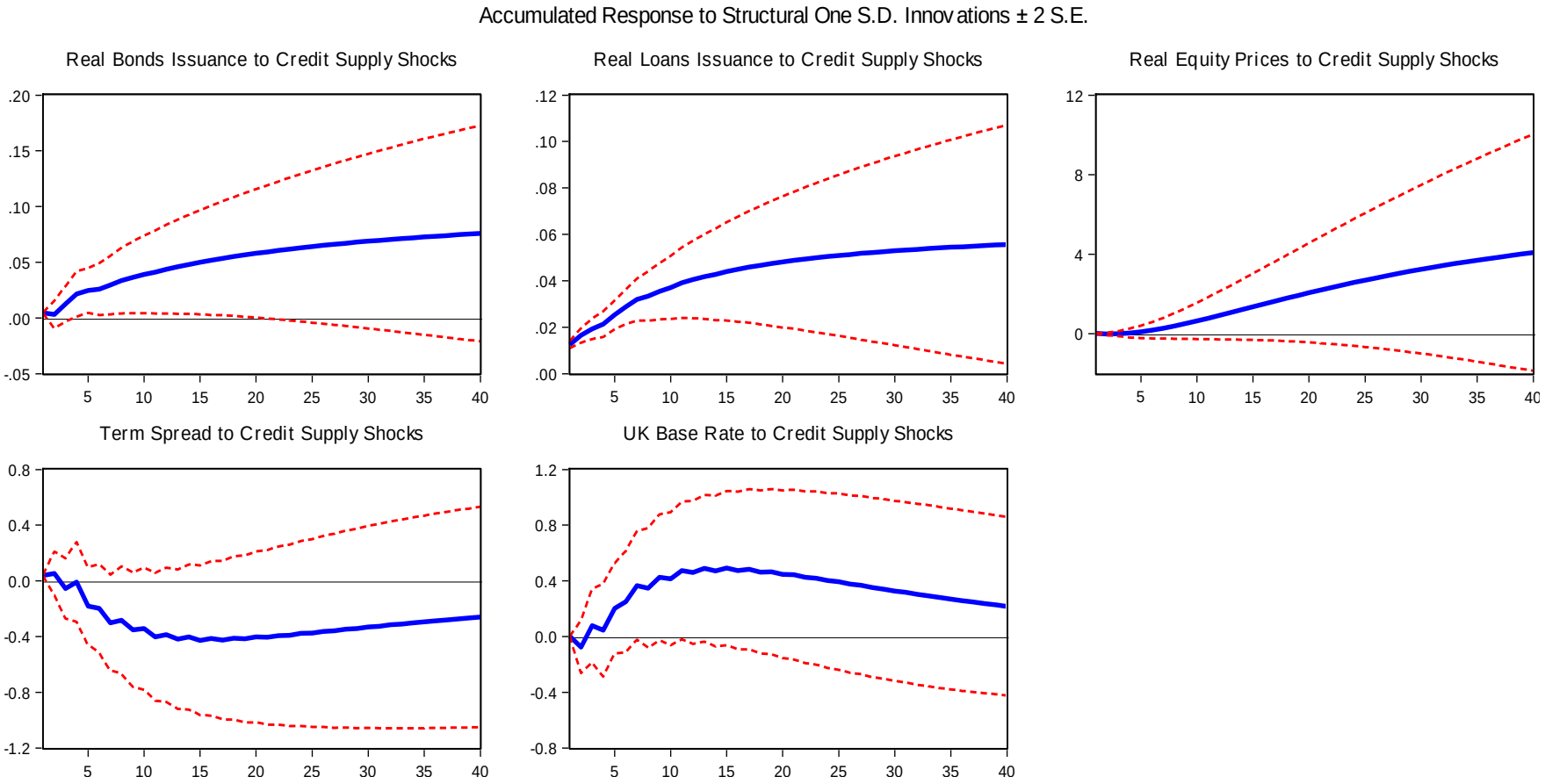


Figure 5: Accumulated responses to credit demand shocks

The figure presents the accumulated impulse responses of the corporate bond issuance, bank loan issuance, equity prices, term spreads and policy rates to structural shocks. The shocks are identified using a SVECM model estimated using the Gali (1999) and Pagan and Pesaran (2008) methodologies, equations 21-25. Shocks are expressed as positive one standard deviation innovations for all the variables. The dotted red lines represent the two standard error bands.

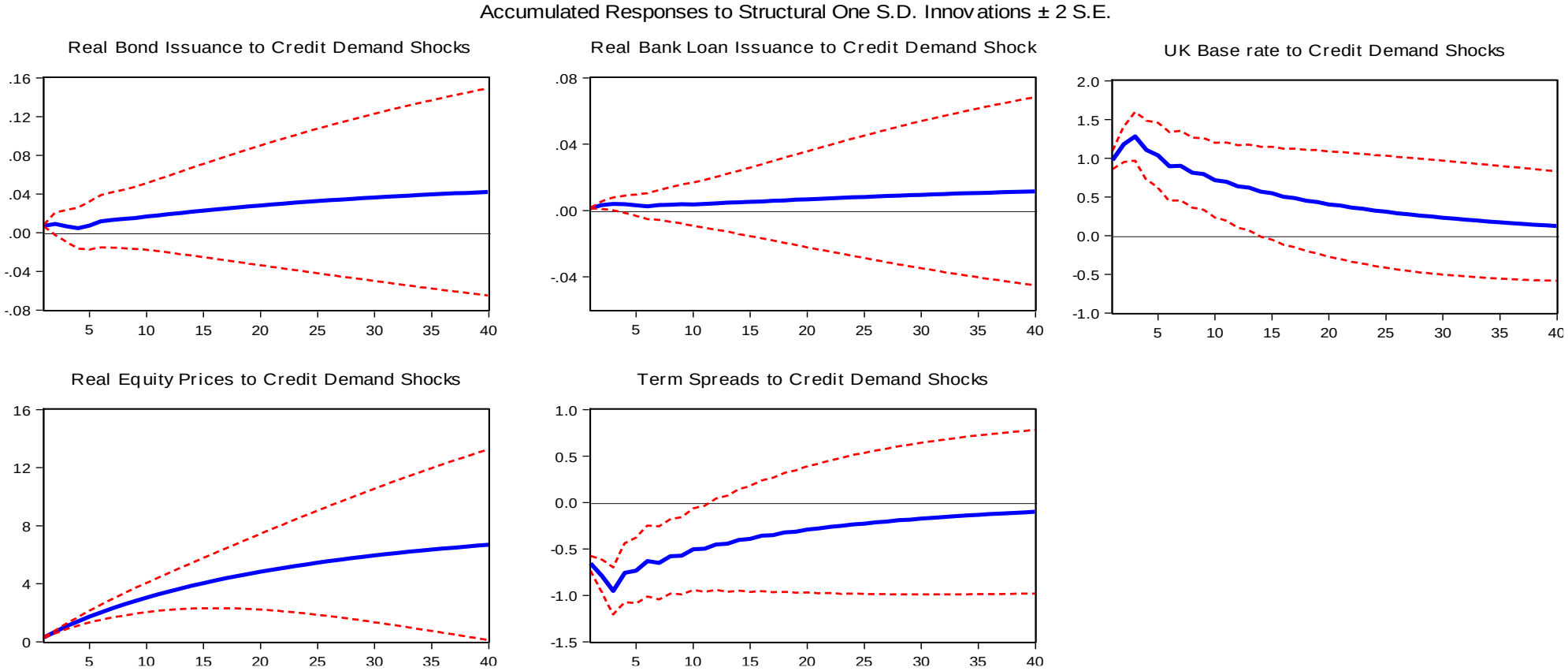


Figure 6: Accumulated responses to bond market specific shocks

The figure presents the accumulated impulse responses of the corporate bond issuance, bank loan issuance, equity prices, term spreads and policy rates to structural shocks. The shocks are identified using a SVECM model estimated using the Gali (1999) and Pagan and Pesaran (2008) methodologies, equations 21-25. Shocks are expressed as positive one standard deviation innovations for all the variables. The dotted red lines represent the two standard error bands.

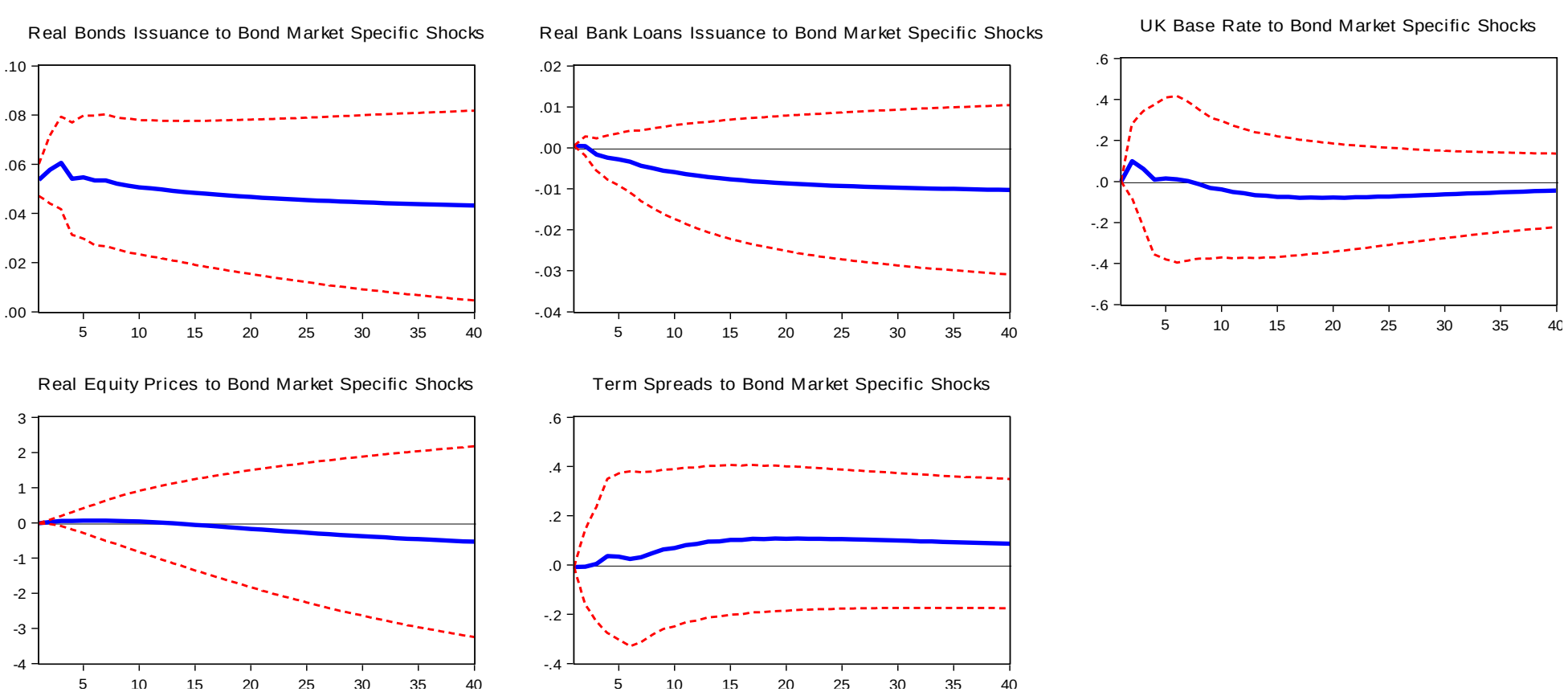
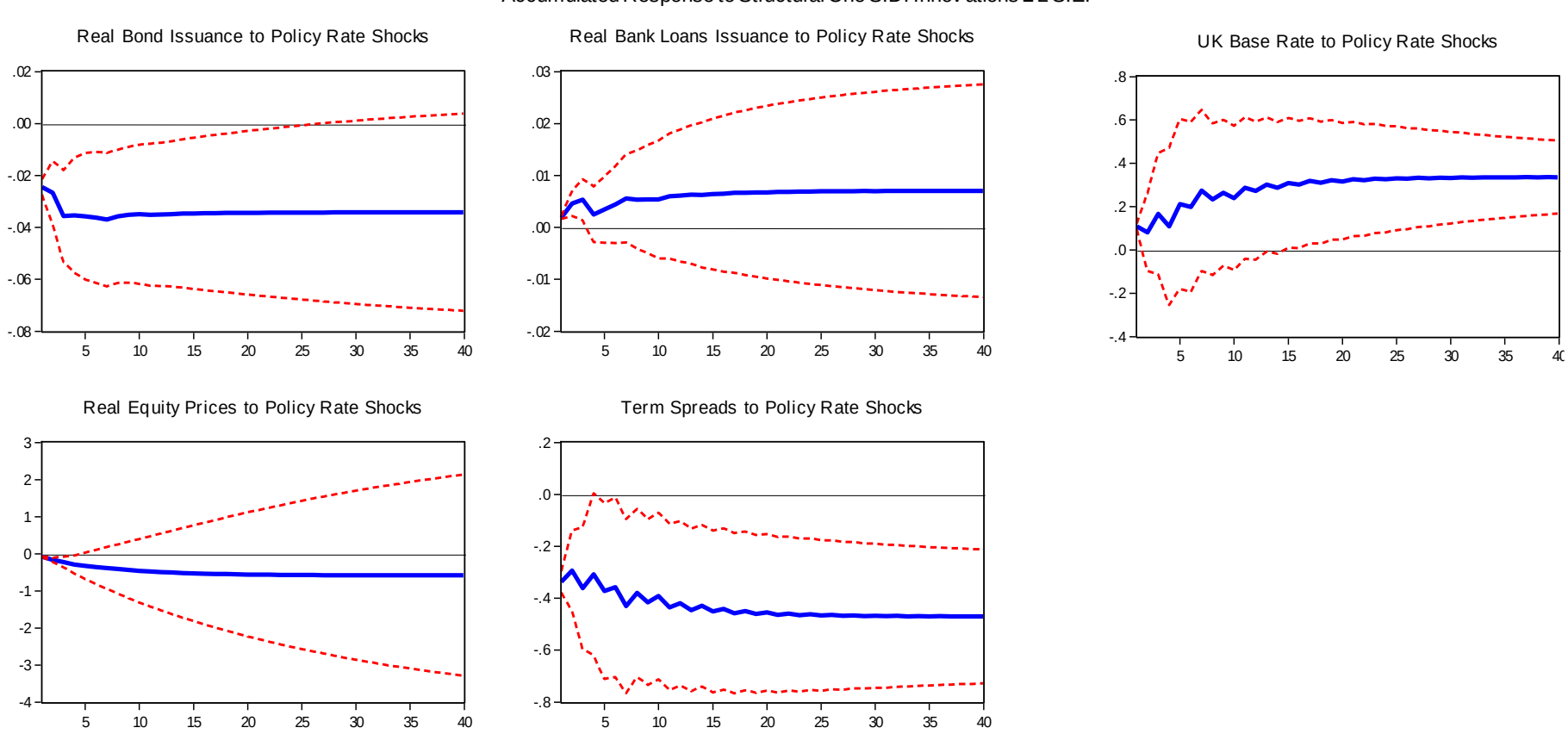


Figure 7: Accumulated responses to monetary policy rate shocks

The figure presents the accumulated impulse responses of the corporate bond issuance, bank loan issuance, equity prices, term spreads and policy rates to structural shocks. The shocks are identified using a SVECM model estimated using the Gali (1999) and Pagan and Pesaran (2008) methodologies, equations 21-25. Shocks are expressed as positive one standard deviation innovations for all the variables. The dotted red lines represent the two standard error bands.



5.8 Structural forecast error variance decomposition (FEVD)

In this section we present results of the forecast error variance decomposition (FEVD) for our SVECM, identified using long run parametric restrictions. The FEVD results profile the relative importance of the five shocks we identify in this model in explaining the respective variance in corporate bond and bank loan issuances over a 40 quarter forecast horizon.

5.8.1 Bond issuance

The results in Table 17 indicate that bond market specific shocks account for at least 63% of the variation in long run corporate bond issuance, while credit supply, credit demand, QE and monetary policy rate shocks account for the remaining cumulative 37%. In the short-run, QE shocks account for 14% of the variation in corporate bond issuance. However, the impact of QE shocks declines to 12% after a period of 20 quarters. Consistent with apriori expectations, the impact is economically significant and implies that QE policies influence up to 14% of new corporate bond issuance. This supports the findings in Kaya and Wang (2014) that QE policies yield an increase in corporate bond issuance. These results imply that QE policies have some potency in influencing corporate bond issuance by non-financial companies and thus are inconsistent with Wallace (1981) neutrality.

Monetary policy rate shocks account for a consistent 15% of the variation in corporate bond issuance both in the short run and in the long-run. This result implies that monetary policy has economically significant long run and permanent effects on corporate bond issuance and thus is an effective tool in influencing debt issuance. This is consistent with the broad credit view of monetary policy transmission where changes in the policy rate tend to influence aggregate debt issuance behaviour (Oliner and Rudebusch (1995)).

Credit supply shocks tend to explain less than 1% of the variation in corporate bond issuance on impact but the effect of credit supply shocks rises gradually to 4% after a period of 4 quarters and to 6% after a period of 20 quarters. Finally, credit demand shocks account for only 3% of the variation in corporate bond issuance in the long run. However, the impacts of aggregate credit demand and credit supply shocks on corporate bond issuance are somewhat surprising and inconsistent with apriori expectations. These results imply that credit demand and supply shocks do not have an economically important influence on the corporate bond issuance behaviour of non-financial firms. This finding is at odds with our panel results in Chapter 3.

5.8.2 Bank loan issuance

The results in Table 17 show that credit supply shocks account for 95% of the observed variation in bank loan issuance on impact. However, the influence of credit supply shocks declines to 85% in the subsequent four quarters and thereafter. The FEVD results indicate that bank loan issuances largely driven by supply related factors.

Cumulatively, bond market specific shocks, credit demand shocks, QE shocks and monetary policy rate shocks account for less than 5% of variation in bank loan issuance on impact, and for up to 15% of the variation in bank loan issuance in the four quarters after initial impact. QE policy shocks account for less than 2% of the variation in bank loan issuance in both the short run and the long run. This result implies that QE policies are not economically important in bank loan issuance. However, this result is not surprising and is consistent with Caballero, Hoshi and Kashyap (2006) and Borio and Disyatat (2009) who assert that QE is ineffective when banks are in the process of deleveraging. Monetary policy rate shocks explain about 9% of the variation in bank loan issuance in the first eight quarters after initial impact, and for about 8% of bank loan issuance in the long run. This implies that monetary policy has economically important effects on both bank loan issuance and corporate bond issuance. However, the policy rate impact seems to be larger for the corporate bond markets relative to the bank loans market. Importantly, between the two, credit supply shocks and monetary policy rate shocks account for more than 90% of the variation in bank loan issuance. The results show that bond market specific shocks are responsible for only about 3% of the variation in bank loan issuance. This reveals that bond market specific developments have a weak effect on bank loan issuance.

5.8.3 Real equity prices

Credit demand shocks account for 95% of the variation in equity prices in the very short run, but the influence of credit demand shocks falls gradually, explaining 73% of the variation in long term real equity prices. Monetary policy shocks account for 6% of the variation in real equity prices on impact, but their effects dissipate to 1% in the long run. Credit supply shocks only explain about 1% of the variation in real equity prices in the first four quarters following impact, although their influence increases significantly over time, explaining almost 22% of the variation in equity prices after a period of 30 quarters. Jointly, credit supply and credit demand shocks account for 96% of the fluctuations in real equity prices in the long run. This result closely mirrors the findings of Adrian and Shin (2012) that

asset growth is credit driven. Bond market specific shocks explain less than 1% of the overall variation in real equity prices and thus are not economically important.

5.8.4 Term spreads

The results in Table 17 reveal that credit demand shocks explain approximately 64% of the variation in term spreads in the short run and close to 58% of the variation in term spreads in the long run. QE shocks tend to account for 20% of the variation in term spreads in the first two quarters following initial impact, which translates to roughly 40 basis points, and their influence declines gradually to 19% in the long run. Monetary policy rate shocks account for 17% of the variation in term spreads the short run, and approximately 15% of the fluctuations in term spreads in the long run. Credit supply shocks have a long run influence of 7%, while bond market specific shocks account for less than 1% of the variation in term spreads. Credit demand shocks and credit supply shocks jointly account for 66% of the long run variation in term spreads, while QE shocks and monetary policy rate shocks explain the remaining 34% of the this variation.

5.8.5 UK base rate

Table 17 highlights the main result here, namely that 99% of the variation in the UK base rate in the short run is explained by changes in credit demand. Gradually, the influence of credit demand shocks declines to explain 84% of the variation in the long run UK base rate. Credit supply shocks contribute only 7% of the variation of the long run UK base rate, while monetary policy surprises account for 4% of this variation. While QE shocks do not explain the variation in the UK base rate upon their impact, the influence of QE shocks in explaining UK base rate movements increases a little to 4% in the second quarter of impact and to 5% in the long run. This implies that during normal times, the QE shock can be thought of as any unexpected disturbance in the financial markets to which the central bank does not feel compelled to respond on impact. Such instances may include temporary movements of liquidity towards the long end of the yield curve that may compress term spreads in the short term.

Table 17: Forecast Error Variance Decompositions (FEVD) for structural shocks
Forecast error variance decompositions (in %) for the structural model in equation 1.

Periods Ahead	S.E.	Bond Market Specific Shocks	Credit Supply Shocks	Credit Demand shocks	QE Shocks	Monetary Policy Rate Shocks
Variance Decomposition of Real Bond Issuance:						
1	0.06	69.99	0.49	1.24	13.71	14.58
4	0.07	66.09	4.25	1.44	12.87	15.35
8	0.07	65.03	5.08	2.08	12.68	15.13
12	0.07	64.56	5.62	2.21	12.58	15.03
20	0.07	64.06	6.14	2.41	12.48	14.91
30	0.07	63.80	6.38	2.55	12.43	14.84
40	0.07	63.69	6.47	2.61	12.41	14.82
Variance Decomposition of Real Bank Loan Issuance:						
1	0.01	0.15	96.23	1.11	0.32	2.19
4	0.01	2.33	84.54	2.86	1.43	8.85
8	0.02	2.61	84.73	2.85	1.31	8.50
12	0.02	2.78	84.92	2.78	1.31	8.21
20	0.02	2.86	84.89	2.98	1.28	7.99
30	0.02	2.87	84.74	3.22	1.27	7.90
40	0.02	2.87	84.65	3.34	1.26	7.87
Variance Decomposition of Real Equity Prices:						
1	0.32	0.25	0.23	93.16	0.00	6.36
4	0.73	0.48	0.32	94.32	0.75	4.14
8	0.96	0.29	3.79	91.45	1.66	2.82
12	1.10	0.28	8.86	86.87	1.71	2.28
20	1.27	0.45	16.78	79.44	1.59	1.74
30	1.37	0.62	21.77	74.64	1.47	1.49
40	1.42	0.70	23.90	72.58	1.42	1.40
Variance Decomposition of Term Spreads:						
1	0.82	0.01	0.23	64.43	18.32	17.01
4	0.90	0.15	1.90	63.11	19.71	15.12
8	0.94	0.19	6.38	59.33	18.95	15.16
12	0.95	0.23	7.17	58.67	18.72	15.21
20	0.96	0.24	7.38	58.50	18.61	15.27
30	0.96	0.24	7.44	58.50	18.57	15.25
40	0.96	0.24	7.49	58.48	18.55	15.23
Variance Decomposition of UK base rate:						
1	0.98	0.00	0.00	98.77	0.00	1.23
4	1.07	1.20	2.68	89.78	4.35	2.00
8	1.12	1.13	5.70	85.13	4.74	3.30
20	1.14	1.15	6.47	83.83	4.88	3.67
30	1.14	1.15	6.57	83.74	4.87	3.67
40	1.14	1.15	6.66	83.67	4.86	3.67

A comparison of results for the SVECM model, identified using parametric restrictions and the sign identified SVECM, is presented in section 5.12 of this study.

5.9 Counterfactual corporate bonds and bank loan issuance

Kapetanios et al.(2012) examine the macroeconomic effects of the QE program, particularly on inflation and growth. They construct several counterfactual simulations using time

varying parameter VARs. These simulations assume that the effects of the QE operations are transmitted through reduced long term interest rates. Similarly, Churm et al. (2015) assume that the macroeconomic effects occur via the reduction of long term rates. However, Churm et al. (2015) augment the Kapetanios et al. (2012) model with the inclusion of bank funding costs in order to capture the impact of the Bank of England's Funding for Lending Scheme. They also develop an ARDL model along the lines of Pesaran and Smith (2016) for counterfactual analysis which can be used as a robustness check.

In this section, we attempt to provide some counterfactuals for the time path of corporate debt issuance behaviour in the absence of the UK QE program using the results of our VECM in Table 15. The counterfactuals are computed based on the results of our benchmark model for nominal bond issuance, namely the cointegration model in columns 1 and 2 of Table 15. We augment the benchmark results with a general dynamic error correction model in line with Engle and Granger (1987). The equations for the general dynamic error correction model we employ takes that same form as the VECM in equation 2 and is specified below:

$$\Delta b_t = \propto \left(b_{t-1} - (\emptyset_1 l_{t-1} + \emptyset_2 f_{t-1} + \emptyset_3 s_{t-1} + \emptyset_4 r_{t-1})\right) + c + \beta_1 \Delta b_{t-1} + \beta_2 \Delta b_{t-2} + \beta_3 \Delta l_{t-1} + \beta_4 \Delta l_{t-2} + \beta_5 \Delta f_{t-1} + \beta_6 \Delta f_{t-2} + \beta_7 \Delta s_{t-1} + \beta_8 \Delta s_{t-2} + \beta_9 \Delta r_{t-1} + \beta_{10} \Delta r_{t-2} + \varepsilon_t \quad \ldots (26)$$

The variables in equation (26) are explained in the earlier discussion of equations 1 and 2. The parameters $\propto$ and $\emptyset_i$ represent the speed of adjustment to long run equilibrium and the long run response of the variables, and they are obtained from the cointegration equation in Table 15, c is the intercept, the β_i parameters are the coefficients for short run dynamics and ε_t is the residual error term. The long run elasticities of the variables are computed as $\emptyset_i / \propto$.[47]

Similarly, the equation for counterfactual loan issuance is specified as follows:

$$\Delta l_t = \propto \left(b_{t-1} - (\emptyset_1 l_{t-1} + \emptyset_2 f_{t-1} + \emptyset_3 s_{t-1} + \emptyset_4 r_{t-1})\right) + c + \beta_1 \Delta l_{t-1} + \beta_2 \Delta l_{t-2} + \beta_3 \Delta b_{t-1} + \beta_4 b_{t-2} + \beta_5 \Delta f_{t-1} + \beta_6 \Delta f_{t-2} + \beta_7 \Delta s_{t-1} + \beta_8 \Delta s_{t-2} + \beta_9 \Delta r_{t-1} + \beta_{10} \Delta r_{t-2} + \varepsilon_t \quad \ldots (27)$$

[47] This is the equivalent of normalising the cointegrating equation on the real bond issuance series.

The variables and the estimated parameters are as defined above in equations 1, 2 and 26 above. Because of the super consistency property[48], the estimated parameters of equations 26 and 27 will be the same as those we obtain if we knew the true value of $\propto$. As a result, the model should produce results that are as close as possible to our benchmark model. The equations are estimated using data up to 2008Q4. The results for the counterfactuals are presented in the table below:

Table 18: Counterfactual Equations

The coefficients on b_{t-1} and l_{t-1} in the bond equation and loan equations are the error correction terms for the bond equation and the loan equation, respectively. This table presents the results for equations 26 and 27. The long run cointegrating relation and the short run dynamics are estimated simultaneously. The asterisks ***,**,*, represent statistical significance at the 1%, 5%, and 10% levels of significance, respectively. Standard errors are presented in rounded brackets (.).

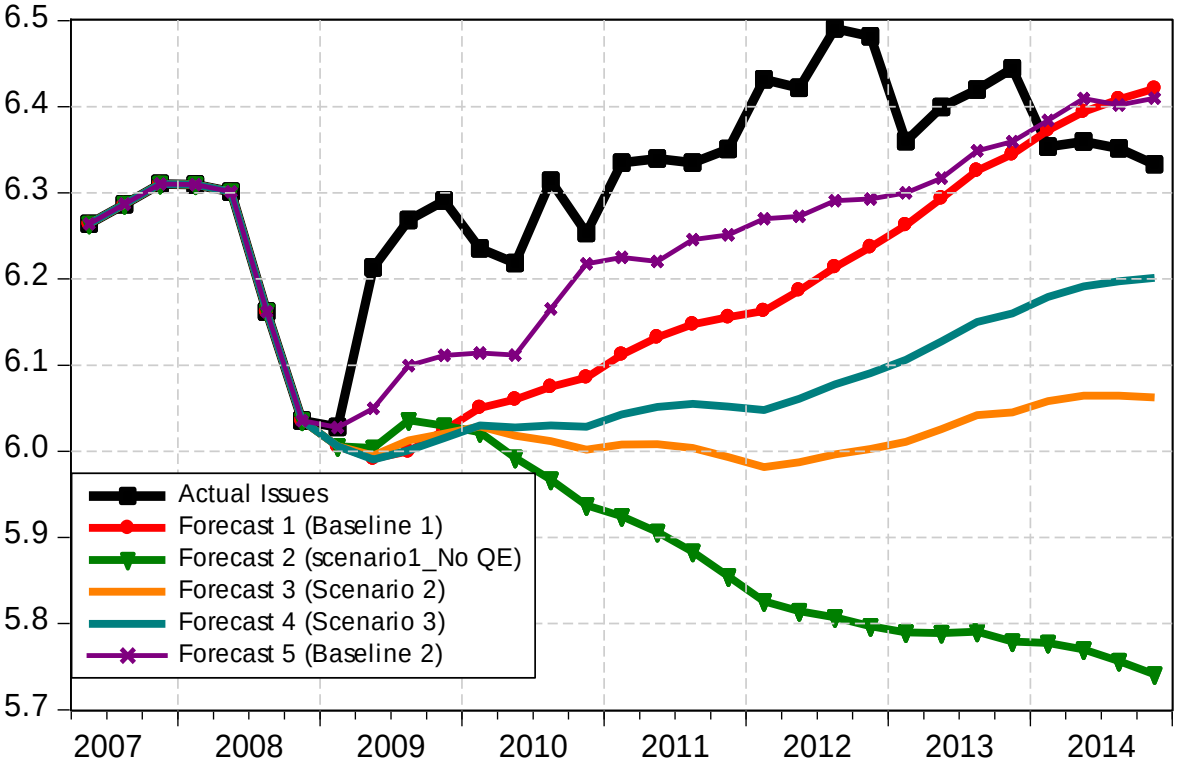
Variable	**Bonds (Equation 26)**	**Loans (Equation 27)**
	$\Delta \boldsymbol{b_t}$	$\Delta \boldsymbol{l_t}$
$\boldsymbol{b_{t-1}}$	-0.0640** (0.0293)	0.0418** (0.0244)
$\boldsymbol{l_{t-1}}$	0.0222 (0.0437)	-0.0713** (0.0312)
$\boldsymbol{f_{t-1}}$	0.0836** (0.0400)	0.0703** (0.0353)
$\boldsymbol{s_{t-1}}$	-0.0041 (0.0082)	-0.0039 (0.0076)
$\boldsymbol{r_{t-1}}$	-0.0028 (0.0066)	-0.0031 (0.0058)
$\boldsymbol{c}$	-0.3744(0.3779)	-0.5094* (0.3158)
$\Delta \boldsymbol{b_{t-1}}$	0.0794 (0.0954)	0.0656 (0.0822)
$\boldsymbol{b_{t-2}}$	0.1333 (0.0980)	0.0685 (0.0849)
$\Delta \boldsymbol{l_{t-1}}$	-0.3003 (0.5423)	-0.4716 (0.3775)
$\Delta \boldsymbol{l_{t-2}}$	0.0393 (0.5417)	0.5551 (0.3810)
$\Delta \boldsymbol{f_{t-1}}$	-0.0247 (0.0708)	-0.0665 (0.0644)
$\Delta \boldsymbol{f_{t-2}}$	0.0441 (0.0732)	-0.015421 (0.0652)
$\Delta \boldsymbol{s_{t-1}}$	0.0047 (0.0128)	0.0014 (0.0123)
$\Delta \boldsymbol{s_{t-2}}$	0.0108 (0.0123)	0.0117 (0.0120)
$\Delta \boldsymbol{r_{t-1}}$	0.0056 (0.0108)	0.0015 (0.0103)
$\Delta \boldsymbol{r_{t-2}}$	0.0072 (0.0103)	0.0028*** (0.0100)
Diagnostic results		
Serial correlation: Breusch-Godfrey LM test	0.7735 (0.6793)	5.5152 (0.0634)
Heteroskedasticity : ARCH	0.01184 (0.9941)	0.0666 (0.7964)
Heteroskedasticity :Breusch-Pagan-Godfrey	13.70441 (0.5481)	27.035** (0.0263)

The results in Table 18 reveal that the estimated equations exhibit neither serial correlation nor heteroskedasticity. Further diagnostic results in Appendix E indicate that the parameter

[48] In the presence of cointegration, OLS estimators converge to the true parameters at a faster rate as the sample size increases to infinity. The consistency of the OLS estimators hold even when the dynamic terms are neglected. As result, the I(0) variables do not need to be included in the long run equation.

estimates are stable, thus are suitable for producing counterfactual estimation. We present the counterfactuals in Figure 8 and Figure 9 below.

Figure 8: Counterfactual Bond issuance
We estimate the VECM results and the 1 step Engle and Granger cointegration procedure (equation 26) using the sample up to 2008q4 before the QE policies are in effect. The forecasts for the natural logs of outstanding corporate bonds are for the period 2009Q1 to 2014Q4.



The results of the baseline forecast (Forecast 1 (Baseline 1)) from our VECM model in equation 2 are derived using the using actual realisations of term spreads and UK base rates during the period 2009 to 2014, when the QE policies are in effect. This is indicated in red. The results of the 1 step Engle-Granger cointegration procedure (Forecast 5 (Base line 2)), estimated using equation 26 are employed as an alternative benchmark or baseline result, from which we can assess the effectiveness of the QE policies. This is indicated in purple. Figure 8 shows that the actual outturn of corporate bond issuance (in black) is higher than expected during the QE phase, based on the results of both the baseline VECM model and the baseline Engle-Granger cointegration model. This implies that other factors apart from QE may contribute to corporate bond issuance. Earlier results seem to suggest that bond market specific shocks, credit supply shocks and monetary policy shocks all play a role influencing corporate bond issuance. Thus, we assess the effectiveness of QE policies using our benchmark estimates instead of the realised corporate bonds issues during the QE

period. The “No QE” scenarios are estimated using the VECM model in equation 2 which is estimated using data up to 2008Q4, before the QE policies are in effect.

We derive our counterfactual “No QE” scenarios as follows:

a. Forecast 2 (No QE Scenario 1): This No QE scenario follows from assuming that term spreads and the UK base rates remain static at the third quarter of 2008 levels.
b. Forecast 3 (No QE Scenario 2): The second No QE scenario 2 assumes that the QE policies only reduce spreads and prime rates by a maximum of 100 basis points. This assumption is based on findings from event studies such as Joyce et al. (2010), Bean et al. (2010), and Steeley (2014), which estimate spread impacts of a similar magnitude.
c. Forecast 4 (No QE Scenario 3): In the third scenario we eliminate the impact of QE on the term spreads and leave the short term rates unchanged.

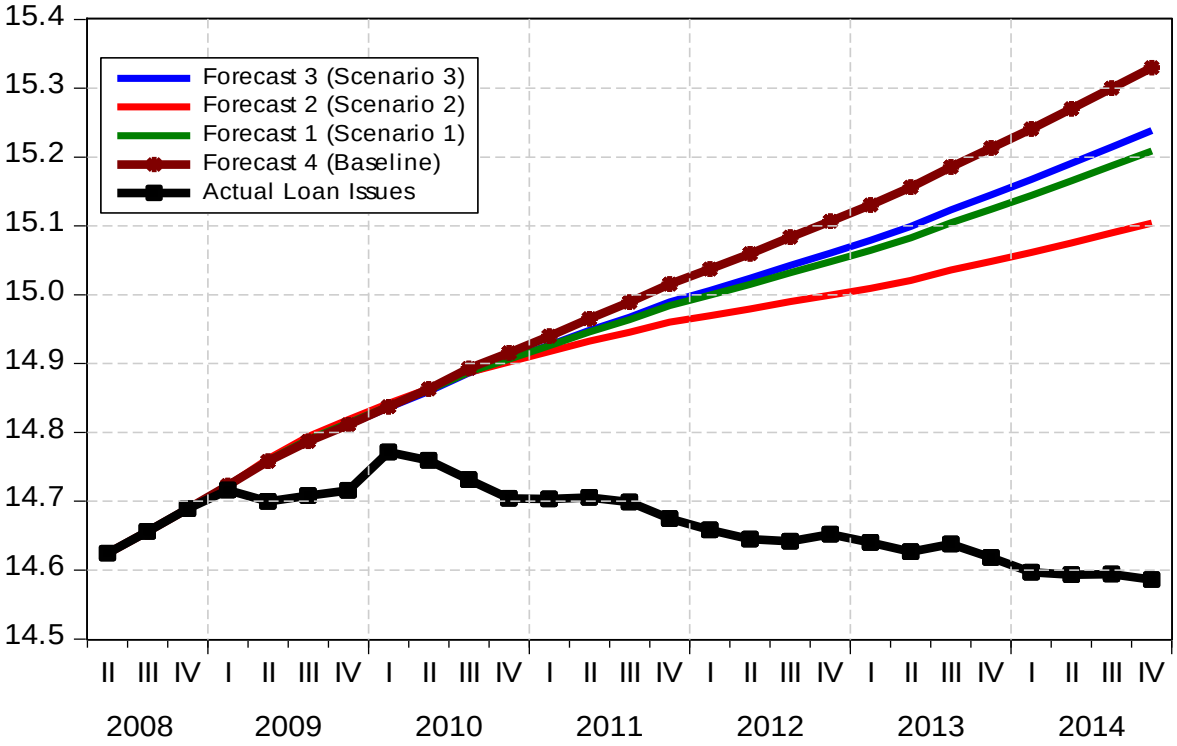
Figure 8 reveals that the QE program results in an increase in corporate bond issuance in the UK. Based on the estimates of our chosen benchmark (Baseline 2), the results in Table 19 show that corporate bond issuance declines by between 3.05% and 4.51% by the fourth quarter of 2010. By the end of the year 2012, corporate bond issuance is predicted to decline by between 3.22% and 7.88% in the absence of QE, and would register its maximum decline of between 3.40% and 9.88% by the second quarter of 2014. The estimated declines are much more severe if we use the actual outturn of corporate bond issuance to estimate the effects of QE. Based on the actual outturn of corporate bond issues, corporate bonds issues would be expected to decline by between 3.60% and 5.05% by the fourth quarter of 2010, and by between 6.03% and 10.56% by the end of 2012. These results show that QE policies play a central role in influencing corporate bond issuance, and help to avert a possible decline in bond issuance of up to a maximum of 10.56%, had the central bank not intervened to ease conditions in the credit markets.

Table 19: Counterfactual estimates of corporate bond issuance
The table presents estimated of the cumulative decline in corporate bond issuance for the No QE Scenarios. The first set of results presents the estimated decline in bond issuance using baseline 1 as the benchmark. In the second set of results we employ baseline 2 as our benchmark and in the last section we use the actual out-turn of corporate bond issues. The cumulative decline is estimated as the percentage difference between the scenario estimate and the benchmark result.

Baseline 1	**No QE Scenario 1**	**No QE Scenario 2**	**No QE Scenario 3**
2009Q1	0.00%	0.00%	0.00%
2009Q4	0.09%	-0.06%	-0.15%
2010Q4	-2.43%	-1.38%	-0.94%
2011Q4	-4.89%	-2.64%	-1.69%
2012Q4	-7.05%	-3.76%	-2.35%
2013Q4	-8.92%	-4.72%	-2.91%
2014Q1	-9.34%	-4.94%	-3.04%
2014Q2	-9.76%	-5.15%	-3.17%
Baseline 2	**No QE Scenario 1**	**No QE Scenario 2**	**No QE Scenario 3**
2009Q1	-0.36%	-0.36%	-0.36%
2009Q4	-1.34%	-1.49%	-1.58%
2010Q4	-4.51%	-3.47%	-3.05%
2011Q4	-6.34%	-4.13%	-3.19%
2012Q4	-7.88%	-4.62%	-3.22%
2013Q4	-9.13%	-4.94%	-3.14%
2014Q1	-9.50%	-5.11%	-3.21%
2014Q2	-9.98%	-5.38%	-3.40%
Actuals	**No QE Scenario 1**	**No QE Scenario 2**	**No QE Scenario 3**
2009Q1	-0.37%	-0.37%	-0.37%
2009Q4	-4.16%	-4.30%	-4.39%
2010Q4	-5.05%	-4.02%	-3.60%
2011Q4	-7.81%	-5.63%	-4.71%
2012Q4	-10.56%	-7.39%	-6.03%
2013Q4	-10.32%	-6.19%	-4.41%
2014Q1	-9.07%	-4.65%	-2.75%
2014Q2	-9.27%	-4.64%	-2.64%

Results from our baseline model, which we estimate using equation 27 in Figure 3 indicate that the actual out-turn of bank loan issuance is lower than expected during the QE phase. The results in Figure 3 indicate that the QE program does not lead to a substantial increase in bank loan issuance and supports the findings of both Churm, Joyce, Kapetanios and Theodoris (2015) and Churm et al. (2015), that lending to private non-financial firms and households remains depressed despite the substantial decline in lending rates and credit spreads brought about by QE. This finding provides justification for the Bank of England launching the funding for lending (FLS) scheme, since improving credit conditions during QE do not translate into an increase in bank loan issuance during the QE period.

Figure 9: Counterfactual Bank Loan Issuance
We estimate the VECM results using the sample up to 2008q4 before the QE policies were in effect. The forecasts for the logs of outstanding corporate bonds are for the period 2009Q1 to 2014Q4



Our counterfactual results indicate that the benefits of the QE program do not spill over from the corporate bond to the bank loans market. Bank loan issuance remains depressed during the QE period. This finding supports the finding by Borio and Disyatat (2010) that the QE program did not result in a significant increase in the money multiplier. Indeed, they find that the money multiplier actually declines during the QE phase. It appears that banks preferred to intermediate over bank reserves rather than to increase their loans to the non-financial sector.

In fact, Figure 9 shows that bank loan issuance undershoots its expected level in the presence of QE policies. Bank loan issuance undershoots its expected level by between 1% and 4% over the period 2009 to 2014. Since banks are not reserve constrained during the QE period, the observation that actual bank loan issuance undershoots its expected level may suggest that banks are capital constrained or experience a reduction in their risk appetite during the QE phase. However, we do not directly test this assertion in this chapter.

5.10 A sign restricted vector error correction model approach to QE identification

In this section we augment our findings based on parametric restrictions by identifying QE shocks and other credit market related shocks using non-parametric contemporaneous sign restriction. Since the results in Table 14 reveal that our data is non-stationary and co-integrated (see Appendix A, Table 24), the appropriate summative model to adopt in this framework is a VECM model. We summarise our data using the VECM model we estimate in equation 2.

Unlike the previous section where permanent and transitory effects are induced in order to identify structural shocks, in this section no such restrictions are placed on the data. We identify structural shocks without imposing parametric identification assumptions by merely relying on the proposed contemporaneous effects of structural shocks, as in Ouliaris, Pagan and Restrepo (2016). Both Uhlig (2005), and Canova and De Nicolo (2002) claim that sign restrictions help resolve the structural identification problem by providing enough information for the estimation of structural parameters.[49]

However, considering that identification using parametric restrictions is limited by its ability to identify at most only as many shocks as there are variables (Blanchard and Quah (1989), Enders (2004)), the structural shocks we identify are near approximations of the actual shocks and the structural estimates we obtain using parametric restrictions serve as conservative point estimates of the impact of QE related shocks. Since shocks in the sign restrictions framework are identified using more information than in the parametric identification frameworks, sign identified models allow us to estimate a possible range of effects for QE and other credit market related shocks. Thus, to some extent they help resolve the structural identification problem.

Fry and Pagan (2011) highlight the fact that for the model to be identified, the sign restriction patterns must be unique. In this study, the primary focus of our analysis is a spread compression shock, which we identify with a QE shock. We specify multiple shocks in order to avoid the "multiple shocks problem" where the impulse responses may carry the same sign patterns if different shock patterns are not fully specified. Furthermore, Fry and Pagan (2011) and Pagan and Pesaran (2008) claim that as more shocks are estimated using sign restrictions, the bias in the estimated structural parameters will be reduced.

[49] However, Fry and Pagan (2011) note that sign restricted models may suffer from model identification problems. This is because the set of impulse responses is not unique. Consequently, there are many models with the identified parameters that can provide the same fit on the data.

Therefore, specifying only one shock to be the focus of interest may result in the different shocks being correlated. In turn, this will invalidate the variance decomposition analysis and the economic interpretation of our results. As such, we believe that the specification of a full set of shocks in our analysis namely: bond market specific shock, credit demand shock, credit supply shock, and monetary policy shock, as well as the above noted spread compression or QE shock (which is our central focus of interest) is justified.

The patterns for the sign restriction we employ are informed by findings from theory (section 5.2), previous empirical studies and our empirical findings in chapter 3. Fry and Pagan (2011) note that sign restrictions provide flexibility in the specification of restrictions. Common ways of specifying sign restrictions include the use of institutional knowledge, extracting predictions from theoretical DSGE models, and previous empirical work (Pagan and Pesaran (2008), and Canova (2005)). A major advantage of employing sign restrictions is that the structural impulse responses can be recovered with some reasonable degree of accuracy once the summative model is known. Furthermore, the focus of the analysis is rarely based on the magnitude of the shocks, but rather the direction of its effects.

In this section we achieve identification by imposing sign restrictions on impact. The identification of a spread compression or QE shock allows us to explore the impact of QE programs in an environment where the policy rate is close to the zero lower bound. The spread compression or QE shock is identified as one that shrinks the term spreads and the policy rate on impact and lowers bank loan issuance, while increasing corporate bond issuance and stock market returns. The configuration of these sign restrictions is informed by event study results which indicate that QE policies are: (i) associated with an increase in corporate bond issuances (Joyce el at (2011), Kaya and Wang (2014), Bank of England (2012)); (ii) result in a reduction in yields, credit spreads and term spreads (Joyce et al. (2011), Bean (2010), Steeley (2014)); and (iii) increase equity prices (Joyce et al. (2011)).

However, in order to pin down the spread shock, all the theoretically plausible restrictions must be imposed. In the present study, we identify a spread compression shock as one associated with a decline in government bonds term spreads and the policy rate on impact, while leading to an increase in corporate bond issuance over and above the effects induced through substitution effects arising from bank loan supply disruptions. We specify the contemporaneous impulse response sign restrictions for the shocks identified in the present study in Table 20.

Table 20: Sign restrictions for contemporaneous impulse responses
The signs +, - and ? Represent a positive, negative and unrestricted impulse response upon impact for the different variables in the VAR system. The signs show the instantaneous direction of movement following the shock of interest.

	Variables				
Shock	**Real Bond issues (b_t)**	**Real Bank loans (l_t)**	**Real Equity prices (f_t)**	**Term spread (s_t)**	**Policy rate (r_t)**
Bond market specific (ε_{bt})	+	+	+	-	-
Credit supply shock (ε_{lt})	+	-	-	+	-
Credit demand shock (ε_{ft})	+	+	+	-	+
QE shock (ε_{st})	+	-	+	-	-
Policy rate shock (ε_{rt})	+	-	?	+	+

Micro-level evidence on firm behaviour during the recent global financial crisis indicates that non-financial corporations increase corporate bond issuance as bank loan financing deteriorates (Becker and Ivashina (2014), Kaya and Wang (2014)). In a related study, Kashyap, Stein and Wilcox (1993) show that during periods of monetary policy tightening, non-financial companies tend to issue more commercial paper. Kashyap, Stein and Wilcox (1993) link this substitution in external financing directly to monetary policy shocks, arguing that the evidence supports the lending channel of monetary policy transmission. Similarly, Adrian, Colla and Shin (2012) and Becker and Ivashina (2014) find evidence to suggest that substitution between corporate bonds and bank loans is indicative of changes in credit supply. In chapter 3 of this study, we find that in the UK, firms with access to the corporate bond markets tend to substitute corporate bonds for bank loans when credit supply deteriorates. As such, we consider substitution to be a common feature associated with credit supply shocks.

In this study we identify credit supply shocks to be associated with a decline in bank loan issuance and asset prices, and an expansion in term spreads that is associated with a decline in the policy rate, as the central bank responds by lowering rates on impact. Since our time series variables are measured at a quarterly frequency, instantaneous sign restrictions seem plausible.

We identify the credit demand shock through asset price channels, in line with the financial accelerator propositions of Bernanke et al. (1999), where collateral values have a pervasive feedback effect on debt issuance. In this study, we identify positive credit demand shocks

as those that increase the FTSE stock price index, debt issuance and policy rates on impact, while narrowing the term spreads. Although our interest in this study focuses on the spread compression shock, we add credit demand, credit supply, policy rate and bond market specific shocks in order to separate the various shocks from one another. This is done in order to eliminate the correlations between shocks so as to achieve identification (Fry and Pagan (2011)).

5.10.1 Structural identification with sign restrictions

The structural model for our cointegrated system given in equation 1, together with the reduced form VECM model error terms, are connected to the structural shocks using equation 28:

$$B_0 \Delta y_t = \Pi^* y_{t-1} + B(L)\Delta y_{t-q} + \varepsilon_t$$

$$\Delta y_t = \Pi y_{t-1} + \Gamma(L)\Delta y_{t-l} + u_t$$

$u_t = B_0^{-1}\varepsilon_t$ where $\varepsilon_t \sim N(0, I_n)$ …(28)

B_0 is an $(n \times n)$ matrix of structural coefficients and $\varepsilon_{t=}[\varepsilon_{bt}, \varepsilon_{lt}, \varepsilon_{ft}, \varepsilon_{st}, \varepsilon_{rt}]'$ is an $(n \times 1)$ vector of structural shocks in equations 16-20, namely; bond market specific shocks, credit supply shocks, credit demand shocks, QE shocks, and monetary policy rate shocks, respectively. The VECM's reduced form innovations u_t from equation 2 are postulated to be zero mean and normally distributed, with a covariance matrix given by:

$$Var(u_t) = \Omega = B_0^{-1}E(\varepsilon_t \varepsilon_t')(B_0^{-1})' = B_0^{-1}B_0^{-1\prime} \text{ and } \Omega = A'A \quad \text{… (29)}$$

where the lower triangular matrix A' is the Cholesky factor decomposition of Ω obtained from the residuals of our VECM, and S is an orthogonal matrix with the property $S'S = I$ drawn from the standard normal distribution N(0,1). This implies that:

$$\Omega = B^{-1}B^{-1\prime} = A'A = A'S'SA = s's \quad \text{…. (30)}$$

where s' is no longer a lower triangular matrix and $B^{-1} = s'$ is a solution to the identification problem. Identification is achieved by generating N draws of the orthonormal matrix S' from an N(0,1) density and then computing $B^{-1} = A'S'$, where A' is the Cholesky decomposition of the reduced from residuals. For each of the 1500 Cholesky factors we search over the possible impulse responses and check whether the impulse responses implied by S' satisfy the set of *a priori* sign restrictions in Table 20. Only the impulse

responses that satisfy the sign restrictions in Table 20 are retained. A different S matrix is generated for each shock.

Canova (2007) and Canova and Pina (2005) maintain that the advantage of sign restriction methodologies, as compared to alternative identification schemes that are based on impact restrictions, is that sign restriction methodologies are fully compatible with general equilibrium models, while other standard identification schemes are not. Fry and Pagan (2011) assert that sign restrictions allow us to identify orthogonal multiple shocks that may operate at the same time, which may be difficult to uncover using alternative identification schemes. They also note that sign restriction methodologies are able to reduce the bias in the estimated responses by introducing more shocks into the VAR system. However, this advantage is conditional on whether the shocks have been correctly extracted.

5.11 Empirical results

In this section we present the analysis of impulse responses of corporate bonds, bank loans, equity price, term spreads and policy rates to the credit market shocks identified using the sign restrictions in Table 20. We also compare the results of the sign identified model to earlier results obtained through long run restrictions in section 5.7.

QE shocks

Figure 10 reveals that QE shocks engender an increase in bond issuance for a period of up to 5 quarters and a permanent decline in bank loan issuance. Furthermore, QE yields an increase in equity prices for a period of up to 20 quarters and a decline term spreads and policy rates in the very short term. The findings on corporate bond issuance, equity prices and term spreads are very consistent with our findings using parametric restrictions. Overall, while results of the parametric restricted VECM show that QE has neutral effects on the policy rates and bank lending, the policy effects tend to be in the same direction as those of the sign identified model.

Credit supply shocks

The results in Figure 11 indicate that adverse credit supply shocks tend to depress bank loan issuance and to increase corporate bond issuance in the short term. The increase in bond issuance following an adverse credit supply shock that depresses bank loan issuance is consistent with our earlier micro level evidence in chapter 3, and supports the view that non-financial firms substitute corporate bonds for bank loans following an adverse credit

supply shock that affects bank loan supply. The results also show that the central bank responds by cutting the policy rate when adverse credit shocks hit the credit markets. Consequently, terms spreads will tend to widen in the very short term. It is worth noting, however, that the increase in term spreads is largely a mechanical one and is therefore temporary.

The results also show the sign identified impulse responses of bank lending, policy rates, term spreads and equity prices move in the same direction as those of the parametric identified model. However, the results are inconsistent for corporate bond issuance. Whilst the sign identified model reveals the existence of substitution between corporate bonds and bank loans following an adverse credit supply shock, the results of the long run restriction identified model indicate that corporate bonds and bank loans tend to be complementary in the medium run.

Credit demand shocks

Results in Figure 12 highlight that credit demand shocks lead to an increase in corporate bond issuance in the short to medium term. At the same time, credit demand shocks yield and increase in bank loan issuance for a period of up to 15 quarters. The results indicate that the central bank responds to an increase in credit demand by increasing the policy rate for a period of up to 15 quarters which tends to lower term spreads for a period of up to 12 quarters. This result is consistent for both the sign identified and the parametric identified model. Furthermore, the results for the sign identified model also show that equity prices increase in the very short–run while the results for the model identified using parametric restrictions indicates that positive credit demand shocks result in a long term increase in equity prices. Although the magnitudes and the length of the responses tend to differ slightly, both models produce impulse responses that move in the same direction.

Bond market specific shocks

Positive bond market specific shocks lead to a permanent increase in corporate bond issuance by non-financial corporations. Results in Figure 13 indicate that positive bond market related shocks will yield a complementary increase in bank loan issuance. Furthermore, bond market shocks also lead to an increase in equity prices in the short term and a decline in policy rates in the long run. The results for the sign identified model differ somewhat from our earlier results for the model identified using long run restrictions. Our

earlier results indicate that bond market shocks have no effects on equity prices, term spreads and policy rates.

Monetary policy rate shocks

Our results in Figure 14 show that an unexpected contraction of monetary policy will yield an increase in corporate bond issuance as firms substitute away from declining bank lending in the short run. Bond issuance will only increase for a period of up to 5 quarters while bank lending will settle at a new lower equilibrium within the same period. Beyond a period of 5 quarters the impact of monetary policy contraction dissipates. The decline in bank lending following a monetary policy contraction is consistent with a bank lending channel of monetary policy transmission. However, the increase in the policy rate has no effect on the equity prices and the term spreads. The increase in bond issuance is inconsistent with out earlier results which show a complementary decline in bond issuance for a period lasting up to 25 quarters. The difference, however, is largely a direct result of the long run identification restriction imposed on bank lending in our parametric restrictions identified model.

Although the results of the sign restrictions model differ slightly with our earlier results for long run restrictions in some instances, most of the results are qualitatively similar in capturing the direction of the shocks. We interpret this as evidence that we can be confident that our parametric identified model is reasonable in capturing the impact of quantitative easing and other credit market shocks on the debt issuance behaviour of UK non-financial corporations.

Figure 10: Responses to QE shocks

The figure represents the accumulated impulse responses of outstanding corporate bonds, bank loans, equity prices, term spreads and policy rate to an unexpected one standard deviation QE shock obtained from an SVECM estimated using quarterly data. Structural shocks are identified using the sign restrictions presented in Table 20. The red line represents the median responses. The pink bands represent the 68% confidence bands similar to Haldane et al. (2016), Kilian and Murphy (2012).

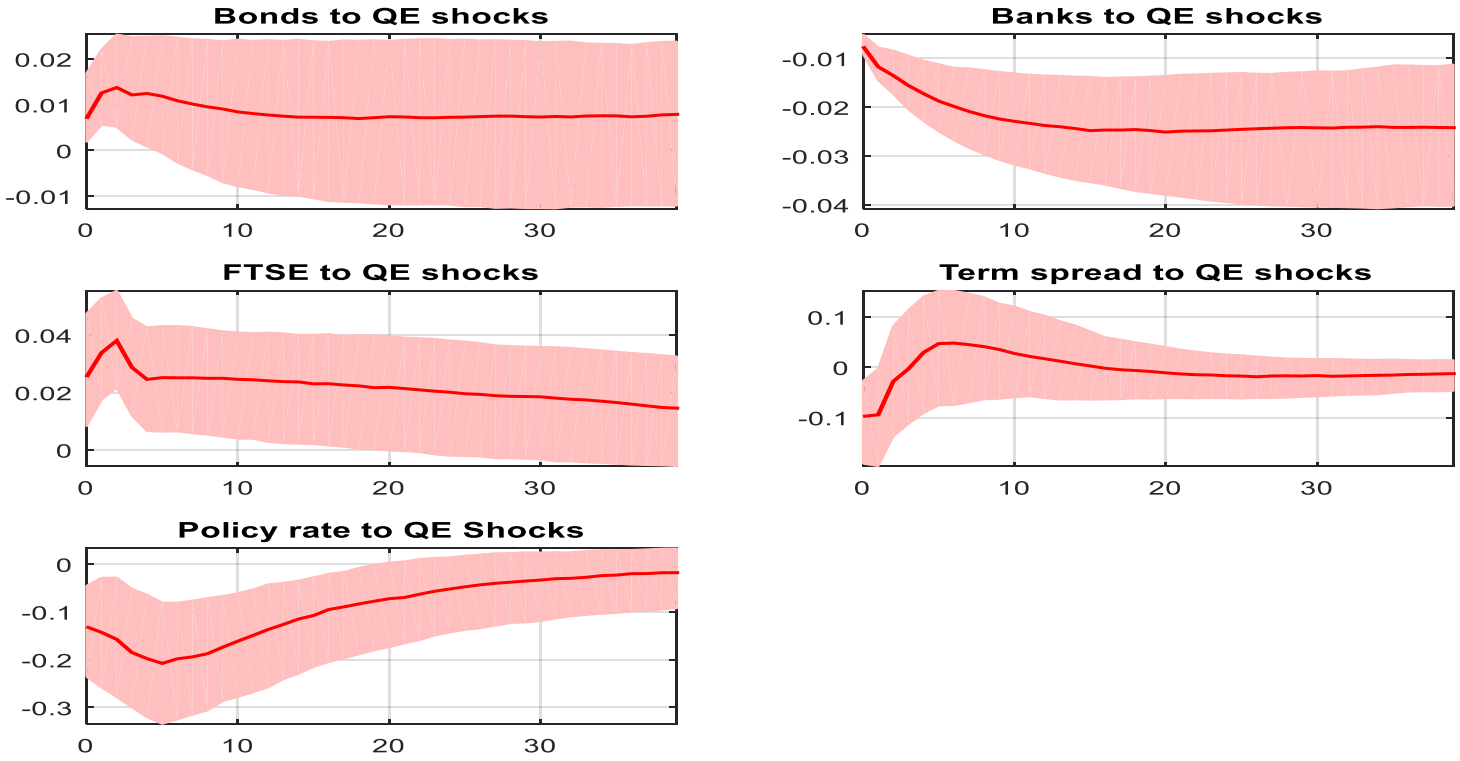


Figure 11: Responses to credit supply shocks

The figure represents the accumulated impulse responses of outstanding corporate bonds, bank loans, equity prices, term spreads and policy rate to an unexpected one standard deviation credit supply shock obtained from an SVECM estimated using quarterly data. Structural shocks are identified using the sign restrictions presented in Table 20. The red line represents the median responses. The pink bands represent the 68% confidence bands similar to Haldane et al. (2016), Kilian and Murphy (2012).

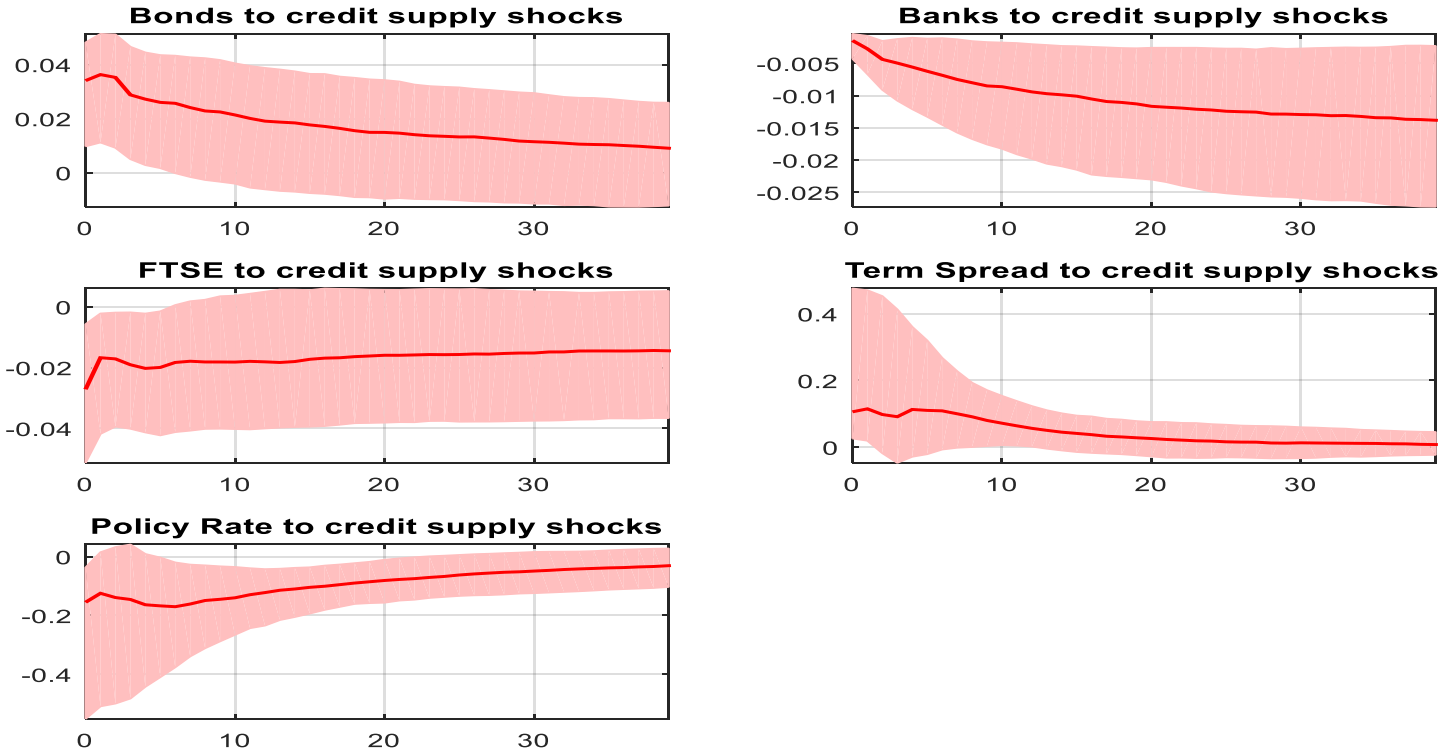


Figure 12: Responses to credit demand shocks

The figure represents the accumulated impulse responses of outstanding corporate bonds, bank loans, equity prices, term spreads and policy rate to an unexpected one standard deviation credit demand shock obtained from an SVECM estimated using quarterly data. Structural shocks are identified using the sign restrictions presented in Table 20. The red line represents the median responses. The pink bands represent the 68% confidence bands similar to Haldane et al. (2016), Kilian and Murphy (2012).

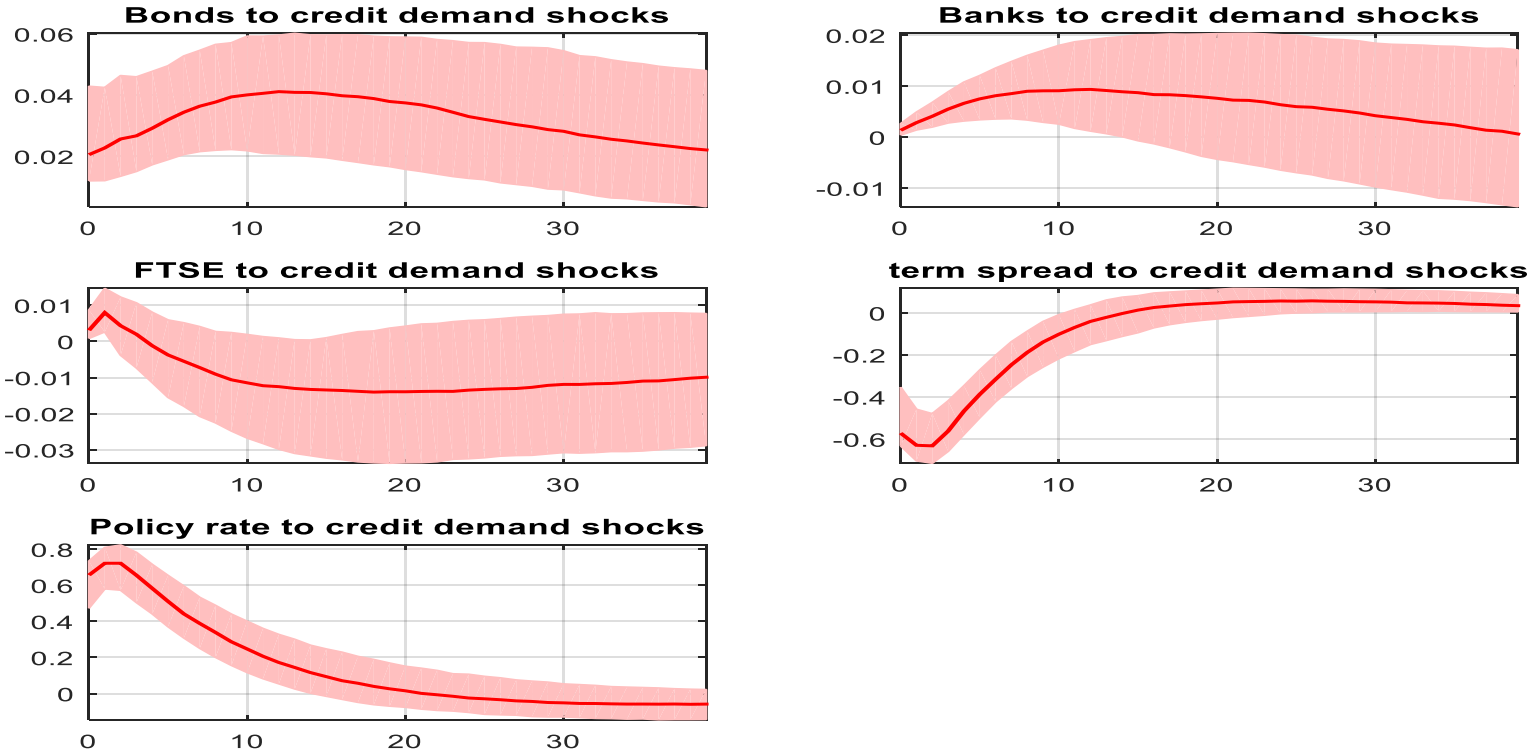


Figure 13: Responses to bond market specific shocks

The figure represents the accumulated impulse responses of outstanding corporate bonds, bank loans, equity prices, term spreads and policy rate to an unexpected one standard deviation bond market specific shock obtained from an SVECM estimated using quarterly data. Structural shocks are identified using the sign restrictions presented in Table 20. The red line represents the median responses. The pink bands represent the 68% confidence bands similar to Haldane et al. (2016), Kilian and Murphy (2012).

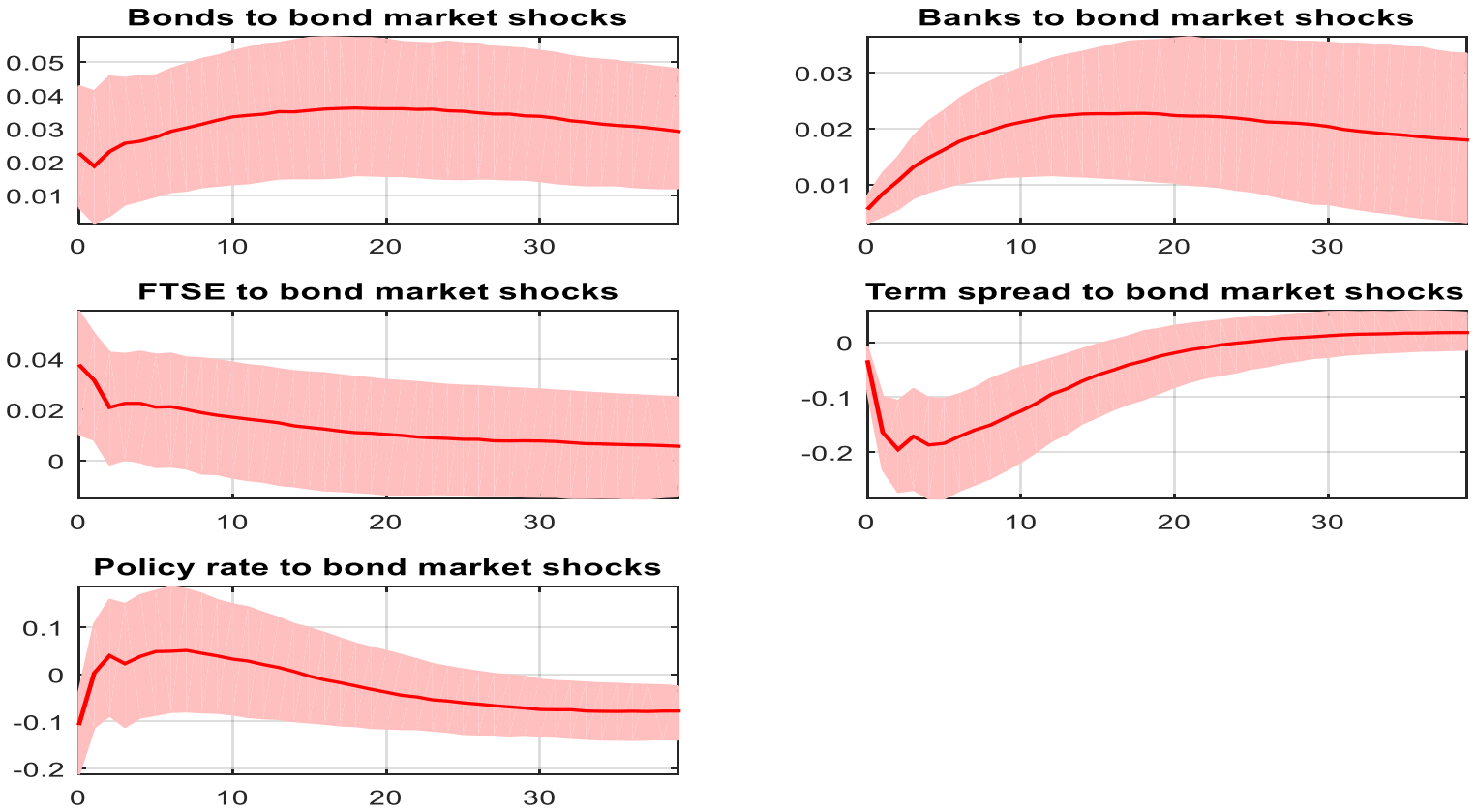
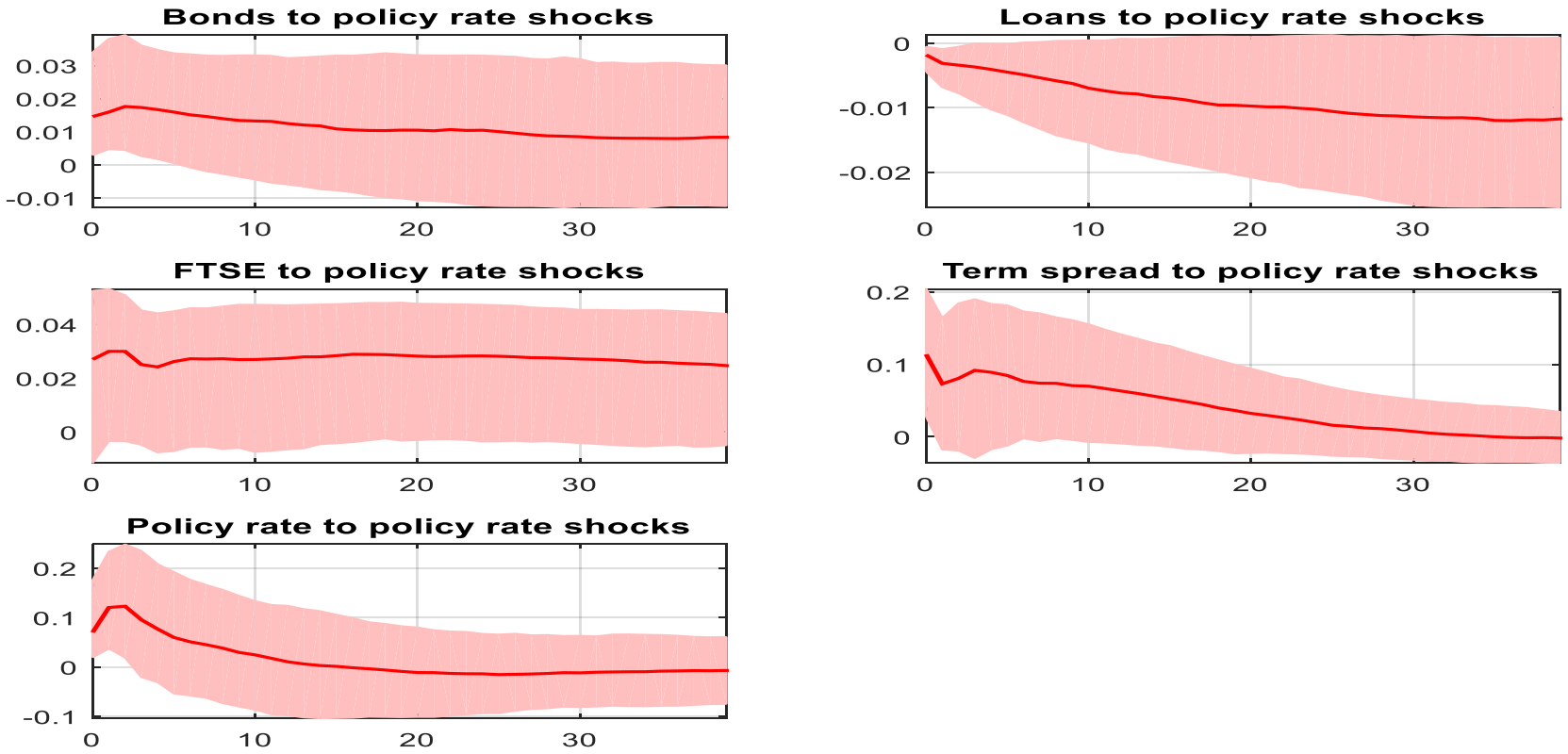


Figure 14: Responses to policy rate shocks

The figure represents the accumulated impulse responses of outstanding corporate bonds, bank loans, equity prices, term spreads and policy rate to an unexpected one standard deviation policy rate shock obtained from an SVECM estimated using quarterly data. Structural shocks are identified using the sign restrictions presented in Table 20. The red line represents the median responses. The pink bands represent the 68% confidence bands similar to Haldane et al. (2016), Kilian and Murphy (2012).



5.12 Historical decomposition of bond issuance

In this section we present a historical decomposition of corporate bond issuance in the UK based on the sign identified model we estimate in this section. The results from this historical decomposition of corporate bond issuance are presented in Figure 15.

Figure 15 indicates that in the late 1980s to mid-1990s period, bond market issuance was dominated by a combination of bond market specific shocks, credit demand and credit supply shocks. The spike in the bond issuance series in the late 1980s is explained by structural developments in the UK bond market which are spurred by the arrival of bulldog bonds and the growth in Eurobonds and floating rate notes (Bank of England (1989)). Between 1984 and the early 1990s, the increase in the issuance of unsecured loans stocks and secured debentures, by both financial and industrial non-financial companies, accelerate the growth in the corporate bond market and narrow aggregate spreads. The development of the interest rate swaps market in the mid-1980s expand corporate bond market activity by granting companies that previously could not directly access the corporate bond markets indirect access to fixed rate financing through the swaps market. This also enables companies with a primary interest in the floating rate market to issue in the fixed rate market.

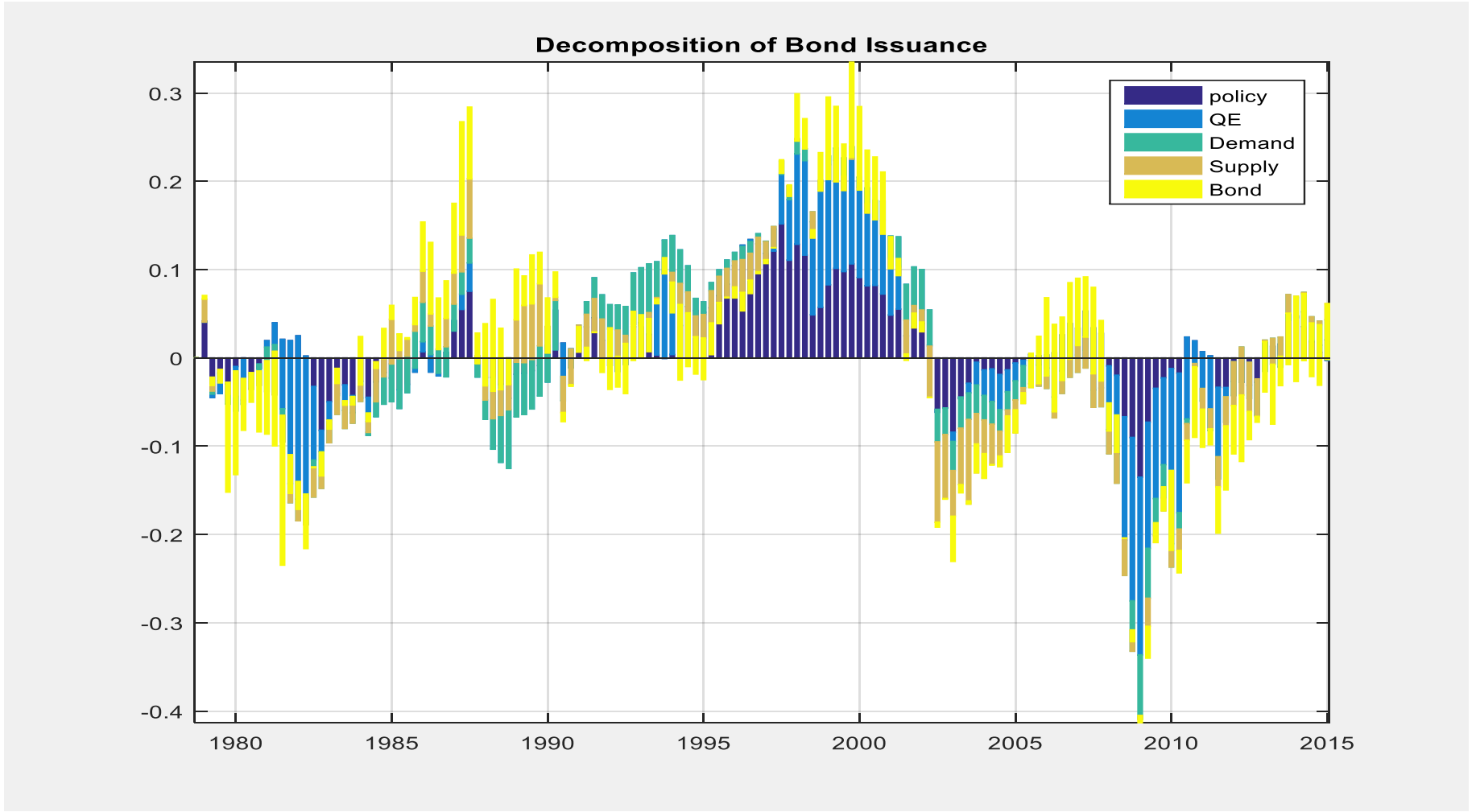
Furthermore, the development of mortgage backed securities, convertible bonds and commercial paper markets contributes to the growth of the UK corporate bond market, which contemporaneously witnesses a reduction in issuance costs. In 1986, options on bonds are introduced in the UK. However, these are mainly limited to gilt securities. Between 1985 and 1989 companies could issue short term corporate bonds with maturities between 1-5 years, as well as short term commercial paper. Furthermore, the deregulation of the corporate bond market in the UK enables unlisted companies to issue corporate bonds, providing that they meet minimum net asset requirements set up by the Bank of England. Post-1986, the structural reforms instituted on the London securities market aid in increasing the corporate bond market's investor base. Coincidentally, our model indicates the dominance of credit supply, credit demand and bond market specific shocks between 1985 and 1991.

Between 1995 and 2002, the model indicates that monetary policy shocks, QE shocks and bond market specific shocks tend to dominate corporate bond issuance. The dominance of monetary policy shocks in corporate bond issuance beginning in 1997 coincides with the

updating of the UK inflation targeting framework with the introduction of central bank independence and increased clarity given to the Bank of England objectives (HM Treasury (2013)). In 1998, the Bank of England Act officially gives the Bank the power to set interest rates. Between 1997 and 2002, the model shows that QE shocks and bond market specific shocks gain importance in explaining corporate bond issuance. The dominance of QE shocks during this period coincides with the Asian crisis of 1997, the Russian debt crisis of 1998, and the subsequent collapse of Long Term Capital Management (LTCM).

During the period 2007 and 2012, policy rate shocks and QE shocks dominate corporate bond issuance. The QE shocks in the model coincide with the credit easing policies by the Bank of England in 2008 following the collapse of Lehman Brothers and the introduction of QE policies in 2009. However, credit supply, credit demand and bond market specific shocks appear to make very little contribution to bond issuance during this period.

Figure 15: Historical decomposition of bond issuance by UK non-financial companies



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5.14 Conclusions

The objective of this chapter is to assess whether observed corporate bond issuances during the QE period are largely a result of QE policies, or other credit market shocks, or some combination of both. We employ VECM techniques to summarise the data, and Granger causality and weak exogeneity tests to understand the patterns of causality in the data. Two structural VAR modelling techniques, namely long-run restrictions and sign restrictions, are then used to give an economic interpretation to the model by identifying the impact of QE shocks and other credit market shocks on firm's debt issuance behaviour. Following an attempt to examine the impact of the Bank of England's QE policies on aggregate debt issuance in the UK, we establish some counterfactual results on debt issuance by UK non-financial companies.

We find that QE shocks result in an increase in corporate bond issuance for a period of 15 quarters, but have no statistically significant discernible effects on real bank loan issuance or real equity prices. Results of our sign-identified model also confirm that QE shocks tend to increase corporate bond issuance but only for a period of up to five quarters. We also find that QE shocks tend to depress the term spread, but have no significant effects on the UK base rate in the long run. At times, results from the two models we employ can differ slightly. An unexpected term spread compression generates an increase in equity prices in both models, and while the sign restricted model finds the range of responses to be positive for a period of up to 30 quarters, our parametric restricted model indicates that such increases are not statistically significant. Further, while our model with parametric restrictions highlights that QE shocks have no effect on the base rate, the sign identified model finds that QE shocks yield a temporary decline in policy rates which dissipates after a period of two and a half years. Our QE results suggest that the portfolio balance channel of QE policy transmission is in effect in the UK during the QE period.

Our analysis of credit supply shocks reveals transitory effects on corporate bond issuance and permanent effects on bank loan issuance. Adverse credit supply shocks shift bank loan issuance to a new lower equilibrium. At times our results may appear to conflict. Our parametric model reveals that adverse credit supply shocks depress corporate bond issuance in the medium term, while our sign identified model shows that the same shock yields an increase in bond issuance in the short term. However, the differences in the effects of credit supply shocks largely stem from the way in which the shocks have been

configured. In the parametric restrictions, a long run complementary relationship is imposed, while in the sign identified model we configure corporate bonds to be an instantaneous substitute for bank loans following a credit supply shock. Results of both models reveal that the central bank responds to an adverse credit supply shock by reducing the policy rate in an attempt to stimulate lending. Thus, adverse credit supply shocks occasion a decline in bank lending and policy rates.

Contractionary monetary policy shocks result in a decline in corporate bond issuance and an increase in loan issuance in the short term. This decline in loan issuance following a sudden increase in policy rates is consistent across models. Once more, bond issuance responds differently to a monetary contraction. In the sign identified model, adverse monetary policy shocks results in an increase in corporate bond issuance in the short term, while the parametric restrictions model indicates that monetary policy rate shocks initiates a decline in bond issuance. Again, this difference in the profile of shocks can be traced to the configuration of the bank loan response to policy rates.

Our models reveal that an increase in credit demand yields an increase in both corporate bond and bank loan issuance, albeit the length of the effect tends to differ between the two models. The sign identified model reports that credit demand effects influence corporate bond issuance in the long run while the parametric model reports that the effects of credit demand on corporate bond issuance are transitory, lasting only up to only one and a half years. Loan issuance is also shown to increase following credit demand shocks in both models, increasing for up to 15 quarters in the sign identified model and up to 5 quarters in the long run restricted model. However, both models reveal that the central bank responds to positive credit demand shocks by increasing the policy rate. The impact of credit demand shocks on the policy rate last for a period of up to 15 quarters. This period coincides with the time profile of the impact of credit demand shocks on bank loan issuance.

Overall, the set of results in this chapter indicate that debt issuance is driven by a number of factors which may all be operating simultaneously. Analysis of the historical decomposition of corporate bond issuance reveals that QE shocks and monetary policy related shocks have a significant role in corporate debt issuance during the period 2008 to 2012, while credit supply shocks and bond market specific shocks play the dominant role in the period following QE.

Our counterfactual results indicate that by embarking on QE policies, the Bank of England managed to avert a 10% decline in corporate bond issuance in the UK. However, the QE policies appear to have no effect on bank loan issuance.

CHAPTER 6

CONCLUSIONS

This thesis aims to: (i) examine the role of credit supply on a firm's ability to substitute between corporate bonds and bank loans, (ii) analyse the micro level effects of quantitative easing policies on debt issuance behaviour among unconstrained firms, (iii) to isolate a time series measure of bank loan supply, (iv) examine the real effects of bank loan supply on the financing and investment decisions of the firm, and (v) establish the role of quantitative easing and other credit market shocks on the aggregate debt issuance of UK firms. The study employs both panel data and time series techniques to establish the existence of a bank lending channel of money supply, and to ascertain the role of QE policies and other credit market shocks on debt issuance.

In chapter 3 we test the hypothesis that substitution between corporate bonds and bank loans among financially unconstrained firms, defined as rated firms with access to both credit markets, captures fluctuation in both aggregate credit supply and bank credit availability. We employ the fixed effects model of Becker and Ivashina (2014) to control for the credit demand effects by exploiting firm's revealed preferences for debt and restricting the sample to firms that issue debt within a given quarter. Since we know that firms issuing debt already have a positive debt demand, we conjecture that the observed substitutability between corporate bonds and bank loans captures fluctuations in bank loan supply. We find that adverse movements credit supply increase the propensity to issue corporate bonds relative to bank loans among UK non-financial firms. This finding supports the hypothesis that the observed substitutability indeed captures fluctuations in bank loan supply and conforms to the findings of Kashyap, Stein and Wilcox (1993), Becker and Ivashina (2014) and Adrian, Colla, and Shin (2012) on the US markets.

Chapter 3 also analyses whether QE policies affect corporate bond issuance, over and above the influence of credit supply related factors. We interact the credit supply factors with QE1 and QE2 period level dummy variables. We find that QE policies have an additional influence over and above the role of credit supply in increasing the propensity to issue corporate bonds relative to bank loans. These findings support the claims in Kaya and Wang (2014) and Fisher (2010) that QE policies occasion an increase in corporate bond issuance by UK non-financial firms. We conclude that the observed increase in corporate bond issuance during the QE period is indeed driven by QE policies and that the Bank of England is successful in stimulating corporate bond issuance, and in reducing the impact of

financial frictions on corporate debt issuance during the QE period. These results are consistent with a portfolio balance channel of QE transmission where QE policies lead to an increase in corporate bond issuance. These QE results in Chapter 3 are a precursor to our study of QE using macro level variables in Chapter 5.

As an ancillary objective in Chapter 3, we study the impact of credit supply on heterogeneous debt in order to assess whether observed debt substitution is consistent among granular debt components that carry different information asymmetry implications, cash flow and control rights. We test the prediction that the new issue proportions of different debt types in the firm's debt structure change at different rates in response to credit supply shocks. In particular, that the proportion of new bank loan issues in the debt structure increases (decreases) at a faster rate than other debt components when credit is readily available (difficult to obtain) and credit conditions are lax (tight).

We find that increases in the proportion of new bank loan issuance in the firm's debt structure when credit supply improves, and the proportions of corporate bonds and program debt increase with a deterioration in bank loan supply, aggregate credit supply and a deterioration in the macroeconomic outlook. Our results reveal that the debt substitution behaviour observed between corporate bonds and bank loans when credit supply deteriorates extends to granular, heterogeneous debt components in the firm's financial structure. These findings, similar to Rauh and Sufi (2010), confirm that debt is heterogeneous and that different debt carry different information asymmetry implications. These results also reveal that these heterogeneous debt components respond differently to changes in credit supply, in particular that corporate bond issuance tends to be countercyclical. This later finding is consistent with the findings of Erel et al. (2011), Leary (2009) and Contessi et al. (2013) for the US market. Furthermore, this result has important macro prudential implications, in that policies targeted at curbing excessive credit growth in the bank loans market may be frustrated by a countercyclical increase in corporate bond issuance.

In Chapter 3 we also estimate a loan to bond substitution index based on the observed debt issuance of unconstrained firms. This measure is designed to capture the fluctuations in bank loan supply. Having established this measure for bank loan supply, we examine whether it is able to predict the bank loan issuance behaviour of financially constrained firms. We find that the propensity to issue debt by constrained bank dependent firms'

increases in line with bank loan supply. Similar to Adrian, Estrella and Shin (2009) and Adrian, Colla and Shin (2012), this finding reveals the procyclical nature of debt issuance behaviour among bank dependent firms. Bank dependent firms tend to issue bank debt when bank loan supply is high and prefer not to issue bank debt when bank loan supply is low. However, a limitation of this result is that the demand for debt among bank dependent firms is not observable. Therefore, it is not clear whether firms do not issue bank loans simply because they have no demand for debt or because they are completely rationed out of the credit markets when bank loan supply is low. Overall, the results in chapter 3 show that the loan to bond substitution measure is a simple, intuitive and practical proxy for bank loan supply over the business cycle that is free of credit demand effects.

In chapter 4, the loan to bond substitution measure is employed as a proxy for changes in bank loan supply in order to predict the debt issuance and investment behaviour of constrained non-financial firms. The results reveal that fluctuations in bank loan supply have heterogeneous effects on the business fixed investment and inventory investment decisions of bank dependent firms relative to financially unconstrained firms. Furthermore, the hiring behaviour of UK non-financial firms is also strongly correlated with fluctuations in bank loan supply. Adverse changes in bank loan supply are associated with a decline in employment, while positive increases in bank loan supply are associated with an increase in employment among constrained bank dependent firms. These findings confirm the existence of a bank lending channel of monetary policy in the UK which operates through the investment and hiring decisions of constrained, bank dependent firms, and the fixed investment behaviour of unconstrained firms, whose investment decisions tend to correlate with bank loan supply. However, adverse changes in credit supply do not seem to have significant effects on the net debt issuance and net leverage decisions of financially constrained firms. The findings in chapter 4 reinforce the claim that credit supply has important real effects which affect the business cycle, and that adverse economic shocks to bank lending may translate into amplified declines in employment and investment if left unmitigated.

Chapter 5 examines the impact of quantitative easing policies on the corporate bond and bank loan issuance behaviour of UK non-financial firms, as well as establishing counterfactuals for corporate bond and bank loan issuance during the QE period in the UK. The objective of this chapter is to assess the impact of the QE policies adopted by the Bank of England on aggregate debt issuance. In this chapter two structural modelling techniques

are employed in to identify the impact of QE shocks. First, we estimate a structural vector error correction model (SVECM) that we identify by imposing long run structural restrictions in order to account for permanent and transitory shocks in the data series, and to obtain the point estimates necessary for us to establish counterfactuals. Second, we augment our SVECM results identified through long run restrictions with another SVECM model identified using sign restriction.

Chapter 5 reveals that QE policies result in an increase in corporate bond issuance for a period of up to 14 quarters following the initial shock. This finding suggests that the portfolio rebalance channels of QE policy transmission are operating, and result in an increase in primary market issuance of corporate bonds. This increase in corporate bond issuance following a QE policy shock is consistent with the findings of Haldane et al. (2016), Kaya and Wang (2014), and parallels the results of Duca (2013) who finds that quantitative easing policies prevent a sharp fall in US commercial paper issuance. However, the results also show that QE policies have no effect on bank loan issuance. This is consistent with the claim in Borio and Disyatat (2010) that QE does not result in an increase in the money multiplier. The weak effects of QE policies on bank lending in this chapter are also consistent with the findings of Joyce and Spaltro (2014) and suggests that the Bank of England may have been justified in launching the funding for lending scheme (FLS) in order to stimulate bank lending.

Results in Chapter 5 also show that at the aggregate level, adverse credit supply shocks depress both corporate bond and bank loan issuance. However, corporate bond issuance tends to respond to credit supply shocks with a lag. Issuance in corporate bond markets only begins to decline 4 quarters after bank loan issuance responds to the initial credit supply shock. However, the impact of a credit supply shock on the corporate bond markets is temporary, and last for a maximum of 15 quarters after the initial shock. We also find that there seems to be a uni-directional causal relationship between primary market activities in the bank loan market and the corporate bond market, flowing from banks to corporate bond markets. This results seems to suggest that at an aggregate level, bond markets tend to complement bank loan markets and that adverse credit supply shocks that affects the bank loan market may easily be amplified through a decline in corporate bonds. This result is inconsistent with the countercyclical behaviour of bond issuance reported in Contessi, Li and Russ (2013).

We also find that although positive credit demand shocks tend to increase corporate bond and bank loan issuance in the first two quarters of the shock, credit demand shocks have no lasting effects on either corporate bond issuance or bank loan issuance. We conjecture this is because an increase in credit demand is somewhat offset by an increase in the policy rate which tends to depress corporate bond issuance. The results reveal that a one standard deviation increase in the policy rate results in a permanent decline in corporate bond issuance in the long run. However, in the immediate 3 quarters following an unexpected policy rate increase, bank loan issuance continues to increase, possibly reflecting an increase in draw downs on pre-committed lines of credit.

Our counterfactual results reveal that QE polices avert a decline in corporate bond issuance of between 3% and 10% over the QE period. This finding is consistent with the results of Duca (2013) on the US commercial paper market. This implies that the Bank of England was successful in helping non-financial firm raise capital in the corporate bonds market.

Furthermore, results from historical decomposition for the corporate bonds series reveals that QE shocks and monetary policy related shocks have a significant role in corporate bond issuance during the period 2008 to 2012, while credit supply shocks and bond market specific shocks play the dominant role in the period following QE.

6.1 Limitations of the study and suggested directions for future research

There are several limitations to this study. In our micro level analysis, we categorise debt into two broad categories namely corporate bonds and bank loans. Non intermediated market finance is broadly classified as corporate bonds while intermediated finance is classified as bank loans. We then examine the impact of credit supply on the propensity to issue bank loans relative to corporate bonds and exploit the substitutability between these two debt components to extract a measure for bank loan supply. However, some debt components, although issued in the market, may closely resemble relationship finance rather than market finance. Since this debt heterogeneity is missed, our bank to bond substitution measure for bank loan supply may not cleanly capture the bank loan supply variations.

One weakness of the results we present in Chapter 4 is that we do not control for effects of different reporting periods for the firms in our sample. The firms that are included in the sample have different year ends and thus different fiscal reporting period. As a result, there is no guarantee that the recorded fixed and inventory investments, as well as the hiring and

financing decisions for a given financial year were obtained under the same macroeconomic conditions.

A challenge that remains, and one for which we do not have an immediate resolution, is that the UK implements QE at a time when the US QE is already in operation. As a result, our variables may capture the indirect spill over effects of US QE programs. We believe that since the UK QE is in response to conditions in the UK markets and is not influenced by changes in the US economy, these spill over effects of US QE may not matter much for UK debt issuance. However, we recognise that financial markets are somewhat integrated in developed markets, and that capital flows are mobile and move freely between countries. As a result, bond issuance in the UK may be influenced by external factors that may temporarily make issuance in one country attractive.[50] Thus, our findings represent a conservative estimate of the impact of UK QE on debt issuance.

Another caveat for our results in Chapter 5 is that other conventional and unconventional monetary policy innovations that affect the economy outside of the effects of these policies on the corporate bond market and the bank loan market are not identified. Furthermore, possible regime shifts or changes in structure have not been accounted for in the regressions. Possible techniques to alleviate these econometric challenges are to use time varying parameter vector autoregressive models and regime switching models in order to capture any possible changes in parameters due to structural shifts.

Further studies should examine the cross border effects of QE policies on debt issuance and asset prices, as well as the distributional effects of QE policies and the consequences of their subsequent reversal. Given that a number of central banks have started increasing interest rates and are indicating the possibility of quantitative tapering in the near future, it would be interesting to examine how such reversals of the central bank balance sheet portfolios will impact debt issuance and capital markets in general.

[50] Recently in a survey by the Bank of England (2016), the Bank found that recent pension reform and increased competition from the euro capital markets have seen a significant reduction in sterling denominated bond issuance in the UK. They highlight that issuance has also declined owing to a shrinkage of the investor base which has tended to make book building difficult and bond issuance expensive in the UK, leading to a number of large companies issuing their bonds externally. However, they acknowledge that domestic issuers with limited capacity to hedge foreign exchange risks, continue to issue in the domestic markets. This demonstrates the fluidity of capital flows in the Eurozone.

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Appendix A

Addendum to Chapter 5

Lag length criteria

Table 21: Lag length selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: RBONDS RLOANS RFTSE UKBASER TERMSPR
Exogenous variables: C
Date: 04/17/17 Time: 22:03
Sample: 1975Q3 2015Q1
Included observations: 147

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-628.2311	NA	0.003795	8.615390	8.717105	8.656718
1	532.6832	2227.060	7.37e-10	-6.839227	**-6.228934***	-6.591258
2	580.2482	88.01148	**5.43e-10***	**-7.146234***	-6.027365	**-6.691625***
3	599.2538	33.87400	5.91e-10	-7.064678	-5.437232	-6.403429
4	618.6043	33.17218	6.41e-10	-6.987813	-4.851790	-6.119924
5	641.9036	38.35663	6.62e-10	-6.964674	-4.320074	-5.890144
6	659.5437	27.84029	7.42e-10	-6.864541	-3.711363	-5.583371
7	685.0666	38.54476	7.51e-10	-6.871655	-3.209901	-5.383844
8	694.3820	13.43441	9.53e-10	-6.658258	-2.487927	-4.963808

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The information criteria results of lag length selection tests generate conflicting results and indicate that between 1 and 2 lags are needs to expunge any serial correlation in the residuals of our VAR model. We select a lag length of 2 based on the Akaike and the Hannan and Quinn Information criteria.

Cointegration tests results

Table 22: Johansen and Jesilius cointegration test results –full sample

Sample (adjusted): 1976Q2 2015Q1
Included observations: 156 after adjustments
Trend assumption: Linear deterministic trend
Series: RBONDS RLOANS RFTSE UKBASER TERMSPR
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	**0.205587**	**74.67361**	**69.81889**	**0.0194**
At most 1	0.110642	38.76995	47.85613	0.2695
At most 2	0.084900	20.47812	29.79707	0.3910
At most 3	0.026701	6.637456	15.49471	0.6201
At most 4	0.015365	2.415558	3.841466	0.1201

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	**0.205587**	**35.90367**	**33.87687**	**0.0283**
At most 1	0.110642	18.29182	27.58434	0.4710
At most 2	0.084900	13.84067	21.13162	0.3783
At most 3	0.026701	4.221898	14.26460	0.8352
At most 4	0.015365	2.415558	3.841466	0.1201

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Both the trace and the maximum eigenvalue statistics indicate the presence of one cointegrating vector between the variables. The results for the cointegration tests remain the same even when we change the number of lags from 2 to 1.

Table 23: Johansen's cointegration tests for the sample 1976Q2-2007Q1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.209873	73.17352	69.81889	0.0263
At most 1	0.151795	43.25715	47.85613	0.1264
At most 2	0.082513	22.34878	29.79707	0.2795
At most 3	0.054038	11.41198	15.49471	0.1874

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.209873	29.91637	33.87687	0.1382
At most 1	0.151795	20.90837	27.58434	0.2818
At most 2	0.082513	10.93680	21.13162	0.6536
At most 3	0.054038	7.055174	14.26460	0.4826

Appendix B

Cointegration tests: 3 variable system

Table 24: Cointegration tests 3 variable system

Date: 04/17/17 Time: 22:14
Sample (adjusted): 1976Q2 2007Q1
Included observations: 124 after adjustments
Trend assumption: No deterministic trend
Series: RBONDS RLOANS RFTSE
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.153959	27.41494	24.27596	0.0195
At most 1	0.052126	6.683676	12.32090	0.3578
At most 2	0.000367	0.045524	4.129906	0.8613

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.153959	20.73127	17.79730	0.0176
At most 1	0.052126	6.638152	11.22480	0.2827
At most 2	0.000367	0.045524	4.129906	0.8613

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

There exists a single cointegration relation between real bonds, real loans and real equity prices and the relationship is given in the equation below. The appropriate lag length is set at 2 lags using the AIC, HQ and SBC information criterion.

Table 25: Three variable Cointegration system

Cointegrating Eq:	CointEq1		
RLOANS(-1)	1.000000		
RFTSE(-1)	0.848065 (0.35497) [2.38915]		
RBONDS(-1)	-1.021562 (0.17005) [-6.00728]		
C	-10.56764 (0.95095) [-11.1128]		
Error Correction Terms:	**D(RLOANS)**	**D(RFTSE)**	**D(RBONDS)**
CointEq1	0.013453 (0.00321) [4.18482]	0.022065 (0.02476) [0.89114]	0.066647 (0.01660) [4.01402]
Diagnostics			
Serial correlation LM test		13.585 (0.1379)	
Heteroskedasticity- no cross terms (Chi-sq)		91.753 (0.2638)	
Jacque-Bera [df] (prob)		1282.58 [6] (0.0000)	

Consistent with our earlier results there exists a positive relationship between real corporate bond issuance and real bank loan issuance and a negative relationship between real equity prices and real corporate bond issuance in the long run. These result imply that there exist a complementary relationship in the long runs where adverse changes in the bank loans are amplified by an adverse movement of corporate bond issuances in the same direction as the loan issues. The diagnostic tests reveal that there is no serial correlation nor heteroskedasticity in the estimated equations. Furthermore, the characteristic roots of the VECM system lie within the unit circle and thus the system is stable.

The cointegrating vector in Table 24 reveals that β_2' is non-singular and thus the SVECM can be converted into an SVAR model and the structural parameters of the SVECM can be estimated using long run assumptions and instrumental variables techniques. Moreover, structural shocks can be separated into permanent and transitory shocks. This implies that the there are two permanent shocks and three transitory shocks in the SVECM system. The permanent shocks are associated with I(1) variables namely, real corporate bond issues and real bank loan issues. The empirical model formulation and the structure of the empirical equations are presented in the next section.

Structural estimation with 3 variable cointegration system

Structural estimation for the SVECM system with 3 variable cointegrating relationship. The VECM model estimated in this section caries two permanent shocks and 3 transitory shocks. We assume that credit demand shocks are transitory. The stationary variables in the system carry transitory shocks.

The cointegration model estimated is $\xi_t = l_t + f_t + b_t$. The results of the cointegration model are presented in Table 24 above.

The variables s_t, r_t and $\Delta\xi_t$ are stationary and therefore carry transitory effects. Identification of the structural shocks is done through imposing long run restriction of the VECM system.

$$\Delta b_t = \alpha_{1,2}^0 \Delta l_t + \alpha_{1,3}^0 s_t + \alpha_{1,4}^0 r_t + \alpha_{1,5}^0 \Delta\xi_t + \alpha_{1,1}^1 \Delta b_{t-1} + \alpha_{1,2}^1 \Delta l_{t-1} + \alpha_{1,3}^1 s_{t-1} + \alpha_{1,4}^1 r_{t-1} + \alpha_{1,5}^1 \Delta\xi_{t-1} + \epsilon_{bt} \quad \dots (1)$$

$$\Delta l_t = \alpha_{2,1}^0 \Delta b_t + \alpha_{2,3}^0 s_t + \alpha_{2,4}^0 r_t + \alpha_{2,5}^0 \Delta\xi_t + \alpha_{2,1}^1 \Delta b_{t-1} + \alpha_{2,2}^1 \Delta l_{t-1} + \alpha_{2,3}^1 s_{t-1} + \alpha_{2,4}^1 r_{t-1} + \alpha_{2,5}^1 \Delta\xi_{t-1} + \epsilon_{lt} \quad \dots (2)$$

$$s_t = \alpha_{3,1}^0 \Delta b_t + \alpha_{3,2}^0 \Delta l_t + \alpha_{3,4}^0 r_t + \alpha_{3,5}^0 \Delta\xi_t + \alpha_{3,1}^1 \Delta b_{t-1} + \alpha_{3,2}^1 \Delta l_{t-1} + \alpha_{3,3}^1 s_{t-1} + \alpha_{3,4}^1 r_{t-1} + \alpha_{3,5}^1 \Delta\xi_{t-1} + \epsilon_{st} \quad \dots (3)$$

$$r_t = \alpha_{4,1}^0 \Delta b_t + \alpha_{4,2}^0 \Delta l_t + \alpha_{4,3}^0 s_t + \alpha_{4,5}^0 \Delta\xi_t + \alpha_{4,1}^1 \Delta b_{t-1} + \alpha_{4,2}^1 \Delta l_{t-1} + \alpha_{4,3}^1 s_{t-1} + \alpha_{4,4}^1 r_{t-1} + \alpha_{4,5}^1 \Delta\xi_{t-1} + \epsilon_{rt} \quad \dots (4)$$

$$\Delta\xi_t = \alpha_{5,1}^0 \Delta b_t + \alpha_{5,2}^0 \Delta l_t + \alpha_{5,3}^0 s_t + \alpha_{5,4}^0 r_t + \alpha_{5,1}^1 \Delta b_{t-1} + \alpha_{5,2}^1 \Delta l_{t-1} + \alpha_{5,3}^1 s_{t-1} + \alpha_{5,4}^1 r_{t-1} + \alpha_{5,5}^1 \Delta\xi_{t-1} + \epsilon_{ft} \quad \dots (5)$$

Only the corporate bonds and bank loan time series carry permanent shocks

$$\alpha_{1,3}^0 + \alpha_{1,3}^1 = 0$$

$$\alpha_{1,4}^0 + \alpha_{1,4}^1 = 0$$

$$\Delta b_t = \alpha_{1,2}^0 \Delta l_t + \alpha_{1,3}^0 \Delta s_t + \alpha_{1,4}^0 \Delta r_t + \alpha_{1,5}^0 \Delta\xi_t + \alpha_{1,1}^1 \Delta b_{t-1} + \alpha_{1,2}^1 \Delta l_{t-1} + \alpha_{1,5}^1 \Delta\xi_{t-1} + \epsilon_{bt} \quad \dots (6)$$

$l_{t-1}, \xi_{t-1}, r_{t-1}$ and s_{t-1} are available to use as instruments. Since equations 1 and 2 are permanent equations, the lagged residuals are available to be used as instruments.

$$\Delta l_t = \alpha_{2,1}^0 \widehat{\epsilon_{b_t}} + \alpha_{2,3}^0 \Delta s_t + \alpha_{2,4}^0 \Delta r_t + \alpha_{2,5}^0 \Delta\xi_t + \alpha_{2,1}^1 \Delta b_{t-1} + \alpha_{2,2}^1 \Delta l_{t-1} + \alpha_{2,5}^1 \Delta\xi_{t-1} + \epsilon_{lt} \quad \dots (7)$$

Only one instrument is required for estimation of equation 7. We employ the residuals from equation 1 $\widehat{\epsilon_{b}}_t$ as an instrument for Δb_t

$$\Delta\xi_t = \alpha^0_{5,1}\widehat{\epsilon_{b}}_t + \alpha^0_{5,2}\widehat{\epsilon_{l}}_t + \alpha^0_{5,3}\Delta s_t + \alpha^0_{5,4}\Delta r_t + \alpha^1_{5,1}\Delta b_{t-1} + \alpha^1_{5,2}\Delta l_{t-1} + \alpha^1_{5,5}\Delta\xi_{t-1} + \epsilon_{ft}$$

… (8)

$\Delta\xi_{t-1}$, r_{t-1}, s_{t-1} are available to use as instruments in the estimation of the structural parameters.

$$\alpha^0_{3,5} + \alpha^1_{3,5} = 0$$

$$s_t = \alpha^0_{3,1}\widehat{\epsilon_{b}}_t + \alpha^0_{3,2}\widehat{\epsilon_{l}}_t + \alpha^0_{3,4}\Delta r_t + \alpha^0_{3,5}\Delta^2\xi_t + \alpha^1_{3,1}\Delta b_{t-1} + \alpha^1_{3,2}\Delta l_{t-1} + \epsilon_{st} \quad \text{… (9)}$$

$$\alpha^0_{4,5} + \alpha^1_{4,5} = 0$$

$$r_t = \alpha^0_{4,1}\widehat{\epsilon_{b}}_t + \alpha^0_{4,2}\widehat{\epsilon_{l}}_t + \alpha^0_{4,3}\Delta s_t + \alpha^0_{4,5}\Delta^2\xi_t + \alpha^1_{4,1}\Delta b_{t-1} + \alpha^1_{4,2}\Delta l_{t-1} + \epsilon_{rt} \quad \text{… (10)}$$

Equations are estimated using instrumental variables techniques.

Selected Impulse Responses from the three variable cointegration system.

Figure 16: Accumulated responses to QE shocks (3 variable cointegration system)

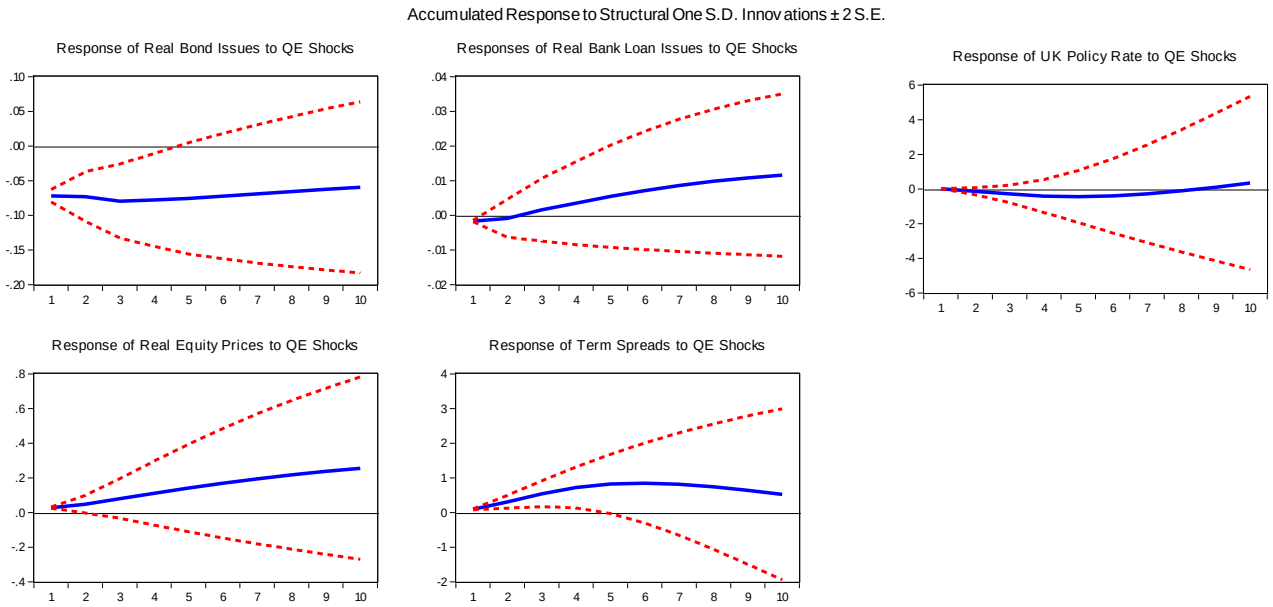


Figure 17: Accumulated impulse responses to a credit demand shock (3 variable cointegration system).

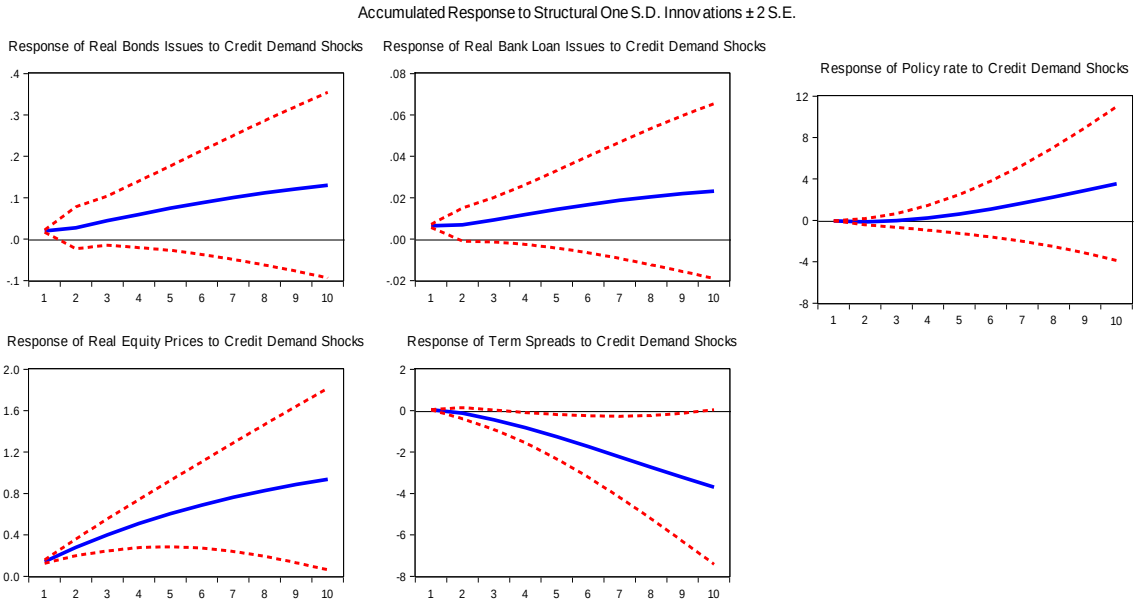
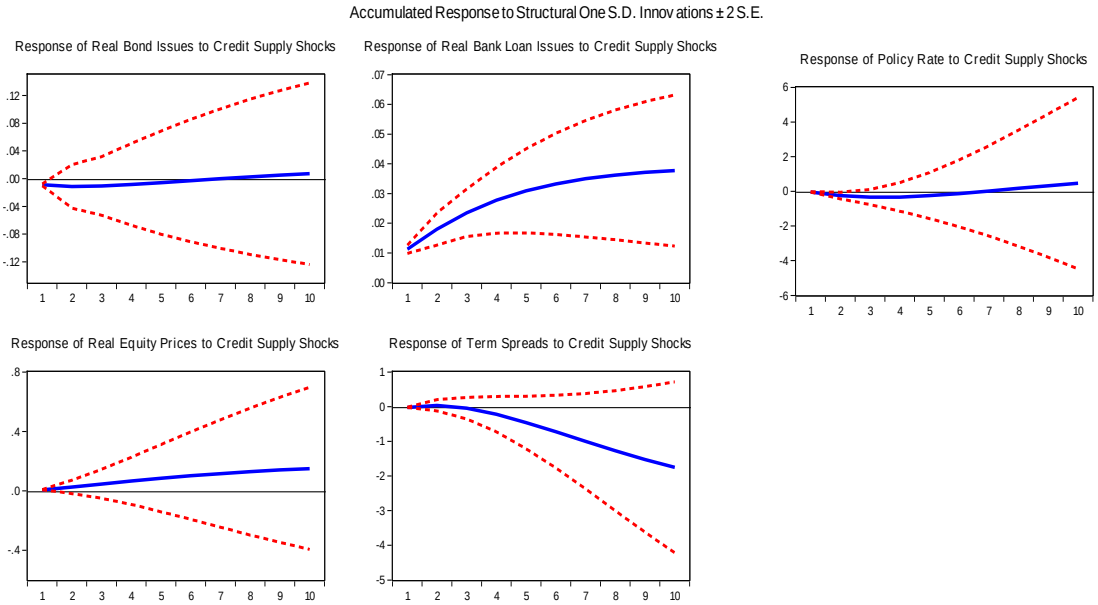


Figure 18: Responses to Credit Supply Shocks



The results for the 3 variable cointegration system are qualitatively similar to those of the 5 variable system presented in the main text. However, there are slight differences relating to the magnitudes and the duration of QE effects in the 3 variable cointegration system and the 5 variable cointegration system.

Appendix C

Relationship between the long term yields and the base rate

We estimate a cointegration relationship between the UK base rate and the 10 year government bond yields in order to examine whether spread compression can be driven by autonomous increases in the base rate. The appropriate lag length for the model is set at 2 using the SBC and the AIC information criterion. The Johansen cointegration results reveal that there exist a cointegrating relationship between the two variables. We therefore estimate an error correction model for the two interest rates.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.104691	18.09533	15.49471	0.0198
At most 1	0.003215	0.512013	3.841466	0.4743

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.104691	17.58332	14.26460	0.0144
At most 1	0.003215	0.512013	3.841466	0.4743

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The cointegration model and the error correction model for the base rate is given as:

Table 26: Cointegrating relationship between base rate and long term yields

Cointegrating Eq:	CointEq1	
UKBASER(-1)	1.000000	
UK10YSPOT(-1)	-1.103548 (0.11909) [-9.26632]	
C	1.270497	
Error Correction:	**D(UKBASER)**	**D(UK10YSPOT)**
CointEq1	-0.139355 (0.04293) [-3.24610]	0.017306 (0.02956) [0.58547]

There is a positive relationship between the long term corporate bond yield and the policy rate such that an increase by 1 basis point in the policy rate will result in a 1.104% increase in the long term gilts. The results reveal that 13.94% of any deviation in the base rate from its long-run level is cleared in the first quarter. This implies that it is unlikely that the spread compression results from an increase in short term rates that is not associated with any increase in the long term government bond yields. Thus our spread compression shock reflects the impact of quantitative easing policies when the policy rates are constrained at the zero lower bound.

Appendix D: Diagnostic results for the Cointegrating relationships (Real Variables)

Figure 19: Inverse characteristic roots for VECM model

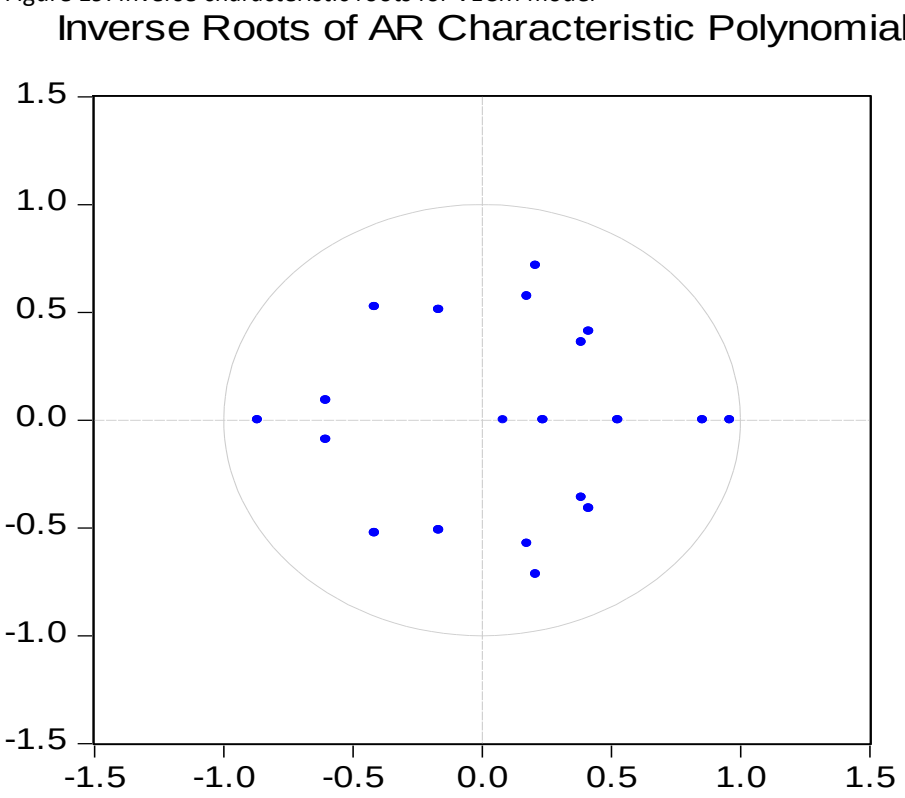


Figure 20: Cointegrating relationship (real variables)
Errors from the co-integration relation normalised on real corporate bond issues outstanding. The relation shows a tendency to gravitate towards the zero line (equilibrium) over time.

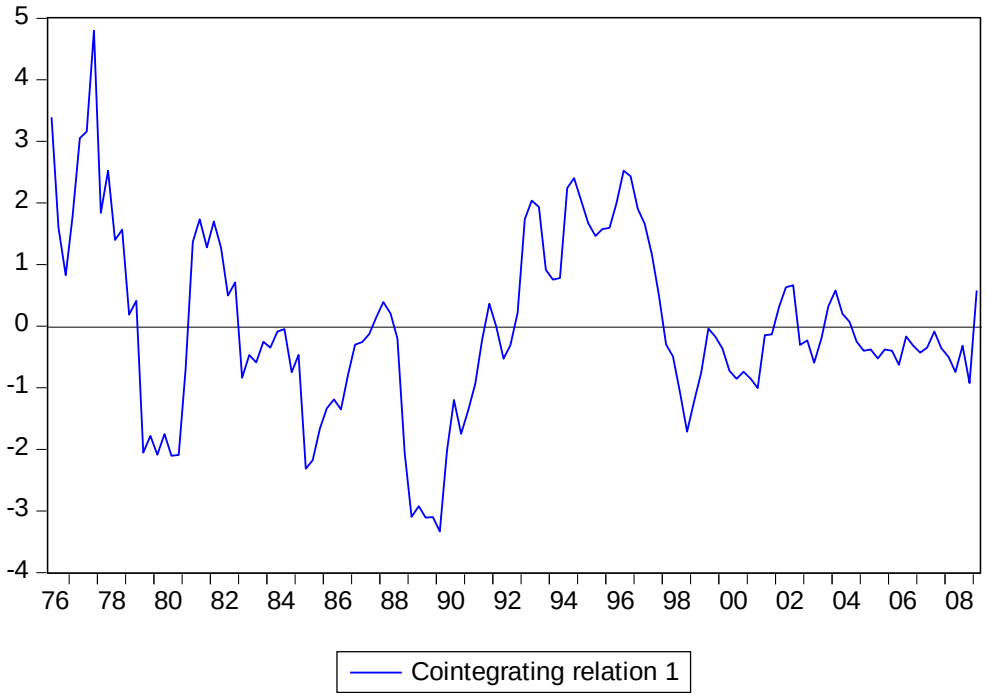
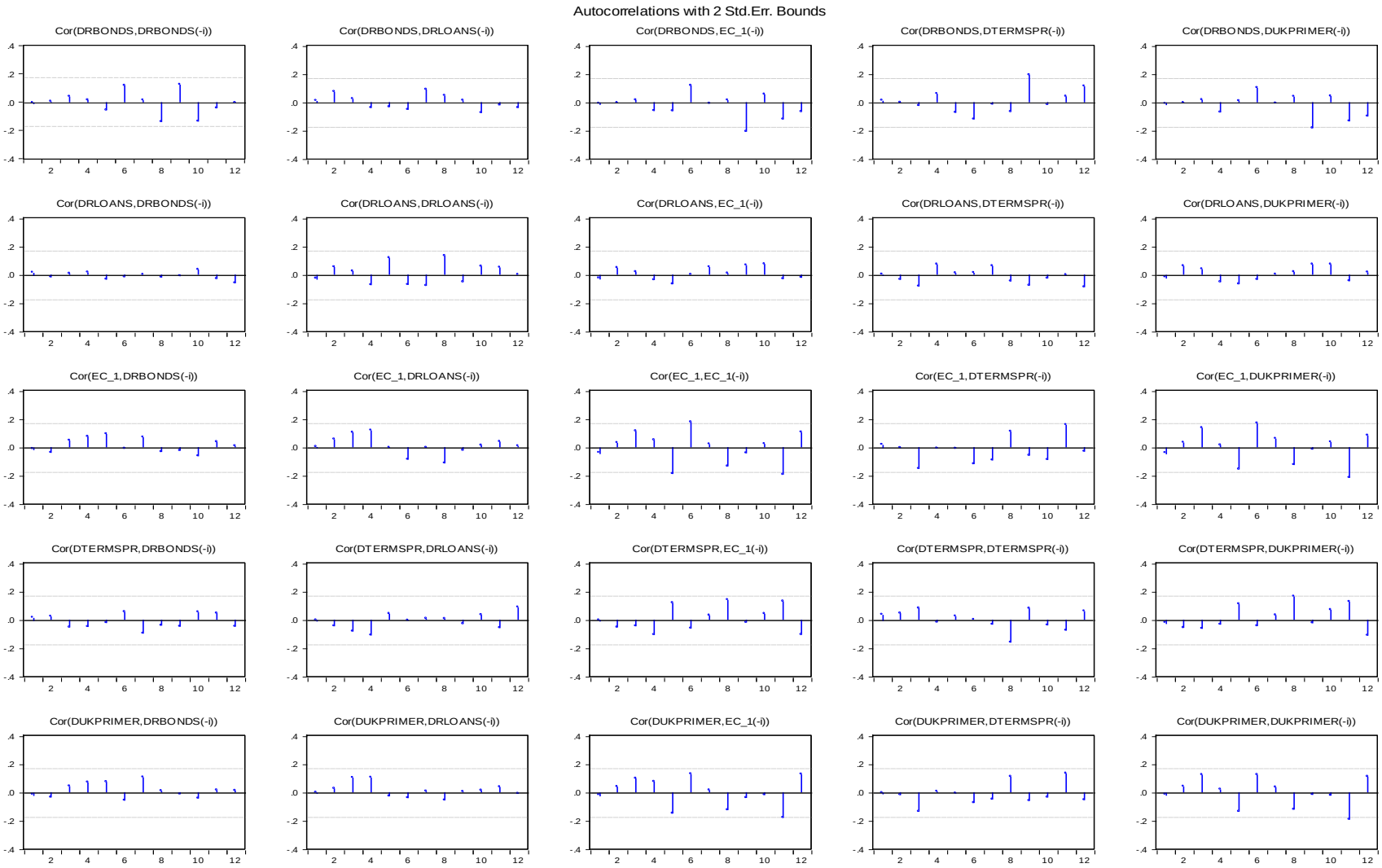


Figure 21: Correlogram of Residuals SVECM



Appendix E

Figure 22: Cusum of Squared residuals for corporate bonds equation

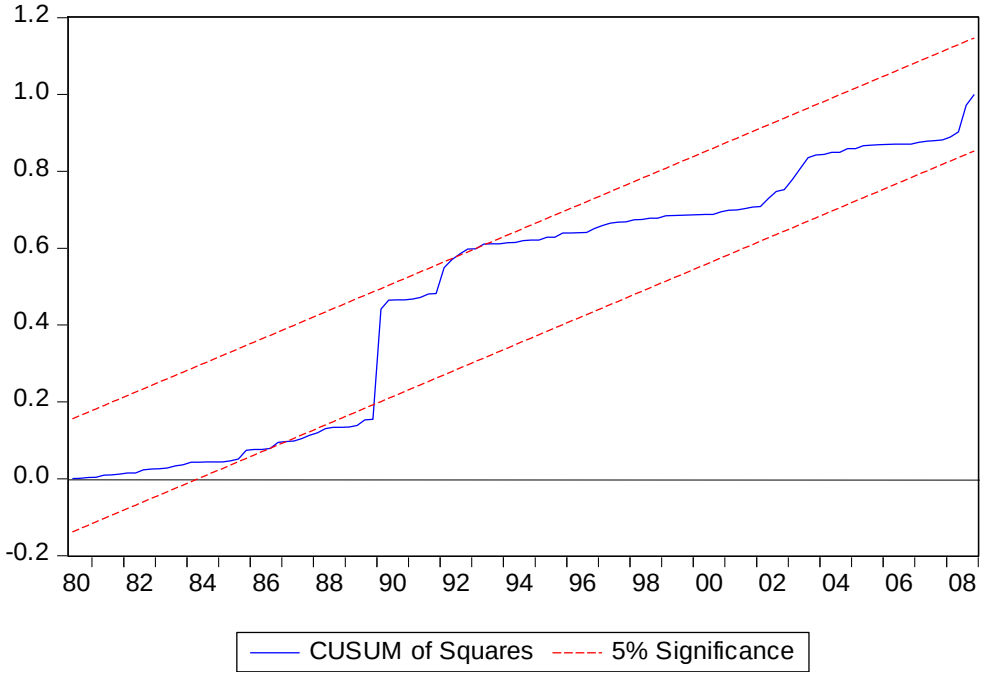
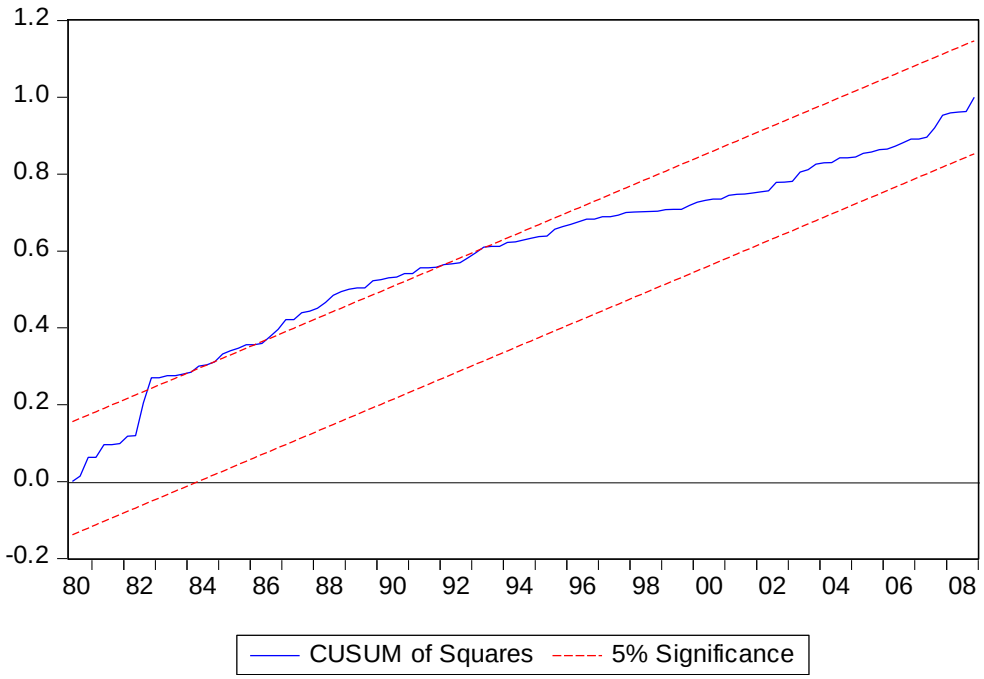


Figure 23: Cusum of squared residuals for loans



Appendix E: Summary statistics

Table 27: Summary of Macroeconomic and Bank of England survey data
The table presents the summary statistics for the macroeconomic variables for the period 1994 to 2013 and the Bank of England credit conditions variables for the period 2007Q1 to 2013. The credit conditions variables are scaled to lie between -100 and 100.

	Min	Mean	Max
Time series variables			
Macroeconomic variables	**Min**	**Mean**	**Max**
Libor	0.51	3.67	7.66
Base rate	0.5	3.46	7.5
Libor base rate spread	-1.29	0.17	0.99
FTSE	1521.44	2631.68	3609.63
Credit conditions survey			
Credit conditions (Actual)	-51.8	0.74	29.4
Credit conditions (Expected)	-49.3	3.12	28.9
Risk appetite (Actual)	-43	-3.07	16.7
Risk appetite (Expected)	-36.1	-2.31	16
Tightening conditions(Actual)	-59	-7	11.4
Tightening conditions (Expected)	-51.1	-5.93	21.5
Economic conditions (Actual)	-53	-4.87	32.5
Economic conditions (Expected)	-48.4	-3.57	38.5
Sector risks (Actual)	-49.8	-6.69	18.9
Sector risks (Expected)	-45.5	5.59	23.9
Market pressure (Actual)	-38.2	1.68	25.1
Market pressure (Expected)	-50.1	0.44	21.2