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Essays on the Bank Lending Channel

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Appendix A

Chapter 1: Introduction

The bank lending channel is one of the many channels through which monetary policy makers transmit their decisions to the economy. This channel operates through loan supply and its existence reflects asymmetric information in credit markets. However, not much attention was paid on the specific channel; by contrast, money view prevailed, since, according to monetarists, only two assets exist in an economy: money and all the other assets – with the latter assumed to be perfect substitutes for each other. This concept, however, changed throughout the years, since the significant role of banks became more obvious, especially due to information asymmetry that exists between lenders (and particularly banks) and borrowers, in conjunction with the fact that non-monetary assets have no perfect substitutes.

This view – credit view – emphasizes the fact that monetary policy affects economy not only through interest rates, but also through other asset prices, which prove to be useful in many applications, supporting the specific view (Mishkin, 1996). Nevertheless, the last few decades – that is, prior to recent crisis – literature overlooked the role of banks as financial intermediaries and hence the bank lending channel had been undermined, mainly due to financial system developments.

The purpose of this thesis is to investigate the operation of the bank lending channel and specifically, how it is affected by the following three distinct issues: First, it examines whether bank system efficiency alters the way monetary policy decisions are transmitted through lending channel. The largest part of literature explores the impact that quantitative characteristics have on the operation of the specific channel, whereas the impact of qualitative ones – such as efficiency – has widely remained unexplored, especially in the case of European banks. Second, it employs the endogenously determined target interest rate emanating from the central bank's monetary policy rule and examines the impact it has on the operation of the bank lending channel. To the best of my knowledge, this approach is novel. Finally, it explores whether disturbances in the financial intermediation – such as those of recent crisis, and specifically, disruptions in the supply of intermediated credit – affect bank lending and therefore, whether they should be taken into account for the investigation of the lending channel. Very few efforts have been made to examine the role of frictions in the lending channel and the impact they have on the response of banks to a monetary policy contraction.

The first paper (Chapter 3) investigates whether lending differentials depend on a qualitative bank-specific characteristic, that is, bank efficiency, which measures the performance of a bank relative to a best-practice bank that faces the same exogenous conditions. Therefore, by allowing the ranking of banks, it recognizes the best and worst practices. Literature distinguishes among three main types of efficiency: productive, cost and profit. This paper examines profit efficiency, which is assumed to be the most complete method – of the three aforementioned – since its objective is to simultaneously minimize production cost and maximize revenues. Specifically, profit efficiency measures the ability of a bank to maximize its profits under certain conditions.

Previous literature analyzed the relationship between bank efficiency and economic growth and showed that a sound financial system fosters growth and vice versa (King and Levine, 1993; Lucchetti et al., 2001; Koetter and Wedow, 2010). Specifically, banks, by recognizing the most innovative entrepreneurs, reallocate their real and financial resources in the most productive way and hence affect economic growth. Although, efficiency is considered an asset for banks, previous studies have not paid much attention on bank quality. On the contrary, they use only quantitative variables, such as capitalization, size, or liquidity, to analyze the relationship between financial development and economic growth, whereas the link between bank efficiency and the lending channel has largely remained undiscovered.

This paper combines these two strands of literature and investigates whether loan supply differs between efficient and less efficient banks. Particularly, it estimates profit efficiency of the banking systems in six European countries over the period 1994 to 2008. This qualitative variable is then incorporated as a bank-specific characteristic into the lending channel model. The empirical findings indicate that the lending channel becomes stronger when banks are less efficient and therefore they are more affected by monetary authorities' decisions. By contrast, more efficient banks are capable of offsetting negative shocks, since they are able to manage their assets and profits in the most efficient and productive way and therefore ensure their liquidity and/or capital.

The second paper (Chapter 4) examines the effects on the operation of the bank lending channel, when different measures of the central banks' primary monetary policy instruments are employed – with the instruments depending on a set of macroeconomic variables. This paper specifies three different types of interest rate rules that depend on timing issues, that is, lagged, current and forecast values to inform the policy rule. Then it considers the bank lending channel for a group of European countries using the alternative monetary policy indicators and compares the results across different policy rules. The empirical findings indicate that the bank lending channel operates most robustly to forward-looking policy rules.

A wide strand of literature has focused on monetary policy rules – or alternatively reaction functions – that describe how central banks alter their policy in response to macroeconomic changes. These interest rate rules are used as a guiding principle for monetary authorities – to attain the fundamental policy objectives. Taylor (1993) was the first to show that the monetary policy in the U.S. conforms to a contemporaneous interest rate rule. Although, the Taylor rule managed to interpret the policy actions of the Federal Reserve at a certain historical period, it presented specific limitations, such as the exclusion from the rule of interest rate smoothing (Levin et al., 1999; Woodford, 1999; Orphanides, 2001; Rudenbusch, 2002; Gerdersmeier and Roffia, 2003) or the issue of availability and timing of the data (Clarida et. al, 1998, 2000; Greenspan, 1999; Taylor, 1999; Meyer, 2002; Orphanides, 2003).

The empirical findings of the second paper indicate that the bank lending channel exists in all cases; however, it exerts a stronger effect when target rates are used as indicators rather than the observed central bank interest rate. This suggests that central banks use target interest rate as the monetary policy indicator and specifically, those emanated by forward-looking rules, since the strongest effects are observed when the lending channel model employs the forward-looking rules. The latter, by incorporating inflationary expectations seem to affect the decisions for the target rate and therefore, monetary policy guides the private sector's (banks') expectations. Consequently, monetary policy becomes more effective, since banks alter their lending behavior according to the rules. Furthermore, this paper, by examining whether lending differentials depend on the strength of a bank, indicates that large and well-capitalized banks are better able to absorb monetary shocks. This finding is more robust, when the bank lending channel uses target rates derived from interest rate rules and especially from the forward-looking rule.

The third paper (Chapter 5) investigates the impact that financial disturbances have on the operation of the bank lending channel. In previous decades, literature did not take into consideration disturbances in the economy, nor focused on credit market imperfections. However, recent crisis, in conjunction with the ongoing changes in the financial system impose alterations both in the way monetary policy works, and also on the role of banks as financial intermediaries. Many macroeconomists argue that traditional literature on the bank lending channel needs to be modified and take into account the financial developments and hence, the alterations they caused to the operation of the banks and their balance sheet strength (Altunbas et al., 2009; Gambacorta and Marques-Ibanez, 2011). Furthermore, until recently, the efficiency or even the existence of the bank lending channel was severely questioned, whereas the role of banks as financial intermediaries was met with skepticism.

Nevertheless, recent crisis reveals the weakness of traditional macroeconomic models – which macroeconomists use to explain an economy's behavior – and imposes the need to reformulate them. These models assume frictionless financial markets, and therefore use a single interest rate. However, in real economies there exist more than a single interest rates, which are different from each other and hence, the difference between them and particularly the variation in this difference, is an indicator of financial conditions (Cúrdia and Woodford, 2008; Woodford, 2010). This paper, following Woodford (2010), allows credit frictions to be integrated into the bank lending channel analysis, using interest rate spread as proxy for the frictions that can impede an efficient supply of credit. The bank lending theory, therefore, captures the changes of loan supply that cannot be justified only by the mere shift in monetary policy, but also by disturbances that take place in the economy. Hence, the operation of the bank lending channel becomes more clear and easier to explain.

Specifically, the analysis of this paper compares the impact that a monetary policy change has on bank lending, initially, in a model that does not incorporate frictions and then in a model that includes them. The empirical results indicate that the bank lending channel exists in all cases; however, it becomes obvious that the change in loans is also affected by frictions. The necessity of including a proxy for frictions in the lending channel model proves more significant in periods of financial distress, identifying this way additional variables – besides monetary policy indicator – that affect loan supply and justify the magnitude of the change, since during boom periods, this proxy tends to eliminate.

Chapter 2: Literature Review

2.1. Monetary Policy

Monetary policy constitutes a powerful tool and is the main topic of discussions on promoting growth and low inflation. The objective of monetary policy is the stabilization of output, inflation and the financial system in general. The monetary policy is implemented by monetary authorities, who must have an accurate estimation of the effects and timing of their decisions and be able to understand the mechanisms through which monetary policy affects the real economy to avoid negative or unexpected consequences (Mishkin, 1996).

The process through which monetary policy decisions are transmitted into the economy is termed the monetary transmission mechanism (Taylor, 1995). Through this mechanism, the monetary policy affects target variables such as income, price, exchange rates and unemployment. However, it is not always known how monetary policy can affect these variables and what changes should be made in order to have an impact on target variables. The transmission of monetary policy can be conducted through various channels, which differ from one another according to the field they focus on. For example, there are channels that emphasize money, others on credit, interest rates, exchange rates, or asset prices. A brief description of various channels is provided below.

2.1.1. The interest rate channel

The traditional view – of transmission channel – is referred as 'the money view' and is based on the notion that decline in quantity of outside money increase real rates of return (Cecchetti, 1995). Increased interest rates imply that fewer profitable projects are available and hence the level of investment is reduced. The channel supporting this view is the 'interest rate channel' and is the key monetary transmission mechanism in the Keynesian IS/LM model. This channel operates in the following manner: when monetary policy (*M*) is tightened, real interest rates (*i*) increase; this lowers investment (*I*) and hence aggregate demand and output (*Y*). The opposite occurs in the case of an expansionary monetary policy. Schematically, the interest rate channel can be characterized in the following manner:

$$M \uparrow\downarrow \Rightarrow i_r \downarrow\uparrow \Rightarrow I \uparrow\downarrow \Rightarrow Y \uparrow\downarrow$$

Initially, the term 'investment' was used to include only business investment decisions, but subsequently research recognized that the investment decisions of households and consumers should also be taken into consideration. With regard to the interest rate, it is crucial to mention that this channel uses the real and not the nominal one, and also that the long-term interest rate is more important than the short-term interest rate for the operation of this channel, since the former has greater impact on spending. As indicated by Taylor (1995), sticky prices are a key assumption, since in the case of an expansionary monetary policy, short-term nominal rates decrease as short-term real rates do, even in a world with rational expectations. Lower short-term interest rates lead to a decrease in the long-term interest rate, since the latter is assumed to be an average of the expected future short-term rates; consequently, business and housing investment increase, which leads to a rise in output.

In addition, Mishkin (1996) further shows the importance of the distinction between real and nominal interest rates by arguing that monetary policy can affect the economy even when nominal interest rates are at a 'floor of zero' – during an inflationary episode. In this case, an expansion of monetary policy raises the expected level of prices (P^e), and therefore expected inflation (π^e). This, in turn, lowers the real interest rate independently of the nominal one, which is at a ‘floor of zero’, thereby increasing investment and output. Schematically,

$$M \uparrow\downarrow \Rightarrow P^e \uparrow\downarrow \Rightarrow \pi^e \uparrow\downarrow \Rightarrow i_r \downarrow\uparrow \Rightarrow I \uparrow\downarrow \Rightarrow Y \uparrow\downarrow .$$

However, the interest rate channel is not the only one through which monetary policy can be transmitted to the real economy.

2.1.2. Asset Price Channels

Interest rate is not the sole asset price that may affect the economy through the monetary transmission mechanism. Foreign exchange and equity are the two other assets whose effects are critical for the transmission of monetary policy.

The exchange rate channel

This channel is of great importance, particularly after the internationalization of world economies that enables the monetary policy to operate through exchange rates with the involvement of interest rate effects. It is a channel that is often neglected in closed-economy models, but is vital in open-economy macroeconomic models (Kuttner *et al.*, 2002).

More analytically, a rise in domestic real interest rates leads to an increase in domestic deposits because these deposits become more attractive relative to foreign ones. Consequently, this leads to the appreciation of domestic currency, denoted by e, which in turn makes exports more expensive than imports, thereby leading to a decrease in net exports. This, in turn, lowers the income of the domestic economy. The exact opposite happens when the interest rate falls (Mishkin, 1995). Schematically,

$$M \downarrow\uparrow \Rightarrow i_r \uparrow\downarrow \Rightarrow e \uparrow\downarrow \Rightarrow NX \downarrow\uparrow \Rightarrow Y \downarrow\uparrow$$

Equity price channels

There have been objections to the viewpoint that there are only two ways through which monetary policy affects the economy: interest rates and exchange rates. Equity price channels operate through Tobin’s q theory and real wealth. According to Tobin’s q theory, the monetary policy affects the economy through equities. Tobin’s q equals the division of the market value of firms with the replacement cost of capital. If q is high, it implies that the market value of the firm is high relative to the replacement cost; therefore, new plant and equipment is cheap relative to the market value of firms, if they decide to issue new equity for which they obtain a high price relative to the new equipment they buy. Hence, investment is favoured because firms are able to buy large quantities of new plants and equipment with only a small amount of equity. On the contrary, when q is low, it becomes too expensive for the firm to buy new equipment because of the low market value, which leads to a decrease in investments. In these cases, it is cheaper for the firm to buy a smaller company and acquire old capital instead. Schematically,

$$M \uparrow\downarrow \Rightarrow P^e \uparrow\downarrow \Rightarrow q \uparrow\downarrow \Rightarrow I \uparrow\downarrow \Rightarrow Y \uparrow\downarrow ,$$

where P^e is the equity price.

The above schema is significant from both the monetarist and Keynesian viewpoints. As far as the former is regarded, when money supply rises, there is an increase in people’s wealth as well and they have more money to spend. One part of their excess liquidity is distributed to the stock market, thereby increasing the prices of stocks and hence the market value of firms. From the Keynesian viewpoint, the consequence of an increase in money supply is a fall in interest rates and, therefore, a rise in the prices of bonds, thereby making them less attractive than stocks. The increase in demand for stocks leads to higher prices, which in turn increase q. The results in investment and output are positive from both perspectives (Mishkin, 1996).

Wealth effects

This channel is also referred to as the wealth channel (Kuttner *et al*. 2002) since households' wealth is an important element of consumption spending. According to Modigliani (1971), households' wealth comprises human capital, real capital and financial wealth. Stocks represent a significant proportion of financial wealth, which implies that when stock prices rise, the value of wealth held by people rises as well, which allows them to spend more. The result is an increase in consumption and therefore in output.

$$M \uparrow\downarrow \Rightarrow P^e \uparrow\downarrow \Rightarrow wealth \uparrow\downarrow \Rightarrow consumption \uparrow\downarrow \Rightarrow Y \uparrow\downarrow .$$

The above discussion on Tobin's q theory and households' wealth can be categorized into *housing and land price channels*. According to Mishkin (1996), housing and land prices are an important element of people's wealth; therefore, whenever they are increased, wealth rises too and, consequently, consumption and output also increase.

With regard to Tobin's q, when housing prices rise, this stimulates their production, since housing is regarded as equity. This happens because an increase in housing prices relative to the replacement cost leads to an increase in Tobin's q, which has the abovementioned result.

2.1.3. Credit channels

Apart from the money view, there is another important viewpoint called the credit viewpoint, which claims that the existence of credit market imperfections necessitates banks and other financial institutions, a viewpoint referred to as 'lending' to indicate the importance of loans in the transmission mechanism (Cecchetti, 1995; Kashyap *et al*., 1994). These institutions comprise a channel through which monetary policy is able to affect the economy. The credit view refers to two channels: bank lending and balance sheet.

The bank lending channel

The existence of this channel is mainly due to the role that banks play in the financial system and the fact that there is asymmetric information in credit markets. More analytical reference to this channel will be made in subsequent sections of this essay. At this point, we provide a brief explanation of how this channel operates. In the case of an expansionary monetary policy, money supply increases and, consequently, there is an increase in deposits, which enables banks to give a greater number of loans. The increase in loans leads to a rise in investments and therefore in output. When monetary policy is tightened, the exact opposite results happen. The schema to represent this is given below (Mishkin, 1996):

$$M \uparrow\downarrow \Rightarrow \textit{bank reserves, bank deposits} \uparrow\downarrow \Rightarrow \textit{bank loans} \uparrow\downarrow \Rightarrow I \uparrow\downarrow \Rightarrow Y \uparrow\downarrow .$$

This channel is also referred as the narrow credit channel and is very important because many firms and households depend on bank financing. Therefore, as already mentioned, a decrease in bank loans will affect investment and consumption in a substantial manner (Kuttner *et al*., 2002).

The balance sheet channel

This channel is mostly based on the notion that monetary policy can affect the balance sheet of a firm – the borrower – and alter its net worth. Specifically, the balance sheet channel exists because monetary policy does not only affect the market interest rates, but also the financial situation of the borrowers both directly and indirectly.

A strict monetary policy may have negative consequences in two direct ways and the opposite happens in the case of an easing of the monetary policy: A rise in interest rates causes an increase in interest expenses that firms have to pay, which in turn leads to a decrease in cash flows. This causes the deterioration of the financial situation of firms. Apart from the previous implication of the increase in interest rates, another effect is a fall in asset prices, which lowers the value of the borrower's collateral. In addition, strict monetary conditions lead to a fall in consumption and this, in turn, indirectly affects the net worth and value of the collateral a firm offers in order to borrow. Consequently, the firm's revenues decline and this leads to further reduction in the firm's net worth and credit worthiness.

Lower net worth implies that firms that need to borrow offer collaterals with less value. Therefore, they are more exposed to problems that may arise from asymmetric information. More specifically, banks face the problem of adverse selection, which implies that most banks do not have the ability to recognize which firms are risky and which are not; therefore, banks charge all firms with higher interest rates in order to be protected from risk.

Apart from the adverse selection problem, moral hazard also exists under these circumstances; this implies that after borrowing, managers have a greater incentive to invest in projects with higher risk, which may increase their personal wealth but also increase the possibility that the firm may not be able to pay for the loan. Therefore, a decrease in the net worth of a firm induces the risk that the bank may not be able to recover the loan; consequently, there is a decrease in loan supply and hence in investment spending. The above results concern not only banks but also all financial institutions that lend to consumers and firms, since they are directly affected (Hernando and Pages, 2001; Horvath, Kreko and Naszodi, 2006).

Conclusively, from among all the channels discussed above, the following two are the main channels that are mostly surveyed in the literature: the interest rate channel and the bank lending channel. The first channel, which is strongly supported by monetarists, is regarding two types of assets: money and all other assets. According to this particular money theory, an increase in reserves leads to a rise in liquidity in the economy; consequently, there is a decrease in interest rates, which causes rational people to transfer this excess liquidity to securities that have higher returns, such as stocks and bonds.

The second channel can be regarded as part of a broader channel: the credit channel. In this case, monetary policy affects the level of economic activity, not only by causing a change in short-term interest rates, but also by altering the availability and supply of loans. This action has negative consequences for firms and consumers who do not have the ability to substitute the fall in the availability of bank loans with alternative sources of funds (Hernando and Pages, 2001).

The more 'traditional' channel – the interest rate channel – has been supported by many researchers such as Taylor (1995), who believe that its operation through the cost of capital is extremely important in the monetary transmission mechanism. On the contrary, a larger number of economists find that empirical evidence does not support the proposition that interest rate affects investments through the cost of capital. Chirinko (1993) concludes that the response of investment to price variables tends to be small and unimportant relative to quantity variables. ‘Macroeconometric models that have been developed are assumed to have large interest rate effects, but those who have used these models, do not find that small changes reduce these interest rate effects substantially’ (Mishkin, 1996). An additional problem of the traditional theory is that it is unclear how changes in the short term interest rates can create changes in investments that should depend on the real long term interest rates.

An important aspect of the credit view is that it emphasizes the methods in which monetary policy affects the economy not only through interest rates, but also through other asset prices. As Mishkin (1996) mentions, the best support for a theory is when it is found to be useful in many applications, which is what empirical research has proved for the credit view. The existence of the (broader) credit channel is very interesting and important for many reasons. First, whenever it operates, monetary policy is able to affect economy without much variation in the interest rate, second, understanding the operation of the credit channel, offers insights on how innovation in financial institutions might affect monetary policy. Furthermore, this channel explains the effects that monetary policy has on both borrowers and lenders, which is not explained by the interest rate channel, and finally, the credit channel does not always have the same effects on the economy, since they depend on the state of the firms’ balance sheets and the health of the banking sector (Horvath *et al*., 2006).

2.1.4. The bank lending channel

This particular channel is based on the notion that non-monetary assets do not have perfect substitutes and there is asymmetric information between banks and borrowers. Specifically, a strict monetary policy, which implies a decrease in deposits, leads to a decrease in funds that banks can lend. If banks are not able to compensate for this fall of loanable funds with alternative sources of financial funds, they are ‘forced’ to lower the supply of loans, which affects consumers and firms and therefore investment and output, as mentioned earlier.

For the bank lending channel to operate, the following three conditions must be satisfied: first, firms must not be perfectly indifferent to various types of finance, such as borrowing funds from financial institutions via loans and borrowing money from the general public via bonds. This implies that firms must be dependent on bank loans and not be able to fully insulate their real spending from changes in the availability of bank loans. Were firms indifferent between the two types of financing, the decrease in loan supply would not have any impact on the firm. Conclusively, bank loans cannot be perfectly substituted with other sources of funds. When this condition holds, firms are not able to replace losses of banks loans – because of the decrease in loan supply by the monetary authority – with other types of finance (Oliner and Rudenbusch, 1995).

The Central Bank must be able to affect loan supply through the changes it imposes on the volume of reserves. Therefore, banks would not be able to offset the decrease in funds from deposits by raising funds from other sources. Specifically, a tightening of the monetary policy constrains bank lending in a direct manner, implying that banks do not rearrange their assets and liabilities portfolio after a decrease in reserves, and therefore leave the volume of loans unchanged. On the contrary, the volume of loans declines as a part of adjustment (Oliner and Rudenbusch, 1995).

The third condition that must be satisfied for the operation of both the bank lending channel and the interest rate channel is that some imperfection must exist in the adjustment of the aggregate price level, otherwise prices would perfectly adjust to offset changes in nominal money and credit on real output. The imperfect adjustment in prices is necessary since monetary policy would have no impact if prices could be adjusted by the same percentage every time there is a change in money supply. For example, if a 5% increase in money supply is accompanied by the same percentile increase in prices, then monetary policy would not exert any effect. It would be effective only if prices are increased by less than 5% (Golodniuk, 2006). This condition is usually satisfied in an economy.

With regard to the first condition, many firms depend on bank loans, particularly the small ones, which have small potential to either have access to the markets for commercial papers or switch between financial intermediaries that lend them money. Firms depend on banks mainly due to asymmetric information. In particular, lenders do not have sufficient information for borrowers – at least as much information as borrowers have for themselves – implying that lenders have to bear high monitoring costs, which is extremely expensive for individual investors. On the contrary, financial intermediaries are able to undertake this cost of monitoring as well as collect even more information on borrowers over time as lenders and borrowers continue to cooperate, which makes it more difficult for the firms/borrowers to switch between different financial institutions, whereas it gives the firms the advantage of lower costs due to the long-term relationship established through cooperation.

The second condition mentions that the central bank has the power to control money supply. It could be claimed, however, that this view is not very valid, since currently there are numerous other financial institutions whose reserves cannot be controlled by a monetary authority; therefore, these institutions are able to lend to investors by using all their funds. However, there are certain important reasons why the central bank controls money supply, one of which is liquidity transformation that provides depositors with access to their money any time they need it and borrowers to use their funds for a long period of time. As mentioned earlier, the bank lending channel operates when a decrease in deposits leads to a corresponding decrease in loan supply. In this case, a bank would respond in three different ways: first, lower the amount of loans that it offers, second, sell T-bills in order to maintain the necessary liquidity that will allow the bank to continue lending and finally, sell Certificate of Deposits (CDs) as an alternative source of funds.

For this particular channel to operate, the bank should 'choose' the first alternative, which implies that the bank will not be indifferent to the amount of CDs or T-bills that it should keep. With regard to T-bills, their existence is important because they can easily be liquidated; however, their return is relatively low and therefore it is unprofitable for a bank to have a large amount of T-bills. In other words, the commercial bank keeps a quantity of T-bills that is adequate in terms of liquidity and return.

A corresponding amount of CDs is also held by banks, although the excess quantity is not indicated because of higher cost. Specifically, selling more CDs, simultaneously implies an increase in the debt of the bank, which increases default risk. Therefore, a commercial bank cannot remain unaffected by the quantity of T-bills and CDs that it keeps in order to deal with any difficulties that will arise from a tightening of the monetary policy. In such cases, banks are not capable of substituting the decline in deposits with selling CDs or liquidating T-bills (Kashyap and Stein, 1993).

Identification problem

Empirical procedure on identifying the bank lending channel had an important problem to overcome. Specifically, empirical research has mostly focused on the correlations among output, bank lending and monetary indicators. For example, Bernanke and Blinder's survey (1992) based on aggregate data and balance sheets, and the conclusion was that a strict monetary policy results in an immediate decrease in bank deposits, has a large impact on loans and consequently leads to a decrease in output. Although, their results converge with the view of the bank lending channel, it is not very clear whether they cannot be derived from the existence of the interest rate channel.

Basically, the above problem is detected in the difficulty of identifying whether the effects are due to shifts either in loan demand or in loan supply. The fact that both output and bank loans decrease after a negative change in monetary policy does not necessarily lead to the conclusion that it occurs due to changes in loan supply (Oliner and Rudenbusch, 1995; Brissimis *et al*., 2001). In contrast, the above changes in output and bank loans may result from a shift in loan demand. Specifically, a tight monetary policy leads to an increase in interest rates and consequently leads to higher cost, which does not favour investments and leads to a fall in loan demand and therefore in the volume of loans.

To resolve this problem – that is, to understand and clearly identify whether the cause for the decrease in the amount of loans reflects a constriction of loan supply or a dampening of loan demand through the traditional interest rate mechanism – the literature has focused not on the analysis of aggregate data, but microeconomic data of firms and banks.

Kashyap *et al*. (1993) were the first to attempt to overcome the identification problem, by examining the relative movements in bank loans and commercial paper after a monetary shock. Specifically, the monetary shock that operates through the usual interest rate channel lowers the demand for all types of finance, while a monetary shock that operates through the bank lending channel affects only the supply of bank debt. The researchers' conclusion, which they consider evidence for the existence of the bank lending channel, is that contractionary monetary policy decreases the amount of bank loans more than the amount of commercial paper (Oliner and Rudenbusch, 1995). However, the necessary assumption for this to hold, is that the disturbances caused by monetary policy have the same effects on the demand for alternative sources of finance.

Different researchers have followed other empirical methods, such as approaches based on identifying loan supply reduction by identifying asymmetric movements in firm behaviour. More precisely, Gertler and Gilchrist (1994) examine whether the impact of monetary policy is greater on smaller firms that are supposed to be dependent on bank lending. However, their results are obtained due to the functioning of the balance sheet channel.

Finally, Kashyap and Stein (1995) follow an alternative method, which is based on investigating bank lending behaviour at the individual bank level. The banks are distinguished into large and small banks and researchers claim that small banks have a steeper increase in the external finance premium than larger banks. On this basis, they suggest identifying shifts in supply by ascertaining differences in loan quantity adjustment for larger and smaller banks. In addition, macroeconomic variables are used to take into consideration country-specific institutional characteristics and loan demand shifts, implying that macroeconomic variables control for demand effects (Gambacorta and Marques-Ibanez, 2011).

2.1.5. Recent developments

The recent crisis and the ongoing changes in the financial system have imposed changes in the way monetary policy works, as well. The traditional channels of the transmission mechanism and specifically the bank lending channel, which this paper examines, need to adapt to the current situation and take into consideration additional parameters in order to operate and affect the real economy. Prior to the recent crisis, literature overlooked the role of banks as financial intermediaries as well as the frictions they may impose in the monetary transmission mechanism.

Many researchers support that traditional literature on the bank lending channel should be modified and suggest new variables that should be taken into account (Altunbas *et al.*, 2009), or argue that certain assumptions in traditional research are misplaced and propose a reformulation of the lending channel (Disyatat, 2011; Bernanke, 2008). The variables that are particularly emphasized in traditional literature characterize the strength of the bank, such as capitalization, liquidity and size. Many studies (Stein, 1998; Gambacorta and Mistrulli, 2004) conclude that well-capitalized, liquid and big banks are better able to confront any change in monetary policy. In other words, in the case of monetary policy contraction, loan supply will be most negatively affected in small, less liquid and poorly capitalized banks that are financed mainly from deposits and equity (Kashyap and Stein, 1995), are unable to protect their loan portfolio by drawing down securities or cash (Kashyap and Stein, 2000) and have no access to alternative sources of funding (Peek and Rosengreen, 1995; Kishan and Opiela, 2000; Van den Heuvel, 2002).

Even though the previously mentioned bank-specific characteristics have proved to affect the way banks react to monetary policy changes, empirical studies have revealed that these characteristics alone can barely be a decisive factor in the identification of a loan supply function; however, more variables need to be taken into account, such as performance, structure and risks that banks face (Brissimis and Delis, 2009). In addition, other studies argue that financial market development has attenuated the impact of these characteristics on the response of banks to monetary policy decisions. For example, Altunbas *et al*. (2009) argue that the development of securitization has changed the way the bank lending channel operates and, in particular, has reduced the importance of this channel. Securitization increases liquidity because the sale of asset-backed security causes short-term inflows; this modifies the liquidity ratio, reduces the amounts of loans on the balance sheet of banks – and, therefore, indicates that size is less important (DeYoung and Rice, 2004) – and may also reduce the accuracy of the capital-to-asset ratio as an indicator of the capital constraints that banks face.

As Altunbas *et al*. (2009) indicate, securitization reduces the significance of the bank lending channel because it increases the liquidity of banks, that is, there is a reduction in funding needs. In fact, the argument that banks are able to obtain additional liquidity coincides with the critique by Romer and Romer (1990), who argued that banks could raise liquidity by issuing CDs or bonds, which are not subject to reserve requirements. In addition, by excluding loans from the balance sheets, securitization allows banks to transfer a significant part of their credit risk to the markets and hence reduce the regulatory capital requirements, which has a positive effect on the supply of loans. As Peek and Rosengren (2009) argue, the innovations of securitization in accordance with the development of credit derivative markets has improved the management of credit risk for banks since it can be transferred to other economic agents, which may have a significant impact on the bank lending channel. Overall, development and innovations in financial markets have changed the effectiveness of the bank lending channel by modifying the banks' incentives and ability to provide credit.

Securitization in the form of loan sales that provides an alternative and less-expensive method of funding for banks, when the deposit market is competitive, is also found in previous literature (Pennacchi, 1988; James, 1988). This activity should be connected to the business cycle, since it would have implications on the monetary policy; however, evidence from various studies is contradictory. Stanton (1998) claims that securitization rises during periods of economic downturn, whereas Estrella (2002) finds that it declines during recessions.

There has been a notion that the bank lending channel works in heavily regulated financial markets and is of less importance in liberalized ones (Walsh, 2010). On the contrary, other studies argue that the bank lending channel would be more significant in these liberalized systems. They claim that the lending channel should be reformulated and highlight the importance of the strength of the balance sheet of banks as well as their risk perception and characteristics through which the channel is supposed to be reinforced. In other words, they claim that the lending channel works through the effect that the monetary policy has on the external finance premium of banks, which can be determined by their balance sheet strength and not through changes in deposits. These studies provide evidence that banks' cost of funds is sensitive to their financial health, which affects the real economy. For example, there is evidence that bank health affects the real economy (Peek *et al.*, 2003), differences in capitalization of banks affect the rate that the borrowers pay (Maechler and McDill, 2006) and poor or riskier banks pay a risk premium on their uninsured deposits (Hubbard *et al*., 2002).

Disyatat 2011 claims that the traditional conceptualization of the lending channel – that is, the notion that monetary policy affects deposits, which consequently affect lending – is misplaced. The author argues that, except through capital requirements, there is no exogenous constraint on the supply of credit, particularly in liberalized financial systems. This paper contradicts the argument of Romer and Romer (1990) and implies that the bank lending channel proves to be more important when banks rely on market-based funding because the sensitivity of the funding costs of banks to monetary policy increases.

The underlying premise of this paper is that changes in the health of financial intermediaries constitute the appropriate mechanism through which the impact of monetary shocks is transmitted. By 'health' the author implies leverage, asset quality, as well as risk perception. Disyatat (2004, 2011) focuses on credit market imperfections that financial intermediaries face and how their external finance-premium, which is affected by monetary policy, is reflected on the cost of funds to firms that depend on these intermediaries for their operations. In other words, bank-specific characteristics affect the sensitivity of external cost of funds to changes in monetary policy. That is, monetary policy may affect fewer well-capitalized, liquid and large banks since these parameters are associated with the strength of a bank, smaller degree of informational asymmetry and therefore less variability of the finance premium. The primary proposition of Disyatat (2011) that needs to be clarified is that the bank lending channel exists, even when banks rely on market funding, because the effect of monetary policy can be transmitted through changes in the required rate of return, rather that changes in deposits. Therefore, in the case of monetary tightening – which would traditionally lead to a reduction in liquidity due to the fact that banks currently are able to access markets for their funding needs – there will be a rise in the price of funding liquidity.

Gambacorta and Marques-Ibanez (2011) emphasize the importance of capital in banks' decisions and claim that investors have to pay a premium because neither the market for bank debt is frictionless, nor are banks' non-reservable liabilities insured. Therefore, bank capital is perceived as a sign for banks' creditworthiness and can affect their external ratings. For example, poorly capitalized banks are perceived as riskier and therefore the cost of market funding (bonds and certificate of deposits) would be higher. Hence, these banks are less capable of shielding their credit relationships and are more exposed to problems of information asymmetry (Jayaratne and Morgan, 2000). Other studies (Kishan and Opiela, 2000; Gambacorta and Mistrulli, 2004; Altunbas *et al*., 2009a) have also shown the importance of capital particularly in periods of financial distress, since, in those times, it is more difficult and expensive to raise capital. Therefore, it is probable that banks decrease their lending in periods of financial distress and due to capital constraints.

Further, as Altunbas *et al*. (2009a) find, securitization could play the role of shock absorber in periods that are not characterized by financial distress; however, this could be reversed in periods of crisis. The same happens in the case of non-interest income – that is, revenues from investment banking, fees and commissions – that is more volatile in periods of financial distress. Non-interest income constitutes an alternative source of funding for banks in periods prior to the recent financial crisis, but declines during the crisis, thereby affecting banks' performance and loan supply.

Overall, the recent crisis has imposed the need to reformulate the macroeconomic models used thus far to explain various mechanisms of the economy.

2.2. Bank Efficiency

During the course of the last few decades, banks all over the world have been operating in an extremely competitive environment. More specifically, changes in the regulatory environment, competition from multinational entities, the fact that governmental intervention is becoming more and more minimized, all these are compelling banks to become more effective in order to survive. Therefore, besides the size, capitalization, liquidation and other quantitative variables, efficiency is one of the main factors that banks should take into consideration.

In order to attain their survival levels in this demanding environment, many banks have diversified into mergers and acquisitions. These activities are believed to lead to increased market power and to the easing of competition. However, there is the view that the effect of mergers and acquisitions is slightly on the negative side since this results in a few firms that have the market power and, hence, are in a position to dictate prices that are above marginal costs. On the contrary, the opposite opinion is that mergers and acquisitions can lead to efficiency through economies of scale, and also through exploiting new technologies or better management. According to English *et al*. (1993), in many cases, mergers that have occurred between a profit generating bank and one that is less profitable, have brought about very positive results not only for the banks but also for their customers, because the less efficient bank is able to exploit the advantages available in technology and the infrastructure of the more efficient one.

This variable, efficiency, has always been an "asset" for the banking system, but was not given due priority, because earlier, the circumstances were different, and banks were able to operate in those environments. However, economic conditions have changed and this affects the way in which the banking sector operates, meaning that its structure, performance and functioning had to necessarily undergo changes in order to be able to adapt to the conditions of the new times that required the banks to become more efficient, a matter that is crucial for their survival, and that can offer them a competitive advantage. An efficient banking sector is thus able to handle negative shocks and contribute to the stability of the financial system.

Before analyzing the relationship between efficiency and the banking system, a short reference is necessary to researches that have examined this variable and its resultant effect on economy.

Efficiency, as a concept, has been analyzed by many surveys in accordance with economic growth. More precisely, it has been examined whether bank efficiency is involved in the relationship between financial development and growth and whether it has any effect – mostly indirectly – on economic growth. There is a notion that a sound financial system fosters economic growth, and vice versa. Many studies indicate that there exists a strong bond between finance and growth, and specifically, that countries with better financial systems have more rapid economic development (King and Levine, 1993). The most frequently asked question is whether this economic growth is being achieved through increasing bank investments or through putting them to more productive uses, and in both cases to what extent.

Most of the studies that analyze the relationship between finance and growth use proxies relating to the size of the financial systems and on other quantitative variables, rather than measuring the quality. This is a "major shortcoming" as Koetter *et al*. (2010) point out. More specifically, they assert that "it is the quality rather than quantity of financial intermediation that influences economic growth".

As far as financial systems are concerned, these consist of several dimensions that can be thoroughly researched, and one should find out which of them matter the most. Such dimensions include the size, efficiency, competitiveness and regulation of banks, the roles of nonbanking financial institutions – such as finance companies, venture capital funds and insurance companies – the scale and liquidity of public debt and equity markets, and so forth (Berger *et al*., 2004). In this thesis (Chapter 3) most emphasis will be put on the banking system's efficiency in order to be connected to the bank lending channel and find the way it influences the transmission mechanism of the monetary policy.

The role of banks is twofold: first, to build up capital, implying that the reduction of transaction costs and risk diversification, would direct the savings of the banking system to finance investments that stimulate the economic growth. This first role (or channel) is often referred to as "Hicksian" (Hicks, 1969), and is considered as one of the two channels through which banks influence economic growth. The second channel refers to the manner in which financial resources are allocated to the most innovative investments. According to Schumpeter (1934), banks should recognize those entrepreneurs who are willing to make the most innovative and productive investments, because development is driven by this segment of the clientele. Although the second channel mostly refers to the quality of banking intermediation, the empirical analysis always uses as proxies quantitative variables and not qualitative ones. This is what Lucchetti *et al*. (2001) try to include in their research.

Specifically, Lucchetti *et al*. (2001), argue that the choice of the variables used to measure the state of the banking system's development comprises the weakness of the previous studies with the same subject of research. In their paper, Lucchetti *et al*. (2001) mention that banks exert an effect on economic development when they recognize the most innovative entrepreneurs and allocate their financial and real resources in the most efficient and productive way. This opinion is similar to that of Fama (1985), Minsky (1986), Moore (1988), and Stiglitz and Weiss (1988), who state that the role of banks in the economic system is not intermediating savings, but rather certifying the borrowers' quality and monetizing liabilities which otherwise would fail to find purchasers in the markets.

Lucchetti *et al*. (2001) measure the efficiency of banks that operate in a particular area and consider that it indicates the health of the banks and therefore, how effective the banking process is. According to Lucchetti *et al*. (2001), if banks were able to always place loans in productive and innovative investments, the health of banks would not be considered as a significant factor for the growth of the economy.

Berger *et al*. (2004) contribute to the literature on the banking system's quality by focusing on the community banks and their effects on economic growth. They argue that these banks' efficiency can be transmitted to the economy through two transmission channels: Small and Medium Enterprises – the so-called SMEs – and the flows of bank credit. Specifically, with regard to SMEs, the notion is that banks extend help in promoting economic growth by providing funds to the most productive firms, because more productive SMEs make their specific sectors stronger, and also through competition, motivate large firms to increase their own productivity as well. The second means of transmission that is, the flows of bank credit refers to the fact that healthier banks provide greater flows of credit and, therefore, reduce the market power of larger banks. Furthermore, competing with the latter, encourages the reduction of prices, and leads to expansion of lending. Results indicate that healthy community banks affect positively the employment share of the SMEs and the bank lending to GDP ratio. Overall, Berger *et al*. (2004) investigate how the health of community banks promotes economic growth, by "measuring" the market share and the efficiency ranking of these banks, as well as the interactions between these two elements of research. The results indicate a positive interaction between market share and efficiency ranking, and a positive relationship between efficiency and growth – measured by GDP – as well.

To this strand of literature belongs another paper written by Koetter *et al*. (2010) who also examine the link between finance and growth, albeit propose a different measure of the quality of banks' financial intermediation using bank-specific efficiency estimates. In other words, they examine the "intermediation quality", that is, the quality of the intermediation function of the banks, which is measured by the banks' ability to convert inputs into outputs, that is, financial products and services.

Lucchetti *et al*. (2001) believe that measuring efficiency makes it easier to answer the question about the causality between finance and growth. There is a wide ongoing debate over this matter, with some researchers believing that economic growth is the cause for the development of financial systems, while others (Goldsmith, 1969; King and Levine, 1993) consider that financial growth is the one that predicts healthy development of the economy. Moreover, there is an additional aspect that financial development is a leading indicator of economic growth and there exists no other relationship between these two (Rajan and Zingales, 1998). Rajan and Zingales (1998) believe that the matter of reverse causality mentioned above is weakened, since they examine the ability of the banks to convert inputs into outputs. Their study is not only on the issue of economizing on costs, but on the quality of the intermediation process. This concept of efficiency has a positive effect on growth and, therefore, the relationship between finance and growth becomes clearer.

As Koetter *et al*. (2010) state: “Our quality proxy of financial development is independent of the credit volume of an individual bank, because the efficiency of a bank does not depend on how much output it produces, but rather how well it does so”. Hence, the authors consider efficiency as independent of the state of the economy. That is, whether banks use their inputs and technology in the most productive way to minimize costs and maximize their profits, is not related to the economic cycle. Therefore, it can be claimed that it is the bankers’ efficiency – and hence the ability of the financial development – that leads to the growth of the economy.

Various definitions of the word “quality” will be touched upon later. At this point, it is worthwhile mentioning that the subject of interest will be referred to as the quality of the banking system.

2.2.1. Definition and measures of efficiency

The efficiency of a bank can be regarded as its ability to convert inputs into financial products and services, thereby exercising a significantly positive effect on growth. In other words, the quality of banks is approximated by their efficiency to gainfully employ resources when generating financial products and services (Koetter, 2010). This derives from the notion that the main task of the banks is to accept funds from savers and allocate them to investors who operate the most profitable projects, and after such investment, to act as monitors.

Specifically, three main concepts of efficiency are analyzed in the literature. First, production efficiency regards the production plan as technically efficient, when there is no other way to produce more output, given the inputs, or produce a certain amount of output, using the fewest inputs possible. Second, cost efficiency measures a bank's ability to produce a given set of outputs with the minimum cost possible given the available technology. It is assumed that the intention of the bank is to minimize its costs, and also that "managerial mistakes are made in input usage" (English *et al*., 1993). Furthermore, an additional assumption is that outputs are determined exogenously. An alternative that may help to understand the concept of efficiency is trying to realize what is meant by the term "inefficient bank". This is a bank that has higher costs than those predicted for an efficient bank that produces the same output/input combination, and this difference cannot be explained by statistical noise.

Finally, profit efficiency measures a bank's ability to maximize profits given the prices of inputs and outputs (Lucchetti *et al*., 2001). Besides this type of yardstick for profit efficiency, there is an alternative which takes into consideration not the price of the output, but its quality. In other words, this measure "captures the fact that the products supplied by banks may be of different quality" and, therefore, the maximization of profits is being accomplished for a given level of output quality. In the rest of this section, more attention will be given to cost and profit efficiency, since they are the more analyzed concepts in literature.

According to Lucchetti *et al.* (2001) the estimation of cost – and profit – efficiency can be symbolized by the following relationship:

$$O = O\ (p, G, u)$$

where, O is the vector of variables to be optimized (costs or profits according to the type of efficiency in research), p is the vector of the prices of the inputs, G is the vector of given variables and u is a residual element which consists of the inefficiency term and a random error.

The above requires that the banks are able to use the inputs in the appropriate proportions and, consequently, to produce outputs. As Koetter *et al*. (2010) refer:

"Bank inefficiency arises when managers employ simply too much input quantities and/or allocate them in wrong proportions". In their paper, Koetter *et al*. (2010) estimate the profit efficiency, because they believe that it should measure not only the ability of the banks to minimize their costs, but it is also important to measure the ability to maximize their profit. Therefore, deviation from the profit frontier is indicative of the bank's inefficiencies. In order to be more accurate, deviations are not entirely explained by inefficiencies, but there is a part of them that result from differences in characteristics of the banks.

Capital accumulation and capital allocation are regarded as two channels that transmit the effects of the banking system to the economy. However, neither cost nor profit efficiency can be expressed by the first channel. This implies that, although, they cannot indicate which bank is able to identify the firms with the most innovative projects that help in economic development, however, they can measure how successful and effective the allocation of resources has been – implying that the banks have been able to use the given technology and inputs correctly and, therefore, either minimize costs or maximize profits.

Studying banking system's efficiency – at the macroeconomic level – and its relationship with economic growth is equivalent to measuring the ability of selecting projects that have the greatest impact on development. However, the measurement of efficiency at the macroeconomic level is unexplored because of the enormous difficulties that arise. Therefore, microeconomic efficiency is used in order to measure the quality of the banking system. Lucchetti *et al*. (2001) refer especially to microeconomic technical efficiency and the ways of measuring it. They believe that "The efficiency of the banking process for a whole area can be thought of as a function of the efficiency of the banks that operate in that area". Hence, the first step is to measure bank efficiency at a microlevel and then aggregate the results, using them as a proxy for the bank quality – the efficiency to finance the most innovative investments. Lucchetti *et al*. (2001) use microeconomic technical efficiency because there is no simultaneity bias between credit and development, since efficiency, according to them, is proved by the proper and most productive way that banks use technology, which is independent of the growth of the economy.

The main difference among Koetter *et al*. (2010) and previous researchers (Berger *et al*., 2004; Lucchetti *et al*., 2001) is the estimation of efficiency. Specifically, Koetter *et al*. (2010) uses a bank-specific fixed-effects panel stochastic frontier model with time-variant inefficiency, to estimate efficiency over time, which was either assumed or not taken into consideration by previous studies. The aforementioned translog profit function takes the following form:

$$\begin{aligned} \ln \pi_{kt} &= \alpha_k + \sum_{i=1}^{n} \alpha_i \ln P_{ikt} + \sum_{m=1}^{n} \beta_m \ln O_{mkt} \\ &+ \delta_o \ln Z_{kt} + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij} \ln P_{ikt} \ln P_{jkt} + \sum_{i=1}^{n} \sum_{m=1}^{n} \gamma_{im} \ln P_{ikt} \ln O_{mkt} \\ &+ \frac{1}{2} \sum_{m=1}^{n} \sum_{n=1}^{n} \beta_{mn} \ln P_{ikt} \ln Z_{kt} + \sum_{m=1}^{n} \zeta_m \ln O_{mk} \ln Z_{kt} + \eta_0 h_{kt} + u_{kt} + \upsilon_{kt} \end{aligned}$$

The above equation indicates that the deviation of a bank from the optimal profit (before taxes) can be explained by u_{kt} and υ_{kt}, which are the inefficiency term and the random error, respectively. The two assumptions for the above terms are that υ_{kt} is iid with υ_{kt}~N(0, σ_{υ}^2) and independent of the explanatory variables. For the inefficiency term, it is also iid and u_{kt}~N|(0, σ_u^2)| and is independent of the υ_{kt}.

The letters *P*, *O* and *Z* stand for input prices, outputs and equity of *k* bank, at time *t*. Koetter *et al*. (2010) have included the term h_k, which is a vector of dummy variables for the control of bank-specific heterogeneity, that is, variables for banking group, location and time-fixed effects. The α_k is the term that controls for any systematic differences across banks that are not explained either by inefficiency or by the term h_k.

More categories of efficiency

Efficiency can be divided into various categories according to the objectives of each bank. Two efficiency measures should be mentioned: input efficiency measures, which measure the effectiveness of an input vector, given the output, and output efficiency measures, which calculate the effectiveness of an output vector given the inputs.

Operational is a general category of efficiency that includes two subcategories of efficiency: technical and allocative. Technical efficiency implies that banks optimize the input mix in order to avoid excessive levels of input usage. A bank is technically inefficient, when it uses too many inputs to produce its output. In this case, the bank operates below its production frontier and not on it (Mester, 1997). Similarly, Berger *et al*. (1993) refer to technical inefficiencies as the loss of profits from failing to meet the chosen production plan.

Allocative efficiency implies that banks should optimize the input mix in order to avoid nonoptimal usage of input proportions. Mester (1997) states that a bank is allocatively inefficient, when it uses inappropriate proportions of its inputs (wrong mix) to produce its output. In the case of allocative inefficiency, the bank may operate on its production frontier, but it does not achieve the minimization of its production costs. According to Berger *et al*. (1993), a bank is defined as allocatively inefficient, when it loses profits, due to the incorrect choices it made with the inputs and outputs.

Scale efficiency requires banks to optimize the output mix in order to take advantage of all-scale economies. Alternatively, scale efficiency is accomplished when banks operate with an efficient level of outputs. And finally, scope efficiency requires banks to optimize the output mix to take advantage of all-scope economies (Apergis *et al*., 2003). In the case of scope efficiency, the objective for a bank is to operate with an efficient mix of outputs, contrary to the efficiency level that is needed in order to achieve efficiency in terms of scale economies.

Allen *et al*. (1996) focus on cost efficiency and, according to them, operational efficiency requires optimization both of the output mix, and the input mix. The first requirement is necessary in order to exploit any economies of scale and scope. Economies of scale are associated with firm size, and these are accomplished, when there is an increase in output, whereas, average production costs may have fallen. On the contrary, economies of scope relate to the joint production of two or more products. In particular, when two or more products can be jointly produced at a lower cost than is incurred in their independent productions, then economies of scope occur (Clark, 1988). As far as optimization of the input mix is concerned, its intention is twofold: first, the usage of only the necessary inputs and not their excessive levels, and second, avoiding nonoptimal relative proportions of inputs.

Data

Bank efficiency is very crucial, since efficient banks have greater possibilities of surviving in a competitive environment and, as was mentioned before, efficiency is estimated as the ability of the banks to convert inputs into financial products and services. To accomplish this and measure efficiency, careful collection of data is a necessary and very important task.

Before mentioning, however, the kinds of inputs and outputs that most surveys use, some issues and problems should be cited. One issue that has "divided" the banking literature is related to the appropriate definition of output and, consequently, bank costs. Two alternative approaches are followed: first, the intermediation approach, under which banks are considered as collectors of deposits and purchasers of funds, which will be intermediated into loans and other assets. In other words, "depository financial institutions" are viewed as producers of services related directly to their role as an intermediate in financial markets. Hence, deposits are treated as inputs -- as labor and capital are. On the contrary, outputs are considered to be the institutions' volumes of earning assets, whereas interest expense and total costs of production constitute the cost. The second approach, the production approach, treats banks as producers of services associated with loans and deposit accounts. In this case, capital and labor are the inputs, whereas loans and deposits are the outputs. Finally, costs are considered to be total costs excluding interest costs. However, although the two approaches differ from each other, empirical results do not seem to be particularly sensitive to the approach used (Clark, 1988).

Although there is no perfect approach, Berger and Humphrey (1997) claim that the most appropriate approach for the evaluation of financial institutions, is the intermediation one, since it includes interest expenses, which comprise a large part of total costs. Furthermore, profit maximization requires the minimization of total costs – and not only that of production costs – and, therefore, this approach is more appropriate (Casu *et al*., 2003).

Although intermediation and production approaches are the main ones, there exists a variant of intermediation approach, the "asset approach", according to which, outputs are strictly defined by assets and mainly by loans, because those banks have more advantages compared to other financial institutions. Favero and Papi (1995) argue that the two main approaches do not take into consideration most of the services provided by banks, such as the purchase and sale of government securities – a common practice in the case of Italy, which is the country under investigation in the paper of Favero *et al*. (1995).

As far as inputs are concerned, most of the studies use labor fixed capital deposits and borrowed funds. On the contrary, loans (interbank, commercial, industrial, real estate, agricultural, loans to depository institutions, loans to foreign governments, loans to individuals) securities, off balance sheet activities, proceeds from services and investment assets are considered as outputs. Finally, the input prices are usually constructed as follows: the wage rate (w_1) is proxied by dividing salaries and staff expenses by total number of reported employees. The unit price of capital is constructed by dividing capital equipment and occupancy expenses by fixed assets net of depreciation. The borrowed funds' price is calculated by dividing interest expense by total interest liabilities.

Estimation methods

Two types of approaches can be used for the estimation of bank efficiency: parametric and non-parametric approach. They both require the specification of a frontier, but the parametric approach involves the specification and econometric estimation of a statistical or parametric function, whereas the nonparametric approach provides a linear frontier by enveloping the observed data points (Drake *et al*., 2003).

In general, these approaches study a "best practice cost/profit frontier". In the case of nonparametric frontiers, inefficiency is measured by the distance of a Decision Making Unit (DMU) from the best practice in the industry, which is on the frontier. On the other hand, parametric frontiers specify a functional form for the "best practice frontier" and account for errors, which can be composed of two terms: random error and inefficiency components (Apergis *et al*., 2003; Drake *et al*., 2003; Koetter, 2010). However, parametric approaches may be difficult to use, since the decomposition of the error term requires an appropriate distribution, availability and accuracy of input prices data, as well as accuracy of the chosen functional forms' approximation to the production/cost/profit function, so that it leads to accuracy of the efficiency estimates in the parametric approach. If the above can be achieved, parametric approaches are preferable.

Certain techniques can be used for each kind of approach. With regard to the parametric approach, the techniques are the follows: Thick Frontier Approach (TFA) divides the banks that are used in the sample into quartiles based on average costs, and assumes that inefficiency is estimated by the differences that are observed in the predicted cost functions, between the lowest and the highest average cost quartiles. Additionally, deviations from predicted costs within each average cost quartile represent random errors. For example, cost differences within cost quartiles represent random errors, whereas cost differences across these quartiles represent efficiency differences.

Distribution Free Approach (DFA) assumes that efficiency differences are stable over time. On the contrary, random errors tend to average out to zero over time. In the case that a cost function is used, this approach employs the average residuals of this function estimated with panel data to construct a measure of cost of X-efficiency (English *et al*., 1993). Finally, Stochastic Frontier Approach (SFA) specifies a functional form for the production/cost/profit relationship among inputs and outputs, and allows for the error term to be composed of two terms: random error and inefficiency components. The former captures measurement errors and other factors that are beyond the control of the firm, while the latter measures inefficiency.

The most common nonparametric approach is the Data Envelopment Analysis (DEA), which is “a mathematical programming approach for the construction of production frontiers, and the measurement of efficiency relative to the constructed frontiers”. The assumption of this method is that there is no random error. The DEA efficiency score for a DMU is not defined in absolute terms, but relative to the other DMUs in the specific dataset under consideration. One main characteristic of the DEA approach is that this production frontier is not determined by some specific functional form, but is generated from the actual data for the banks in the sample. The above features differentiate DEA from the parametric approaches, because the latter require a specific prespecified functional form of the modeled production or cost or profit function (Casu and Molyneux, 2003).

2.3. Monetary Policy Rules

Implementing monetary policy requires an understanding of a variety of rules and practices, referred to as operating procedures. It is important to examine and distinguish the instruments that are controlled by monetary authorities, the factors that determine the optimal instrument choice and how this choice affects the response of short-term interest rates or reserve aggregates to policy actions and non-policy disturbances.

Two of the most important aspects of monetary policy are rules and discretion and there is a long-standing debate over the role played by both. Older literature, which mostly favoured discretionary policy, argued that an intelligent policymaker is one who decides on the optimal policy and is capable of using imperfect information and take the right decisions. Furthermore, the supporters of discretion claimed that rule-based monetary policy decisions were motivated by interest groups who had access to imperfect information and therefore ended up creating suboptimal policies. Therefore, discretion implies flexibility, which allows the policymaker to act in an appropriate manner.

In general, under discretion, the policymaker promises to take those actions that will best further his/her objectives subsequently. This implies that 'the decision selected is best, given the current situation and that the decisions will be similarly selected in the future' (Kydland and Prescott, 1977). However, Barro (1986) claims that such promises are easy to keep. On the contrary, rules are defined as a form of commitment or a binding contract that specifies the actions someone will take in advance, while these actions are possibly contingent on observable exogenous variables. From the above discussion, discretion can be considered a kind of rule in which none of today's provisions restrict a person's future actions.

Overall, under discretionary policy, the best action is chosen given the current situation. However, this strategy does not ultimately lead to maximisation of the social objective function, but results in consistent – though suboptimal – planning or economic instability. On the contrary, economic performance can be improved through a rule-based monetary policy. Moreover, rules can be evaluated using economic theory, which permits the selection of the theory with the best operating characteristics (Lucas, 1976). It is preferable that rules be simple and easily understood, so that they can be easily tracked when the policymaker deviates from target.

Besides rules and discretion, reputation constitutes a third type of government commitments, in which people's expectations of future policy depend on past performance. For example, when government always defaults on its debts, then potential bondholders have the perception that future defaults are more likely. An additional example is when a municipality sharply raises property taxes and this consequently leads to a reduction in the value of these properties, thereby deterring bondholders from moving in. However, it is difficult to formalise the linkages between past actions and future expectations in a model.

Analytically about monetary rules, they operate to lead towards a more transparent and effective monetary policy. Through them, the monetary authority defines its operating instrument as a function of one or two variables that reflect the inflationary and real activity conditions in the economy. There is a large volume of articles that deal with the determination of the best monetary policy rule. The general approach is, first, to choose a policy instrument – usually the monetary base or a short term interest rate; second, to choose a target variable, such as nominal GDP, inflation, unemployment, and on this basis to create the appropriate rule. Therefore, by using a model, it is possible to examine how the economy would have behaved under the particular rule versus how it actually behaved. The rule expresses the policy instrument as a function of the deviation of the target variable from its target value. The actual values of the variances of key macroeconomic variables, such as real growth rate and inflation rate, are compared to the values of the variances that would have occurred had the rule been followed.

According to Barro (1986), rules are divided into two categories: quantity and price rules. With regard to quantity rules, the policymaker aims for a target path of a monetary aggregate (such as monetary base or a broader concept of money). On the contrary, under price rules, the monetary authority, through its instruments such as open market operations, discount rate or a set price of gold (in the past), achieves a desired path for a certain target price (a general index of prices, an interest rate or the exchange rate).

A trinity of policy objectives has been emphasised by many generations of policymakers (Laxton and Pesenti, 2003). Specifically, under this trinity, it is attempted to simultaneously maintain fixed exchange rates, perfect capital mobility and an independent monetary policy. However, this type of trinity would probably lead to losses; therefore, central banks adopt an alternative trinity comprising flexible exchange rates, an inflation target and a monetary policy rule. Such a policy is characterised as targeting rule and is both feasible and desirable.

Another definition of a targeting rule – as it is referred to this time – is that given by Svensson (1999). The objective of the targeting rule is the optimal design of loss functions for the central bank. The loss function can be interpreted either as a representation of the central bank's preferences or as a prescribed target function that the government instructs the central bank to achieve as far as possible. This rule can be specified as one or more target variables, target levels and weights assigned to these objectives in the loss function.

It is assumed that the central bank minimises the loss function. A central bank that places greater weight on the inflation target than society does (conservative bank) improves the discretionary equilibrium when the output target is overambitious. Examples of targeting rules, other than the inflation targeting, are output growth targeting and nominal income targeting. Leitemo *et al*. (2005) showed that policy rules perform well in traditional open economy backward-looking models as long as the exchange rate is forward-looking. They also proved that policy rules in new Keynesian literature are more robust than previously believed.

The objective of policymakers is to create a rule (including the choice of the target variable) that aims to achieve the best overall performance of the economy. This rule should be operational, perform well in a variety of plausible macroeconomic models or when financial innovations or other shocks change the linkages between the policy instrument and the intermediate target, ensure long-run price stability, perform well and promote greater levels of price stability than historical discretionary policies (Thornton, 1998).

Fair and Howrey (1996) evaluate different policy rules using the following approach: first, they select a particular loss function and assume that is agreeable that this is the loss function whose expected value the central bank should minimise ('true' loss function). Afterwards, they select a policy instrument and use this instrument to minimise the expected value of the true loss function. Then, they use the instrument to minimise the expected value of other, simpler loss functions (such as one that targets only nominal GDP). And finally, they compare the different outcomes to investigate how close the minimisation of the expected value of the simpler loss functions is to the minimisation of the expected value of the true loss function. Moreover, they compare the outcomes to the actual, historical outcome to examine whether economy would perform better, had the central bank minimised the expected value of the particular loss function in question.

Bernanke and Gertler (2001) analyse the performance of policy rules by assessing the expected loss for alternative policy rules with respect to the entire probability distribution of economic shocks; that is, they consider stock price bubble shocks, technology shocks and the two combined. The primary effect of a bubble is to increase aggregate demand by increasing consumers' wealth and improving the balance sheets of borrowers. With regard to policy rules, Bernanke and Gertler (2001) considered simple rules relating the central bank's nominal interest rate to the expected inflation in the next period, the current level of the stock market and the output gap (actual output minus output under flexible prices and with no credit frictions). They suggest that good policy rules will react sensitively to expected inflation and the output gap. A shock to asset prices (either from a bubble or a technological shock) may temporarily change the natural real rate of interest, a change that should be accommodated by the policy rule if it is completely optimal. The main results indicate that an aggressive inflation targeting rule stabilises output and inflation when asset prices are volatile, irrespective of whether the volatility is due to bubbles or technological shocks; thus, there is no significant additional benefit to responding to asset prices.

The most 'famous' rule is Taylor rule, on which many analysts and policymakers have focused in terms of both actual policy and a prescription of desirable policy (Woodford, 2001). Taylor rule, in its initial form, recommends the determination of a particular level of the federal funds rate based on the state of the economy. For example, it recommends raising federal funds rate when inflation is above target and vice versa. Specifically, according to Taylor rule, the target for the nominal interest rate depends on the following four factors: first, current inflation rate, second, equilibrium real interest rate (a benchmark recommendation for the nominal interest rate is provided if the aforementioned two factors are added), third, inflation gap adjustment factor, that is the difference between inflation rate and its target – if the actual inflation is above its target, then interest rate increases and vice versa. And finally, output gap adjustment factor based on the difference between real GDP and potential real GDP – if the gap is positive, then the monetary authority raises the interest rate and vice versa – (Kozicki, 1999).

The use of the equilibrium real interest rate is important in formulating monetary policy. The last two components of the Taylor rule comprise two monetary policy objectives, which aim at a low and stable rate of inflation, while promoting maximum sustainable growth. It is claimed that the output adjustment component brings a forward-looking motive to policy recommendations, implying that a positive output gap predicts future increases in inflation.

Although Taylor rule has received plenty of attention and there is agreement on its fundamental features, its usefulness is not well established among policymakers. There are many reasons for this. First, the Taylor rule several assumptions, which if were replaced by reasonable alternatives, it is doubtful whether the rule would be robust. Furthermore, a rule should replicate the favourable policy actions of the past, to be considered reliable. However, even if a rule replicates past settings, it may still not be considered reliable, in the case when past policy decisions were influenced by economic events beyond the scope of the rule. And finally, Taylor rule uses specific weights on inflation and output gap measures. On the contrary, Taylor rule may be useful in the following ways: it incorporates the characteristics of sound monetary policy generally agreed upon by policymakers and analysts. It may provide a good starting point for issues related to monetary policy and it plays an important role in most forecasting models (Kozicki, 1999).

Apart from Taylor rule, additional types of rules exist, that may be similar to Taylor rule – referred to as Taylor-type rules – or not. The main drawback of monetary rules is the relatively unrealistic assumptions on which they are based. These assumptions regard the timeliness of data availability, whereas they ignore difficulties associated with the accuracy of initial data and subsequent revisions. This happens because the actual variables required for implementation of such a rule are not accurately known until much later and therefore, it may be regarded that the rule describes a policy, which can not actually have been followed (Orphanides, 2001).

Quantitative evidence suggests that monetary policy achieves good results, when guided by simple rules, which offer useful baselines for policy discussions. One reason that explains why simple rules are believed to be useful is that they can provide the policymaker with the flexibility to achieve some of the benefits of a discretionary short-run stabilisation policy, while retaining credibility towards the long-term goal of price stability. On the contrary, while the main virtue of the Taylor rule is its simplicity, a question that is raised is whether such a rule can be adequate representation of a process as complex as monetary policy.

The simple rule, which is one that avoids any direct response to other information regarding real disturbances and that incorporates only contemporaneous feedback from goal variables, is usually considered suboptimal (Woodford, 2001).

This is in agreement with Orphanides (2001), who argues that policy discussions do not give adequate attention to the informational problem of policy rules. The presence of noise in real-time estimates of inflation and output gap must be accounted for in evaluating rules-setting policies in reaction to these variables.

The central bank faces uncertainty regarding the impact of monetary policy decisions on the economy. Therefore, it must follow strategies that enable monetary authorities to consider a wide range of economic and financial indicators in order to establish an appropriate path for target variables. To accomplish this, expectations of the private sector constitute extremely important information because they can signal future inflationary risks.

Heterogeneity refers to the difference between private and central bank forecasts. This factor may increase inflationary persistence and therefore policy reaction becomes necessary. Information asymmetries regarding the nature of shocks, the economic model, the monetary transmission mechanism and policy rules may be considered sources of heterogeneity. In this case, optimal monetary rules are obtained through minimisation under the discretion of a standard central bank loss function subject to specific constraints.

Specifically, private inflation forecasts not only serve as useful information variables in monetary policy analysis, but also function as a potential intermediate target for the conduct of monetary policy. When the private sector inflation forecast is higher than that of the central bank, monetary authorities will react by increasing the interest rate and vice versa. In general, when private forecasts are inconsistent with central bank forecasts, the central bank reacts by adjusting its monetary policy, thereby speeding up the convergence of inflation to its target (Brisimis and Magginas, 2006).

Chadha *et al*. (2004) attempt to deal with the informational problem by examining whether asset prices and exchange rates should be incorporated into a standard interest rate rule as information variables. The results of their analysis indicate that not only can monetary policymakers use asset prices and exchange rates as part of their information set for determining interest rates, but they can also use them to set interest rate to offset deviations of asset prices or exchange rates from their equilibrium level. In their research, Chadha *et al*. (2004) consider the role of asset prices and exchange rates in the interest rate rule and attempt to ascertain whether the three major central banks that they examine (the US Federal Reserve Bank, the Bank of England and the Bank of Japan) have responded to asset prices and exchange rates during the last two decades or whether they have used asset prices and exchange rates only as information variables that can help predict future inflation or output. Their results indicate that these major central banks act in response to exchange rates or asset prices when needed in order to prevent the destabilisation of the economy.

There has been a debate, however, on whether there should be a direct response to asset prices. According to one viewpoint, including stock prices in the central bank's policy rule may be optimal because it enables the central bank to react significantly to stock market movements by changing the short term interest rate (Rigobon and Sack, 2003), contrary to the other viewpoint that is not in favour of the direct response of central banks to asset prices (Bernanke and Gertler, 1999).

Apart from choosing which instruments should be incorporated into a monetary rule, the effects of these instruments on economic variables have also been examined. As mentioned earlier, monetary rules are used as a means towards an effective monetary policy – that is, to positively affect real sector variables, such as employment, inflation, and GDP. Apart from these, the impact on financial markets should also be studied. Svensson (1989) identifies specific monetary rules and although he shows that they have significant effects on interest rate risk and international trade, he does not examine their impact on equity values. Boyle and Peterson (1995) generalise Svensson's model in an infinite horizon, however they do not address the implications of specific monetary policy targets, as well. On the contrary, Boyle and Young (1999) demonstrate that monetary policy can affect equity values. Specifically, they show that an inflation rule – contrary to a money growth rule – offers not only lower dividend volatility but also lower expected dividends. Moreover, consumption data show that in the stock market, a money growth rule is preferred to an inflation rule.

According to many policymakers, a country that does not choose to 'permanently' fix its exchange rate through a currency board, a common currency or some kind of dollarization, the only alternative monetary policy that can follow in the long run is the one that is based on the trinity of a flexible exchange rate, an inflation target (the inflation rate around which the central bank would like the actual inflation rate to fluctuate) and a monetary policy rule (a contingency plan that specifies how the central bank should adjust the instruments of monetary policy, that is the interest rate, in order to meet its inflation and other targets) as mentioned earlier.

The central bank should adjust the instruments of monetary policy in order to meet its inflation target or other targets that may have set. According to Taylor (1998), the question that arises concerns the role of the exchange rate in the monetary policy rule, which is answered following a four-step approach: first, place a potential monetary policy rule into a macro model, second, solve the model using a numerical solution algorithm, third, examine the properties of the stochastic behaviour of the variables (inflation and output) and finally, select the rule that leads to the most satisfactory performance using a loss function that comes as close as possible to capturing people's preferences. After performing this procedure, it can be proved that the exchange rate is an important part of the transmission mechanism in many policy evaluation models. Specifically, the exchange rate is usually involved as part of an arbitrage equation relating the interest rate in one country to the interest rates in other countries through the expected rate of appreciation of the exchange rate.

With regard to the question of how much of an interest rate reaction there should be to the exchange rate in a monetary regime under a flexible exchange rate, an inflation target and a monetary policy rule, research thus far shows that monetary policy rules that react directly to the exchange rate, inflation and output do not have a better function in stabilising inflation and real output and occasionally react in a worse manner than policy rules that do not react directly to the exchange rate. In other words, the indirect effect has more advantages compared to the direct effect because it results in fewer fluctuations in the interest rate.

Initially, the goal of the central bank is to lower inflation. If this is achieved, then the objective is to maintain this low and stable level of inflation; consequently, this increases monetary credibility that provides a firmer anchor for expectations of inflation and this, in turn, affects price adjustment. When economic behaviour changes, the central bank must adjust its reaction in order to reap any benefits and avoid any increase in volatility that may endanger stable inflation and output. However, when economic behaviour changes, then it should be examined whether there are implications for efficient monetary rules. According to Amano *et al*. (1999), of all the rules, special attention should be paid to one specific class of monetary rules that are popular among all inflation targeting rules. These are rules that call for the central bank to raise or lower short-term interest rates, when the rule for a consistent forecast of inflation is above or below the inflation target.

In general, the central bank should adjust its reaction function in order to maintain the gains from credibility. In actual policymaking, the central bank regularly monitors and analyses information regarding inflation expectations as reflected in surveys or financial market prices. Apart from this, inflation forecasts are at the centre of interest for the central banks, since they are important for policy decisions.

As already mentioned, monetary policy rules are a means towards an effective monetary policy which ensures macroeconomic stability. However, in order for the monetary policy to be effective, rules should be sufficiently operational and flexible to capture any changes in economic behaviour or absorb any shocks. Clarida *et al*. (2000) explore the role of monetary policy and identify how monetary policy differed before and after Volker being the Fed chairman in the United States in 1979 by estimating policy rules in these two periods. Specifically, the evaluation is conducted by estimating a general rule that incorporates the federal funds rate as an instrument of monetary policy. The rule concerns the adjustment of the funds rate to the gaps between expected inflation and output and their respective target levels. A special feature of the specification is the assumption of the forward-looking behaviour of the central bank.

The difference between policy rules across time is their response to expected inflation. In the pre-Volker period, the Federal Reserve raised the nominal rates, but not at that level in order to cover the increase in expected inflation; consequently, the real interest rates became low. On the contrary, during the Volker period, the increase in expected inflation was taken into consideration, thereby resulting in a rise in the nominal interest rates that responded to higher expected inflation. Thus, the antiinflationary stance of the Fed was stronger in the Volker period and resulted in macroeconomic stability. One possible reason for following an inferior rule in the pre-1979 period is that the Fed believed that the unemployment rate was lower than it actually was. Another explanation is that neither the Fed nor those in the economics profession understood the dynamics of inflation very well. In such cases, in order to achieve necessary results, one should take into consideration the level of the policymakers' knowledge of the economy.

Some empirical evidence regarding the reaction of major central banks is presented in Clarida *et al.* (1997). Specifically, they estimate monetary policy reaction functions for two sets of countries: G3 that includes Germany, Japan and the United States and E3 that includes the United Kingdom, France and Italy. The rule that emerges for G3 is inflation targeting, which resulted in stabilisation. On the contrary, E3 attempted to gain stability and credibility through fixed exchange rates, the result of which was the loss of monetary control. These results indicate that inflation targeting may be considered as alternative to flexible exchange rates (King, 1996; Tabellini and Persson, 1996).

Monetary policy rules were originally designed to fit the specific economic and institutional features of large and relatively closed economies. The question is whether these rules, after being modified appropriately, can be successfully imported to smaller and emerging economies, which are characterised by trade dependence and less-developed financial markets, more vulnerability to external sources of uncertainty, strong movement in productivity and relative prices, as well as destabilising exposure to volatile capital flows. Alternatively, it should be investigated whether the response of the instrument to inflation and output gap changes, depending on the degree of openness and size of a country. The answer to this question is given by Laxton and Pesenti (2003) who examined and contrasted the implications of alternative monetary rules in economies that differ in size and degree of openness. The results indicate that some rules do not perform well in small, open economies. Specifically, the original Taylor rule or the simple inflation forecast-based rule (IFB) may be inefficient when applied in small, open economies, since they respond too weakly to inflation forecasts and too strongly to movements in the output gap. In this case, a modified IFB rule would be more appropriate – a rule that would respond better to inflation forecasts and therefore produce better macroeconomic performance in small, open emerging economies. However, the authors emphasise, that these results should not be used as a general conclusion for all emerging countries, but as a benchmark for the analysis of monetary rules across heterogeneous economies. Therefore, to use the specific model in other economies, country-specific and institutional factors must be taken into account.

An important feature taken into consideration when competing frameworks are compared, is the manner in which and the degree to which they absorb unexpected shocks. The latter generate deviations from expected macroeconomic paths when the instruments are set or the target values are chosen. They may arise from imperfections in forecasting models, unpredictable external events, and diverging behaviours of agents. If policies are governed by fixed rules, then it is difficult for the shocks to be absorbed and lead to new decisions. On the contrary, if targets are periodically revised, the next step can be based on the observations and shocks.

According to Tobin, shocks can be distinguished into three types: real demand shocks, financial shocks and price shocks. More specifically, real demand shocks affect the aggregate demand for goods and services and may arise in consumer spending, investment, net exports and fiscal operations. Financial shocks affect the demand for monetary assets relative to their portfolio substitutes, whereas price shocks affect current and expected prices of goods and services and may arise in domestic wage and price settings (Tobin, 1983).

Devereux (2004) demonstrates the manner in which monetary rules respond to specific kinds of shocks. Specifically, he compares monetary policy rules, which allow for differential degrees of exchange rate targeting (fixed and floating), in a sticky-price dynamic stochastic general equilibrium model with capital accumulation. He examines two types of shocks: country-specific supply or demand policy shocks. In Devereux's model, allowing the exchange rate to float prevents monetary rules to respond to particular types of shocks, contrary to fixed exchange rates that perform better by increasing employment, long-run GDP and welfare. In particular, according to his model, a cooperative exchange rate peg leads to higher welfare in contrast to a floating or one-sided peg. The above-mentioned results are due to country-specific supply or demand policy shocks. When examining government spending shocks, it can be shown that they do not have any effect on the welfare comparison between fixed and floating exchange rates. Since there is no response to this type of shocks, a passive floating exchange rate regime does not improve welfare relative to a peg; therefore, a cooperative peg continues to dominate.

Conclusively, central bankers cannot administer mechanical rules, which are independent of actual and prospective economic conditions. It should be noted that instrument settings, targets and operating rules are not permanent. On the contrary, central bankers should regularly take into account and evaluate various deviations from the target. New information need to be considered, and shocks must be examined and absorbed into the rule. It is important that the fundamental objectives of rules and monetary policy are generally understood, as well as that policymakers should reconsider whether their policies attain their goals – that is, whether the monetary policy is effective. As Tobin argues, ‘the monetary policy cannot by governed by fixed rules blind to actual economic developments, monetary authorities cannot escape their responsibilities for real economic outcomes of significance to the society, the choices of targets should be guided by the ways they interact with economic and financial structure to convert shocks of various kinds into macroeconomic outcome and by the probabilities of the several kinds of shocks’.

Finally, an additional and important aspect concerning monetary policy is that it should not be designed in isolation from the fiscal policy, but in cooperation with it, since monetary strategies, targets and projections need to be consistent with those that fiscal policy is based on. The two types of macroeconomic policy should not be made by separate governments, which may either not communicate at all or rarely communicate. On the contrary, monetary and fiscal policy must be designed and implemented in coordination and cooperation, to obtain the best outcome.

2.4. Credit Frictions

Conventional models of monetary economics do not allow financial intermediation and credit frictions to be incorporated into macroeconomic analysis in a straightforward manner. The role of banks and financial intermediaries has been, in general, passive. They were mostly used as a channel by central banks to transmit monetary policy to the economy. As Adrian and Shin (2010) indicate, the common friction in standard models is the sticky prices of goods and services.

Traditionally, money plays an important role in the monetary theory for understanding the determination of the general level of prices and average inflation rates. The general idea of the money view is that there are no perfect substitutes for money. Hence, the demand and supply for money determine the short-term interest rate that affects investment and output. Moreover, this view emphasizes the special nature of liabilities of banks' balance sheets, since money supply mainly comprises bank liabilities (Gertler and Gilchrist, 1993). However, this does not imply that money is the most important indicator of the impact that the financial sector has on the economy.

In contrast to the money view, the credit view emphasizes the asset side of the banks' balance sheets. This view distinguishes the different roles played by financial assets and liabilities. It also divides different non-monetary assets into either bank versus non-bank funding sources or internal versus external financing in general. This implies that unlike the money view, the credit view does not aggregate all non-money financial assets into a single category.

Credit market frictions were introduced in the literature to analyse the response of credit to tight money. Apart from price stickiness, two additional hypotheses form the basis of the credit channel. The first is the ability of central banks to control loan supply through reserve requirements on deposits, and the second is the condition that there are borrowers – particularly households and small firms – who depend on bank credit. Both these conditions hold due to informational frictions. It is difficult and expensive for a large class of borrowers to fund their needs through sources other than banks, such as issuing securities on the open market. Since borrowers have more information regarding themselves than lenders, the latter would have to bear high monitoring costs, which consequently is costly for individual investors. On the contrary, financial intermediaries are able to bear monitoring costs and build a long-term relationship with their borrowers, which enables them to collect even more information throughout their cooperation. This long-term relationship provides borrowers the advantage of lower costs, which makes it difficult for them to switch between different financial intermediaries. Hence, since they depend primarily on banks for finance – particularly small firms – the impact of a contractionary monetary policy decision on the flow of credit affects the real economy.

The first hypothesis underlying the credit view – central banks' control of legal reserve requirements – has received considerable criticism. Romer and Romer (1990) argue that in the case of tightening monetary policy, banks can avoid restricting their loan supply by issuing Certificate of Deposits (CDs) or other types of managed liabilities. Another argument criticizing this hypothesis is that banks are able to offset any reduction in deposits by selling assets, a certain amount of which banks hold as a liquidity buffer, such as government securities or securitized loans sold on secondary markets. Although the above should be taken into account, there are other considerations that may be regarded as counterarguments. Specifically, even though there are no longer any reserve requirements on managed liabilities, past experience has shown that central banks reinstate them when needed, particularly in periods of tight money, when the contraction of bank credit is required. In addition, banks – particularly the small ones – are not able to raise large CDs because they have less access to the market due to informational asymmetries. Moreover, selling more CDs raises the default risk of a bank. With regard to the liquidity buffer, it is not profitable for banks to hold large amounts of these assets (T-bills for instance) as their return is relatively low.

Further, the broader aspect of the credit view emphasizes that if there are monitoring or agency costs that are associated with information asymmetries, then investment may be sensitive to other variables such as net worth or cash flow (Walsh, 2010). This implies that the effect of monetary policy on the economy may be even stronger if balance sheets are already weak. Overall, the presence of credit imperfections is critical to the presence of the credit channel. Imperfect information between the counterparts in credit relationships determines the role of credit effects in the monetary policy transmission mechanism. As Walsh (2010) states, "the information that each party to a credit transaction brings to the exchange will have important implications for the nature of credit contracts, the ability of the credit markets to match borrowers and lenders efficiently, and the role played by the rate of interest in allocating credit among borrowers."

As already mentioned, the credit view emphasizes the special role played by banks in the financial system, particularly when information asymmetry problems are pronounced. The theories of credit frictions are based on moral hazard, adverse selection and monitoring and agency costs. With regard to moral hazard, problems may arise when the borrower's behaviour depends on the terms of the loan contract. Supposedly, the lender cannot monitor the borrower's choice between projects of differing risk; moreover, in the case of higher loan rates, borrowers would invest in riskier projects, thereby lowering the lenders' expected return in this manner. The adverse selection problem occurs when different types of borrowers seem identical to lenders and hence the latter offer borrowers the same loan contract. If lenders were able to distinguish between several types of borrowers according to the riskiness of their projects, lenders would offer different interest rates. More explicitly, borrowers with riskier projects are willing to borrow if rates rise, which is in contrast to those with less risky projects. However, due to information asymmetries, lenders are unaware of the ex ante quality and, hence, adverse selection occurs.

An additional theory of credit market imperfections is based on monitoring costs that financial intermediaries have to bear because of the possibility that borrowers have of faking bankruptcy. Therefore, financial intermediaries are able to reveal those entrepreneurs that fake bankruptcy and hence offset this incentive by subjecting them to a monitoring process (Ellison-financial frictions). Finally, agency costs rise when the lender is not able to share the borrowers' information or monitor their actions. During downturns, firms are forced to turn to external sources of funds due to the decline in internal funds. However, the deterioration of the borrowers' balance sheet makes external funding sources more expensive since agency problems become more intense. This contributes to recessions by further contracting investments. Overall, credit market imperfections affect the economy by amplifying the impact of shocks to it through financial markets that do not work perfectly (Walsh, 2010).

However, credit market imperfections were not incorporated into conventional models of monetary economics. These models assume frictionless markets and, hence, financial intermediaries play a passive role in the economy. Contrary to this traditional notion regarding the inactive role of financial intermediation, Adrian and Shin (2010) argue that financial intermediaries drive the financial cycle. This is achieved by influencing the determination of the price of risk. They claim that the net interest margin, which is determined as the difference between the total interest income and the interest expense, indicates the profitability of bank lending; on the other hand, the term spread indicates "the marginal profitability of an extra dollar of loans" on the balance sheet. Furthermore, the net interest margin increases the present value of bank income and consequently the forward-looking measures of bank capital. The boost in bank capital implies that banks have greater risk-bearing capacity, which enables them to make marginal loans feasible – something that would not happen before the boost in capital – and hence increase lending. Therefore, as banks expand their balance sheets, the price of risk decreases. Consequently, the components of banks' balance sheets can be considered as indicators of their risk-bearing capacity and, therefore, the marginal real project that receives financing. In this manner, Adrian and Shin (2010) describe the role banks play in determining the level of activity in the real economy.

Monetary policy can affect the rate of growth of financial intermediaries' balance sheets and therefore their risk-bearing capacity and consequently the supply of credit. In other words, monetary policy affects the decisions that depend on the price of risk in the economy. Specifically, monetary authorities determine short-term interest rates by varying the target rate. This, in turn, varies spreads, such as term spreads and other credit spreads that are used as proxies for the profitability of financial intermediaries. The impact of lowering interest rates on the banks' profitability is an issue that was raised again during the recent financial crisis due to its consequences on the recapitalization of the banking system from their dangerously low levels.

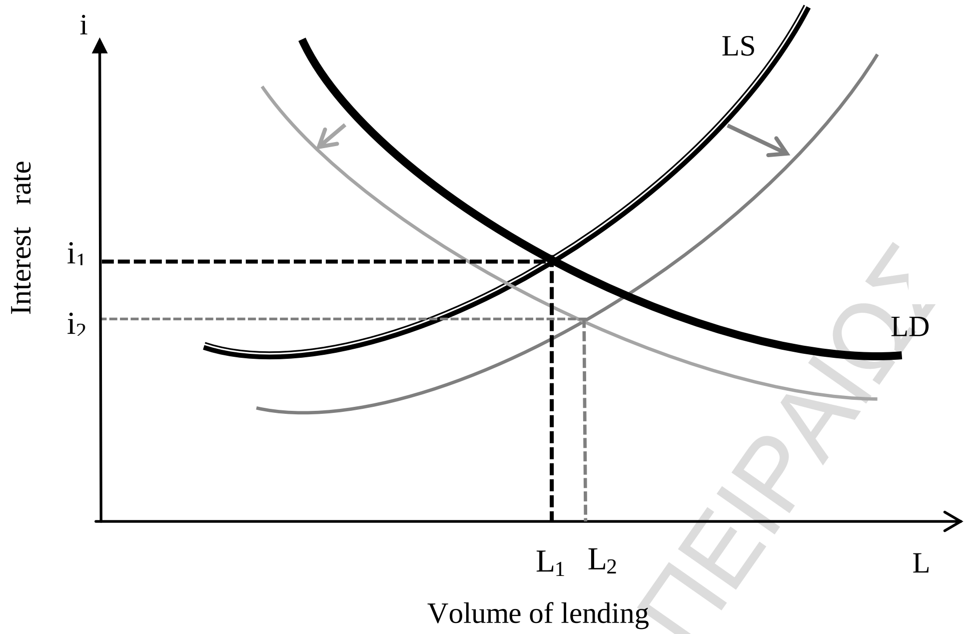
Contrary to conventional models of monetary policy, Woodford (2010) also argues that financial intermediation is significant and macroeconomic models should be reconstructed to confront the current reality. Traditionally, these models use a single interest rate that is determined in the credit market. In this market, the supply of loans determines the amount of loans that savers are willing to offer for different interest rate levels, whereas the demand for loans shows the amount of funding for each level of the interest rate that borrowers are willing to pay. Therefore, for different levels of the interest rate, the savers and the borrowers defer their current spending.

In the simple model generated by Woodford (2010), the loan supply and demand are specified assuming a specific level of aggregate output Y. This implies that if output and, therefore, income changes, the loan supply and demand will change as well. Specifically, a higher level of income should increase loan supply, whereas the demand for loans would decline since borrowers are able to finance their needs with their available current income, which is higher. This is presented graphically in Figure 1A, where the *LS* curve is the loan supply, *LD* is the demand for loans, and finally i_1 and L_1 are the market-clearing interest rate and equilibrium volume of lending, respectively; i_2 and L_2 are the new equilibrium values when Y increases.

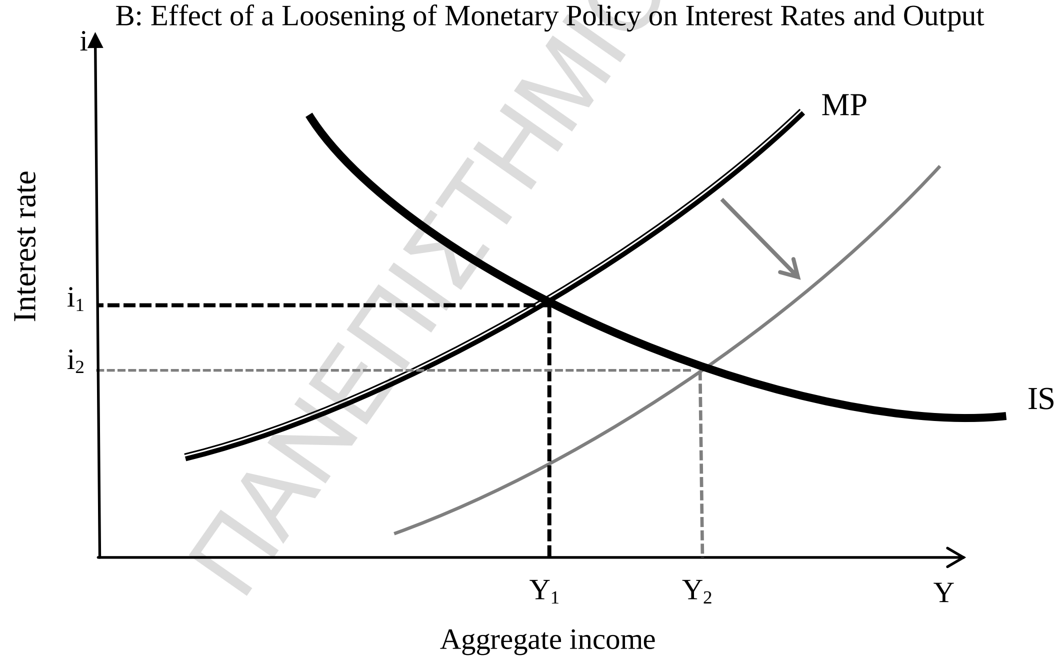
Curves *IS* and *MP* are plotted in Figure 1B. The *IS* curve shows the level of national income for which the supply of loans equals the demand for loans, at any given interest rate. On the other hand, the *MP* curve demonstrates the central bank's monetary policy reaction function. In other words, it shows the central bank's policy rate for each level of economic activity under the assumption of a given inflation rate.

Figure 1. Interest rate and output determination in the standard model

A: Effect of an Increase in Aggregate Income on Loan Supply and Demand



B: Effect of a Loosening of Monetary Policy on Interest Rates and Output



Notes: In panel A, *LS* is the loan supply schedule and *LD* is the loan demand schedule, which are specified holding constant aggregate income, *Y*. The arrows show how the curves shift with an increase in *Y*. Panel B shows an *IS* schedule, derived by tracing out the equilibrium interest rate for any assumed level of current income *Y*, and a monetary policy reaction function (*MP*), showing how the central bank's interest rate target will vary with the level of economic activity. The *MP* curve is drawn for a given inflation rate. The arrow shows the consequence of an exogenous shift in the policy reaction function that implies a lower interest rate for any given level of economic activity.

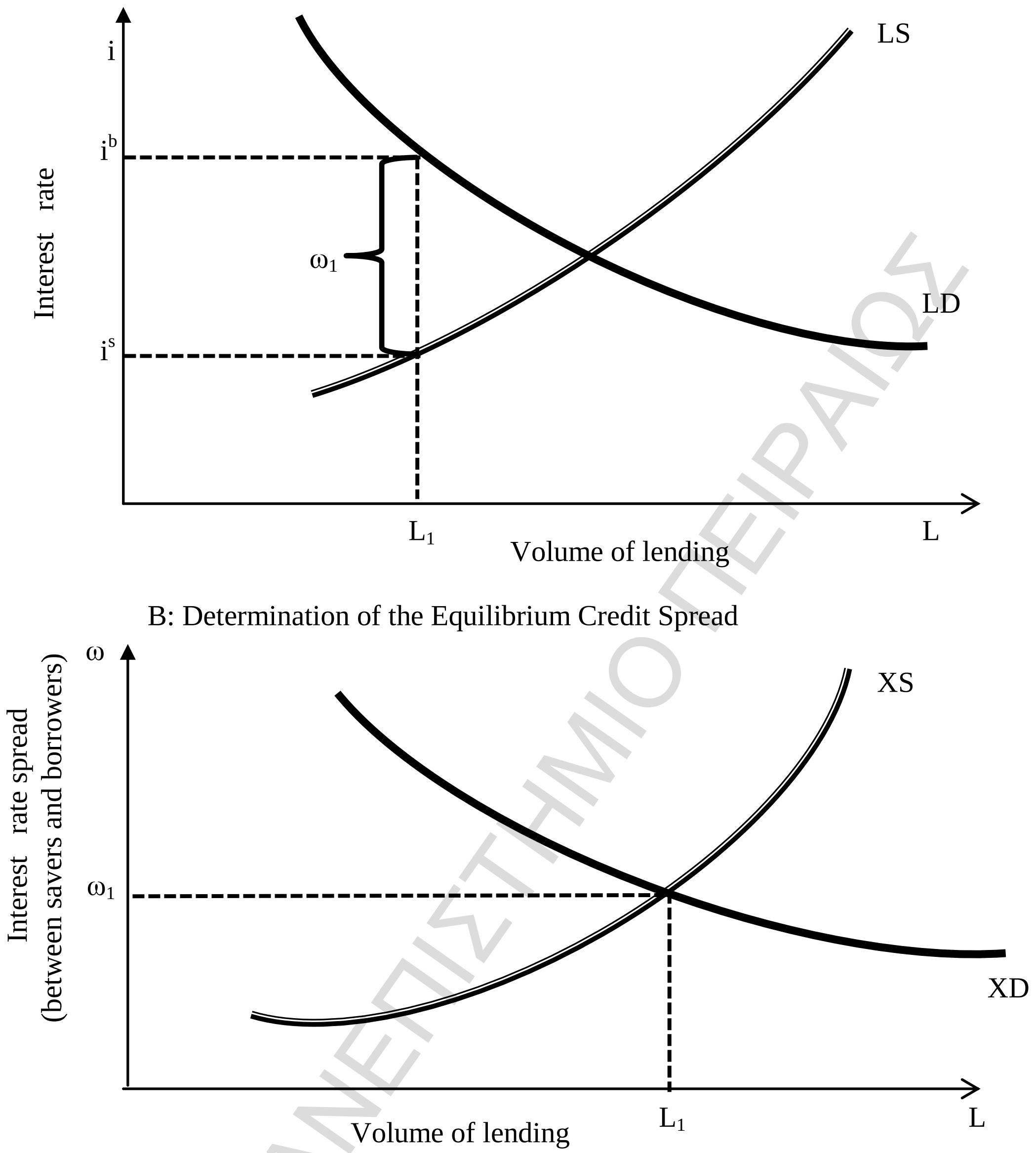
Source: Woodford M., (2010). Financial intermediation and macroeconomic analysis. Journal of Economic Perspectives, 24, 21-44.

Woodford (2010) expands the simple standard model mentioned above and incorporates multiple interest rates as well as financial intermediaries that transfer the funds from savers to borrowers. Actual economies have more than a single interest rate. In Woodford's (2010) model there are two interest rates: 1) the savings sate (i^s), at which savers fund financial intermediaries and 2) the borrowing rate (i^b), at which intermediaries fund the borrowers. In the case of multiple interest rates, the *LS* curve shown in Figure 2A determines the supply of funds for the intermediaries, whereas the *LD* curve represents the demand for loans by the borrowers. The equilibrium is accomplished at a point, which is different from the intersection of the two curves (Figure 2A). If interest rates change, then their difference (ω), which is the credit spread, changes as well, thereby modifying the volume of intermediated lending.

Figure 2B depicts the supply curve of intermediation (*XS*), that is, the amount of credit that intermediaries are willing to transfer from lenders to borrowers at each level of credit spread. On the other hand, the demand for intermediation (*XD*) determines how much above the saving rate the borrowers are willing to pay to induce savers to finance their expenditures. However, it must be noted that, as with the simple model, the level of supply and demand of intermediated credit at each particular level of interest rate spread is determined under a given level of income (*Y*). If *Y* changes, the *XS* and *XD* curves will shift. Therefore, a graph of the IS-MP model (Figure 3B) is derived, which is a model with credit frictions. The difference with Figure 1B is that the equilibrium interest rate refers to the interest rate paid to savers – that is, the rate at which intermediaries fund themselves – and is the one that corresponds to the target rate of the central bank. In other words, the *IS* schedule shows the equilibrium savings rate for any level of income (*Y*) under a certain assumption regarding the supply of intermediation.

Figure 2. Credit market equilibrium with credit supply frictions

A: Effect of a Credit Spread *ω_1* on the Equilibrium Interest Rates for Borrowers and Savers and on the Equilibrium Volume of Credit



Notes: i^s is the interest rate paid to savers, at which intermediaries are able to fund themselves, and i^b is the interest rate (the borrowing or the loan rate) at which ultimate borrowers are able to finance additional current expenditure. In this figure, *LS* schedule represents the supply of funding for intermediaries, the *LD* schedule is the loan demand schedule and these schedules are functions of two different interest rates. Hence the equilibrium level of lending *L* can be at a point other than the one where the two schedules cross, as shown in Figure A. *ω* is the spread between i^b and i^s. Given the *IS* and *LD* curves, we can determine the unique volume of intermediation that is consistent with any given spread *ω*. This relation between the quantity of the intermediated credit and the credit spread is graphed as the curve *XD* in panel B, which can be thought of as the 'demand for intermediation'. The corresponding 'supply of intermediation' schedule *XS* indicates the credit spread required to induce financial institutions to intermediate a certain volume of credit between savers and ultimate borrowers.

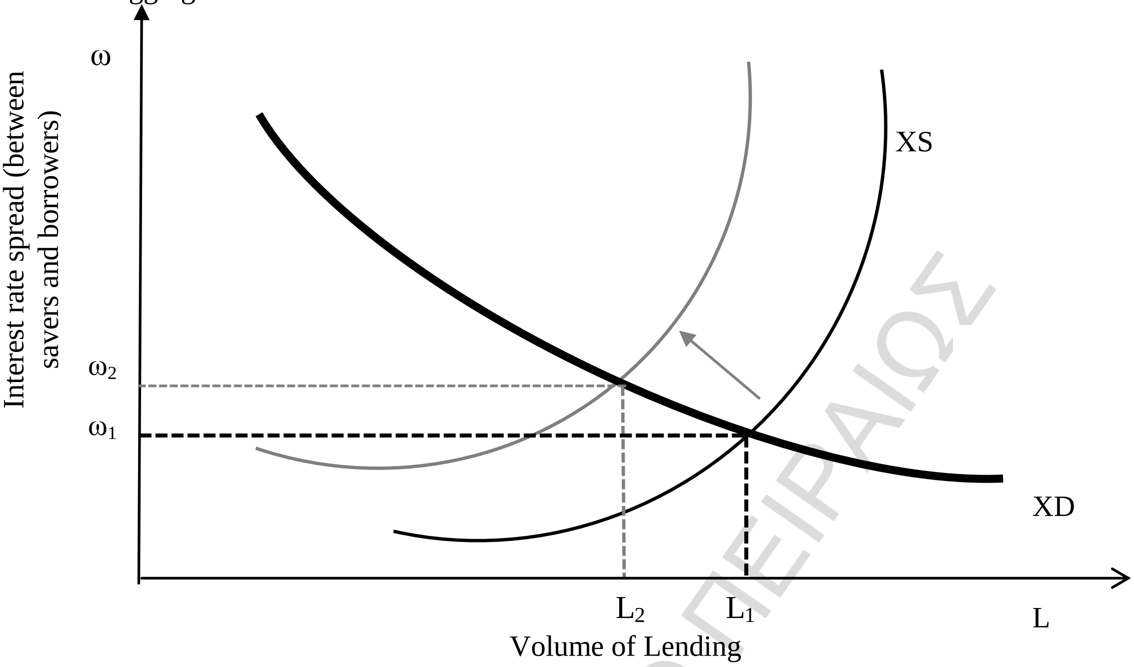
Source: Woodford M., (2010). Financial intermediation and macroeconomic analysis. Journal of Economic Perspectives, 24, 21-44.

Woodford's (2010) model, which includes credit frictions, is indicative of how disruptions in the supply of intermediation affect aggregate demand and, consequently, economic activity. Specifically, a negative effect in the supply of intermediation implies that at every level of interest rate spreads, intermediaries would supply less credit; this alters the equilibrium spread to become higher and the quantity of lending to become lower (Figure 3A). A larger spread implies a lower savings rate and a higher borrowing interest rate for a given level of income. Under the assumption that the monetary policy reaction function does not change, the decrease in the savings rate – which is considered the policy rate – leads to a contraction in economic activity, as shown in Figure 3B. Conclusively, Woodford (2010) shows how the supply of intermediation affects the target rate of central banks as well as economic activity. This paper suggests that the conduct of monetary policy should be modified to take into account the changes in interest rate spreads.

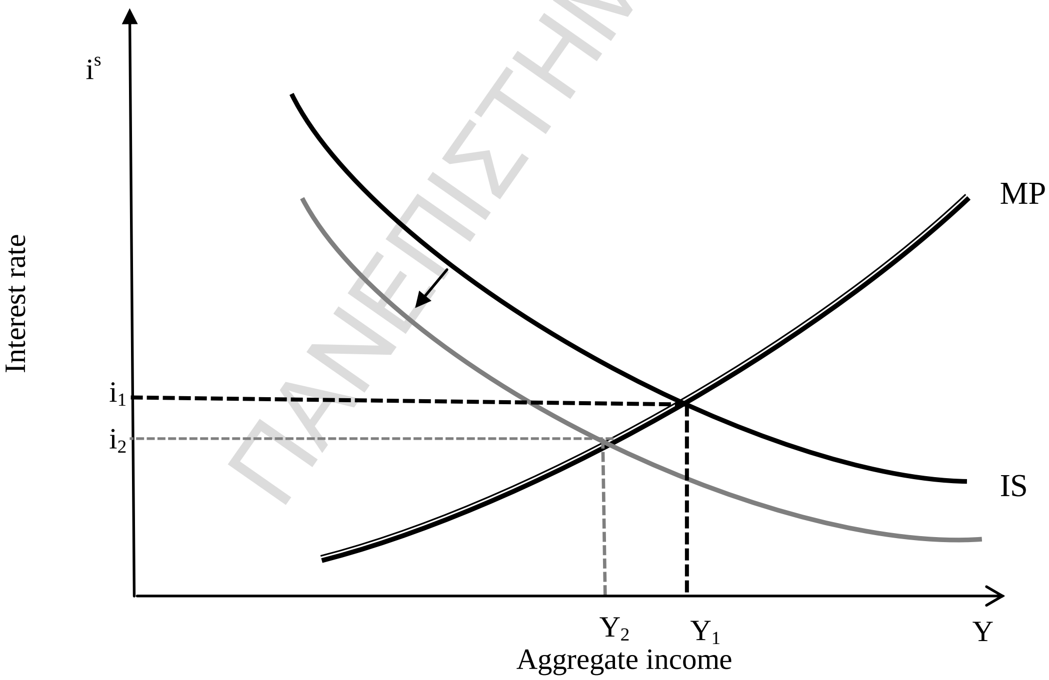
The adjustment for financial sector stress has also been proposed by Taylor (2008). Specifically, he suggested that a smoothed version of the spread between Libor rates and overnight fed funds rate should be subtracted by the interest rate target. These term rates impact the securities derived from sub-prime mortgages and other assets, and as Taylor and Williams (2008) document, the spreads are due to counterparty risk between banks. Taylor (2008) claims that this adjustment will provide more transparency and predictability than discretionary adjustment. This adjustment will be temporary until counterparty risk decreases to normal levels. Hence, when banks are better able to handle their counterparty risk, they will lend 'more freely' and spreads will decline. A similar adjustment was proposed by McCulley and Toloui (2008), who suggested the decline of the funds rate when credit spreads rise. This process should be followed to prevent an increase in credit spreads 'from effectively tightening monetary

Figure 3. Effects of a Disruption of Credit Supply

A: Effects on the Equilibrium Credit Spread *ω* and Volume of Lending *L f*or a Given Level of Aggregate Income *Y*



B: Effects on the Equilibrium Policy Rate and Aggregate Income, Taking into Account the Monetary Policy Reaction



Notes: *XS* and *XD* are the supply and demand for intermediation. *ω* is the spread between i^b, the interest rate for borrowers, and i^s, the interest rate for savers. The *IS* schedule shows the equilibrium interest rate for any assumed level of current income *Y*, and *MP* is the monetary policy reaction function (*MP*).

Source: Woodford M., (2010). Financial intermediation and macroeconomic analysis. Journal of Economic Perspectives, 24, 21-44.

conditions' when the inflation or output gap cannot be justified otherwise.

Cúrdia and Woodford (2008) compare the standard New-Keynesian model with its extended version that incorporates the spread between the interest rate available to savers and borrowers. They find that the variation in spreads, and not just its mere existence, is of greater significance. The authors note that financial frictions affect the relationship between aggregate output and inflation, as well as the relationship between the expected path of the policy rate and aggregate expenditure; therefore, they should be monitored in real time. However, their study documents that the standard New-Keynesian model is able to provide a good approximation of optimal policy despite credit frictions. They argue that these types of frictions are not different from the types of shocks already considered in the standard New-Keynesian model.

In addition, Cúrdia and Woodford (2008) compare an unadjusted Taylor rule with a spread-adjusted one – that is, a Taylor rule, the intercept of which is adjusted in proportion to variations in spreads. As the authors state, the spread-adjusted Taylor rule can prescribe the right direction of adjustment when financial shocks occur, but a central bank should determine the type of disturbance in order to make the correct adjustment, rather than simply tracking spreads. Therefore, their results show some improvement over the simple Taylor rule. However, they argue that the spread-adjusted rule remains inferior to the targeting rule.

Another study by Cúrdia and Woodford (2010) uses the extended model mentioned above and modifies the Taylor rule to include a response to financial conditions in two different ways: an adjustment to variations in the credit spread and an adjustment to a measure of aggregate private credit. The former adjustment is superior to the simple Taylor rule, a finding similar to that of their previous study; however, the adjustment to aggregate credit is not helpful. The authors seem to favour a different approach – that is, the central bank adjust the policy target according to economic projections for inflation and real activity in order to take into consideration the impact of financial conditions on aggregate supply and demand.

Another ‘failure’ of the existing macroeconomic models is that during periods of crisis, an unconventional monetary policy is implemented. This is what Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) describe in their studies by attempting to analyse the Fed’s credit market interventions and capture the relevant key elements. They note that after the recent crisis, the Fed directly injected credit into the markets to offset a disruption of private financial intermediaries. Specifically, the current crisis deteriorated the balance sheet of financial intermediaries, which led to a sharp rise in credit spreads and tightened lending standards. This decrease in lending raised the cost of borrowing and enhanced the negative effects in financial and real activity, which motivated such central bank intervention. Although the authors recognize that central banks are not as efficient as private financial intermediaries, they claim that unconventional monetary policy should be used in periods of crisis since financial intermediaries tighten their lending because of the balance sheet constraints they face; on the other hand, central banks can obtain funds by issuing riskless government debt and injecting credit into private markets. This, of course, will be reversed as the economy returns to normal and financial intermediaries re-capitalize.

Overall, it is of great significance to consider credit frictions because they create additional uncertainty in the conduct of monetary policy and in the effect of interest rate changes on economic activity.

Chapter 3: Bank Efficiency and the Bank Lending Channel: Evidence from a Panel of European Banks

Abstract

This chapter examines two issues: First, it investigates the efficiency of the banking system in six European countries spanning the period of 1994 to 2008. The methodology used is the profit frontier methodology, following the approach suggested in Mester (1996), who indicates that financial capital should be taken into account. Furthermore total assets consist an additional variable that controls for size and is included in the model as well. Second, the chapter examines the impact of efficiency on monetary policy, through the bank lending channel, using the GMM estimator methodology suggested in Arellano and Bond (1991). The results indicate that when efficiency is explicitly included in the model, it weakens the operation of the bank lending channel.

1. Introduction

Over the last decades, banks operated in an extremely competitive environment, which forced them to become more effective in order to survive. Furthermore, recent period of crisis highlighted the importance of the bank lending channel. This paper attempts to examine whether and how banks affect the economic environment. This is accomplished by investigating the existence of the bank lending channel – whether monetary policy decisions are transmitted through it to the real economy. Moreover, the innovation and main objective of this paper is to examine whether bank efficiency and specifically profit efficiency has any impact on the operation of this channel.

There are two major views of the monetary transmission mechanism: the money and the credit view. The first theory is based on the notion that monetary policy can influence aggregate demand through interest rates, whereas the second theory supports the idea that monetary policy affects the economic activity by changing the availability and supply of loans (Hernando and Pages, 2001). A debate exists over the question whether the credit view can be considered separately from the money one. Empirical evidence indicates the difficulty of identifying quantitatively important effects of interest rates through the cost of capital and, therefore, it favors the presence of the credit channel (Bernanke and Gertler, 1995; Mishkin, 1995).

There exist two different mechanisms of the credit channel that affect loan supply: the bank lending and the balance sheet channel. According to Gambacorta (2005), the first mechanism "*stems from financial market incompleteness and relies on imperfect substitutability between bank loans and privately issued debt*". Therefore, it operates through banks and specifically, through loan supply. The operation of the balance sheet channel, however, depends on the impact that monetary policy has on the financial situation of a borrower, due to asymmetric information in credit markets. Particularly, contractionary (expansionary) monetary policy weakens (strengthens) the borrowers' balance sheet by decreasing (increasing) the collateral value of their assets (Kishan and Opiela, 2000). Hence, adverse selection problems decrease lending, which is aimed to finance investment. An additional impact of restrictive monetary policy is the net worth decrease, implying that owners' equity stake in firms becomes lower, which in turn initiates moral hazard. This means that owners have more incentives to undertake risky investments, increasing this way the likelihood of not paying back the loans. Banks, however, being familiar with this possibility, decrease their loan supply and consequently, investment spending also declines.

Many surveys have analyzed bank efficiency in conjunction with economic growth and state that a sound financial system fosters economic growth and vice versa (King and Levine, 1993; Koetter and Wedow, 2010; Lucchetti *et al.*, 2001; Minsky, 1986; Moore, 1988). According to Lucchetti *et al.* (2001) banks affect economic growth by recognizing the most innovative entrepreneurs and therefore allocating their financial and real resources in the most efficient and productive way. Koetter and Wedow (2010) argue that the "major shortcoming" of previous studies is the use of quantitative variables – such as size, liquidity and capitalization – to analyze the relationship between financial development and economic growth. On the contrary, Koetter and Wedow (2010) suggest an alternative variable: the efficiency of the banking sector, which can be considered as qualitative characteristic. Specifically, bank efficiency measures the performance of a bank relative to the performance of a best-practice bank under the same exogenous conditions. Therefore, ranking of banks becomes feasible, whereas it proves to be useful for government policy (by showing the effects of deregulation or mergers), as well as for the identification of best and/or worst practices, which leads to improvement of managerial performance (Berger and Humphrey, 1997).

Extensive literature investigates the relationship between quantitative bank-specific variables and loan supply, but, to the best of my knowledge, very few papers examine the connection between the bank lending channel and a qualitative characteristic – such as bank efficiency – in a theoretical or empirical manner. This paper combines two strands of literature: bank efficiency and the bank lending channel and it contributes to the investigation of the relationship between bank-specific characteristics and the lending channel by examining, however, a qualitative characteristic, which is bank efficiency. Specifically, we investigate whether efficiency affects the operation of the lending channel in any way and, consequently, the impact that a monetary decision may have on economic activity.

A similar study combining bank efficiency and the bank lending channel was conducted by Jonas and King (2008). They use frontier approach for a panel data of US banks to estimate cost efficiency, spanning the period of 1984 to 2005. Their results indicate that banks, which are cost efficient, react more to a monetary policy shock. A difference between my study and theirs is the region under examination, and specifically, this analysis focuses on European banks, whereas the research by Jonas and King (2008) investigate US banks. The main difference, however, concerns first, the type of efficiency that is estimated and second, the results in the two surveys, which contradict to one another. With regard to the latter, in Jonas and King's paper, cost-efficient banks decrease loan supply more than inefficient banks, when the federal fund rate increases, whereas in this analysis it is efficient banks that are able to offset monetary policy shocks. A possible explanation is the different type of bank efficiency that is examined. Specifically, this paper estimates profit efficiency, whereas Jonas and King investigate cost efficiency. The estimation of efficiency in profit terms is a more complete method compared to cost efficiency, since it takes into consideration the effects of production on both the cost and the revenue side. Therefore, high-quality banks – which in terms of cost may seem inefficient – are not penalized, since they achieve higher revenues and consequently they are compensated for any cost "inefficiency"[1] (Maudos *et al.*, 2002).

[1] The study by Berger and Mester (1997) indicates that profit efficiency is negatively correlated with cost efficiency, whereas the opposite happens between revenue and profit efficiency (Rogers, 1998). This may

Furthermore, Jonas and King divide banks in three groups of different levels of efficiency and investigate the existence of the lending channel in each of these groups separately. The difference and innovation of this analysis, is that bank efficiency variable is incorporated into the model for the estimation of the bank lending channel as an additional variable and specifically as a qualitative bank-specific characteristic.

The empirical analysis of this paper yields that the bank lending channel is weaker when banks are profit efficient. Efficiency in profit terms is particularly emphasized to distinguish it from cost efficiency and the contradictory outcome of Jonas and King (2008) – their results indicate that cost efficient banks are more sensitive to monetary shocks. Profit efficiency concept is superior compared to cost efficiency, since it takes into consideration the effects of vector of production on both revenues and cost. Specifically, revenue inefficiencies, such as wrong choice of output or its mispricing, are as important as cost inefficiencies. Moreover, profit efficiency does not necessarily imply cost efficiency, since high-quality banks may be penalized, when they are evaluated according to cost efficiency only. As Berger and Mester (1997) point out, profit function is based on profit maximization, which is a more accepted economic goal and evaluates the overall performance of the bank.

Profit efficiency protects banks against possible monetary shocks, because it enables them to acquire liquidity buffer, and therefore they have the ability to draw down cash securities when needed, or build up capital above target, which enables them to have more access to markets for uninsured funding. This way the initial argument by Romer and Romer (1990) is confirmed – they claimed that banks could raise liquidity by issuing CDs or bonds, which are not subject to reserve requirements. In general, an efficient bank is able to employ funds from sources other than deposits. Specifically, it

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constitute an additional explanation for the contradictory results of this survey and the one of Jonas and King (2008).

is capable of holding the appropriate amount of Certificate of Deposits (CDs), even though they are costly, or the appropriate amount of T-bills, which do not provide adequate returns, with the option of selling them in the case of a negative monetary shock and compensate, therefore, for the decrease in liquidity, following a decline in reserves. An additional source of funds would be external finance from the capital market.

Overall, an efficient bank is considered as more capable of managing its funds in a better and more productive way, as well as reallocate them when needed. Therefore, the condition of bank dependence on the actions of central banks, which is a prerequisite for the existence of the bank lending channel, does not hold in the case of efficient banks, which are able to raise funds from alternative sources. Furthermore, long lending relationships with borrowers, contribute to efficiency by reducing informational asymmetries and risk exposure of banks. Conclusively, an efficient banking sector contributes to the stability of the financial system by handling negative shocks.

The rest of the paper is organized as follows. Sections 2 and 3 report a short analysis of the concepts of the bank lending channel and bank efficiency, respectively. Section 4 describes the data whereas the econometric methodological approach is described in Section 5. Section 6 presents the results and finally, Section 7 concludes.

2. The bank lending channel

Literature concerning the bank lending channel, investigates whether the decisions of monetary authorities are transmitted through it and the impact they may have on economic activity. This channel operates through the supply of loans. Specifically, contractionary (expansionary) monetary policy results to a decline (increase) in bank reserves and deposits and, hence, loan supply decreases (increases) as well. Therefore, consumers and firms, who depend on bank lending, reduce (increase) purchases of durable goods and investment capital and consequently output declines (increases) (Golodniuk, 2006).

For the bank lending channel to operate, three certain conditions are required. First, borrowers must depend on bank lending and not be indifferent to various types of finance. That is, they must not be able to replace bank loans with other types of funding, when monetary authorities follow contractionary monetary policy and therefore, loan supply declines (Oliner and Rudenbusch, 1995). If borrowers are indifferent between various types of financing, the decrease in loan supply has no particular impact on the economy. Second, central banks must affect the supply of loans through the changes they impose on the volume of reserves. Therefore, under this assumption, in the case of restrictive monetary policy, banks are not able to offset the decrease in funds, which are raised from deposits, by raising funds from alternative sources (Oliner and Rudenbusch, 1995). Finally, the third condition is common for both bank lending and interest rate channel: imperfect adjustment in aggregate price level. The latter condition is a prerequisite, because if prices could adjust by the same percentage every time money supply is changed, monetary policy would not be effective (Golodniuk, 2006).

The existing literature on the bank lending channel investigates its operation in different economies or in a group of countries. Specifically, it examines whether the effect on lending responds differently, depending on the strength of a bank, as it is determined by specific characteristics, such as asset size, capitalization and liquidity. The empirical evidence supports the idea that well capitalized and liquid banks are less affected by monetary policy changes than banks that exhibit low capital or liquidity ratios. Furthermore, most studies indicate that both small banks and large banks exhibit similar levels of sensitivity to monetary policy shocks (Gambacorta, 2005; Golodniuk, 2006; Peek and Rosengren, 1995). Other studies, though, argue that large banks in conjunction with high capitalization ratios are less responsive to monetary policy shocks (Kishan and Opiela, 2000).

However, empirical investigation had an important problem to overcome: the difficulty to disentangle among supply and demand factors, that is to identify whether the effects on output are caused by shifts either in loan supply or in loan demand. The fact that both output and bank loans decrease after a negative change in monetary policy does not necessarily imply that it reflects a shift in loan supply (Brissimis *et al.*, 2001; Oliner and Rudenbusch, 1995). On the contrary, these changes may be caused by a shift in loan demand. For example, tight monetary policy increases interest rates and consequently costs become higher – which does not favor investments – affecting directly loan demand, which decreases and therefore, volume of loans declines as well. To resolve this issue, literature uses individual bank data, claiming that certain bank-specific characteristics have impact on loan supply movements, whereas the demand for loans (from borrowers) is mostly independent of them (Altunbas *et al.,* 2009). Additionally, macroeconomic variables – such as the GDP growth rate, housing and stock price changes or inflation – are used to take into consideration country-specific institutional characteristics and loan demand shifts. In other words, macroeconomic variables control for demand effects (Gambacorta and Marques-Ibanez, 2011; Kashyap *et. al*., 1993).

3. Bank efficiency

During the course of the last few decades, banks have been operating in an extremely competitive environment. Therefore, it is important for them to consider – among other factors – certain characteristics, which might ensure their survival. These bank-specific characteristics, on which recent literature has focused, are mostly quantitative, such as liquidity, capitalization and size. However, banks should take into consideration qualitative characteristics as well and efficiency constitutes one of them. This variable has always been regarded as an "asset" to the banking system, but was not given priority, due to certain circumstances, which enabled banks to operate profitably without worrying about efficiency. Changing economic conditions, however, affected banks' structure, performance and functioning and necessitated adaptation to the new times, a crucial matter for their survival. An efficient banking sector is assumed to absorb any negative shock and therefore, contribute to the stability of the financial system.

A general concept of an efficient bank is that it converts the appropriate amounts of inputs and in the right proportions, into financial products and services. This way, a numerical efficiency value is provided, which allows the discrimination of banks into those that perform well from those that perform poorly. Hence, the evaluation and ranking of banking performance becomes feasible. According to Berger and Humphrey (1997) this is "a sophisticated way to 'benchmark' the relative performance of the production units". Alternatively, each bank's performance is estimated relative to the performance of a hypothetical best-practice bank, which, facing the same exogenous conditions as the bank under examination, would be on the efficient frontier.

Three types of efficiency are distinguished: productive, cost and profit efficiency. The first type is related to the output production. Specifically, the production plan is technically efficient if for a certain amount of inputs given, no additional unit of output can be produced. Alternatively, technical efficiency is accomplished when for a given amount of output, the least possible amount of inputs have been used in the production process (Favero and Papi, 1995). Accordingly, Hughes and Mester (2008) claim that a bank/firm is operating on its production frontier, when managers organize production in such a way, that output is maximized given the amount of inputs.

Cost efficiency estimates the ability of a bank to minimize costs taking the prices of inputs as given. In other words, this particular type of efficiency calculates the distance of each bank's cost from the cost of a best-practice bank, which is on the efficient frontier. The latter produces the same output under the same conditions, however at the lowest possible cost. If the estimated cost of the bank under examination, is higher than that of the best-practice bank and this difference cannot be explained by any statistical noise, then the bank is characterized as cost inefficient (Mester, 1996).

Finally, profit efficiency represents the ability of a bank to maximize its profits, considering the prices of inputs and outputs as given. Specifically, it implies output maximization (cost minimization), taking the level of expenditures (output) as given. This concept is broader than cost or productive efficiency, since its objective is minimization of production cost and simultaneously maximization of revenues. Therefore, under profit efficiency the effects of production are considered not only on the cost side, but also on the revenue side and hence, high quality banks – unlike cost and productive efficiency – are not penalized, since they are able to compensate for this cost "inefficiency" by achieving higher revenues, when compared with their competitors (Maudos *et al.*, 2002). Furthermore, this measure of profitability is considered more appropriate compared to simple accounting ratios, such as return on assets (ROA) or return on equity (ROE), since an efficient profit frontier model takes into consideration differences in market prices and output mix[2] (DeYoung and Hasan, 1998).

Several studies consider economies of scale or/and scope as alternative types of efficiency measurement. Economies of scale refer to the relationship between the average cost per unit and the production volume and exist when average production cost declines, as output increases. On the contrary, economies of scope occur, when the joint cost of producing two complementary outputs is less than the combined cost of producing the two outputs separately. In other words, this term is associated to the lower cost of producing a group of outputs in a single bank, relative to the cost of producing them in different banks (Clark, 1988).

It has already been mentioned that efficiency enables banks to acquire liquidity buffer or build up capital above target and have access to markets for uninsured funding; in general, they are more capable of managing their funds in the best and most productive way. However, it could be argued that the previous methods, which an efficient bank employs, may contradict the regulatory constraints that aim to buttress banks' capital, since the effort to become efficient, due to increased competition may lead to greater risk taking. Regulators can force banks to increase their capital accordingly to the amount of risk taken. Furthermore, banks with higher levels of risk may hold additional capital buffers above the regulatory minimum, to avoid the costs

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[2] Bank efficiency is regarded more suitable than accounting ratios, such as average costs or ROE/ROA. For many years, these indicators showed remarkable differences in the efficiency of banks, due to the existence of low levels of competitiveness. However, liberalization process intensified competition among banks, indicating that the dispersion of costs and profits among banks and countries could no longer be justified by low levels of competition and therefore, the suitability of accounting ratios was questioned (Maudos *et al*., 2002).

that occur when they have to issue additional equity at short notice (Peura and Keppo, 2006).

A substantial number of studies have examined whether higher capital ratios reduce banks' risk as well as the effect that bank capital and efficiency have on bank risks (Casu and Girardone, 2009; Gropp and Heider, 2010; Fiordelisi *et al*., 2011). Hughes and Mester (1998) contributed to this by emphasizing the need to consider bank efficiency when the relationship between capital and risk is analyzed. They argue that the level of bank efficiency determines both capital and risk. Specifically, they claim that supervisory authorities may allow efficient banks a greater flexibility as regards their risk profile or their capital leverage, ceteris paribus. Along the same lines, Berger and De Young (1997) claim that banks with low levels of efficiency have inefficient control and inadequate credit monitoring of operating expenses and hence, higher costs. Therefore, reductions in cost efficiency lead to problem loans and vice versa, especially in thin capitalized banks. Furthermore, according to Jeitschko and Jeung (2005), in banks with low levels of capital, which are considered inefficient, managers have moral hazard incentives to take on more risk, whereas in better capitalized banks, they have less such incentives and hence they are more likely to adopt practices that reduce costs. Moreover, there exist additional studies which provide evidence that capital and efficiency are determinants of bank risk (Kwan and Eisenbeis, 1997; Williams, 2004). Fiordelisi *et al*. (2011) show that lower bank efficiency leads to higher bank risks, whereas efficiency improvements result in better capitalized banks and vice versa. That is, increases in bank capital precede cost efficiency improvements, since moral hazard incentives tend to decrease, when bank capital increases. This indicates that it is more probable for better capitalized banks to reduce their costs. Overall, Fiordelisi *et al*.

(2011) argue that it is important to achieve long-term efficiency gains, which support financial stability objectives.

Regarding the estimation of bank efficiency, there are two types of approaches: parametric and non-parametric. Both approaches require the specification of a frontier and study the best-practice production/cost/profit frontier. One main difference between the approaches is that the parametric approach requires the econometric specification of a statistical function, whereas the non-parametric approach provides a linear frontier by enveloping the observed data points (Drake and Hall, 2003). However, an important drawback of the latter approach is that it does not take into consideration factors, which are not under the control of management, measurement errors and other random factors. Therefore, any difference between the estimates of the bank under examination and the best-practice bank are considered to exist solely due to this particular bank's inefficiency. In this analysis stochastic frontier approach is used, implying that the inefficiency term is separated from random errors, contrary to the non-parametric approach.

4. Data description

A balanced sample of 611 commercial and savings[3,4] banks from six European countries is used. The countries in the sample are Austria, Belgium, Denmark, France, Germany and Luxembourg, which are reported in Table 3.1 with the respective number of banks.

[3] The purpose of using the specific sample is to include financial institutions that offer as near-identical as possible products and services. Investment banks are omitted, due to their high dependence on non-interest sources of income.

[4] These banks were in continuous existence over the period under examination; they had no questionable or missing data on any of the variables used. Berger and Mester (1997) do the same and claim that any differences observed, would not reflect any differences in the data set, but rather the impact of changes in measurement techniques, concepts and potential correlates that are used. Maudos *et al*. (2002) use balanced panel of 832 European banks as well.

A two-step approach is followed in the empirical analysis: efficiency estimates of each country's banking system are initially derived, and then, these estimates are included into the model for the investigation of the bank lending channel. The definition of the dataset is described following this two-step approach.

4.1. Bank efficiency data description

For the estimation of bank efficiency, balance sheet and income statement annual data, obtained from the BankScope database, is used. A certain advantage of this database is the standardized form at which the accounting information at the bank level is presented – after adjusting for differences in accounting and reporting standards across countries. The period under investigation spans year 1994 to year 2008.

The dependent variable is each bank's profit and is specified as the sum of interest income plus non-interest income minus the sum of interest expenses plus non-interest expenses. A debate over the appropriate definition of bank output has taken place. Two main views exist: the "intermediation-" and the "production approach". The former approach considers financial institutions as intermediates in financial markets, that is they collect deposits and purchase funds, which, in turn, intermediate into loans and other assets. Therefore, according to this approach, deposits are treated as inputs. On the contrary, production approach regards financial institutions as producers of services, which are associated with individual loan and deposit accounts, and hence treats deposits as output (Clark, 1988; Sealey and Lindley, 1977).

This study adopts the intermediation approach, which considers balance sheet items to be adequate indicators of output and also treats deposits as inputs of banks' production process. Besides deposits, labor and fixed assets are considered as inputs for the production process of a bank, as well. However, according to the alternative profit function (which is described in section 5.1), the prices of the inputs – and not the inputs themselves – are used as independent variables for the estimation of bank efficiency. Specifically, the price of deposits (w_1) is computed by dividing total interest expenses by total deposits, the price of physical capital (w_2) is denoted as other operating expenses divided by fixed assets and finally, the price of labor (w_3) is estimated as the ratio of personnel expenses to total assets[5]. Furthermore, total loans and total securities are used as independent variables as well, and are considered as outputs[6] of the production process, on which the bank's profit depends on.

Total assets and financial capital control for size and risk respectively and are used as additional inputs for the estimation of bank efficiency. Table 3.2 reports total assets in each European country as a percentage of the sum of total assets in all countries of the sample. On the contrary, the probability of default depends on the composition of bank's assets and its ability to absorb any failed investments, which is achieved through financial capital (Maudos *et al.*, 2002). The latter is included to account for the risk of insolvency and differences in risk preferences, which affect efficiency estimates (Berger and Mester, 1997; Mester, 1996). Specifically, financial capital is treated as input, since it provides cushion against losses, whereas it can also be used to fund loans, as it can be considered substitute for deposits (Mester, 1996; 1997).

Regarding the model, its estimation is carried out using Frontier 4.1 software, which has been developed by Coelli (Coelli, 1996; Coelli *et al.*, 1998). An important note that should be taken into account, is that the program does not tolerate missing values (Coelli *et al.*, 1998) and therefore, banks with incomplete data are not included

[5] As Maudos *et al*. (2002) mention, this is a common approximation in all studies using BankScope data. Regarding *PE* is the personnel expenses, *A* is the total assets and *L* is the labour, the variable can be interpreted as labor cost per worker, which is adjusted for differences in labor productivity: (PE/A) = (PE/L)(L/A).

[6] Off-balance sheet data are not used as outputs, since they are not available for all the institutions in the sample.

into the sample. Moreover, all data is corrected for inflation, which is estimated as the percentage change of the Consumer Price Index, obtained by the International Financial Statistics database.

4.2. Bank lending channel data description

The same sample of banks is used for the estimation of the bank lending channel. Total gross loans constitute the dependent variable and have already been derived by the BankScope database, as mentioned in the first part of the data description section (4.1). The period under examination spans from 1995 to 2008.

Short-term interest rates are used as a proxy for monetary policy indicator and are derived by the Datastream database. Finally, GDP growth and inflation rates for each country are obtained by the latter database to control for demand effects, that is, to isolate changes in total loans, which are caused by movements in loan demand. E-views 6 assisted this part of the analysis.

5. The econometric approach

5.1. Bank efficiency

Two profit functions are distinguished: the standard and the alternative one. The assumption underlying the standard profit function is that there is perfect competition in the markets of inputs and outputs. This implies that there is no market power on the banks' side and therefore prices are considered as exogenous. In this case, an efficient bank aims at maximizing its profit, by adjusting the amounts of inputs and outputs (Maudos *et al.*, 2002). In reality, however, perfect market competition is difficult to occur, allowing this way banks to have market power over the prices they charge. Therefore, in cases when perfect competition in pricing is questionable, or when differences of production quality exist among banks, alternative profit function – instead of standard – is considered more appropriate for the estimation of bank efficiency (Berger and Mester, 1997). The specific function regards the amounts of outputs and the input prices as exogenous, and hence, banks maximize their profits by adjusting the price of outputs and the quantity of inputs (Maudos *et al.*, 2002). In this analysis, the alternative profit function is more appropriate, since the sample consists of banks from a diverse group of countries with different levels of competition.

Whereas the production function indicates the relationship between inputs and outputs (Girardone *et al*., 2004), profit function determines the relationship between profits and input prices as well as outputs, specifying the profit of the i^{th} bank relative to the profit that could have been earned by a fully efficient bank, which would use the same vector of input prices and outputs. The profit function can be characterized as the frontier of the profit alternatives, which extracts the maximum levels of profit from adopted input prices and outputs. The general form of the profit function yields:

$$\ln(\pi + \vartheta + 1) = f(w, y) + e \qquad (1)$$

where π is the profit of the bank, θ is a constant added to the profit of every bank plus one to attain a positive number when treated logarithmically – a constant which indicates the absolute minimum value of profits – w is the vector of input prices, y is the output vector and e is the error term. It is important to mention that e is a two-component error term, which can be written as:

$$\text{e} = \ln(\text{v}) - \ln(\text{u}) \qquad (2)$$

where *ln(v)* is measurement errors and other random factors and *ln(u)* is the inefficiency component. More analytically, *ln(v)* is a two-sided error term, which represents statistical noise – factors, which are not under the control of management, measurement and approximation errors, associated with the choice of the functional form – and is assumed to be independently and identically distributed. On the contrary, *ln(u)* measures inefficiency and is a non-negative random variable – distributed independently of the *ln(v)* – and ensures that all observations lie on or beneath the stochastic profit frontier. Furthermore, *ln(v)* is assumed to be normally distributed with mean zero and variance σ^2_v, whereas *ln(u)* is assumed to be distributed as half normal with mean zero and variance σ^2_u. Moreover, *ln(u)* is subtracted from *ln(v)*, since this frontier represents the maximum profit.

In this chapter, the specification of the functional form used is the translog profit function, which is a generalization of the Cobb-Douglas and a more flexible form. An additional common specification and widely used in the literature, is the Fourier-flexible form. There is considerable controversy over which of the two forms, the translog or Fourier-flexible form, is better. Certain studies (McAllister and McManus, 1993; Mitchell and Onvural, 1996) argue that the Fourier-flexible form is considered a global approximation and becomes flexible, by adding Fourier-trigonometric terms to the model and therefore is better. However, little difference between the results of the two forms – translog and Fourier-flexible – exist. In this chapter, the translog form is used, since the Fourier-flexible form requires a great amount of variables, losing this way too many degrees of freedom. Specifically, the stochastic profit function takes the following form:

$$\begin{aligned}\ln(\pi_{it}+\vartheta+1) &= a_0+\sum_{j=1}^{3}\beta_j \ln w_{ijt}+\frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3}\beta_{jn}\ln w_{ijt}\ln w_{int}+\sum_{l=1}^{2}\gamma_l \ln y_{ilt} \\ &+\frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2}\gamma_{lm}\ln y_{ilt}\ln y_{imt}+\sum_{j=1}^{3}\sum_{l=1}^{2}\phi_{jl}\ln w_{ijt}\ln y_{ilt}+e_{it}\end{aligned} \tag{3}$$

where t = 1, …, T, π_{it} is the profit of the i^{th} bank in year t – measured by the sum of interest income plus non-interest income minus the sum of interest expenses plus non-interest expenses – w_{ijt} (accordingly w_{int}) is the input price for the i^{th} bank in year t, whereas j = 1, 2, 3 (n = 1, 2, 3 as well), which is the number of inputs used in the equation and specifically the price of deposits, the price of fixed assets and the price of labor, y_{ilt} (y_{imt}) represents output quantities, where l = 1, 2 (m = 1, 2 as well), and particularly total loans and total securities, α, β, γ and φ are the parameters to be estimated using the maximum likelihood approach and e_{it} denotes the error term. The equation estimates the profit of each bank for any given country. Furthermore, the second order parameters of the profit function must be symmetric, that is $\beta_{jn} = \beta_{nj}$, and $\gamma_{lm} = \gamma_{ml}$ for all j, n, l and m. The following model differs from the previous one, by adding an additional variable:

$$\begin{aligned}\ln(\pi_{it}+\vartheta+1) = {} & a_0+\sum_{j=1}^{3}\beta_j \ln w_{ijt}+\frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3}\beta_{jn}\ln w_{ijt}\ln w_{int}+\sum_{l=1}^{2}\gamma_l \ln y_{ilt} \\ & +\frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2}\gamma_{lm}\ln y_{ilt}\ln y_{imt}+\delta_r \ln z_{irt}+\frac{1}{2}\delta_{rr}\ln z_{irrt} \\ & +\sum_{j=1}^{3}\sum_{l=1}^{2}\phi_{jl}\ln w_{ijt}\ln y_{ilt}+\sum_{j=1}^{3}\rho_{jr}\ln w_{ijt}\ln z_{irt}+\sum_{l=1}^{2}\tau_{lr}\ln y_{ilt}\ln z_{irt}+e_{it}\end{aligned} \tag{4}$$

where z is either the financial capital or total assets.

When both of these variables are added in the same model, it takes the following form:

$$\begin{aligned}\ln(\pi_{it}+\vartheta+1) = {} & a_0+\sum_{j=1}^{3}\beta_j \ln w_{ijt}+\frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3}\beta_{jn}\ln w_{ijt}\ln w_{int}+\sum_{l=1}^{2}\gamma_l \ln y_{ilt} \\ & +\frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2}\gamma_{lm}\ln y_{ilt}\ln y_{imt}+\sum_{r=1}^{2}\delta_r \ln z_{irt}+\frac{1}{2}\sum_{r=1}^{2}\sum_{s=1}^{2}\delta_{rs}\ln z_{irt}\ln z_{ist} \\ & +\sum_{j=1}^{3}\sum_{l=1}^{2}\phi_{jl}\ln w_{ijt}\ln y_{ilt}+\sum_{j=1}^{3}\sum_{r=1}^{2}\rho_{jr}\ln w_{ijt}\ln z_{irt}+\sum_{l=1}^{2}\sum_{r=1}^{2}\tau_{lr}\ln y_{ilt}\ln z_{irt}+e_{it}\end{aligned} \tag{5}$$

where symmetry restrictions are imposed for δ_{rs} as well, that is $\delta_{rs} = \delta_{sr}$.

5.2. The bank lending channel

The empirical specification of the second part of the analysis, for the estimation of the bank lending channel, is designed initially to test, whether banks react to a monetary policy shock. The baseline model takes the following form:

$$\Delta \ln L_{ikt} = \phi \Delta \ln L_{ikt-1} + \sum_{j=1}^{n} \beta_j \Delta \ln r_{kt-j} + \sum_{j=1}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=1}^{n} \omega_j \pi_{kt-j} + \varepsilon_{ikt} \qquad (6)$$

with i = 1,...,611, k = 1,…,6 and t=1,…,T, where i is the number of banks, k denotes the country and T is the final year. Furthermore, L_{ikt} denotes the loans of bank i in country k at year t, r_{kt} denotes the short-term interest rate of country k at year t, GDP_{kt} denotes the Gross Domestic Product of country k at year t, π_{kt} denotes the inflation in country k at year t and ε_{ikt} denotes the error term.

In equation (6), the growth rate of bank lending (ΔlnL) is regressed on GDP growth ($\Delta lnGDP$) and inflation rates (π), to control for country-specific loan demand changes. In this manner, isolation of shifts in total loans – which are caused by movements in loan demand due to macroeconomic activity – is achieved. The inclusion of these two variables allows the isolation of the monetary policy indicator that is the short-term interest rate, on which the growth rate is regressed as well. According to the bank lending channel theory, the coefficient of the policy indicator is expected to exhibit negative sign, implying that loans decrease following monetary tightening. Furthermore, regarding the dependent variable, its lagged values are incorporated into the model, since lagged loans affect current loans, by establishing a stable relationship between the bank and the borrower/customer. To create such an environment, banks need to acquire "informational monopoly" over a client. Specifically, a new bank, due to the need to collect information about the new customer, charges its services more (Golodniuk, 2006), and hence it is extremely costly for a customer to change between banks.

The baseline equation (6) alters to the following form when bank efficiency is included as an additional independent variable:

$$\begin{aligned}\Delta \ln L_{ikt} = \phi \Delta \ln L_{ikt-1} + \sum_{j=1}^{n} \beta_j \Delta \ln r_{kt-j} + \sum_{j=1}^{n} \gamma_j \Delta \ln eff_{ikt-j} + \sum_{j=1}^{n} \varphi_j \Delta \ln eff_{ikt-j} \Delta \ln r_{kt-j} \\ + \sum_{j=1}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=1}^{n} \omega_j \pi_{kt-j} + \varepsilon_{ikt}\end{aligned} \tag{7}$$

Equation (7) differs from equation (6) in that two additional variables are incorporated into the model: bank efficiency (*Δlneff*) and its interaction term with the monetary policy indicator. Efficiency is included as a qualitative bank-specific characteristic, to investigate whether it affects loan supply. A positive coefficient of bank efficiency implies that efficient banks are more likely to expand their supply of loans. More broadly, efficiency provides banks with additional flexibility to face changes related to monetary policy movements. To identify differential responses of loans, the interaction term of the monetary policy indicator with efficiency is included. Specifically, the interaction term captures the difference that may exist to policy responses for countries with banking systems at different efficiency levels and describes whether more or less efficient banks respond differently to a monetary policy shock. A positive coefficient of the interaction term indicates that more efficient banks are better able to buffer their lending activity against monetary shocks that affect the availability of external finance.

The model has been estimated using the GMM approach, which is applied, when the sample consists of many observations – number of banks in this case – albeit for a restricted time period, when the explanatory variables are endogenous and when unobserved bank-specific effects are correlated with other regressors. Furthermore, GMM methodology is preferable for specific reasons: first differences are employed, which control for bank-specific effects, additionally, this method allows lagged dependent variables to be included as regressors, controls for the endogeneity of explanatory variables (Roodman, 2006) and exploits the time series element of the data as well (Altunbas *et al.*, 2009). Overall, GMM estimator is used, because it ensures efficiency and consistency, while only statistically significant lags are used in the estimation.

6. Empirical analysis

6.1. Efficiency estimates

For stochastic profit frontier analysis, one frontier is created for all commercial and savings banks in each year, to allow the regression coefficients to vary over time and provide a flexible estimation procedure. Tables 3.3 to 3.6 report the weighted profit efficiency estimates of the banking system in each country and their corresponding t-statistics[7]. A general conclusion derived from the observation of Tables 3.3 to 3.6 is that profit efficiency is relatively high in every country. Specifically, in the period 1994-2006, it takes values between 0.942 to 0.999, implying that the average bank earns about 94 to 99 percent of the potential profits that a best-practice bank could have earned. A plausible explanation is the consecutive existence and operation of all the banks in the sample throughout the whole period under examination. Hence, it may be concluded that these banks can already be considered as the most efficient. Furthermore, the estimates in years 2007-2008 – that is, the period when the effect of recent crisis becomes apparent – are significantly lower for all the countries when compared to previous years.

[7] We test the following hypothesis (H_0): efficiency=1, which describes a fully efficient banking system.

It should be noted that Tables A.1 to A.12 in the Appendix report the summary statistics for the efficiency of banking systems in each country and each year. The minimum and maximum values indicate the range of efficiency scores, i.e. a minimum efficiency score of 0.6455, implies that there is a certain bank, which is almost 65 percent profit efficient compared to the best achievable performance based on the other banks in the sample (of the specific country). Furthermore, an important issue that needs to be clarified is that in the next step of the analysis, concerning the estimation of the bank lending channel, the efficiency of each bank in every country is used, rather than the efficiency of the banking system as a whole.

The entries of Table 3.3 present the results of equation (3); that is efficiency estimates, which have been calculated without taking into consideration either risk or size variables. The highest estimates are reported in Denmark and Luxembourg. Germany's banking system seems to be efficient throughout the years as well. However, the results indicate comparatively efficient banking systems in all countries, as mentioned before.

In Tables 3.4 and 3.5 profit efficiency estimates are derived by equation (4), which incorporates risk (Table 3.4) or size (Table 3.5) variable. The average estimates of Denmark and Luxembourg take the largest values when financial capital or size is included in the estimation of efficiency. In Table 3.6 profit efficiency measures have been estimated according to equation (5), which incorporates both financial capital and total assets as risk and size variables respectively. In literature, risk preferences and size are considered to be important factors, which should be taken into account, since inefficiency seems to be miscalculated when they are not included for the specification of the profit function.

6.2. Bank lending channel results

The entries of Table 3.7 are obtained by estimating equations (6) and (7). Specifically, the objective of this part of the analysis is to investigate: first, whether the bank lending channel operates and second, whether and how it is affected by including efficiency as a bank-specific characteristic, into the model for the estimation of the bank lending channel. The difference with previous studies is that this characteristic is a qualitative one – versus the quantitative characteristics used in the literature – and that the specific type of efficiency – that is profit efficiency – has not been used as an additional variable in the lending channel model before. Results have been calculated using the GMM estimator and unit root testing ensures that the appropriate level of differentiation is used. Finally, in all cases, the Sargan test ensures the validity of instruments used.

Model (I) – the baseline model, the results of which are reported in the first column – is estimated using equation (6) that is, the model that does not include any type of profit efficiency. The results of equation (7) are presented in the next four columns. Each model (Models II – V) estimates the bank lending channel by incorporating efficiency as a bank-specific characteristic. The difference between them is in the way efficiency has already been estimated in the first part of the analysis. Specifically, in Model (II), the efficiency that is used has been calculated by estimating equation (3), which does not include either risk or size variables. Model (III) uses bank efficiency for the estimation of which risk variable has been incorporated into equation (4), whereas Model (IV) uses efficiency estimated by equation (4) as well, albeit including size as an additional variable. Finally, Model (V) includes bank efficiency that has been estimated by equation (5), which includes both financial capital and total assets as risk and size variable respectively.

In all Models, the coefficient of the monetary policy indicator – which represents the effects of the decisions of monetary policy on lending – is statistically significant and exhibits negative sign, as is expected when lending decreases following an increase in the monetary policy indicator, implying that the bank lending channel exists. Particularly, in Model (I), a one percent increase in monetary policy indicator leads to a 2.9 percent increase in bank lending. Furthermore, economic activity changes, which are represented by GDP growth, have a positive and significant impact on bank lending in all cases – Model (II) is an exception, where GDP growth has the expected positive sign (7.427), but is statistically insignificant – whereas the coefficient of inflation is statistically insignificant in all Models. Finally, a long-standing lending relationship increases the ability of the bank to learn more about the borrower, which is indicated by the positive coefficient of the lagged loans variable – where statistically significant.

Models (II) – (V), the results of which are presented in the last four columns of Table 3.7, incorporate two additional variables: bank efficiency and its interaction term with the monetary policy indicator. The coefficient of efficiency is statistically significant in all Models, as well as positive, which implies that an efficient bank is able to expand its loan supply, i.e., a one percent increase in profit efficiency (estimated in Model I), leads to a 10.7 percent increase in bank lending. The entries in the sixth row of Table 3.7 are the coefficients of the interaction term between bank efficiency and the monetary policy indicator, which have the expected positive sign, implying that more efficient banks are more capable of facing changes in monetary policy, than less efficient banks. However, the coefficients are not statistically significant.

Comparing Models (II) – (V), which include bank efficiency as a bank-specific characteristic with the baseline model (I), it is noted that the monetary policy indicator coefficient is negative in all cases. However, the value of the coefficient in Model (I) is the largest of all (-2.961), indicating that when profit efficiency is not taken into account – regardless of incorporating or not risk and/or size variables – the bank lending channel is stronger. On the contrary, in Models (II) – (V) the inclusion of profit efficiency weakens the operation of the bank lending channel, since loan decease is smaller in the case of contractionary monetary policy (i.e., a one percent increase in the monetary policy indicator leads to a 1.725 reduction in bank lending – Model III).

Overall, the results indicate that the bank lending channel is weaker when banks are profit efficient. This implies that banks are more protected against possible monetary shocks, since an efficient bank is considered capable of employing funds from sources other than deposits, as well as managing its funds in a better and more productive way and reallocate them when needed. Conclusively, an efficient banking sector contributes to the stability of the financial system by handling negative shocks.

7. Conclusions

Bank efficiency has been given priority over the last decades, since it has proved to be an important asset for banks, the survival of which has become rather uncertain in an extremely competitive environment. Bank lending, on the other hand, constitutes one of the channels, through which monetary authorities are able to affect economic activity. This is accomplished through changes they impose on bank reserves and consequently on lending.

This chapter estimates profit efficiency of the banking systems in six European countries spanning the period of 1994 to 2008. The specific type – profit efficiency – outperforms the production and cost efficiency, since high-quality banks, which may be considered inefficient according to cost efficiency, are not penalized because both the cost and the revenue side are taken into account. Furthermore, this measure of profitability seems to be preferable to simple accounting ratios, since it considers differences in output mix and input prices, while it allows ranking of banks and hence, identifies best and worst practices. Efficiency indicates that it is important for bankers to pursue cost minimization and revenue maximization, regardless of the state of the economy, since this quality proxy does not depend on 'how much output a bank produces, but rather how well it does so' (Koetter and Wedow, 2010).

Efficiency is then used as a qualitative bank-specific characteristic for the investigation of the bank lending channel in the specific group of countries. The results indicate that the bank lending channel is apparent, both in the case in which efficiency is incorporated into the model as a bank-specific variable, as well as in the case when it is not taken into consideration. The difference is that in the latter case – that is, when efficiency is not taken into account – the impact of the monetary authorities' decisions is stronger and the lending channel becomes stronger as well. On the contrary, when efficiency is incorporated into the model as a bank-specific characteristic, the bank lending channel becomes weaker, implying that efficient banks are more capable of offsetting negative shocks. This is accomplished, because banks are able to manage their (higher) profits and reallocate them in the most efficient and productive way, as mentioned before, ensuring liquidity and/or increased capital. Therefore, efficiency strengthens the capacity of banks to buffer their lending ability against monetary shocks and hence, it reduces the importance of the bank lending channel.

Efficiency seems to have a rather significant effect on the transmission of monetary policy. This is an important finding for monetary authorities as well, since this qualitative characteristic of the banking system reduces the effectiveness of the lending channel. Overall, taken together the results suggest that the more efficient banking sector decreases the role of the bank lending channel. However, it should be noted, that monetary decisions still affect economic activity, although at a lag, when the banking sector is more efficient. Therefore, monetary authorities should adjust their policy conduct, according to the state of efficiency of the banking sector, when taking decisions that aim to affect economic activity.

Table 3.1 Number of banks in each country

Country	Number of banks
Austria	21
Belgium	11
Denmark	46
France	59
Germany	438
Luxembourg	36
Total	611

Table 3.2 Total assets of each country as a percentage over the EU-6

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	1.54	1.44	1.34	1.26	1.18	1.14	1.14	1.44	1.41	1.43	1.38	1.40	1.35	1.16	1.05
Belgium	0.58	0.57	0.53	0.50	0.51	0.47	0.41	0.39	0.48	0.42	0.39	0.38	0.39	0.37	0.38
Denmark	2.37	2.35	2.44	2.59	2.50	2.43	2.54	3.18	3.52	3.53	3.76	3.87	4.36	4.86	4.98
France	24.60	27.11	26.61	25.45	26.07	26.29	21.70	22.53	22.74	24.55	25.52	25.64	25.57	25.66	25.51
Germany	63.25	61.45	62.50	63.80	63.70	64.01	68.49	66.67	66.33	64.78	63.92	63.68	62.74	62.75	63.42
Luxembourg	7.65	7.09	6.58	6.40	6.05	5.65	5.72	5.78	5.51	5.30	5.04	5.04	5.59	5.20	4.65
EU-6	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Notes: EU-6 stands for the six European countries of the sample.

Table 3.3 Profit efficiency estimates for the 6 European countries

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Austria	0.991	0.998	0.998	0.998	**0.960**	0.979	0.983	0.979	0.976	0.977	0.974	0.944	0.963	**0.944**	**0.922**
	(0.47)	*(0.08)*	*(0.09)*	*(0.08)*	*(2.03)*	*(1.06)*	*(0.86)*	*(0.84)*	*(0.99)*	*(0.93)*	*(1.06)*	*(2.35)*	*(1.70)*	*(2.73)*	*(3.99)*
Belgium	0.990	0.998	0.998	0.999	0.961	0.983	0.987	0.988	0.979	0.981	0.982	0.979	0.981	**0.948**	**0.935**
	(0.26)	*(0.04)*	*(0.05)*	*(0.04)*	*(1.02)*	*(0.48)*	*(0.35)*	*(0.35)*	*(0.71)*	*(0.64)*	*(0.63)*	*(0.82)*	*(0.76)*	*(2.54)*	*(3.22)*
Denmark	0.983	0.999	0.999	0.999	0.976	0.995	0.996	0.998	0.996	0.995	0.995	0.994	0.995	0.987	0.983
	(1.05)	*(0.05)*	*(0.07)*	*(0.06)*	*(1.50)*	*(0.28)*	*(0.22)*	*(0.12)*	*(0.21)*	*(0.29)*	*(0.30)*	*(0.33)*	*(0.30)*	*(0.72)*	*(0.96)*
France	**0.986**	0.999	0.999	0.998	**0.921**	0.987	0.988	0.991	0.988	0.990	0.994	**0.980**	0.992	**0.738**	**0.549**
	(2.19)	*(0.21)*	*(0.21)*	*(0.22)*	*(12.87)*	*(1.93)*	*(1.86)*	*(1.25)*	*(1.75)*	*(1.42)*	*(0.78)*	*(2.59)*	*(0.99)*	*(56.03)*	*(155.1)*
Germany	**0.993**	**0.999**	**0.998**	**0.998**	**0.965**	**0.971**	**0.978**	**0.972**	**0.944**	**0.942**	**0.946**	**0.974**	**0.970**	**0.960**	**0.620**
	(15.04)	*(2.82)*	*(2.94)*	*(2.73)*	*(60.13)*	*(48.66)*	*(35.36)*	*(43.90)*	*(92.67)*	*(94.91)*	*(85.06)*	*(31.67)*	*(37.45)*	*(45.78)*	*(842.1)*
Luxembourg	0.995	0.999	0.998	0.999	**0.976**	**0.984**	0.991	0.992	**0.980**	**0.981**	**0.984**	**0.979**	**0.986**	**0.967**	**0.931**
	(0.92)	*(0.25)*	*(0.27)*	*(0.23)*	*(3.92)*	*(2.64)*	*(1.52)*	*(1.31)*	*(2.99)*	*(2.90)*	*(2.45)*	*(3.36)*	*(2.28)*	*(5.48)*	*(11.54)*

Note: Profit efficiency estimates for the six European countries, according to the model that does not include either risk or size variables. T-statistics are provided in brackets. The model is given by the following equation:

$$\ln(\pi_{it}+\vartheta+1)=a_0+\sum_{j=1}^{3}\beta_j \ln w_{ijt}+\frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3}\beta_{jn}\ln w_{ijt}\ln w_{int}+\sum_{l=1}^{2}\gamma_l \ln y_{ilt}+\frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2}\gamma_{lm}\ln y_{ilt}\ln y_{imt}+\sum_{j=1}^{3}\sum_{l=1}^{2}\phi_{jl}\ln w_{ijt}\ln y_{ilt}+e_{it}$$

with t=1,…T, π_{it} denotes the profit of the i^{th} bank in year t, w_{ijt} (accordingly w_{int}) is the input price for the i^{th} bank in year t, whereas j = 1, 2, 3 (n as well), which is the number of inputs used in the equation -- the price of deposits, the price of fixed assets and the price of labor -- y_{ilt} (y_{imt}) represents output quantities, where l = 1, 2 (m as well) -- total loans and total securities -- α, β, γ and φ are the parameters to be estimated and e_{it} denotes the error term. The equation estimates the profit of each bank for any given country. We estimate the model using the maximum likelihood approach.

Table 3.4 Profit efficiency estimates for the 6 European countries, with risk variable taken into consideration

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	0.992	0.989	0.988	0.989	0.964	0.983	0.987	0.987	0.980	0.975	0.990	**0.947**	0.962	**0.951**	**0.920**
	(0.42)	*(0.54)*	*(0.61)*	*(0.55)*	*(1.84)*	*(0.88)*	*(0.66)*	*(0.51)*	*(0.83)*	*(1.03)*	*(0.42)*	*(2.25)*	*(1.76)*	*(2.39)*	*(4.18)*
Belgium	0.993	0.993	0.993	0.994	0.964	0.986	0.990	0.989	0.978	0.976	0.990	0.980	0.981	**0.946**	**0.932**
	(0.19)	*(0.17)*	*(0.18)*	*(0.16)*	*(0.94)*	*(0.41)*	*(0.29)*	*(0.31)*	*(0.74)*	*(0.78)*	*(0.35)*	*(0.78)*	*(0.78)*	*(2.63)*	*(3.43)*
Denmark	0.973	0.998	0.997	0.998	**0.952**	0.995	0.995	0.998	0.996	0.996	0.995	0.994	0.995	0.986	**0.960**
	(1.73)	*(0.11)*	*(0.18)*	*(0.15)*	*(3.04)*	*(0.32)*	*(0.31)*	*(0.11)*	*(0.22)*	*(0.25)*	*(0.26)*	*(0.31)*	*(0.30)*	*(0.78)*	*(2.29)*
France	**0.984**	0.990	0.991	0.987	**0.916**	0.989	0.990	0.994	0.988	0.988	0.995	**0.978**	0.992	**0.742**	**0.557**
	(2.52)	*(1.46)*	*(1.32)*	*(1.82)*	*(13.90)*	*(1.65)*	*(1.44)*	*(0.91)*	*(1.72)*	*(1.70)*	*(0.69)*	*(2.91)*	*(1.03)*	*(54.57)*	*(150.5)*
Germany	**0.994**	**0.992**	**0.991**	**0.987**	**0.965**	**0.968**	**0.976**	**0.971**	**0.944**	**0.922**	**0.972**	**0.974**	**0.967**	**0.961**	**0.625**
	(12.58)	*(16.68)*	*(16.52)*	*(24.03)*	*(60.60)*	*(54.69)*	*(37.59)*	*(47.14)*	*(94.06)*	*(128.8)*	*(43.04)*	*(31.90)*	*(40.68)*	*(44.97)*	*(831.2)*
Luxembourg	0.995	0.995	0.995	0.994	**0.979**	**0.987**	0.992	0.991	**0.976**	**0.974**	0.989	**0.977**	**0.984**	**0.966**	**0.925**
	(0.81)	*(0.92)*	*(0.93)*	*(0.95)*	*(3.57)*	*(2.07)*	*(1.30)*	*(1.36)*	*(3.64)*	*(3.91)*	*(1.66)*	*(3.64)*	*(2.55)*	*(5.71)*	*(12.76)*

Note: Profit efficiency estimates for the six European countries, according to the model that includes risk variable only. t-statistics are provided in brackets. The model is given by the following equation:

$$\ln(\pi_{it} + \vartheta + 1) = a_0 + \sum_{j=1}^{3} \beta_j \ln w_{ijt} + \frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3} \beta_{jn} \ln w_{ijt} \ln w_{int} + \sum_{l=1}^{2} \gamma_l \ln y_{ilt} + \frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2} \gamma_{lm} \ln y_{ilt} \ln y_{imt}$$

$$+ \delta_r \ln z_{irt} + \frac{1}{2}\delta_{rr} \ln z_{irrt} + \sum_{j=1}^{3}\sum_{l=1}^{2} \phi_{jl} \ln w_{ijt} \ln y_{ilt} + \sum_{j=1}^{3} \rho_{jr} \ln w_{ijt} \ln z_{irt} + \sum_{l=1}^{2} \tau_{lr} \ln y_{kilt} \ln z_{irt} + e_{it}$$

The notation and the rest of the notes are similar to Table 3.3. The difference is on the additional terms that appear -- financial capital and its interaction with both the input price and output.

Table 3.5 Profit efficiency estimates for the 6 European countries, with size variable taken into consideration

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	0.992	0.999	0.998	0.999	0.965	0.984	0.984	0.980	0.977	0.978	0.975	**0.951**	**0.957**	**0.946**	**0.918**
	(0.40)	*(0.07)*	*(0.08)*	*(0.07)*	*(1.81)*	*(0.82)*	*(0.80)*	*(0.78)*	*(0.93)*	*(0.92)*	*(1.04)*	*(2.04)*	*(1.99)*	*(2.63)*	*(4.28)*
Belgium	0.991	0.999	0.998	0.999	0.964	0.986	0.988	0.989	0.980	0.981	0.982	0.983	0.981	**0.947**	**0.939**
	(0.23)	*(0.04)*	*(0.04)*	*(0.04)*	*(0.93)*	*(0.41)*	*(0.34)*	*(0.32)*	*(0.70)*	*(0.63)*	*(0.62)*	*(0.67)*	*(0.77)*	*(2.58)*	*(3.04)*
Denmark	0.982	0.999	0.999	0.999	0.975	0.995	0.997	0.998	0.996	0.994	0.995	0.995	0.997	0.987	0.978
	(1.14)	*(0.05)*	*(0.06)*	*(0.05)*	*(1.57)*	*(0.28)*	*(0.20)*	*(0.11)*	*(0.20)*	*(0.32)*	*(0.30)*	*(0.27)*	*(0.19)*	*(0.71)*	*(1.26)*
France	**0.983**	0.999	0.999	0.998	**0.916**	0.987	0.988	0.991	0.988	0.990	0.994	**0.975**	0.992	**0.743**	**0.556**
	(2.58)	*(0.20)*	*(0.19)*	*(0.22)*	*(13.98)*	*(1.84)*	*(1.86)*	*(1.25)*	*(1.84)*	*(1.42)*	*(0.83)*	*(3.38)*	*(1.10)*	*(54.33)*	*(148.4)*
Germany	**0.993**	**0.999**	**0.999**	**0.998**	**0.965**	**0.972**	**0.975**	**0.971**	**0.945**	**0.943**	**0.945**	**0.975**	**0.962**	**0.961**	**0.631**
	(13.99)	*(2.70)*	*(2.75)*	*(2.75)*	*(59.89)*	*(47.03)*	*(39.50)*	*(46.15)*	*(92.26)*	*(93.12)*	*(87.51)*	*(30.65)*	*(46.73)*	*(43.94)*	*(759.7)*
Luxembourg	0.995	0.999	0.999	0.999	**0.978**	**0.986**	0.991	0.991	**0.979**	**0.981**	**0.983**	**0.979**	**0.983**	**0.967**	**0.920**
	(0.85)	*(0.23)*	*(0.25)*	*(0.23)*	*(3.62)*	*(2.34)*	*(1.54)*	*(1.38)*	*(3.20)*	*(2.86)*	*(2.62)*	*(3.33)*	*(2.64)*	*(5.41)*	*(13.67)*

Note: Profit efficiency estimates for the six European countries, according to the model that includes total assets only. t-statistics are provided in brackets. The model is given by the following equation:

$$\ln(\pi_{it}+\vartheta+1)=a_0+\sum_{j=1}^{3}\beta_j\ln w_{ijt}+\frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3}\beta_{jn}\ln w_{ijt}\ln w_{int}+\sum_{l=1}^{2}\gamma_l\ln y_{ilt}+\frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2}\gamma_{lm}\ln y_{ilt}\ln y_{imt}$$

$$+\delta_r\ln z_{irt}+\frac{1}{2}\delta_{rr}\ln z_{irrt}+\sum_{j=1}^{3}\sum_{l=1}^{2}\phi_{jl}\ln w_{ijt}\ln y_{ilt}+\sum_{j=1}^{3}\rho_{jr}\ln w_{ijt}\ln z_{irt}+\sum_{l=1}^{2}\tau_{lr}\ln y_{kilt}\ln z_{irt}+e_{it}$$

The notation and the rest of the notes are similar to Table 3.3. The difference is on the additional terms that appear -- total assets variable and its interaction with both the input price and output.

Table 3.6 Profit efficiency estimates for the 6 European countries, with both risk and size variables taken into consideration

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	0.992	0.999	0.990	0.989	0.964	0.982	0.987	0.988	0.980	0.977	0.990	**0.951**	**0.958**	0.960	**0.904**
	(0.38)	*(0.06)*	*(0.52)*	*(0.55)*	*(1.83)*	*(0.89)*	*(0.68)*	*(0.48)*	*(0.80)*	*(0.96)*	*(0.41)*	*(2.03)*	*(1.95)*	*(1.91)*	*(5.06)*
Belgium	0.993	0.999	0.994	0.994	0.964	0.986	0.990	0.989	0.979	0.976	0.989	0.983	0.979	**0.944**	**0.925**
	(0.19)	*(0.03)*	*(0.17)*	*(0.16)*	*(0.94)*	*(0.42)*	*(0.29)*	*(0.32)*	*(0.72)*	*(0.78)*	*(0.36)*	*(0.66)*	*(0.83)*	*(2.73)*	*(3.79)*
Denmark	0.973	0.999	0.997	0.998	**0.951**	0.995	0.994	0.998	0.996	0.995	0.995	0.995	0.996	0.986	0.974
	(1.77)	*(0.04)*	*(0.17)*	*(0.15)*	*(3.15)*	*(0.32)*	*(0.33)*	*(0.11)*	*(0.23)*	*(0.27)*	*(0.26)*	*(0.27)*	*(0.21)*	*(0.77)*	*(1.48)*
France	**0.984**	0.999	0.993	0.990	**0.919**	0.989	0.991	0.994	0.988	0.988	0.995	**0.973**	0.992	**0.765**	**0.556**
	(2.49)	*(0.18)*	*(1.05)*	*(1.50)*	*(13.39)*	*(1.57)*	*(1.41)*	*(0.80)*	*(1.74)*	*(1.64)*	*(0.65)*	*(3.57)*	*(1.05)*	*(47.50)*	*(147.3)*
Germany	**0.994**	**0.999**	**0.992**	**0.987**	**0.965**	**0.968**	**0.977**	**0.971**	**0.944**	**0.924**	**0.972**	**0.975**	**0.962**	**0.963**	**0.643**
	(12.83)	*(2.30)*	*(15.55)*	*(24.45)*	*(60.89)*	*(54.86)*	*(36.69)*	*(45.66)*	*(93.29)*	*(125.6)*	*(42.78)*	*(30.03)*	*(46.87)*	*(42.24)*	*(707.7)*
Luxembourg	0.996	0.999	0.996	0.995	**0.980**	**0.987**	0.992	0.991	**0.977**	**0.976**	0.990	**0.978**	**0.982**	**0.968**	**0.903**
	(0.66)	*(0.19)*	*(0.75)*	*(0.82)*	*(3.36)*	*(2.08)*	*(1.31)*	*(1.32)*	*(3.57)*	*(3.66)*	*(1.58)*	*(3.44)*	*(2.80)*	*(5.26)*	*(16.55)*

Note: Profit efficiency estimates for the six European countries, according to the model that includes both financial capital and total assets t-statistics are provided in brackets. The model is given by the following equation:

$$\ln(\pi_{it}+\vartheta+1)=a_0+\sum_{j=1}^{3}\beta_j\ln w_{ijt}+\frac{1}{2}\sum_{j=1}^{3}\sum_{n=1}^{3}\beta_{jn}\ln w_{ijt}\ln w_{int}+\sum_{l=1}^{2}\gamma_l\ln y_{ilt}+\frac{1}{2}\sum_{l=1}^{2}\sum_{m=1}^{2}\gamma_{lm}\ln y_{ilt}\ln y_{imt}+\sum_{r=1}^{2}\delta_r\ln z_{irt}+\frac{1}{2}\sum_{r=1}^{2}\sum_{s=1}^{2}\delta_{rs}\ln z_{irt}\ln z_{ist}$$

$$+\sum_{j=1}^{3}\sum_{l=1}^{2}\phi_{jl}\ln w_{ijt}\ln y_{ilt}+\sum_{j=1}^{3}\sum_{r=1}^{2}\rho_{jr}\ln w_{ijt}\ln z_{irt}+\sum_{l=1}^{2}\sum_{r=1}^{2}\tau_{lr}\ln y_{ilt}\ln z_{irt}+e_{it}$$

The notation and the rest of the notes are similar to Table 3.3. The difference is on the additional terms that appear -- financial capital, total assets and their interaction with both the input price and output.

Table 3.7 The bank lending results for Eurogroup.

Dependent variable: annual growth rate of lending	Baseline model (I)	Baseline model with profit efficiency (II)	Baseline model with profit efficiency (including risk variable) (III)	Baseline model with profit efficiency (including size variable) (IV)	Baseline model with profit efficiency (including both variables) (V)
ΔlnL_{ikt-1}	**1.080**	**0.946**	**0.826**	-0.055	**0.836**
	(7.26)	*(4.47)*	*(4.78)*	*(-1.03)*	*(4.07)*
Δlnr_{kt-1}	**-2.961**	**-2.436**	**-1.725**	**-2.137**	**-2.117**
	(-3.16)	*(-3.05)*	*(-3.71)*	*(-2.59)*	*(-3.78)*
$\Delta lnGDP_{kt-1}$	**5.906**	7.427	**0.913**	**1.669**	**3.609**
	(2.13)	*(1.31)*	*(2.61)*	*(2.47)*	*(2.83)*
π_{kt-1}	-5.679	-0.585	-16.887	11.083	-14.865
	(-1.19)	*(-0.06)*	*(-0.27)*	*(1.10)*	*(-1.08)*
$\Delta lneff_{kt-1}$		**10.777**	**8.572**	**8.879**	**10.695**
		(2.21)	*(2.29)*	*(2.31)*	*(2.67)*
Δlnr_{kt-1}*$\Delta lneff_{kt-1}$		7.849	7.155	9.195	7.410
		(0.13)	*(0.21)*	*(0.14)*	*(0.17)*
Adjusted R-squared	0.841	0.559	0.331	0.242	0.329
Sargan test	0.963	0.975	0.959	0.970	0.978

Note: Coefficient estimates for the group of European countries, according to the model that does not include and the one that includes the different types of bank efficiency. T-statistics are provided in brackets. Bolded coefficients prove statistically significant. Model (I) that does not incorporate efficiency, is given by the following equation:

$$\Delta \ln L_{ikt} = \phi \Delta \ln L_{ikt-1} + \sum_{j=1}^{n} \beta_j \Delta \ln r_{kt-j} + \sum_{j=1}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=1}^{n} \omega_j \pi_{kt-j} + \varepsilon_{ikt}$$

Whereas, Models (II) – (V) are estimated by the following equation, in which efficiency and its interaction term with the monetary policy indicator are added. The baseline model with the different types of efficiency is given by the following equation, which includes interaction terms, that are the product of the monetary policy indicator and efficiency.

$$\Delta \ln L_{ikt} = \phi \Delta \ln L_{ikt-1} + \sum_{j=1}^{n} \beta_j \Delta \ln r_{kt-j} + \sum_{j=1}^{n} \gamma_j \Delta \ln eff_{ikt-j} + \sum_{j=1}^{n} \varphi_j \Delta \ln eff_{ikt-j} \Delta \ln r_{kt-j} + \sum_{j=1}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=1}^{n} \omega_j \pi_{kt-j} + \varepsilon_{ikt}$$

Specifically, Model (II) includes bank efficiency, in which neither risk nor size variable have been included for its estimation. Model (III)/(IV) includes efficiency, for the estimation of which risk/size variable has been incorporated into the model. Finally, Model (V) uses efficiency, for the estimation of which both risk and size variables have been included.

Appendix A: Efficiency estimates for each country

A. 1. Summary statistics for the efficiency of the banking system in Austria

Austria	mean efficiency	t-stat	st.dev.	min	max	mean efficiency (incl. financial capital)	t-stat	st.dev.	min	max
1994	0.9906	0.4722	0.0911	0.9795	0.9961	0.9916	0.4246	0.0912	0.9863	0.9965
1995	0.9984	0.0800	0.0919	0.9982	0.9987	0.9894	0.5354	0.0907	0.9851	0.9972
1996	0.9982	0.0898	0.0924	0.9980	0.9985	0.9879	0.6106	0.0910	0.9823	0.9969
1997	0.9984	0.0773	0.0921	0.9983	0.9987	0.9892	0.5470	0.0909	0.9850	0.9967
1998	**0.9604**	2.0309	0.0893	0.9393	0.9805	0.9640	1.8379	0.0897	0.9314	0.9800
1999	0.9792	1.0557	0.0904	0.9746	0.9904	0.9826	0.8793	0.0908	0.9763	0.9921
2000	0.9831	0.8579	0.0902	0.9780	0.9928	0.9869	0.6618	0.0906	0.9829	0.9939
2001	0.9789	0.8398	0.1149	0.9731	0.9922	0.9869	0.5142	0.1164	0.9849	0.9933
2002	0.9757	0.9928	0.1120	0.9678	0.9924	0.9795	0.8325	0.1128	0.9686	0.9943
2003	0.9775	0.9339	0.1105	0.9762	0.9868	0.9751	1.0309	0.1105	0.9662	0.9876
2004	0.9742	1.0645	0.1112	0.9634	0.9858	0.9896	0.4220	0.1134	0.9801	0.9932
2005	**0.9443**	2.3513	0.1085	0.9201	0.9882	**0.9466**	2.2461	0.1089	0.9228	0.9896
2006	0.9628	1.6979	0.1003	0.9452	0.9911	0.9617	1.7551	0.1000	0.9420	0.9918
2007	**0.9442**	2.7282	0.0937	0.8901	0.9799	**0.9509**	2.3856	0.0942	0.8364	0.9824
2008	**0.9224**	3.9905	0.0891	0.8850	0.9768	**0.9195**	4.1832	0.0881	0.8313	0.9659

Note: The first five columns present the results of equation (3), in which neither risk nor size variable is included, whereas the last five columns present the results of equation (4), which includes risk variable (financial capital).

A. 2. Summary statistics for the efficiency of the banking system in Austria (cont'd)

Austria	mean efficiency (incl. total assets)	t-stat	st.dev.	min	max	mean efficiency (incl. financial capital and total assets)	t-stat	st.dev.	min	max
1994	0.9921	0.3991	0.0913	0.9866	0.9961	0.9924	0.3816	0.0912	0.9873	0.9975
1995	0.9985	0.0743	0.0919	0.9984	0.9987	0.9987	0.0625	0.0919	0.9986	0.9989
1996	0.9984	0.0806	0.0924	0.9982	0.9986	0.9896	0.5216	0.0911	0.9832	0.9962
1997	0.9985	0.0743	0.0921	0.9984	0.9987	0.9891	0.5481	0.0907	0.9831	0.9976
1998	0.9646	1.8056	0.0898	0.9360	0.9789	0.9643	1.8268	0.0895	0.9317	0.9792
1999	0.9836	0.8231	0.0911	0.9729	0.9911	0.9823	0.8944	0.0907	0.9769	0.9920
2000	0.9842	0.7981	0.0905	0.9814	0.9935	0.9866	0.6758	0.0906	0.9824	0.9945
2001	0.9805	0.7772	0.1152	0.9758	0.9929	0.9877	0.4839	0.1165	0.9839	0.9942
2002	0.9772	0.9291	0.1123	0.9683	0.9924	0.9804	0.7962	0.1129	0.9692	0.9935
2003	0.9778	0.9220	0.1105	0.9765	0.9863	0.9768	0.9599	0.1107	0.9697	0.9858
2004	0.9747	1.0415	0.1113	0.9679	0.9862	0.9898	0.4126	0.1135	0.9721	0.9940
2005	**0.9511**	2.0445	0.1097	0.9298	0.9913	**0.9513**	2.0324	0.1097	0.9302	0.9913
2006	0.9568	1.9940	0.0993	0.9356	0.9926	0.9577	1.9529	0.0994	0.9365	0.9932
2007	**0.9460**	2.6313	0.0940	0.8899	0.9791	0.9602	1.9053	0.0957	0.8400	0.9864
2008	**0.9176**	4.2752	0.0884	0.8703	0.9975	**0.9043**	5.0601	0.0867	0.8451	0.9923

Note: The first five columns present the results of equation (4), which includes size variable (total assets), whereas the last five columns present the results of equation (5), in which both risk and size variables are incorporated.

A. 3. Summary statistics for the efficiency of the banking system in Belgium

Belgium	**mean efficiency**	**t-stat**	**st.dev.**	**min**	**max**	**mean efficiency (incl. financial capital)**	**t-stat**	**st.dev.**	**min**	**max**
1994	0.9903	0.2566	0.1252	0.9726	0.9945	0.9928	0.1908	0.1258	0.9896	0.9958
1995	0.9984	0.0398	0.1290	0.9983	0.9986	0.9933	0.1721	0.1283	0.9919	0.9958
1996	0.9983	0.0451	0.1231	0.9982	0.9985	0.9932	0.1835	0.1225	0.9915	0.9961
1997	0.9985	0.0408	0.1183	0.9985	0.9987	0.9942	0.1628	0.1178	0.9928	0.9959
1998	0.9610	1.0210	0.1267	0.9490	0.9828	0.9640	0.9364	0.1274	0.9524	0.9829
1999	0.9834	0.4826	0.1139	0.9773	0.9926	0.9859	0.4102	0.1142	0.9805	0.9957
2000	0.9874	0.3545	0.1178	0.9840	0.9925	0.9897	0.2883	0.1181	0.9875	0.9942
2001	0.9883	0.3453	0.1126	0.9860	0.9924	0.9894	0.3121	0.1128	0.9865	0.9930
2002	0.9793	0.7084	0.0969	0.9734	0.9834	0.9784	0.7388	0.0969	0.9677	0.9830
2003	0.9807	0.6359	0.1008	0.9768	0.9835	0.9763	0.7813	0.1005	0.9684	0.9826
2004	0.9817	0.6260	0.0970	0.9790	0.9849	0.9897	0.3503	0.0980	0.9872	0.9914
2005	0.9788	0.8159	0.0864	0.9691	0.9855	0.9797	0.7791	0.0865	0.9649	0.9866
2006	0.9813	0.7565	0.0821	0.9766	0.9882	0.9806	0.7846	0.0820	0.9742	0.9886
2007	**0.9481**	2.5428	0.0677	0.9345	0.9695	**0.9459**	2.6260	0.0683	0.9198	0.9694
2008	**0.9352**	3.2174	0.0668	0.8797	0.9742	**0.9316**	3.4334	0.0661	0.8882	0.9598

Note: The notes are similar to Table A.1.

A. 4. Summary statistics for the efficiency of the banking system in Belgium (cont'd)

Belgium	**mean efficiency (incl. total assets)**	**t-stat**	**st.dev.**	**min**	**max**	**mean efficiency (incl. financial capital and total assets)**	**t-stat**	**st.dev.**	**min**	**max**
1994	0.9914	0.2286	0.1254	0.9891	0.9954	0.9929	0.1859	0.1258	0.9894	0.9970
1995	0.9985	0.0374	0.1290	0.9985	0.9987	0.9988	0.0303	0.1291	0.9987	0.9990
1996	0.9985	0.0415	0.1231	0.9984	0.9986	0.9936	0.1731	0.1225	0.9909	0.9961
1997	0.9986	0.0393	0.1183	0.9985	0.9987	0.9943	0.1603	0.1179	0.9916	0.9963
1998	0.9642	0.9325	0.1273	0.9530	0.9847	0.9640	0.9364	0.1275	0.9490	0.9845
1999	0.9858	0.4112	0.1143	0.9806	0.9935	0.9856	0.4196	0.1142	0.9803	0.9957
2000	0.9880	0.3378	0.1178	0.9851	0.9927	0.9897	0.2903	0.1181	0.9874	0.9944
2001	0.9890	0.3240	0.1127	0.9869	0.9926	0.9892	0.3181	0.1128	0.9855	0.9935
2002	0.9797	0.6951	0.0969	0.9753	0.9835	0.9789	0.7235	0.0969	0.9687	0.9834
2003	0.9809	0.6285	0.1008	0.9783	0.9834	0.9762	0.7835	0.1006	0.9676	0.9797
2004	0.9819	0.6175	0.0970	0.9800	0.9852	0.9894	0.3591	0.0980	0.9857	0.9914
2005	0.9825	0.6679	0.0868	0.9707	0.9894	0.9826	0.6646	0.0868	0.9743	0.9914
2006	0.9808	0.7748	0.0820	0.9757	0.9893	0.9795	0.8326	0.0819	0.9754	0.9889
2007	**0.9473**	2.5781	0.0677	0.9348	0.9701	**0.9439**	2.7302	0.0682	0.8956	0.9726
2008	**0.9388**	3.0388	0.0668	0.8931	0.9709	**0.9249**	3.7938	0.0656	0.8521	0.9746

Note: The notes are similar to Table A.2.

A. 5. Summary statistics for the efficiency of the banking system in Denmark

Denmark	**mean efficiency**	**t-stat**	**st.dev.**	**min**	**max**	**mean efficiency (incl. financial capital)**	**t-stat**	**st.dev.**	**min**	**max**
1994	0.9835	1.0527	0.1065	0.9803	0.9951	0.9732	1.7291	0.1050	0.9674	0.9956
1995	0.9992	0.0515	0.1105	0.9981	0.9994	0.9983	0.1070	0.1106	0.9759	1.0000
1996	0.9989	0.0694	0.1110	0.9978	0.9990	0.9971	0.1801	0.1109	0.9734	0.9988
1997	0.9991	0.0566	0.1120	0.9982	0.9992	0.9975	0.1496	0.1120	0.9802	0.9992
1998	0.9757	1.5013	0.1098	0.9263	0.9781	**0.9523**	3.0405	0.1064	0.9107	0.9827
1999	0.9953	0.2829	0.1127	0.9660	0.9983	0.9948	0.3154	0.1127	0.9655	0.9980
2000	0.9964	0.2158	0.1145	0.9736	0.9984	0.9948	0.3066	0.1143	0.9710	0.9960
2001	0.9979	0.1210	0.1202	0.9733	1.0000	0.9980	0.1122	0.1202	0.9681	1.0000
2002	0.9963	0.2053	0.1223	0.9674	1.0000	0.9960	0.2215	0.1223	0.9634	1.0000
2003	0.9947	0.2949	0.1212	0.9705	0.9978	0.9955	0.2485	0.1215	0.9324	1.0000
2004	0.9946	0.3012	0.1217	0.9731	0.9977	0.9954	0.2587	0.1216	0.9817	0.9969
2005	0.9941	0.3295	0.1213	0.9383	0.9982	0.9944	0.3140	0.1213	0.9298	0.9982
2006	0.9948	0.2953	0.1192	0.9589	0.9981	0.9948	0.2960	0.1192	0.9460	0.9983
2007	0.9872	0.7180	0.1206	0.9428	0.9943	0.9861	0.7842	0.1204	0.9231	0.9930
2008	0.9829	0.9641	0.1205	0.8881	0.9975	**0.9605**	2.2864	0.1172	0.8807	0.9928

Note: The notes are similar to Table A.1.

A. 6. Summary statistics for the efficiency of the banking system in Denmark (cont'd)

Denmark	**mean efficiency (incl. total assets)**	**t-stat**	**st.dev.**	**min**	**max**	**mean efficiency (incl. financial capital and total assets)**	**t-stat**	**st.dev.**	**min**	**max**
1994	0.9822	1.1371	0.1063	0.9779	0.9960	0.9726	1.7712	0.1049	0.9665	0.9961
1995	0.9992	0.0480	0.1105	0.9980	0.9994	0.9993	0.0430	0.1105	0.9985	0.9995
1996	0.9990	0.0640	0.1110	0.9977	0.9991	0.9972	0.1708	0.1109	0.9778	0.9987
1997	0.9991	0.0550	0.1120	0.9980	0.9992	0.9975	0.1486	0.1120	0.9833	0.9992
1998	0.9746	1.5704	0.1096	0.8997	0.9800	**0.9507**	3.1485	0.1062	0.9165	0.9826
1999	0.9953	0.2832	0.1127	0.9623	0.9979	0.9947	0.3182	0.1127	0.9642	0.9980
2000	0.9966	0.2030	0.1145	0.9609	0.9985	0.9944	0.3341	0.1142	0.9736	0.9954
2001	0.9980	0.1125	0.1202	0.9638	1.0000	0.9980	0.1132	0.1202	0.9755	1.0000
2002	0.9963	0.2032	0.1223	0.9686	1.0000	0.9959	0.2266	0.1223	0.9606	1.0000
2003	0.9944	0.3155	0.1212	0.9704	0.9974	0.9951	0.2712	0.1215	0.9400	1.0000
2004	0.9946	0.2986	0.1217	0.9703	0.9976	0.9954	0.2564	0.1216	0.9796	0.9972
2005	0.9952	0.2690	0.1213	0.9179	0.9983	0.9952	0.2665	0.1213	0.9162	0.9984
2006	0.9966	0.1922	0.1194	0.9233	1.0000	0.9963	0.2091	0.1194	0.9275	1.0000
2007	0.9874	0.7089	0.1206	0.9467	0.9943	0.9862	0.7747	0.1205	0.9217	0.9936
2008	0.9777	1.2633	0.1196	0.8928	0.9938	0.9739	1.4821	0.1194	0.7970	0.9885

Note: The notes are similar to Table A.2.

A. 7. Summary statistics for the efficiency of the banking system in France

France	mean efficiency	t-stat	st.dev.	min	max	mean efficiency (incl. financial capital)	t-stat	st.dev.	min	max
1994	**0.9856**	2.1913	0.0503	0.9577	0.9988	**0.9835**	2.5178	0.0502	0.9584	0.9993
1995	0.9986	0.2110	0.0509	0.9971	0.9990	0.9903	1.4614	0.0508	0.9571	0.9993
1996	0.9986	0.2095	0.0516	0.9973	0.9991	0.9912	1.3166	0.0515	0.9664	0.9993
1997	0.9985	0.2175	0.0536	0.9977	0.9993	0.9874	1.8232	0.0530	0.9725	0.9992
1998	**0.9215**	12.8703	0.0469	0.8517	0.9958	**0.9165**	13.8967	0.0462	0.8622	0.9919
1999	0.9866	1.9261	0.0535	0.9503	1.0000	0.9885	1.6459	0.0536	0.9581	1.0000
2000	0.9877	1.8594	0.0509	0.9491	1.0000	0.9904	1.4424	0.0510	0.9676	1.0000
2001	0.9912	1.2453	0.0543	0.9683	1.0000	0.9935	0.9122	0.0544	0.9701	1.0000
2002	0.9882	1.7497	0.0519	0.9562	1.0000	0.9883	1.7238	0.0520	0.9441	1.0000
2003	0.9900	1.4154	0.0543	0.9463	0.9972	0.9879	1.7041	0.0544	0.9182	1.0000
2004	0.9944	0.7780	0.0552	0.9555	1.0000	0.9951	0.6884	0.0552	0.9766	0.9983
2005	**0.9804**	2.5859	0.0583	0.9310	0.9963	**0.9779**	2.9149	0.0582	0.9213	0.9966
2006	0.9924	0.9912	0.0592	0.9659	0.9970	0.9920	1.0336	0.0592	0.9596	0.9974
2007	**0.7376**	56.0296	0.0360	0.5723	1.0000	**0.7425**	54.5684	0.0363	0.5720	1.0000
2008	**0.5493**	155.1260	0.0223	0.2470	0.9997	**0.5568**	150.5016	0.0226	0.2720	0.9968

Note: The notes are similar to Table A.1.

A. 8. Summary statistics for the efficiency of the banking system in France (cont'd)

France	mean efficiency (incl. total assets)	t-stat	st.dev.	min	max	mean efficiency (incl. financial capital and total assets)	t-stat	st.dev.	min	max
1994	**0.9832**	2.5752	0.0501	0.9585	0.9992	**0.9838**	2.4853	0.0502	0.9633	0.9993
1995	0.9987	0.2019	0.0509	0.9972	0.9991	0.9988	0.1751	0.0510	0.9977	0.9993
1996	0.9987	0.1927	0.0516	0.9975	0.9992	0.9930	1.0472	0.0515	0.9697	0.9994
1997	0.9985	0.2186	0.0536	0.9977	0.9993	0.9896	1.5010	0.0531	0.9754	0.9992
1998	**0.9160**	13.9818	0.0461	0.8505	0.9957	**0.9193**	13.3909	0.0463	0.8655	0.9922
1999	0.9872	1.8442	0.0535	0.9554	1.0000	0.9891	1.5659	0.0536	0.9561	1.0000
2000	0.9877	1.8614	0.0509	0.9500	1.0000	0.9907	1.4080	0.0510	0.9692	1.0000
2001	0.9911	1.2548	0.0543	0.9697	1.0000	0.9943	0.7972	0.0544	0.9693	1.0000
2002	0.9875	1.8429	0.0519	0.9531	1.0000	0.9882	1.7448	0.0520	0.9428	1.0000
2003	0.9900	1.4168	0.0543	0.9554	0.9972	0.9884	1.6430	0.0544	0.9275	1.0000
2004	0.9941	0.8263	0.0552	0.9541	1.0000	0.9954	0.6470	0.0552	0.9778	0.9982
2005	**0.9746**	3.3758	0.0578	0.9209	0.9971	**0.9732**	3.5715	0.0577	0.9181	0.9970
2006	0.9915	1.0963	0.0592	0.9530	0.9981	0.9919	1.0462	0.0592	0.9483	0.9976
2007	**0.7428**	54.3335	0.0364	0.5796	1.0000	**0.7645**	47.5035	0.0381	0.6077	1.0000
2008	**0.5555**	148.4293	0.0230	0.2336	0.9933	**0.5558**	147.3693	0.0232	0.2372	0.9877

Note: The notes are similar to Table A.2.

A. 9. Summary statistics for the efficiency of the banking system in Germany

Germany	**mean efficiency**	**t-stat**	**st.dev.**	**min**	**max**	**mean efficiency (incl. financial capital)**	**t-stat**	**st.dev.**	**min**	**max**
1994	**0.9927**	15.0439	0.0101	0.9760	1.0000	**0.9939**	12.5809	0.0101	0.9718	1.0000
1995	**0.9986**	2.8185	0.0105	0.9978	0.9994	**0.9917**	16.6805	0.0105	0.9721	1.0000
1996	**0.9984**	2.9373	0.0111	0.9975	0.9994	**0.9913**	16.5244	0.0110	0.9707	1.0000
1997	**0.9985**	2.7277	0.0117	0.9973	0.9995	**0.9868**	24.0276	0.0115	0.9535	1.0000
1998	**0.9650**	60.1257	0.0122	0.8902	1.0000	**0.9648**	60.6035	0.0122	0.8777	1.0000
1999	**0.9713**	48.6625	0.0124	0.9269	0.9973	**0.9682**	54.6909	0.0122	0.9006	0.9982
2000	**0.9775**	35.3552	0.0133	0.9371	0.9988	**0.9763**	37.5870	0.0132	0.9331	0.9987
2001	**0.9723**	43.8951	0.0132	0.9451	0.9989	**0.9706**	47.1412	0.0131	0.9429	0.9990
2002	**0.9443**	92.6651	0.0126	0.6502	0.9961	**0.9436**	94.0616	0.0126	0.6413	0.9961
2003	**0.9419**	94.9069	0.0128	0.7680	0.9930	**0.9225**	128.8265	0.0126	0.6753	0.9951
2004	**0.9463**	85.0636	0.0132	0.8073	0.9925	**0.9718**	43.0388	0.0137	0.9038	0.9952
2005	**0.9739**	31.6690	0.0173	0.9119	1.0000	**0.9737**	31.8999	0.0172	0.8916	1.0000
2006	**0.9695**	37.4547	0.0170	0.9007	1.0000	**0.9669**	40.6813	0.0170	0.8967	1.0000
2007	**0.9598**	45.7798	0.0184	0.7850	1.0000	**0.9606**	44.9706	0.0183	0.7554	1.0000
2008	**0.6201**	842.1637	0.0094	0.0000	0.9997	**0.6249**	831.1960	0.0094	0.0000	0.9960

Note: The notes are similar to Table A.1.

A. 10. Summary statistics for the efficiency of the banking system in Germany (cont'd)

Germany	mean efficiency (incl. total assets)	t-stat	st.dev.	min	max	mean efficiency (incl. financial capital and total assets)	t-stat	st.dev.	min	max
1994	**0.9933**	13.9894	0.0101	0.9748	1.0000	**0.9938**	12.8311	0.0101	0.9779	1.0000
1995	**0.9986**	2.7038	0.0105	0.9978	0.9994	**0.9988**	2.3015	0.0105	0.9982	0.9995
1996	**0.9986**	2.7460	0.0111	0.9975	0.9994	**0.9918**	15.5526	0.0110	0.9723	1.0000
1997	**0.9985**	2.7520	0.0117	0.9971	0.9995	**0.9866**	24.4507	0.0115	0.9530	1.0000
1998	**0.9651**	59.8892	0.0122	0.9027	1.0000	**0.9646**	60.8941	0.0122	0.8798	1.0000
1999	**0.9723**	47.0254	0.0123	0.9223	0.9969	**0.9681**	54.8607	0.0122	0.9001	0.9983
2000	**0.9751**	39.4953	0.0132	0.9338	0.9987	**0.9769**	36.6861	0.0132	0.9340	0.9987
2001	**0.9711**	46.1497	0.0131	0.9494	0.9989	**0.9714**	45.6552	0.0131	0.9464	0.9989
2002	**0.9446**	92.2610	0.0126	0.6508	0.9960	**0.9440**	93.2881	0.0126	0.6455	0.9966
2003	**0.9429**	93.1170	0.0128	0.7723	0.9934	**0.9242**	125.6506	0.0126	0.6801	0.9956
2004	**0.9449**	87.5117	0.0132	0.8042	0.9934	**0.9720**	42.7756	0.0137	0.9046	0.9950
2005	**0.9747**	30.6466	0.0172	0.8933	1.0000	**0.9753**	30.0301	0.0172	0.8904	1.0000
2006	**0.9621**	46.7257	0.0170	0.8674	1.0000	**0.9620**	46.8720	0.0170	0.8738	1.0000
2007	**0.9614**	43.9382	0.0184	0.8031	1.0000	**0.9629**	42.2405	0.0184	0.7770	1.0000
2008	**0.6313**	759.7642	0.0102	0.0000	0.9998	**0.6434**	707.7772	0.0105	0.0000	0.9985

Note: The notes are similar to Table A.2.

A. 11. Summary statistics for the efficiency of the banking system in Luxembourg

Luxembourg	mean efficiency	t-stat	st.dev.	min	max	mean efficiency (incl. financial capital)	t-stat	st.dev.	min	max
1994	0.9945	0.9239	0.0356	0.9796	0.9989	0.9952	0.8071	0.0357	0.9830	0.9991
1995	0.9986	0.2474	0.0332	0.9982	0.9990	0.9949	0.9202	0.0331	0.9851	0.9990
1996	0.9985	0.2676	0.0340	0.9976	0.9988	0.9948	0.9278	0.0339	0.9860	0.9984
1997	0.9986	0.2314	0.0354	0.9982	0.9989	0.9944	0.9534	0.0353	0.9862	0.9985
1998	**0.9765**	3.9217	0.0360	0.9133	0.9961	**0.9786**	3.5660	0.0360	0.9278	0.9968
1999	0.9840	2.6386	0.0364	0.9760	0.9956	**0.9874**	2.0712	0.0365	0.9774	0.9952
2000	0.9910	1.5172	0.0355	0.9859	0.9960	0.9923	1.2954	0.0355	0.9862	0.9963
2001	0.9915	1.3102	0.0387	0.9764	0.9977	0.9912	1.3615	0.0387	0.9755	0.9973
2002	**0.9803**	2.9889	0.0396	0.9698	0.9916	**0.9761**	3.6409	0.0394	0.9637	0.9911
2003	**0.9808**	2.8958	0.0397	0.9709	0.9891	**0.9742**	3.9132	0.0395	0.9569	0.9872
2004	**0.9844**	2.4546	0.0382	0.9730	0.9953	0.9894	1.6611	0.0383	0.9850	0.9947
2005	**0.9786**	3.3610	0.0382	0.9146	0.9932	**0.9770**	3.6358	0.0380	0.9475	0.9907
2006	**0.9856**	2.2802	0.0378	0.9478	0.9945	**0.9840**	2.5485	0.0376	0.9615	0.9948
2007	**0.9669**	5.4768	0.0362	0.9211	0.9876	**0.9657**	5.7083	0.0360	0.9193	0.9882
2008	**0.9314**	11.5399	0.0357	0.8435	0.9961	**0.9253**	12.7561	0.0351	0.8631	0.9961

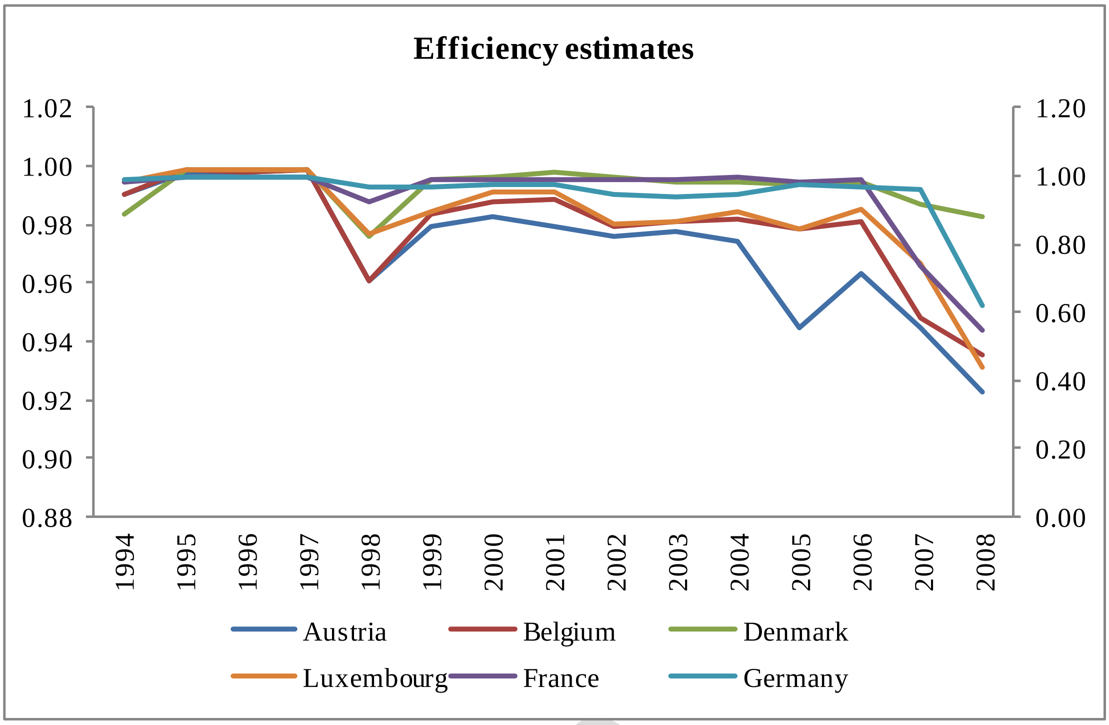
Note: The notes are similar to Table A.1.

A. 12. Summary statistics for the efficiency of the banking system in Luxembourg (cont'd)

Luxembourg	**mean efficiency (incl. total assets)**	**t-stat**	**st.dev.**	**min**	**max**	**mean efficiency (incl. financial capital and total assets)**	**t-stat**	**st.dev.**	**min**	**max**
1994	0.9949	0.8504	0.0357	0.9818	0.9989	0.9961	0.6576	0.0357	0.9819	0.9990
1995	0.9987	0.2313	0.0332	0.9983	0.9990	0.9990	0.1867	0.0332	0.9986	0.9992
1996	0.9986	0.2460	0.0340	0.9983	0.9989	0.9958	0.7489	0.0339	0.9878	0.9985
1997	0.9987	0.2276	0.0354	0.9984	0.9989	0.9952	0.8222	0.0353	0.9883	0.9986
1998	**0.9782**	3.6178	0.0361	0.9195	0.9967	**0.9798**	3.3639	0.0361	0.9298	0.9962
1999	**0.9858**	2.3432	0.0365	0.9792	0.9969	**0.9873**	2.0849	0.0365	0.9761	0.9966
2000	0.9909	1.5374	0.0355	0.9805	0.9966	0.9922	1.3128	0.0355	0.9854	0.9962
2001	0.9911	1.3780	0.0387	0.9791	0.9979	0.9915	1.3196	0.0387	0.9729	0.9975
2002	**0.9790**	3.1962	0.0395	0.9674	0.9914	**0.9765**	3.5719	0.0394	0.9612	0.9922
2003	**0.9811**	2.8611	0.0397	0.9702	0.9893	**0.9759**	3.6588	0.0396	0.9569	0.9916
2004	**0.9834**	2.6228	0.0380	0.9711	0.9952	0.9899	1.5832	0.0384	0.9823	0.9950
2005	**0.9790**	3.3282	0.0379	0.9546	0.9948	**0.9782**	3.4441	0.0379	0.9545	0.9936
2006	**0.9834**	2.6427	0.0376	0.9692	0.9966	**0.9825**	2.7981	0.0376	0.9603	0.9960
2007	**0.9673**	5.4055	0.0363	0.9116	0.9878	**0.9684**	5.2555	0.0361	0.9130	0.9871
2008	**0.9198**	13.6729	0.0352	0.7980	0.9994	**0.9034**	16.5548	0.0350	0.6534	0.9951

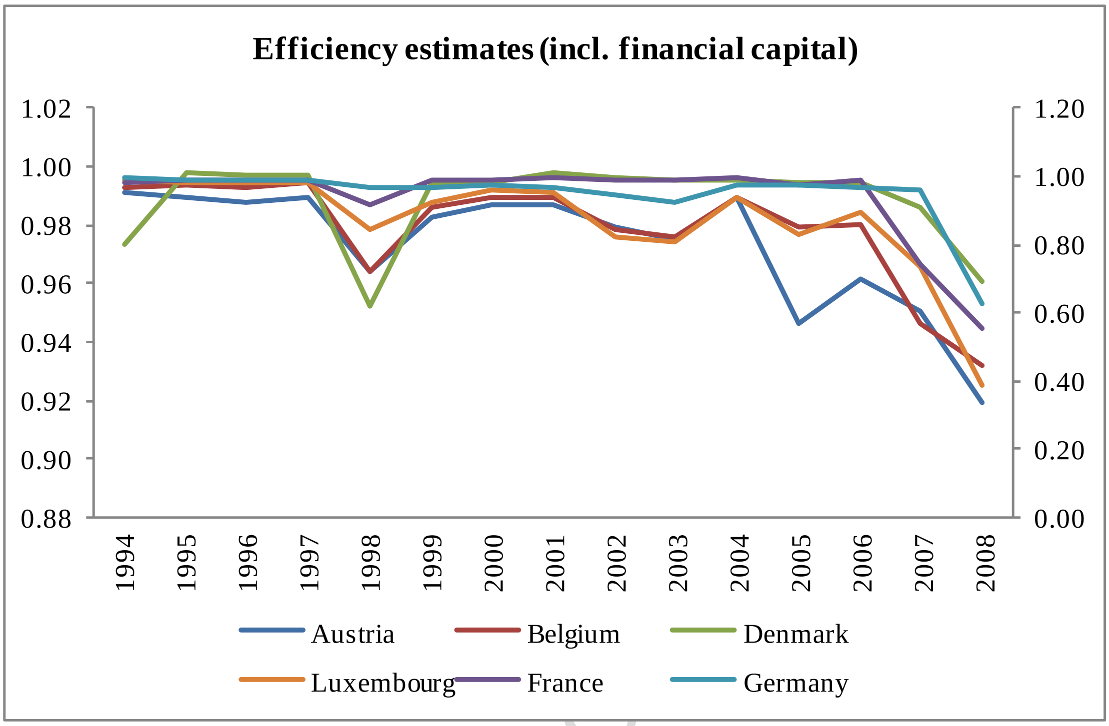
Note: The notes are similar to Table A.2.

Figure A. 1. Profit efficiency estimates for the 6 European countries



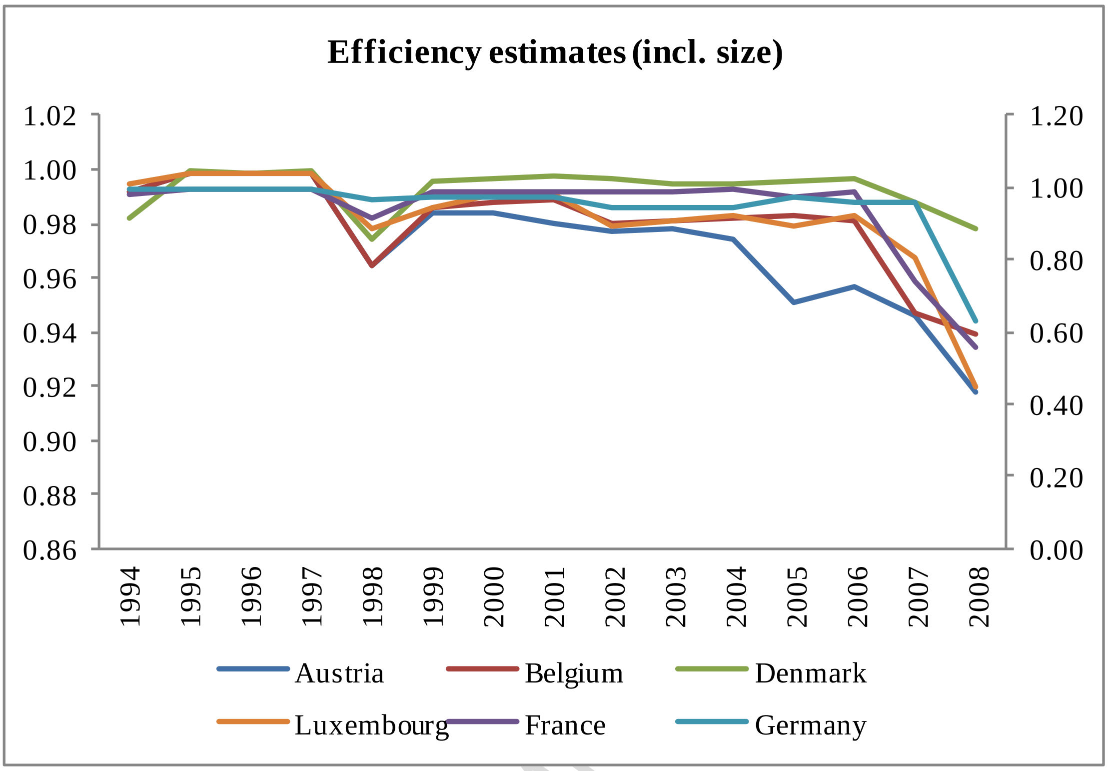
Note: Graphical presentation of the entries in Table 3.3. The results for Germany and France are displayed in the right axis, whereas the results for the rest of the countries are displayed in the left axis.

Figure A. 2. Profit efficiency estimates for the 6 European countries, with risk variable taken into consideration



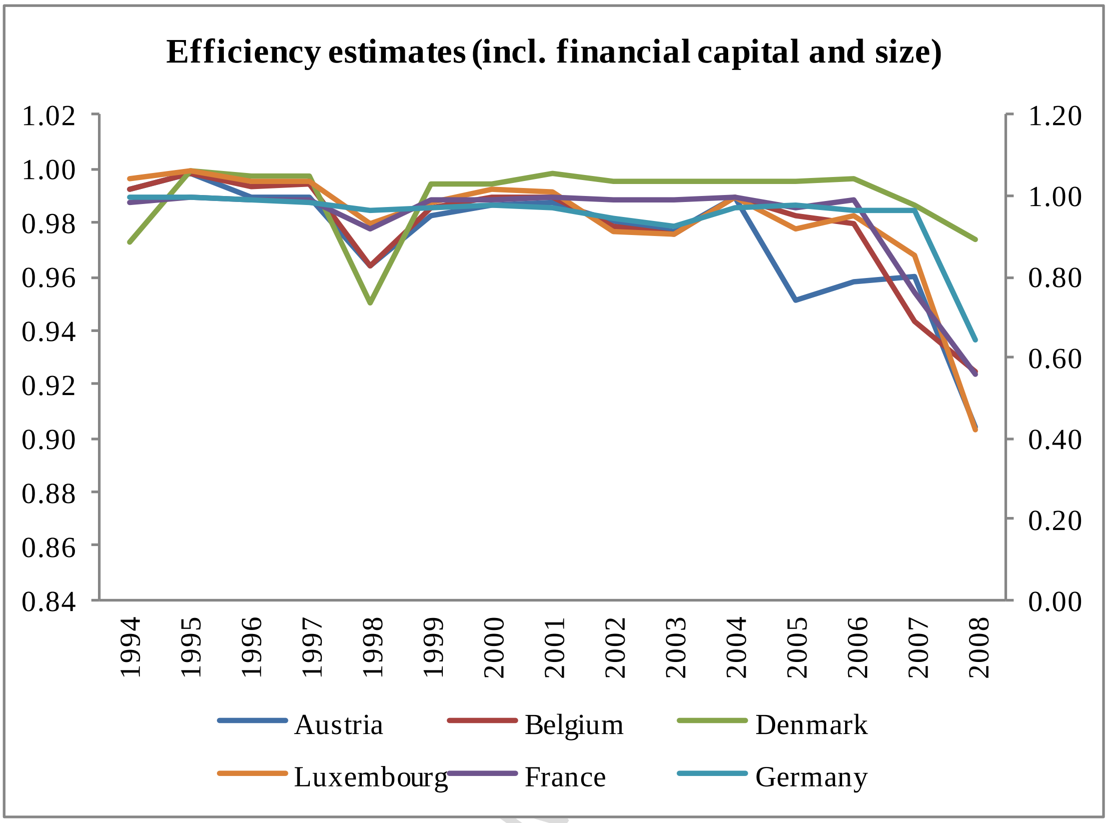
Note: Graphical presentation of the entries in Table 3.4. The results for Germany and France are displayed in the right axis, whereas the results for the rest of the countries are displayed in the left axis.

Figure A. 3. Profit efficiency estimates for the 6 European countries, with size variable taken into consideration



Note: Graphical presentation of the entries in Table 3.5. The results for Germany and France are displayed in the right axis, whereas the results for the rest of the countries are displayed in the left axis

Figure A. 4. Profit efficiency estimates for the 6 European countries, with both risk and size variables taken into consideration



Note: Graphical presentation of the entries in Table 3.6. The results for Germany and France are displayed in the right axis, whereas the results for the rest of the countries are displayed in the left axis

Chapter 4: The Bank Lending Channel and Monetary Policy Rules for European Banks

Abstract

The monetary authorities affect the macroeconomic activity through various channels of influence. This paper examines the bank lending channel, which considers how central bank actions affect deposits, loan supply, and real spending. The monetary authorities influence deposits and loan supplies through its main indicator of policy, the real short-term interest rate. This paper employs the endogenously determined target interest rate emanating from the central bank's monetary policy rule to examine the operation of the bank lending channel. Furthermore, it examines whether different bank-specific characteristics affect how European banks react to monetary shocks. That is, do sounder banks react more to the monetary policy rule than less-sound banks. In addition, inflation and output expectations alter the central bank's decision for its target interest rate, which, in turn, affect the banking system's deposits and loan supply. Robustness tests, using additional control variables, (i.e., the growth rate of consumption, the ratio loans to total deposits, and the growth rate of total deposits) support the previous results.

1. Introduction

The monetary transmission mechanism includes various channels through which the monetary authorities can affect the macroeconomy. Two main channels include the interest rate (money view) and credit (credit view) channels. In the money view, monetary policy affects aggregate demand through real interest rates, whereas in the credit view, monetary policy facilitates the transmission of policy through the availability of deposits and loans (Hernando and Pages, 2001). A sub-channel within the credit view (bank lending channel) relates to the supply of credit and "stems from financial market incompleteness and relies on imperfect substitutability" (Gambacorta, 2005, p. 1737). An alternative sub-channel within the credit view (balance sheet channel) relates to the balance sheet and income statements and the informational frictions that alter the external finance premium.

Literature provides evidence on the presence of the bank lending channel in European countries, whereas in the U.S. mixed evidence is reported. However, the operation of the specific channel was seriously questioned and severely criticized during the last decade, with many surveys suggesting its reformulation (Bernanke, 2007; Altunbas *et al*., 2009; Gambacorta and Marques-Ibanez, 2011; Disyatat, 2011), since changes in the monetary policy indicator proved quite inadequate to shift private banks' lending behavior. This paper examines whether banks' incentives are affected more by the central bank's reception about economic environment and therefore its actions and announcements (which are more likely to guide private banks' expectations), rather than by the current policy indicator that exists in each specific time. Hence, banks' behavior depends on their perception concerning the reaction function of the monetary authority. This paper investigates the presence of the bank lending channel by employing not only the current policy rate, but also the target rates emanating from the central bank's interest rate rules.

Changes in bank reserves cause changes in bank deposits and loans, resulting initially from central bank's adjustment in its target interest rate. This paper extends Apergis and Alevizopoulou (2012) and examines the effects on the operation of the bank lending channel when we employ different measures of the central banks' primary monetary policy instrument (i.e., a target interest rate), which depends on a set of macroeconomic variables. In other words, this paper investigates the effect on the bank lending channel in a number of euro area economies, since most European developed economies rely much more heavily on indirect bank finance rather than direct stock and bond market finance, where we use different interest rate rules as alternative monetary policy indicators[1].

Apergis and Alevizopoulou (2012) consider the bank lending channel for a group of six European countries – Austria, Belgium, Finland, France, Germany, and the Netherlands – as well as Denmark and the UK as separate analyses. They specify interest rate policy rules that depend on timing issues – lagged, current, or forecast values to inform the policy rule. They then compare the results across the different policy rules. Their empirical findings show that the bank lending channel operates most robustly to forward-looking monetary policy rules.

Our analysis differs and extends that of Apergis and Alevizopoulou (2012) in several important ways. First, we include bank specific information to see if differences in bank performance affect how the bank responds to changes in monetary policy through the bank lending channel. For example, do sound banks respond more vigorously to a monetary policy change than do less-sound banks? Second, we consider the robustness of our findings by including other variables to control for loan demand – the growth rate of consumption, the ratio of loans to deposits, and the growth rate of

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[1] A limited literature exists on direct econometric estimates of the European Central Bank (ECB) monetary policy rules. Although Hayo and Hoffman (2005) estimate such rules, their empirical analysis does not examine flexible forms of monetary policy rules.

deposits. Third, for both the interest rate rules and the bank lending channel estimations, our GMM estimation uses up to four lags whereas Apergis and Alevizopoulou (2012) only consider up to two lags. Fourth, the bank lending channel estimates in our paper use deviations from the mean, whereas Apergis and Alevizopoulou (2012) do not. Fifth, one of the three interest rate rules, the forward-looking rule, requires forecasts of the inflation rate and the output gap. Apergis and Alevizopoulou (2012) provide forecasts of inflation, but not the output gap. We provide forecasts of both. Furthermore, our forecast of the inflation rate includes additional information. Finally, we collect the data from scratch, given updated data bases from which to draw our sample. As a result, the coverage of banks differs slightly and the data on the banks reflects new revisions.

The empirical findings document that the bank-lending channel exists, with differences emerging in the degrees of responsiveness of loan growth to changes in the monetary policy indicator. Moreover, the bank-lending channel exerts a stronger effect when target rates are used as indicators, while the strongest effects generally emerge in the models employing the forward-looking rules. These results recommend that central banks use target interest rate rules, especially a forward-looking rule as the monetary policy indicator, since such rules incorporate inflationary expectations that affect the decisions for monetary policy.

These empirical findings survive a number of robustness tests, such as a number of idiosyncratic bank characteristics that define the strength of a bank (i.e., capitalization, asset size, and liquidity), while we also account for additional variables, in addition to real GDP growth (i.e., the growth rate of real consumption spending, the ratio of total loans to total deposits, and the growth rate of deposits). The new results indicate that large and well-capitalized banks more easily absorb monetary shocks. Moreover, the robustness checks do not alter the initial results that suggest using the forward-looking rule as the monetary policy indicator, retain their validity.

We organize the rest of the paper as follows. Section 2 reviews the literature concerning the bank lending channel and interest rate rules. Section 3 presents and analyses the data. Section 4 outlines the methodologies used, first, to estimate the different monetary policy rules and, second, to estimate the effect of monetary policy on the bank lending channel. Finally, Section 5 reports the findings and Section 6 concludes.

2. Literature Review

2.1. The Bank Lending Channel

This study considers how the monetary authorities affect the macroeconomy through the bank lending channel, which largely depends on the quantities of deposits and loans and the factors that determine these quantities. In particular, the monetary authorities implement an expansionary (contractionary) policy by increasing (decreasing) bank reserves and lowering (raising) interest rates. As reserves expand (contract), the banking system increases (decreases) deposits and loans. Therefore, businesses and consumers, who depend on bank lending, can increase (decrease) their purchases of durable goods and capital for investment. Hence, expansions (contractions) in bank reserves affect output positively (negatively) (Golodniuk, 2006).

Three necessary conditions must exist for the bank lending channel to exert significant economic effects. First, firms must respond differently to different types of finance. That is, they must depend on bank loans, since they cannot rely on other types of finance (Oliner and Rudenbusch, 1995). Second, the supply of loans must respond to changes in reserves that the central bank imposes on the system. For instance, when confronted with a restrictive monetary policy, banks cannot easily offset the decrease in funds from deposits by raising funds from other sources. In other words, banks face restrictions in issuing uninsured liabilities to replace the shortfall in deposits (Oliner and Rudenbusch, 1995; Disyatat, 2010). Third, some imperfections must exist in the adjustment of the aggregate price level. That is, monetary policy will exert no effect, if prices can adjust proportionally and quickly with changes in the money supply (Golodniuk, 2006).

The existing literature on the bank lending channel searches for this channel in different economies or in a group of countries. More specifically, it examines whether the effect on lending responds differently, depending on the influence of the banking system, which, in turn, depends on such characteristics as capitalization, asset size, and liquidity. Most studies on euro area economies provide empirical support for the presence of the channel, while the empirical analysis for the US case provides mixed results (Ehrmann *et al.*, 2003; Gambacorta, 2005). Juurikkala *et al.* (2011) also find evidence that supports the presence of the channel in Russia. The empirical evidence also supports the idea that well capitalized and liquid banks experience more insulation from monetary policy changes than banks that exhibit low capital and liquidity ratios. In addition, the majority of studies show that small banks do not exhibit more sensitivity to monetary policy shocks than large banks (Peek and Rosengren, 1995; Gambacorta, 2005; Golodniuk, 2006). Other empirical studies, however, find that large banks, in combination with high capitalization ratios, respond less to monetary policy shocks (Kishan and Opiela, 2000). It should be noted, however, that the existence of the bank lending channel was questioned in the last decade[2].

Empirical implementation faces an important problem. More precisely, merely observing that both output and bank loans decrease after a negative change in monetary policy does not necessarily imply that this change reflects a reduction in loan supply (Oliner and Rudenbusch, 1995; Brissimis *et al.*, 2001). Such changes, however, may only reflect a reduction in loan demand. For instance, a tight monetary policy increases interest rates and, consequently, generates higher costs, which do not favor investment, leading to a fall in loan demand and, therefore, in the volume of loans. To resolve this issue, the literature either analyzes microeconomic data on firms and banks (Kashyap *et al*., 1993), rather than aggregate data, or it uses a number of macroeconomic control variables (i.e., GDP and inflation) that affect the demand for loans.

This analysis of bank lending is based on the model by Ehrmann *et al*. (2001) [3,4], who assume that deposits (D) equal money (M), which are both dependent on the policy interest rate (i) in the following way:

$$M = D = -\psi i + \chi \quad (1)$$

The demand for loans depends on real GDP (*y*), the price level (*p*), as well as the lending rate (i_l) – the sign of coefficients is indicated by their sign in the equations:

$$L_i^d = \phi_1 y + \phi_2 p - \phi_3 i_l \quad (2)$$

whereas, the supply of loans is modeled as follows:

$$L_i^s = \mu_i D_i + \phi_4 i_l - \phi_5 i \quad (3)$$

It is evident from the above equation that the supply of loans depends on the amount of deposits (or money) that is available, the lending interest rate and a direct effect of the

[2] More details on this issue are given in Chapter 5.
[3] The notation adopted is similar to that used in the model by Ehrmann *et al*. (2001).
[4] They use a simple version of the model by Bernanke and Blinder (1988).

monetary policy rate, which arises when opportunity costs[5] exist for a bank. Moreover, an additional assumption that is taken into consideration is that banks respond in a different way to changes in deposits, depending on different bank-specific characteristics; that is, the higher the bank-specific characteristic (denoted by x_i), the lower the impact of deposit changes is expected to be:

$$\mu_i = \mu_0 - \mu_1 x_i \tag{4}$$

Combining equations (1) and (4), while considering the cleaning of the loan market, leads to the following reduced form:

$$L_i = \frac{\phi_1\phi_4 y + \phi_2\phi_4 p - (\phi_5 + \mu_o\psi)\phi_3 i + \mu_1\psi\phi_3 i x_i + \mu_o\phi_3\chi - \mu_1\phi_3\chi x_i}{\phi_3 + \phi_4} \tag{5}$$

The above equation is simplified to the following:

$$L_i = \alpha y + bp - c_0 i + c_1 i x_i + d x_i + cons\tan t \tag{6}$$

where $c_0 = \frac{(\phi_5 + \mu_0\psi)\phi_3}{\phi_3 + \phi_4}$ relates the reaction of bank lending to the monetary policy, whereas $c_1 = \frac{\mu_1\psi\phi_3}{\phi_3 + \phi_4}$ relates the reaction of bank loan supply to the monetary policy to the bank-specific characteristic.

It is obvious from the model that a decrease in the monetary policy indicator, leads to an increase in bank lending and vice versa. Taking also into account the normalization of the bank-specific characteristics, the loan supply can be considered mainly as a function of the monetary policy indicator (*i*), that is, $L \equiv f(i)$. As mentioned before, this paper investigates the effects on the operation of the bank lending channel, when different measures of the central banks' primary policy instrument are employed; that is, it specifies interest rate rules that depend on timing issues and specifically,

[5] Specifically, when the bank uses the interbank rate to finance its loans or in the case of mark-up pricing by banks, which passes on increases in deposit rates to lending rates.

lagged, current and forward values to inform the rule. It is expected that the target rates derived by forward-looking rules exert the strongest effects on bank lending, since bank's expectation are influenced by the monetary authorities' actions. Therefore, the policy indicator (i) in the aforementioned function of loan supply ($L \equiv f(i)$), is replaced by $E(i_{t+1} / I_t)$, that is, the conditional expectation of the policy indicator (i) at time $t+1$, given the information set I at time t. This alternative definition incorporates the standard approach if it is assumed that i_t is a martingale process, suggesting that the best forecast for tomorrow is today's price: $E(i_{t+1} / I_t) = i_t$. However, assuming that banks may be focusing on expected reactions of central banks, this modification of the model indicates that these expectations can be integrated in the model and justify the approach of including specific reaction functions of central banks in the empirical model.

As shown in the model above, in order to control for loan demand – and therefore, to face the identification problem – loan growth of every bank in each country is regressed on the country-specific GDP growth and the respective inflation rate.

2.2. Monetary Policy Rules

Macroeconomists model the policy process as follows. The central bank chooses its operating targets to optimize its objective function subject to the macroeconomic model of the economy. Hence, they derive central bank reaction functions or monetary policy rules that describe how central banks alter their policy in response to macroeconomic changes. The central bank most frequently uses the short-term interest rate as the policy instrument and, therefore, "monetary policy rules" typically mean "interest rate rules" (Fourcans and Vranceanu, 2004).

Gerdesmeier and Roffia (2003) identify three main reasons for the interest in central bank reaction functions. First, an interest rate rule makes the evaluation of the central bank feasible. Second, a rule provides a good forecasting tool to evaluate the changes that the central bank imposes on the policy instrument. Finally, the correct reaction function plays an important role in estimating the entire macro model, when the model includes rational expectations.

Interest rate rules model the interest rate as depending on deviations of a set of macroeconomic variables, such as the inflation rate and output, from their target values. Taylor (1993) shows that monetary policy in the U.S. conforms to a contemporaneous interest rate rule, where the short-term interest rate depends on deviations of the inflation rate and real output from the target inflation rate and potential output, respectively. Moreover, such a rule closely follows observed movements in that interest rate. More precisely, the target federal funds rate equals the long-run equilibrium real interest rate plus the current inflation rate, plus coefficients multiplied by the deviations of inflation and real output from the target inflation rate and potential output, respectively. When the inflation rate exceeds (falls below) its target, the rule recommends an increase (decrease) in the interest rate. This term captures the goal of the central bank to achieve price stability.

With a positive (negative) output gap, the Taylor rule recommends an increase (decrease) in the interest rate. Kozichi (1999) argues that the output gap plays a forward-looking role, since a positive gap signals potential increases of the inflation rate in the future. Therefore, adjustments of the interest rate, vis-à-vis the output gap, implement policy responses aimed at preempting an expected increase in the future inflation rate. The specification of the original Taylor rule is as follows:

$$i_t = \pi_t + \bar{r} + 0.5(\pi_t - \pi^*) + 0.5x_t, \qquad (7)$$

where i_t is the target nominal interest rate, π_t is the inflation rate, $\bar{r}$ is the long-run equilibrium real interest rate, assumed to equal 2 percent, π^* is the target inflation rate, also assumed to equal 2 percent, and x_t is the output gap.

This contemporaneous Taylor rule facilitates a good interpretation of the historical monetary policy actions of the Federal Reserve, as mentioned in Orphanides (2003), suggesting that this rule serves as a "useful organizing device for interpreting past policy decisions and mistakes. However, the adoption of the Taylor-type framework for policy analysis is not insurance that past policy mistakes would not have occurred."

Nevertheless, the Taylor rule possesses certain limitations. First, central banks do not know the contemporaneous output and inflation gap when setting the interest rate for a given time. To address this problem, one can use lagged output and inflation rate gap data (i.e., backward-looking rules). Or, one can replace current measures of these variables with forecasts (i.e., forward-looking rules).

Second, the specific rule estimates the weights – at the level of 0.5 for both the inflation and the output gap, values that applied to the Federal Reserve reaction function at that time – representing the policy responsiveness to deviations of inflation and output from their targets. In addition, several measures of the inflation rate and the output gap exist and, therefore, researchers can use different measures.

Third, the contemporaneous Taylor rule does not incorporate interest rate smoothing. Observation suggests that central banks smooth interest rate movements, which researchers can incorporate into the contemporaneous Taylor rule (Kozichi, 1999; Woodford, 1999). Gerdesmeier and Roffia (2003) argue that interest rate smoothing may reflect optimal "monetary policy inertia". Levin *et al.* (1999) and Woodford (1999) argue that policy inertia by affecting expectations of future policy and economic developments influences the ultimate goals, such as real GDP or inflation. Orphanides (2001) suggests that interest rate smoothing may reflect data uncertainty. Furthermore, central banks also want to stabilize financial markets, since abrupt changes in interest rates may disrupt bond and equity markets. This interest in financial market stability as well as the learning process through which central banks behave leads them to place some weight on the previous level of the interest rate (Woodford, 1999). Woodford (1999) also argues that with forward-looking inflation expectations, optimal policy may adjust the interest rate with some inertia because this smoothing provides leverage with respect to longer-term interest rates, which transmits monetary policy decisions to aggregate demand and the real economy. Finally, Rudebusch (2002) argues that the interest rate smoothing term may compensate for the misspecification of empirical rules that display substantial partial adjustments and that do not take into consideration serially correlated shocks.

The contemporaneous Taylor rule conforms to two interpretations: a narrow interpretation (i.e., it’s the specific algebraic form mentioned above) or a broader interpretation. Orphanides (2003) argues that the broad interpretation introduces a degree of flexibility that overcomes the limitations of the contemporaneous framework. Taylor also emphasizes that one can interpret the rule as a monetary policy program, which the central bank uses to attain the fundamental policy objectives. In other words, one should not use the rule as a “mechanical formula,” but rather as a guiding principle for the monetary authorities.

The existing literature debates whether the backward-looking or forward-looking rules better fit historical data when compared to the contemporaneous rule. Taylor (1999) argues that forward-looking rules may incorporate additional variables beyond the inflation and output terms that may improve the forecast. But, Haldane and Batini (1999) find that the interest rate setting by the European Central Bank (ECB) dominates such forward-looking rules. Taylor (1999) reports that in fact forecasts use current and lagged data and hence, forward-looking rules depend on current and lagged data as well.

Greenspan (1999) argues that using past macroeconomic behavior to form rules embodies a “notion” that the future will mimic the past. Meyer (2002) also argues that while forecasts play an important role in the implementation of monetary policy, future values (forecasts) do not play a role in the standard Taylor rule. Hence, we can view monetary policy as a forward-looking process, which ought to take into consideration all available information to form adequate policy rules (Orphanides, 2003). Many argue that central banks behave in a forward-looking manner and, therefore, the policy rule must incorporate such forward-looking behavior. Moreover, since monetary policy transmission operates with at least one lag, it directs the monetary authorities to anticipate inflation and not rely on its current value (Gerdesmeier and Roffia, 2003).

Clarida *et al.* (1998, 2000) adopt this approach and replace current and recent outcomes of output and inflation with forecasts of these variables. Fourcans and Vranceanu (2004) also apply this procedure for the ECB’s interest rate rule. Their results indicate that the response of the interest rate to deviations of future inflation from its target exerts a stronger effect than if the rule incorporates current inflation. Finally, Fendel and Frenkel (2006) estimate different versions of the forward-looking rule for the case of the ECB, documenting that the ECB applies a Taylor-type rule to its monetary policy. In sum, debate continues about the efficacy of contemporaneous, backward-looking, and forward-looking interest rate rules. As a result, this paper shall use all approaches in the econometric analysis that follows.

It should be noted, however, that in the last decade, existing literature on policy rules claims that estimates of reaction functions carried out using revised data convey misleading descriptions of historical policy and therefore, argues that real time data should be used instead. Orhpanides (2001, 2003) examined whether real-time policy recommendations are different from those using revised data, claiming that the existing analysis is based on unrealistic assumptions concerning the timeliness of data availability. The results demonstrate that the real-time policy recommendations are different from those based on the revised data. Therefore, Orphanides argues that it is essential to take into consideration data which are actually available to policy makers in real time. Along the lines presented by Orphanides (2001), many authors were interested in addressing the issue of using real-time data instead of ex-post revised data (Gerdesmeier and Roffia, 2004; Boivin, 2006; Molodtsova *et al*., 2008). Gerdesmeier and Roffia (2004) focus on euro area data and compare the results they get using real-time versus revised data, under the assumption that the central bank follows a simple Taylor rule. They find that the rule estimated in real time differs significantly from the one, which uses ex post revised data. Molodtsova *et al*. (2008) compare Taylor rules based on real-time and revised data in Germany and the U.S. Their results report that the rules differ more for Germany that for the U.S., suggesting significant differences in the way the two economies conduct monetary policy.

However, estimating reaction functions using real-time data raises certain issues. Some data series are less timely available, since the release of the data differs across these series and therefore, make them more incomplete. Another serious drawback in most of the analyses, which mostly concern the Euro area, was the quite short span of data available, due to the fact that the European Central Bank was officially responsible of conducting monetary policy in the euro area only since the start of Stage Three of EMU. Furthermore, Molodtsova *et al*. (2008) argue that Orphanides (2001) reached the specific conclusion about the Federal Reserve – that inflation was not stabilizing during the period between 1987-1992 – due to the short span of data. By contrast, they use a larger span of real-time data and the results confirm those of Taylor (1993), who uses revised data.

3. Data Description

3.1. Interest Rate Rule Data Description

Quarterly data from Datastream and Bloomberg databases are collected to estimate interest rate rules for three different economies: a European group (i.e., Austria, Belgium, Finland, France, Germany, and the Netherlands, countries using the euro as a common currency), Denmark, and the United Kingdom. Denmark and the U.K., although operating with their own currency, however, follow the monetary policy of the euro zone, but still maintain some degree of autonomy. The remaining Eurozone economies are not taken into account due to unavailability of continuous banking data over the time span of the paper. For each country, the rate of change in the consumer price index measures inflation, while we detrend real GDP, using the Hodrick-Prescott filter, to measure potential output and the output gap. The following short-term interest rates are used: the EONIA interest rate for the ECB on main refinancing operation (MRO), which is a short-term open market operation in form of reverse transactions that allows it to control the degree of liquidity in the interbank market; the Danish discount rate of the Danmarks Nationalbank; and the bank rate of the Bank of England. The analysis spans 2000 through 2009, using quarterly data. We construct weighted averages of the Euro-group variables, an approach similar to that recommended by the

International Monetary Fund.

3.2. Bank Lending Channel Data Description

Annual data of total loans are collected as the dependent variable, that come from the BankScope database, spanning 2000 through 2009.[6] In particular, we use a sample of 739 European commercial and savings banks. The European group of countries includes Austria, Belgium, Finland, France, Germany, and the Netherlands, which are used as a group, as well as Denmark and the United Kingdom separately. Table 4.1 reports the countries and the number of banks.

As noted above, short-term interest rates are collected, which proxy for monetary policy, from the Bloomberg database. Real GDP values and inflation rates for each country come from Datastream to control for demand effects (i.e., to isolate changes in total loans, which are caused by movements in loan demand). We also use bank-specific characteristics in the analysis for the bank lending channel and, therefore, we collect data concerning the financial strength of a bank from BankScope. More specifically, we use the bank capitalization measured by equity to total assets, bank size measured by total assets, and bank liquidity measured by the ratio of liquid assets to total assets. Finally, we use two more variables to implement robustness checks – consumption of each country from Datastream and total deposits from the BankScope database.

We use quarterly data for the estimation of our three different interest rate rules (see Section 4). Since the BankScope data on bank-specific variables only come at the annual frequency, we use the interest rate rules estimated with quarterly data to generate

[6] The BankScope database does not report quarterly data for our purposes.

annual forecasts (by choosing the last observation of the fourth quarter) and to combine them with the analysis of the bank-lending channel (in which all variables are set on an annual basis).

4. The Econometric Specifications

4.1. The Interest Rate Rule

We largely adopt the methodology from Clarida *et al.* (1998) and, therefore, borrow their notation. Monetary policy is measured by the short-term interest rate. This allows the central bank to choose the level of the interest rate from period to period and conduct policy. More specifically, central banks vary the nominal interest rate – the target rate – to control effectively the real interest rate. We estimate this target rate as follows:

$$i_t^* = \bar{i} + \beta[E(\pi_{t+1} / \Omega_t) - \pi^*] + \gamma E(x_t / \Omega_t)\,, \qquad (8)$$

where *i** is the target interest rate, π^* is the target inflation rate, $\bar{i}$ is the long-run equilibrium nominal interest rate, π_{t+1} is the inflation rate between periods *t* and *t+1*, and x_t is the output gap, the difference between output and its potential level. Furthermore, *E* is the expectation operator and Ω_t is the information set at time *t*, when central banks set the target for the interest rate. Thus, the target rate depends both on the expected inflation rate gap and expected output gap.

Clarida *et al.* (1998, 2000) define the ex-ante real interest rate as $r_t \equiv i_t - E(\pi_{t+1} / \Omega_t)$. Therefore, equation (8) becomes the following:

$$r_t^* = \bar{r} + (\beta - 1)[E(\pi_{t+1} / \Omega_t) - \pi^*] + \gamma E(x_t / \Omega_t)\,, \qquad (9)$$

where r^* is the target real interest rate, $\bar{r}$ is the long-run equilibrium *real* interest rate. In an economy with inflation targeting, β plays an important role. If $\beta > 1$, then the target real interest rate increases in response to an increase in the expected inflation rate; whereas, if $\beta < 1$, then the target real interest rate decreases with an increase in expected inflation. In this latter case, monetary policy proves procyclical. The coefficient γ, according to economic theory, should exceed zero. These coefficients of the policy rule indicate the weights that central banks set on inflation and output gaps and how the monetary policy responds to changes in inflation and the output gap.

We also assume that the interest rate rule should incorporate interest rate smoothing, which takes the following form:

$$\boldsymbol{i_t = (1-\rho)i_t^* + \rho i_{t-1} + u_t}\,, \qquad (10)$$

where the degree of interest rate smoothing is ρ, where $0 \le \rho \le 1$, and u_t is an exogenous random shock, which follows an *i.i.d.* process.

Additionally, we redefine the constant in equation (8) as follows:

$$\alpha \equiv \bar{i} - \beta\pi^*. \qquad (11)$$

Using equation (11), equation (8) becomes:

$$i_t^* = \alpha + \beta E(\pi_{t+1} / \Omega_t) + \gamma \mathrm{E}(x_t / \Omega_t). \qquad (12)$$

Next, incorporating equation (12) into equation (10) yields:

$$i_t = (1-\rho)[\alpha + \beta E(\pi_{t+1} / \Omega_t) + \gamma \mathrm{E}(x_l / \Omega_t)] + \rho i_{t-1} + u_t. \qquad (13)$$

Next, rewriting the above equation in terms of realized variables produces:

$$i_t = (1-\rho)[\alpha + \beta\pi_{t+1} + \gamma x_t] + \rho i_{t-1} + \varepsilon_t\,, \qquad (14)$$

where $\varepsilon_t \equiv -(1-\rho)[\beta(\pi_{t+1} - E(\pi_{t+1} / \Omega_t)) + \gamma(x_t - \mathrm{E}(x_t / \Omega_t))] + u_t$ is a linear combination of the forecast errors of inflation and the exogenous random shock u_t. Clarida *et al.*

(1998, 2000) indicate that v_t represents a vector of variables the central bank can use in setting the interest rate target and are orthogonal to ε_t. That is,

$$E(\varepsilon_t / v_t) = 0 \Rightarrow E(i_t - (1-\rho)[\alpha + \beta\pi_{t+1} + \gamma x_t] - \rho i_{t-1} / v_t) = 0 . \qquad (15)$$

We estimate α, β, γ, and ρ, using the Generalized Method of Moments (GMM) methodology. The instrument list contains lagged values of inflation, the output gap, and interest rates.

Clarida *et al.* (1998, 2000) derive the relationship between the target inflation and the long-run equilibrium real interest-rate from coefficients β and α. In other words, we can determine π^* as follows:

$$\pi^* = \frac{\bar{r} - \alpha}{\beta - 1}, \qquad (16)$$

which comes from the following relationships:

$$\alpha \equiv \bar{i} - \beta\pi^* \text{ and } \bar{i} = \bar{r} + \pi^*. \qquad (17)$$

Using equation (8) and defining expectations on once-lagged values gives us the backward-looking rule as follows:

$$i_t^* = \bar{i} + \beta(\pi_{t-1} - \pi^*) + \gamma x_{t-1}, \qquad (18)$$

where π_{t-1} and x_{t-1} are the lagged values of the inflation rate and output gap, respectively. As with the forward-looking rule, we can rearrange this rule to derive the rule for the real target rate as follows:

$$r_t^* = \bar{r} + (\beta - 1)(\pi_{t-1} - \pi^*) + \gamma x_{t-1}. \qquad (19)$$

After incorporating interest rate smoothing, this rule takes the following form:

$$i_t = (1-\rho)[\alpha + \beta\pi_{t-1} + \gamma x_{t-1}] + \rho i_{t-1} + u_t . \qquad (20)$$

We also use the GMM methodology to estimate the parameters in the backward-looking case.

Finally, we adjust the classic Taylor rule to the European data and find the interest rate target, by adding the interest rate smoothing process to the rule and using current data (Taylor-type rule). The estimating equation is as follows:

$$i_t = (1-\rho)[\alpha + \beta\pi_t + \gamma x_t] + \rho i_{t-1} + u_t, \tag{21}$$

using the GMM methodology.

4.2. Inflation and Output Gap Forecasting: Forward-Looking Rule

This section describes the method that generated the forecasts for the inflation rate and the output gap, which we then use to estimate the forward-looking rule. To generate out-of-sample forecasts, we use a moving window of 72 quarters, starting from 1980Q1 to 1997Q4, to identify the best model and to generate the forecasts for the upcoming sample quarter. We compare three alternative approaches for modeling and forecasting the inflation rate and the output gap: autoregressive integrated moving average (ARIMA) models, vector autoregressive (VAR) models, and the Stock and Watson transfer function model. We use the Theil criterion to select the best model, given the out-of-sample forecasts for each method. In particular, we use a rolling window and estimate all models for each period and select the best model. In other words, using 1980Q1-1997Q4, we estimate and then forecast one-period ahead, 1998Q1. Then, we estimate all models, using 1980Q2-1998Q1, and forecast 1998:Q2. And so on.

First, we consider the ARIMA(p, d, q) model. That is, we consider the following specification:

$$\Delta^d Y_t = \alpha_1 \Delta^d Y_{t-1} + \alpha_2 \Delta^d Y_{t-2} + \ldots + \alpha_p \Delta^d Y_{t-p} + \beta_1 u_{t-1} + \ldots + \beta_q u_{t-q},$$

where *Y* denotes either the inflation rate or the output gap, *p* denotes the number of autoregressive terms, *d* denotes the number of differences of the series, and *q* denotes the number of moving average terms. Both the inflation rate and the output gap are I(0). Thus, d = 0. Then we estimate all possible models for p, q: (1,…,11) and using the Akaike information criterion (AIC), we choose the specification with the lowest AIC.

Second, we consider the VAR model's forecasts the inflation rate and the output gap. The estimated VAR models include the following additional variables: the growth rate of M_1, the unemployment rate, and the output gap when we forecast the inflation rate, and the growth rate of M_1, the unemployment rate, and the inflation rate when we forecast the output gap. Once again, we select the optimal order of VAR using the AIC criterion.

Finally, we consider Stock and Watson (1999) model's forecasts of the inflation rate and the output gap. This transfer function model takes the following form:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \ldots + \alpha_p Y_{t-p} + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \ldots + \beta_q x_{t-q} + u_t ,$$

where Y is the inflation rate and x is either the output gap or the unemployment rate. As in the prior two models, we chose the appropriate lag length using the Akaike criterion and estimated the inflation forecasts both in the case of the output gap and in the case of the unemployment rate.

Table 4.2 reports the results of the analysis, using the Theil criterion to select the best (optimal) forecasting models for each country.

4.3. The Bank Lending Channel

The econometric method to investigate the bank lending channel estimates the following baseline equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}\,, \qquad (22)$$

where k = 1, …, K and t = 1, …, T, k denotes the country, K equals six when we estimate the bank lending channel for the Euro-group and one when we estimate the lending channel for Denmark or the United Kingdom, L_{mkt} denotes the loans of the m^{th} bank of country k in year t, i_{kt} denotes the monetary policy indicator of country k in year t, GDP_{kt} denotes the GDP of country k in year t, π_{kt} denotes the inflation rate of country k in year t, and u_{mkt} denotes the error term.

We use four different monetary policy indicators: the actual short-term interest rate (not coming from a rule) and short-term interest rates that come from the three central bank interest rate rules. That is, this paper examines how loan growth reacts to the actual short-term interest rate as well as the interest rate target coming out of our forward-looking, backward-looking, and contemporaneous interest rate rules.

In equation (22), we regress the growth rate of a country's lending (*ΔlnL*) on the real GDP growth rate (*ΔlnGDP*) and on the inflation rate (π) to control for country-specific loan demand changes due to macroeconomic activity. In other words, we isolate shifts in total loans caused by movements in loan demand to identify the supply relationship. The introduction of these two variables also proves important because it isolates the monetary policy indicator, the short-term interest rate and the target interest rates from our three policy rules. Additionally, we include lagged values of the dependent variable, because lagged loans affect current loans in an environment where banks establish continuing relationships with their customers. In other words, the bank acquires "informational monopoly over its clients." Hence, customers encounter large costs to change their banks, because new banks will need to collect costly information about its new customers in the provision of banking services (Golodniuk, 2006).

Monetary policy also affects lending with lags, due to long-term contractual commitments. According to the bank lending channel, the negative coefficient on the interest rate causes loans to fall after a monetary tightening. We estimate the model using the panel GMM estimator, suggested by Arellano and Bond (1991), where we only include statistically significant lags in the estimation.

4.3.1. Bank-Specific Characteristics

In addition to the baseline model, we also construct a similar model designed to test whether banks with different characteristics react differently to a monetary shock. This model takes the following form:

$$\begin{aligned}\Delta \ln L_{mkt} &= \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} \\ &+ \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.\end{aligned} \qquad (23)$$

This equation differs from equation (22), because it incorporates two additional terms – a bank-specific characteristic and its interaction with the monetary policy indicator. More specifically, we introduce three separate bank-specific characteristics (BS_{mk}) -- bank capitalization, asset size, and liquidity – and the interaction terms ($\Delta i_{kt-j} BS_{mkt-1} : j = 1, \ldots, n$). The monetary authority chooses either the short-term interest rate or the target short-term interest rates derived by the policy rules described above. Following Gambacorta (2005), we define the BS_{mk} as deviations from their respective means. Analytically, all of the three bank-specific characteristics are normalized in respect to their average across all the banks in the sample, to acquire indicators that sum to zero over all observations. That is, the average of the interaction terms is zero and therefore, the coefficients β_j can be directly interpreted as the overall effect of the monetary policy on loans for the average bank.[7] Thus, the effect of the BS_{mk} on the growth rate of lending evaluated at the mean of the BS_{mk} equals γ .

4.3.2. Robustness Tests

We also examine the robustness of the results concerning the bank lending channel, excluding the bank-specific characteristics. As noted previously, we control for demand effects using two particular variables – the real GDP growth rate and the inflation rate. In this specification, we consider alternative control variables as a robustness check. First, we replace the real GDP growth rate and the inflation rate with the growth rate of real consumption spending. Now, equation (22) takes the following form:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln Con_{kt-j} + u_{mkt} , \qquad (24)$$

where *Con* is real consumption spending. Similar to equation (22), the bank lending channel operates when the monetary policy indicator affects loan supply negatively. In this case, we isolate changes in total loans caused by movements in loan demand by the private consumption. Thus, for changes in consumption, a positive coefficient is expected.

Second, we also substitute for the inflation rate in equation (24), in turn, the ratio of total loans to total deposits and then total deposits. Growth in loan demand may cause banks to issue more insured deposits. Absent informational asymmetries, banks can obtain funding both from internal (insured deposits) and external (noninsured deposits) sources. Due to the absence of perfect information, however, banks exhibit different attitudes toward different sources of funding. In other words, the presence of such

[7] The three indicators (capitalization, liquidity and size) have been normalized with respect to the mean over the whole sample period. However, the size indicator has been normalized with respect to each single period, to remove unwanted trends in size.

frictions links deposits and lending, causing them to move together because a growing demand for loans generates faster growth in deposits. An increasing loan-to-deposit ratio, because of loan demand growth, may force banks to search, in addition to insured deposits, for additional reserves, and, therefore, they may use more non-deposit funding to finance the presence of higher demand for loans (Jayaratne and Morgan, 1997; Juks, 2004). Thus, the 'new' model, when we include the ratio of total loans to total deposits, yields:

$$\begin{aligned} \Delta ln\, L_{mkt} &= \varphi \Delta ln\, L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta ln\, GDP_{kt-j} \\ &+ \sum_{j=0}^{n} \gamma_j\, ln(\, L/Dep_{mkt-j}\,) + u_{mkt}\,, \end{aligned} \tag{25}$$

where *L/Dep* equals the ratio of total loans to total deposits. In this case, we expect a positive coefficient on this ratio in that an increase in the ratio causes an increase in bank lending.

When we include total deposits as an additional variable to control for loan demand, the model takes the following form:

$$\begin{aligned} \Delta ln\, L_{mkt} &= \varphi \Delta ln\, L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta ln\, GDP_{kt-j} \\ &+ \sum_{j=0}^{n} \gamma_j \Delta ln(\, Dep_{mkt-j}\,) + u_{mkt}\,, \end{aligned} \tag{26}$$

where *Dep* equals total deposits. In this last case, we also expect a positive coefficient, since when the growth of total deposits increase, bank reserves grow as well, leading to increases in the growth of loans.

5. Empirical Analysis

5.1. Interest Rate Rules Results

Table 4.3 reports the results of estimating the three interest rate rules for the Euro-group, Denmark, and the U.K. The estimates of the coefficients for the backward-looking, Taylor, and forward-looking rules tell a consistent story within and across the Eurogroup, Denmark, and the U.K. An activist monetary policy that stabilizes the macroeconomy requires a β coefficient, (i.e., the coefficient on the inflation gap) that exceeds one. At the same time, the γ coefficient (i.e., the coefficient on the output gap) should also exceed zero, but with no size requirement. In all rules and countries, the coefficient of the inflation gap exceeds one and the coefficient of the output gap exceeds zero, albeit by a small amount. The Eurogroup, Denmark, and the UK respond vigorously to the inflation gap, especially for the backward-looking model. More specifically, the inflation gap generates the largest effect on the target rate for the backward-looking rule in the Eurogroup (the coefficient equals 3.1828 versus 2.7876 and 1.6987 for the Taylor and forward-looking rules, respectively). Accordingly, in Denmark the largest effect is generated on the target rate for the backward-looking rule, as well (3.9951). By contrast, in the UK this happens for the forward-looking rule (2.8948), whereas in both economies, the smallest effect is exerted on the target rate for the Taylor-type rule (1.8 in Denmark and 1.2969 in the U.K.). In addition, Denmark responds the most to the output gap and the U.K. the least. The small weight on the output gap, across all three rules, indicates a more ambitious inflation objective, whereas the coefficient on inflation decreases, when the coefficient of the output gap rises. Interest rate smoothing plays an important role in each country, and plays the largest role in the U.K. In the Eurogroup, almost 60 percent of the desired change is occurring within the quarter for the Taylor rule, whereas only around 27 percent for the forward-looking rule. However, in the U.K. this percentage exceeds 85 percent across all rules. The J-statistics imply that we cannot reject the over identifying restrictions of the models. Our findings show β coefficients that uniformly exceed those reported in Apergis and Alevizopoulou (2012), suggesting a more aggressive anti-inflation central bank policy response. In fact, Apergis and Alevizopoulou report that the Taylor rule and the forward-looking rule in the UK exhibit a β coefficient that falls below one, indicating a procyclical monetary policy response to increases in inflation as the real interest rate actually rises with inflation.

5.2. Bank Lending Channel Results

We report the results for the bank lending channel in Tables 4.4 to 4.10. We estimate the models using the panel GMM estimator and the Sargan test indicates valid instruments in all cases. The entries in all tables include the coefficients of the variables and their corresponding p-values estimated for the Eurogroup, Denmark, and the UK by introducing the four different indicators for the estimation of the bank lending channel. In all Tables, columns 1 and 2 report the findings when we include the European Central Bank (ECB) interest rate in the model for the estimation of the bank lending channel (Model I). Then, columns 3 and 4, 5 and 6, and 7 and 8 record the results when we include the target interest rate derived from the backward-looking rule (Model II), the target interest rate from the Taylor–type rule (Model III), and the target interest rate from the forward-looking rule (Model IV), respectively.

The findings for the annual growth rate of lending in the benchmark model expressed in equation (22) appear in Table 4.4. The coefficients of the monetary policy indicator, showing the effects of the decisions of monetary policy on lending, exhibit the expected negative sign in all four models and for all countries and prove significant at the 5-percent level in each case. This implies that higher interest rates – actual or target – induce lower loan growth. The findings identify the highest effect for the forward-looking rule and the smallest effect for the actual interest rate, except for Denmark and the UK, where the Taylor-rule interest rate exerts the largest and smallest effects, respectively. Specifically, in the Eurogroup, a one-percent increase in the target rate, specified by the forward-looking rule, reduces bank lending by almost 3.4 percent, while the same percentage increase in the actual interest rate reduces the loan growth by 0.59 percent. In Denmark, a one-percent increase in the target rate, emanated by the Taylor-type rule reduces the growth of lending by 1.26 percent, whereas the effect from the actual interest rate is a 0.66 percent decrease in bank lending. Accordingly to the Eurogroup, also in the U.K., the largest impact on bank lending (11.9 percent) is exerted by the target rate specified by the forward-looking rule. The Taylor-rule interest rate exerts its influence contemporaneously whereas the other interest rates generally exert their influence with a lag.

Table 4.4 also reports the coefficients and their corresponding p-values for the real GDP growth rate and the inflation rate, respectively, for the four models and the three countries. The coefficients of real GDP growth exhibit positive and statistically significant effects in all models and for all countries. In particular, an increase in GDP growth by one percentage point, affects bank lending positively by only 0.11 percent in the Eurogroup and in the case when the actual interest rate is estimated, while it turns to get the value of 0.23 percent when the case of the forward-looking rule is considered. In Denmark and the U.K., the largest impact on loan growth is considered in the case of the forward-looking rule, as well (4.6 percent and 1.27 percent respectively). The coefficients of the inflation rate generally show a positive effect, when significant, except for the significant negative effect for the actual and forward-looking interest rate in Denmark. The inflation coefficient proves insignificant at the 5-percent level in the UK, except for the Taylor-rule model where this coefficient is significantly positive.

Overall, the empirical analysis for equation (22) indicates that the bank lending channel operates better if the target interest rate comes from the forward-looking rule, if one considers the magnitude of the effect. These conclusions match those reported in Apergis and Alevizopoulou (2012). If the policy maker wants a quicker response, then the Taylor-rule interest rate response dominates the other interest rates, a finding that Apergis and Alevizopoulou (2012) do not consider in their model specification.

5.3. Results with Bank-Specific Characteristics

Tables 4.5, 4.6, and 4.7 present the results for the bank lending channel from the estimation of equation (23), which, in addition to lagged loans, the monetary policy indicator, and the real GDP growth rate, includes, in turn, two additional terms – bank-specific characteristics and the interaction terms between each bank-specific characteristic and the change in the monetary indicator. Note, however, that equation (23) excludes the inflation rate.[8] Thus, the results, presented in Tables 4.5, 4.6, and 4.7, use only the real GDP growth rate to control for demand effects.

Tables 4.5, 4.6, and 4.7 report the coefficients of the parameters in equation (23) for bank capitalization, size, and liquidity, respectively. Guiso *et al.* (2002) find that proxies for banks' health, such as size, capitalization, efficiency, and liquidity, provide

[8] We also estimated models that included the inflation rate, but its coefficient never proved significant and, thus, we exclude those results from our reported findings. Moreover, the inclusion or exclusion of the inflation rate does not alter the sign and significance of any of the other coefficients.

useful instruments for the interest rate that banks charge on their loans, while Altunbas *et al.* (2009) confirm the hypothesis that bank characteristics represent key drivers of banks' ability to supply new loans. When controlling for bank specific characteristics, monetary policy affects the growth of lending negatively across all specifications and countries and usually the effect proves significant at the 5-percent level. The exceptions include insignificant effects for the current interest rate for the UK with size as the bank-specific effect, for the backward-looking and Taylor rules for the Eurogroup with size as the bank-specific effect and for the current interest rate in the Eurogroup and the UK with liquidity as the bank-specific effect.

The growth rate of real GDP proves positive, whenever the coefficient proves significant at the 5-percent level. Three instances occur where the positive coefficient on the growth rate of real GDP is not significant – all with positive signs.

The bank-specific variables lead to the following outcomes when we consider the effects of BS_{mk} at their mean value. Higher bank capitalization or bigger banks associate with higher lending growth whenever the coefficient is significant (see Table 4.5 and 4.6). More specifically, in the Eurogroup, a one-percent increase in capitalization leads to a 0.08 percent increase in bank lending for the forward-looking rule, while only a 0.04 percent and 0.026 percent increase for the Taylor and actual rules, respectively. The estimate for the backward-looking rule proves statistically insignificant. By contrast, the latter proves significant in Denmark and the U.K., with the impact on loan growth reaching the level of 0.01 and 0.04 percent respectively. Larger banks associate with significantly more bank lending, except in two cases (see Table 4.6); a one percent increase in the size of the bank exerts the largest effect on bank lending for the backward-looking rule (i.e., 0.075 percent) and the lowest effect for the forward-looking rule (i.e., 0.048 percent) in the case of the Eurogroup. The exceptions, where larger banks significantly associate with lower bank lending, occur for the UK when using the Taylor and forward-looking rules (a one percent increase in size leads to a 0.06 and 0.07 percent decrease in bank lending). Finally, more liquid banks associate with significantly more bank lending in all cases (see Table 4.7), with the strongest effect, in the Eurogroup, occurring for the forward-looking rule (i.e., 0.044 percent) and the weakest effect occurring for the Taylor rule (i.e., 0.009 percent).

When we consider the interaction terms in conjunction with the interest rate effects, we find the following results. More capitalized banks associate with a smaller bank lending effect, since all coefficients of the interaction terms prove positive and significant except in three cases (see Table 4.5). More specifically, in the Eurogroup, the coefficient for the forward-looking rule exerts the highest effect on bank lending (i.e., a one-percent increase in the interaction term leads to a 32.31 percent increase in bank lending), while the weakest effect comes from the actual policy rule (i.e., 4.2 percent). Two significant exceptions occur in the UK for the current interest rate and the forward-looking rule. In these two cases, more capitalized banks exhibit higher bank lending, since the coefficients are significantly negative (-13.26 percent and -17.68 percent respectively). Larger banks also exhibit a significantly smaller bank lending effect in most cases (see Table 4.6). But, the Eurogroup experiences a larger bank-lending effect for the backward-looking rule. Specifically, while the forward-looking rule exhibits a positive effect (i.e., a one-percent increase in the interaction term leads to a 7.36 percent increase in bank lending), the backward-looking rule experiences a negative effect (i.e., a one-percent increase in the interaction term leads to a decline in bank lending of 17.40 percent). By contrast, Denmark experiences a larger bank-lending effect for the current interest rate (1.88 percent decrease in loan growth). Focusing on significant coefficients, more liquid banks associate with a significantly smaller bank lending effect, except for the UK and with backward-looking and Taylor rules (see Table 4.7). In the case of the Eurogroup and Denmark, the strongest effect comes from the forward-looking rule, indicating that a one-percent increase in the interaction term leads to 22.67 percent and 22.21 percent increase in bank lending activities, respectively.

5.4. Robustness Tests

Table 4.8 reports the results of replacing the growth rate of real GDP with the growth rate of real consumption spending whereas Tables 4.9 and 4.10 use loans to deposits and the growth rate of deposits in equation (25) and (26), respectively, as robustness checks. Once again, the monetary policy variable exhibits a negative effect wherever the coefficient proves significant at the 5-percent level in all cases in Tables 4.8, 4.9, and 4.10. In Table 4.8, the growth rate of real consumption spending exhibits a significant positive effect on the growth rate of lending in every case. In the Eurogroup, the strongest effect occurs for the actual rule (i.e., 1.01) and the weakest effect occurs for the Taylor rule (i.e., 0.77), whereas in Denmark the strongest effect occurs for the forward-looking rule (4.13), while in the U.K. for the backward-looking rule (1.43). In terms of the intervention interest rate, the strongest effect in the Eurogroup comes for the Taylor rule (i.e., a one-percent increase in interest rates leads to a 1.62 percent reduction in bank lending activities), whereas in Denmark and the U.K. it comes from the forward-looking rule (-2.38 and -2.75 percent decrease in loan growth, respectively).

In Tables 4.9 and 4.10, the growth rate of real GDP produces a significant positive effect on the growth rate of lending, except for the Eurogroup when we include the ratio of total loans to total deposits and the UK when we include the growth rate of deposits both using the Taylor-rule target interest rate. In Table 4.9, a higher ratio of loans to deposits generates a positive effect on the growth rate of lending, wherever the coefficient is significant, except for Denmark, in the case of the backward-looking rule (a one percent increase in the ratio of loans to deposits leads to a 0.13 percent decrease in the growth of loan supply). In the Eurogroup, a one-percent increase in the ratio of loans to deposits leads to a significant 0.0001 percent increase in bank lending activities across three of the four monetary rules. In terms of the bank lending channel estimates, the strongest effect comes for the forward-looking rule (a one percent increase in intervention interest rates leads to 1.05 percent decline in bank lending activities). In Table 4.10, a larger growth rate of deposits generates a significant positive effect on the growth rate of lending, except for Denmark using the forward-looking rule target interest rate (a 0.26 percent decrease in bank lending is caused by a one percent increase in the growth rate of deposits). More specifically, the strongest effect comes again for the forward-looking rule in the case of the Eurogroup (i.e., a one percent increase in the growth rate of deposits generates a 0.24 percent increase in bank lending activities), whereas in the U.K. the strongest effect comes for the Taylor-type rule. By contrast, the weakest effect comes for the Taylor-looking rule in the Eurogroup (i.e., 0.17 percent) and for the current interest rate in the U.K. (i.e., 0.35 percent). Finally, in terms of the bank lending channel, in the Eurogroup, countercyclical monetary policies achieve their strongest effect on bank lending for (again) the forward-looking rule (i.e., a one percent increase in the monetary policy interest rate leads to a 1.42 percent decline in bank lending), whereas in Denmark and the U.K. this happens for the backward-looking rule.

6. Conclusions

Interest rate rules now command significant attention amongst economists and policymakers, since they provide a structure within which to analyze the behavior of central banks. The bank lending channel also commands significant attention as well, because its operation provides an alternative channel whereby the monetary authorities' decisions can affect the real economy by altering the supply of bank loans.

In this paper, we estimate three types of interest rate rules – backward-looking, contemporaneous (Taylor-type), and forward-looking rules. We estimate these interest rate rules for three economies: the Euro-group, which consists of selected European countries with the Euro as a common currency, Denmark, and the U.K. over the period 2000 to 2009. We use these estimates in the second part of the paper to examine the bank lending channel in these economies under four scenarios concerning the interest rate used as a monetary policy indicator – the central bank interest rate and the three different interest rate targets derived from the backward-looking, Taylor, and forward-looking rules.

The bank-lending channel exists in all cases, but differences emerge in the degrees of responsiveness of loan growth to changes in the monetary policy indicator. Thus, the bank-lending channel exerts a stronger effect when we use target rates as indicators rather than the observed central bank interest rates. The strongest effects generally emerge in the models employing the forward-looking rules. This suggests that the monetary authorities use target interest rate rules, especially a forward-looking rule as the monetary policy indicator. That is, forward-looking rules incorporate inflationary expectations that seem to affect the decisions for the target rate and, hence, for monetary policy. Monetary policy guides, through its actions and announcements, the private sector's (banks') expectations. Therefore, banking institutions alter their supply of loans according to the rules, making monetary policy decisions more effective.

This paper also examines whether lending differentials depend on the strength of a bank, characterized by capitalization, asset size, and liquidity. Furthermore, we also account for additional variables, in addition to real GDP growth, in the estimation of the bank lending channel. We use the growth rate of real consumption spending, the ratio of total loans to total deposits, and the growth rate of deposits as additional control variables. The results indicated that large and well-capitalized banks more easily absorb monetary shocks. In most of the cases, the bank lending channel strengthens when we use target rates derived from interest rate rules and, specifically, from the forward-looking rule as the monetary policy indicator, a conclusion that strengthens our initial results.

Our empirical findings also show that the significance of the bank lending channel under all alternative monetary policy rules signals the inability of European banks to issue unlimited amounts of CDs or bonds not subject to reserve requirements. Moreover, the same banks cannot easily issue new equity due to the presence of tax disadvantages, adverse selection problems, and agency costs.

Our empirical findings highlight the role of the banking sector in providing credit to the real economy, which became important in the recent global financial crisis. Within such a distressed financial environment, changes in bank lending terms should become an explicit component of macroeconomic models that describe monetary policy rules used for policy advice, especially Dynamic Stochastic General Equilibrium (DSGE) models. At the same time, the effects of financial innovations on the transmission mechanism of monetary policy should feed the need for more intensive financial supervision.

Finally, our empirical analysis abstracts from the zero lower bound (ZLB) hypothesis on nominal interest rates, a hypothesis asserting that central banks cannot lower the interest rate in the face of a weak economy and low inflation, which can impair the effectiveness of monetary policy to stabilize output and inflation (Williams, 2009). Therefore, future empirical attempts will modify our alternative policy rules to account for the ZLB environment.

Table 4.1. Number of banks in each country

Country	Number of banks
Austria	68
Belgium	16
Finland	2
France	94
Germany	475
Netherlands	3
Denmark	59
United Kingdom	22
Total	739

Table 4.2. Models to Forecast the Inflation Rate and the Output Gap

Country	Inflation Rate Model	Output Gap Model
Eurogroup	Stock & Watson (with unemployment rate)	ARIMA
Denmark	Stock & Watson (with unemployment rate)	Stock & Watson (with unemployment rate)
UK	ARIMA	Stock & Watson (with unemployment rate)

Table 4.3. Interest rate rule results for Eurogroup, Denmark, and the United Kingdom

	α	***β***	***γ***	***ρ***	**Adj. R-squared**	**J-stat**	**Prob.**
Eurogroup							
Backward	0.0130	3.1828	0.0003	0.5878	0.7545	0.0930	0.2719
	(0.024)	*(5.366)*	*(0.001)*	*(0.262)*			
Taylor	0.0163	2.7876	0.0005	0.6013	0.8948	0.0000	1.0000
	(0.020)	*(4.802)*	*(0.001)*	*(0.134)*			
Forward	0.0220	1.6987	0.0009	0.2653	0.7351	0.0000	1.0000
	(0.031)	*(7.113)*	*(0.000)*	*(1.239)*			
Denmark							
Backward	0.0085	3.9951	0.0011	0.6738	0.7358	0.0000	1.0000
	(0.019)	*(3.605)*	*(0.003)*	*(0.121)*			
Taylor	0.0199	1.8000	0.0033	0.6663	0.8474	0.0000	1.0000
	(0.013)	*(2.434)*	*(0.002)*	*(0.104)*			
Forward	0.0171	2.5025	0.0049	0.5102	0.7807	0.0674	0.3568
	(0.006)	*(1.087)*	*(0.002)*	*(0.117)*			
U.K.							
Backward	0.0308	2.5192	0.0001	0.8796	0.8547	0.0636	0.3838
	(0.842)	*(204.006)*	*(0.000)*	*(0.081)*			
Taylor	0.0382	1.2969	0.0001	0.8571	0.8992	0.0325	0.6682
	(0.023)	*(4.760)*	*(0.000)*	*(0.060)*			
Forward	0.0356	2.8948	0.0001	0.8743	0.8524	0.0762	0.3009
	(0.006)	*(1.092)*	*(0.000)*	*(0.025)*			

Notes: Backward-looking, Taylor-type, and forward-looking rules are given by the following equations, respectively:

$$i_t = (1-\rho)[\alpha + \beta\pi_{t-1} + \gamma x_{t-1}] + \rho i_{t-1} + u_t$$

$$i_t = (1-\rho)[\alpha + \beta\pi_t + \gamma x_t] + \rho i_{t-1} + u_t$$

$$i_t = (1-\rho)[\alpha + \beta E(\pi_{t+1} / \Omega_t) + \gamma E(x_j / \Omega_t)] + \rho i_{t-1} + u_t$$

where α is a constant, reflecting the changes in the inflation target and the equilibrium real interest rate, π = the inflation gap, x = the output gap and ρ = the interest rate smoothing parameter. Standard errors are provided in brackets. We estimate the models using the GMM methodology. The J-statistics implies that we cannot reject the null hypothesis of over identifying restrictions.

Table 4.4. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		Monetary policy indicator: Backward rule (Model II)		Monetary policy indicator: Taylor rule (Model III)		Monetary policy indicator: Forward rule (Model IV)	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}					**-0.9710**	0.0010		
Δi_{kt-1}	**-0.5994**	0.0237	**-1.0895**	0.0037			**-3.3783**	0.0000
$\Delta lnGDP_{kt}$			**0.2806**	0.0357	**0.4712**	0.0004		
$\Delta lnGDP_{kt-1}$	**0.1055**	0.0002					**0.2252**	0.0000
π_{kt}					**2.1265**	0.0361		
π_{kt-1}	-0.8394	0.3707	**1.2003**	0.0196			**1.9916**	0.0002
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}			**-0.8508**	0.0000	**-1.2620**	0.0000		
Δi_{kt-2}	**-0.6628**	0.0000					**-1.0087**	0.0000
$\Delta lnGDP_{kt-1}$	**0.4532**	0.0000			**0.7084**	0.0000	**4.6166**	0.0000
$\Delta lnGDP_{kt-2}$			**0.3057**	0.0000				
π_{kt}					**2.5152**	0.0000		
π_{kt-1}	**-1.6048**	0.0000	**0.9205**	0.0000			**-16.8969**	0.0000
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}					**-0.8684**	0.0000		
Δi_{kt-1}	**-0.8903**	0.0472	**-1.4195**	0.0000				
Δi_{kt-2}							**-11.9038**	0.0085
$\Delta lnGDP_{kt}$			**1.1908**	0.0000	**0.3693**	0.0000		
$\Delta lnGDP_{kt-1}$	**0.8808**	0.0000					**1.2709**	0.0051
π_{kt}	-6.1414	0.0858	1.0730	0.2896	**2.8665**	0.0001	-2.4020	0.6047

Note: Coefficient and p-value estimates for the group of European countries, Denmark, and the United Kingdom, according to the four models that use different monetary policy indicators. Bolded coefficients prove significant at the 5-percent level. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}$$

with k = 1, …, K, where k denotes the country and K=6 for the group of European countries and K=1 for Denmark and the United Kingdom, t=1,…T, L_{mkt} denotes the loans of the m^{th} bank of country k in year t, i_{kt} denotes the monetary policy indicator of country k in year t, GDP_{kt} denotes the GDP of country k in year t, π_{kt} denotes the inflation rate of country k in year t, and u_{mkt} denotes the error term. The monetary policy indicator takes four forms: in Model I: the actual short-term interest rate (not coming from a rule) and in Models II to IV: the interest rate target coming out of our backward-looking, Taylor-type, and forward-looking rule, respectively. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991). For the Eurogroup, instruments include the first lag in Model III, and the second lag in the rest of the models for the monetary policy indicator and inflation, whereas for the real GDP growth rate the first lag in Models II and III and the second lag in Models I and IV. For Denmark, instruments include the second lag in Models II and III, and the third lag in Models I and IV for the monetary policy indicator. We use the second lag as an instrument for the real GDP growth rate in Models I, III, and IV, whereas in Model II, we use the third lag. For inflation, we use the first lag as an instrument in Models III and IV and the second lag in the rest of the Models. In the UK case, instruments for the monetary policy indicator include the first lag in Model III, the second lag in Models I and II, and the third lag in Model IV. We use the first lag as an instrument for the real GDP growth rate in Models II and III and the second lag in the rest of the models. Finally, we use the first lag as an instrument for inflation. We use the second lag as an instrument for the lagged loans in all cases.

Table 4.5. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom, including capitalization as bank-specific characteristic

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		Monetary policy indicator: Backward rule (Model II)		Monetary policy indicator: Taylor rule (Model III)		Monetary policy indicator: Forward rule (Model IV)	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	**-0.9600**	0.0060	**-3.8256**	0.0011	**-1.7250**	0.0003	**-5.2451**	0.0000
$\Delta lnGDP_{kt-1}$	**0.3310**	0.0131	**0.5238**	0.0002	0.7269	0.0726	**0.6581**	0.0000
Cap_{ikt-1}	**0.0261**	0.0000	0.0165	0.2766	**0.0405**	0.0000	**0.0761**	0.0000
$\Delta i_{kt-1} *Cap_{mkt-1}$	**4.1960**	0.0129	**19.5085**	0.0029	**5.4612**	0.0001	**32.3149**	0.0000
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}			**-1.3787**	0.0000			**-3.7975**	0.0000
Δi_{kt-1}					**-14.5588**	0.0000		
Δi_{kt-2}	**-1.4175**	0.0000						
$\Delta lnGDP_{kt-1}$	**3.3882**	0.0000	**4.6323**	0.0000	**9.5442**	0.0000	**4.7153**	0.0000
Cap_{mkt}							**0.0230**	0.0000
Cap_{mkt-1}	0.0041	0.1499	**0.0103**	0.0000	-0.0022	0.0931		
$\Delta i_{kt} *Cap_{mkt}$							**5.7402**	0.0000
$\Delta i_{kt} *Cap_{mkt-1}$			**5.8059**	0.0000				
$\Delta i_{kt-1} *Cap_{mkt-1}$					**7.9525**	0.0000		
$\Delta i_{kt-2} *Cap_{mkt-1}$	**4.8895**	0.0000						
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}			**-16.7576**	0.0000				
Δi_{kt-2}	**-1.9468**	0.0482			**-23.6321**	0.0173	**-10.7103**	0.0000
$\Delta lnGDP_{kt}$			**1.2604**	0.0000				
$\Delta lnGDP_{kt-1}$	0.1165	0.8741			**0.8981**	0.0009	**1.3704**	0.0000
Cap_{mkt}							-0.0054	0.6775
Cap_{mkt-1}	0.0131	0.4688	**0.0370**	0.0341	0.0137	0.2835		
$\Delta i_{kt-1} *Cap_{mkt-1}$			**7.6316**	0.0035				
$\Delta i_{kt-2} *Cap_{mkt}$							**-17.6760**	0.0000
$\Delta i_{kt-2} *Cap_{mkt-1}$	**-13.2636**	0.0000			1.3753	0.9369		

Note: See Table 4.4. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}$$

The notation and the rest of the notes are similar to Table 4.4. Two differences exist. First, we do not include the inflation rate in the equation and, second, two additional terms appear – a bank-specific characteristic (capitalization) and its interaction with the monetary policy indicator. For the Eurogroup, instruments include the second lag in all cases. For Denmark, instruments include the first lag in Models II and IV, the second lag in Model III, and the third lag in Model I for the monetary policy indicator. We use the second lag as an instrument for the real GDP growth rate in all Models. In the UK case, instruments for the monetary policy indicator include the second lag in Model II and the third lag in the rest of the Models. We use the first lag as an instrument for the real GDP growth rate in Model II and the second lag in the rest of the models. Finally, we use the first lag as an instrument for capitalization in all cases and in all countries. We use the second lag as an instrument for the lagged loans in all cases as well.

Table 4.6. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom, including size as bank-specific characteristic.

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		**Monetary policy indicator: Backward rule (Model II)**		**Monetary policy indicator: Taylor rule (Model III)**		**Monetary policy indicator: Forward rule (Model IV)**	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	**-0.6260**	0.0392	-0.8028	0.0604	-0.6763	0.0809	**-0.6907**	0.0016
$\Delta lnGDP_{kt}$			**0.4803**	0.0016				
$\Delta lnGDP_{kt-1}$	**0.9039**	0.0134			**1.1776**	0.0009	**0.7129**	0.0176
$Size_{mkt-1}$	**0.0571**	0.0000	**0.0746**	0.0000	**0.0579**	0.0000	**0.0480**	0.0000
$\Delta i_{kt-1} *Size_{mkt-1}$	-1.9926	0.3438	**-17.3960**	0.0000	-1.4896	0.4120	**7.3599**	0.0370
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}			**-2.6435**	0.0000			-0.0616	0.6868
Δi_{kt-1}					**-14.9740**	0.0000		
Δi_{kt-2}	**-0.9977**	0.0000						
$\Delta lnGDP_{kt-1}$	**3.3829**	0.0000	**4.2513**	0.0000	**7.9619**	0.0000	**3.3863**	0.0000
$Size_{ikt-1}$	**0.0297**	0.0000	**0.0621**	0.0000	**0.0483**	0.0000	**0.0446**	0.0000
$\Delta i_{kt} *Size_{mkt-1}$			**3.5655**	0.0000			**0.7395**	0.0000
$\Delta i_{kt-1} *Size_{mkt-1}$					**3.6328**	0.0000		
$\Delta i_{kt-2} *Size_{mkt-1}$	**-1.8848**	0.0000						
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	-0.3618	0.4792	**-19.8440**	0.0000	**-26.7560**	0.0000		
Δi_{kt-2}							**-30.7020**	0.0000
$\Delta lnGDP_{kt}$			**1.5952**	0.0000				
$\Delta lnGDP_{kt-1}$	**1.1387**	0.0004			**1.4895**	0.0002	0.6117	0.2809
$Size_{mkt-1}$	**0.0198**	0.0004	**0.2600**	0.0000	**-0.0639**	0.0000	**-0.0739**	0.0000
$\Delta i_{kt-1} *Size_{mkt-1}$	**8.1192**	0.0000	-15.7370	0.0607	**39.5253**	0.0001		
$\Delta i_{kt-2} *Size_{mkt-1}$							**40.5341**	0.0000

Note: See Table 4.4. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}$$

The notation and the rest of the notes are similar to Table 4.4. Two differences exist. First, we do not include the inflation rate in the equation and, second, two additional terms appear – a bank-specific characteristic (size) and its interaction with the monetary policy indicator. For the Eurogroup, instruments include the second lag for the monetary policy indicator, whereas for the real GDP growth rate we use the first lag in Model II and the second lag in the rest of the Models. For Denmark, instruments include the first lag in Models II and IV, the second lag in Model III, and the third lag in Model I for the monetary policy indicator. We use the second lag as an instrument for the real GDP growth rate in all Models. In the UK, instruments for the monetary policy indicator include the second lag in Models I, II, and III and the third lag in Model IV. We use the first lag as an instrument for the real GDP growth rate in Model II and the second lag in the rest of the models. Finally, we use the first lag as an instrument for size in all cases and in all countries. We use the second lag for the lagged loans as an instrument in all cases as well.

Table 4.7. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom, including liquidity as bank-specific characteristic.

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		Monetary policy indicator: Backward rule (Model II)		Monetary policy indicator: Taylor rule (Model III)		Monetary policy indicator: Forward rule (Model IV)	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	-0.5648	0.1483			**-1.2088**	0.0198		
Δi_{kt-2}			**-1.5174**	0.0500			**-1.6044**	0.0289
$\Delta lnGDP_{kt-1}$	**1.0636**	0.0049	**0.7404**	0.0001	**2.6858**	0.0000	**0.9127**	0.0010
Liq_{mkt-1}	**0.0164**	0.0000	**0.0187**	0.0000	**0.0098**	0.0026	**0.0444**	0.0001
$\Delta i_{kt-1}*Liq_{mkt-1}$	0.6920	0.6554			**4.1788**	0.0005		
$\Delta i_{kt-2}*Liq_{mkt-1}$			**12.2259**	0.0111			**22.6709**	0.0000
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}			**-1.4331**	0.0000				
Δi_{kt-1}					**-14.9980**	0.0000		
Δi_{kt-2}	**-1.0845**	0.0035					**-2.5178**	0.0000
$\Delta lnGDP_{kt-1}$	**3.4278**	0.0000	**4.2187**	0.0000	**7.9890**	0.0000	**3.2893**	0.0000
Liq_{mkt-1}	**0.0253**	0.0011	**0.0147**	0.0000	**0.0266**	0.0000	**0.0210**	0.0002
$\Delta i_{kt}*Liq_{mkt-1}$			**4.2437**	0.0000				
$\Delta i_{kt-1}*Liq_{mkt-1}$					0.5100	0.3022		
$\Delta i_{kt-2}*Liq_{mkt-1}$	**17.2301**	0.0000					**22.2071**	0.0000
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	-2.5036	0.0569	**-8.6421**	0.0000				
Δi_{kt-2}					**-18.6640**	0.0182	**-13.8750**	0.0000
$\Delta lnGDP_{kt}$			**1.2706**	0.0000				
$\Delta lnGDP_{kt-1}$	**0.8082**	0.0097			**1.2609**	0.0158	**1.0183**	0.0012
Liq_{mkt-1}	**0.0231**	0.0005	**0.0427**	0.0000	**0.0640**	0.0000	**0.0616**	0.0000
$\Delta i_{kt-1}*Liq_{mkt-1}$	0.7010	0.8710	**-25.5600**	0.0000				
$\Delta i_{kt-2}*Liq_{mkt-1}$					**-22.9770**	0.0100	**26.0581**	0.0000

Note: See Table 4.4. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}$$

The notation and the rest of the notes are similar to Table 4.4. Two differences exist. First, we do not include the inflation rate in the equation and, second, two additional terms appear – a bank-specific characteristic (liquidity) and its interaction with the monetary policy indicator. For the Eurogroup, instruments include the second lag in Models I and III and the third lag in Models II and IV for the monetary policy indicator, whereas for the real GDP growth rate, we use the second lag in all Models. For Denmark, instruments include the first lag in Model II, the second lag in Model III, and the third lag in Models I and IV for the monetary policy indicator. We use the second lag as an instrument for the real GDP growth rate in all Models. In the UK, instruments for the monetary policy indicator include the second lag in Models I and II and the third lag in Models III and IV. We use the second lag as an instrument for the real GDP growth rate in Model II and the second lag in the rest of the models. Finally, we use the first lag as an instrument for liquidity in all cases and in all countries. We use the second lag for the lagged loans as an instrument in all cases as well.

Table 4.8. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom, including the growth rate of real consumption.

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		**Monetary policy indicator: Backward rule (Model II)**		**Monetary policy indicator: Taylor rule (Model III)**		**Monetary policy indicator: Forward rule (Model IV)**	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	**-0.6791**	0.0115	**-1.1602**	0.0017			-0.3997	0.2545
Δi_{kt-2}					**-1.6219**	0.0014		
$\Delta lnCon_{kt}$	**1.0055**	0.0000	**0.8746**	0.0183			**0.7907**	0.0000
$\Delta lnCon_{kt-1}$					**0.7655**	0.0105		
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}			**-1.3678**	0.0000	**-0.4448**	0.0180		
Δi_{kt-2}	-0.0859	0.4594					**-2.3790**	0.0000
$\Delta lnCon_{kt}$	**3.0108**	0.0000			**3.3027**	0.0000		
$\Delta lnCon_{kt-1}$			**2.4957**	0.0000			**4.1339**	0.0000
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}			**-1.3519**	0.0000				
Δi_{kt-2}	**-1.1132**	0.0000			**-2.7047**	0.0000	**-2.7452**	0.0000
$\Delta lnCon_{kt}$	**0.7212**	0.0000	**1.4269**	0.0000				
$\Delta lnCon_{kt-1}$					**0.9974**	0.0000	**1.1538**	0.0000

Note: See Table 4.4. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln Con_{kt-j} + u_{mkt}$$

The notation and the rest of the notes are similar to Table 4.4. Two differences exist. First, we do not include the inflation rate and real GDP growth rate, replacing them with the growth rate of real consumption spending, $\Delta lnCon_{kt-j}$. For the Eurogroup, instruments include the second lag in Models I, II, and IV and the third lag in Model III for the monetary policy indicator whereas for the growth rate of real consumption spending, we use the first lag in Models I, II, and IV and the second lag in Model III. For Denmark, instruments include the second lag in Models II and III and the third lag in Model I and IV for the monetary policy indicator. We use the first lag as an instrument for the growth rate of real consumption spending in Models I and III and the second lag in Models II and IV. In the UK, instruments for the monetary policy indicator include the second lag in Model II and the third lag in the rest of the Models. We use the first lag as an instrument for the growth rate of real consumption spending in Models I and II and the second lag in the rest of the models. We use the second lag for the lagged loans as an instrument in all cases.

Table 4.9. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom, including the ratio loans to total deposits.

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		Monetary policy indicator: Backward rule (Model II)		Monetary policy indicator: Taylor rule (Model III)		Monetary policy indicator: Forward rule (Model IV)	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	**-0.7855**	0.0151	**-1.0080**	0.0418			**-1.0478**	0.0420
Δi_{kt-2}					**-1.0127**	0.0102		
$\Delta lnGDP_{kt-1}$	**1.1762**	0.0013	**1.9991**	0.0000	0.0366	0.8324	**0.8904**	0.0044
$ln(L/Dep_{mkt})$	**0.0001**	0.0277			**0.0001**	0.0185	**0.0001**	0.0313
$ln(L/Dep_{mkt-1})$			-0.0002	0.1568				
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}							**-1.0689**	0.0000
Δi_{kt-1}			**-1.7002**	0.0000	**-15.0473**	0.0000		
Δi_{kt-2}	**-2.1832**	0.0000						
$\Delta lnGDP_{kt}$			**0.2137**	0.0000				
$\Delta lnGDP_{kt-1}$	**3.0431**	0.0000			**7.5497**	0.0000	**4.0320**	0.0000
$ln(L/Dep_{mkt})$	**0.1979**	0.0000			**0.2213**	0.0000	**0.0524**	0.0000
$ln(L/Dep_{mkt-1})$			**-0.1306**	0.0000				
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	**-2.0224**	0.0032	**-20.6942**	0.0000	**-35.2343**	0.0000		
Δi_{kt-2}							**-24.8312**	0.0000
$\Delta lnGDP_{kt}$			**1.7804**	0.0000				
$\Delta lnGDP_{kt-1}$	**1.2954**	0.0000			**2.1354**	0.0000	**1.1446**	0.0000
$ln(L/Dep_{mkt})$			**0.0234**	0.0002			0.0024	0.7431
$ln(L/Dep_{mkt-1})$	-0.0323	0.1303			-0.0460	0.1066		

Note: See Table 4.4. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \gamma_j \ln(L / Dep_{mkt-j}) + u_{mkt}$$

The notation and the rest of the notes are similar to Table 4.4. Two differences exist. First, we do not include the inflation rate in the equation and, second, we include one additional variable – the ratio loans/total deposits of bank L/Dep_{mkt-j}. For the Eurogroup, instruments include the first lag in Model II, the second lag in Models I and IV, and the third lag in Model III for the monetary policy indicator, whereas for the real GDP growth rate, we use the second lag in all Models. We use the first lag as an instrument for the ratio in Models I, III, and IV and the second lag in Model II. For Denmark, instruments include the first lag in Model IV, the second lag in Models II and III, and the third lag in Model I for the monetary policy indicator. We use the first lag as an instrument for the real GDP growth rate in Model II and the second lag in the rest of the Models. We use the first lag as an instrument for the ratio in Models III and IV and the second lag in Models I and II. In the UK, instruments for the monetary policy indicator include the second lag in Models I, II, and III and the third lag in Model IV. We use the first lag as an instrument for the real GDP growth rate in Model II and the second lag in the rest of the models. Finally, we use the first lag as an instrument for the ratio in Models II and IV and the second lag in Models I and III. We use the second lag for the lagged loans as an instrument in all cases.

Table 4.10. The bank lending channel results for the Eurogroup, Denmark, and the United Kingdom, including the growth rate of total deposits.

	Dependent variable: Annual growth rate of lending							
	Monetary policy indicator: ECB rate (Model I)		Monetary policy indicator: Backward rule (Model II)		Monetary policy indicator: Taylor rule (Model III)		Monetary policy indicator: Forward rule (Model IV)	
Eurogroup	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}					**-0.3802**	0.0093		
Δi_{kt-1}	-0.5338	0.0726	**-0.8672**	0.0188			**-1.4239**	0.0000
$\Delta lnGDP_{kt}$			**0.3571**	0.0062	**0.5917**	0.0000		
$\Delta lnGDP_{kt-1}$	**0.7414**	0.0417					**0.8807**	0.0000
$\Delta ln(Dep_{mkt})$	**0.1710**	0.0000	**0.1750**	0.0000	**0.1652**	0.0000	**0.2388**	0.0000
Denmark	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt}							**-0.7169**	0.0001
Δi_{kt-1}			**-1.3782**	0.0000	**-1.3018**	0.0000		
Δi_{kt-2}	**-1.1829**	0.0000						
$\Delta lnGDP_{kt}$			**0.2493**	0.0000				
$\Delta lnGDP_{kt-1}$	**0.2904**	0.0000			**0.7178**	0.0000	**0.3775**	0.0000
$\Delta ln(Dep_{mkt})$	**0.4079**	0.0000	**0.3505**	0.0000	**0.3246**	0.0000		
$\Delta ln(Dep_{mkt-1})$							**-0.2556**	0.0000
U.K.	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**	**Coef.**	**Prob**
Δi_{kt-1}	**-1.4980**	0.0013	**-13.2820**	0.0000				
Δi_{kt-2}					-2.9676	0.6329	**-12.7300**	0.0042
$\Delta lnGDP_{kt}$	**0.2894**	0.0000	**0.8931**	0.0000	0.1540	0.0937		
$\Delta lnGDP_{kt-1}$							**0.5680**	0.0285
$\Delta ln(Dep_{mkt})$	**0.3452**	0.0000	**0.4108**	0.0000	**0.4785**	0.0000	**0.4415**	0.0000

Note: See Table 4.4. The models are given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \gamma_j \Delta \ln(Dep_{mkt-j}) + u_{mkt}$$

The notation and the rest of the notes are similar to Table 4.4. Two differences exist. First, we do not include the inflation rate in the equation and, second, we include one additional variable – the growth rate of total deposits $\Delta ln(Dep_{mkt-j})$. For the Eurogroup, instruments include the first lag in Model III and the second lag in the rest of the Models, for the monetary policy indicator, whereas for the real GDP growth rate, we use the first lag in Models II and III and the second lag in Models I and IV. We use the first lag as an instrument for total deposits in all Models. For Denmark, instruments for the monetary policy indicator and the GDP growth match those in Table 4.9. For total deposits, we use the first lag as an instrument in Models I, II, and III and the second lag in Model IV. In the UK, instruments for the monetary policy indicator include the second lag in Models I and II and the third lag in Models III and IV. We use the first lag as an instrument for the real GDP growth rate in Models I, II, and III and the second lag in Model IV. Finally, we use the first lag as an instrument for total deposits in all Models. We use the second lag for the lagged loans as an instrument in all cases.

Chapter 5: Credit frictions and the bank lending channel: evidence from a group of European banks

Abstract

Monetary policy decisions are transmitted into the economy through many channels, one of which is the bank lending channel. It is based on the central bank's actions that affect loan supply and real spending. This paper examines whether the bank lending channel operates when disturbances, such as those of recent crisis, take place. Recent literature on monetary policy takes into account credit frictions and investigates monetary implications. We use interest rate spreads, that is, the difference between the interest rate available to savers and borrowers, as an indicator of the disruptions in the financial situation and incorporate them into the model for the estimation of the bank lending channel across Eurozone countries. The results indicate that these credit frictions have an impact on the lending growth process.

1. Introduction

Recent crisis and the ongoing changes in the financial system impose alterations in the way monetary policy works. The traditional channels of the transmission mechanism and, specifically, the credit and the bank lending channels, were severely criticized over the previous decade, whereas more attention was paid to the expectations channel. Additionally, prior to recent crisis, literature overlooked the role of banks as financial intermediaries as well as the frictions they may impose in the monetary transmission mechanism. This paper argues that the bank lending channel needs to take into consideration additional parameters, which will provide a more thorough understanding of its operation.

A substantial number of authors suggest that traditional literature on the bank lending channel should be modified. They argue that certain assumptions in traditional research are misplaced and new variables need to be taken into account; hence, a reformulation of the bank lending channel is recommended (Bernanke, 2007; Altunbas *et al*., 2009; Disyatat, 2011; Gambacorta and Marques-Ibanez, 2011). However, certain variables, which characterize the banks' strength, such as capitalization, liquidity and size and are emphasized in traditional literature, remain significant. Many studies conclude that well-capitalized, liquid and large banks are better equipped to confront with any changes in monetary policy (Kashyap and Stein, 1995, 2000; Peek and Rosengreen, 1995; Stein, 1998; Kishan and Opiela, 2000; Van den Heuvel, 2002; Gambacorta and Mistrulli, 2004)[1].

Disyatat (2004, 2011) highlights the importance of the banks' balance sheet strength, as well; however, he claims that the lending channel should be reformulated. The author argues that the central condition, regarding deposits and the impact that monetary policy has on them is misplaced. Banks rely, to a greater extent, on market-based financing, which, however, does not diminish the importance of the particular channel. On the contrary, it is reinforced, not only through the banks' balance sheet

[1] It should be noted that other studies reach controversial conclusions regarding size as an indicator for the distributional effects of monetary policy (Ehrmann *et al*., 2003; Gambacorta, 2005).

strength, but also their risk perception. Furthermore, the author focuses on credit market imperfections that financial intermediaries face, and how their external finance-premium – that monetary policy affects – is reflected on the cost of funds to firms, which primarily depend on these intermediaries. The results indicate that monetary policy may affect less, banks that are well-capitalized, more liquid and large, since these parameters are associated with the strength of a bank, a smaller degree of informational asymmetries, and, therefore, less variability of the finance premium.

The bank-specific characteristics previously mentioned, affect the way banks react to monetary policy changes. Recent studies claim that financial market developments attenuate the impact of these characteristics on the banks' response to monetary policy decisions. Overall, they argue that innovations in financial markets have changed the effectiveness of the bank lending channel, by modifying the banks' incentives, as well as by affecting their ability to obtain liquidity and, hence, to provide credit (Gambacorta and Marques-Ibanez, 2011). Such developments are securitization[2] and non-interest income revenues – that is, revenues from investment banking, fees and commissions – which constitute an alternative source of funding for banks (Altunbas *et al*., 2009). Furthermore, innovations regarding securitization, in conjunction with credit derivative market developments, have improved the credit risk management for banks, which are able to transmit this type of risk to other economic agents – a development that may have a significant impact on the bank lending channel (Peek and Rosengren, 2009).

The studies aforementioned emphasize the need to reformulate the bank lending channel, which, along with the broad credit channel, were surrounded by skepticism

[2]Earlier studies also mention securitization in the form of loan sales that provides an alternative and less expensive way of funding for banks, when deposit market is competitive (James, 1988; Pennacchi, 1988).

regarding their importance – even their existence – at least for the period before recent crisis. Furthermore, the banking sector has not played a prominent role in conventional models of monetary economics so far. Adrian and Shin (2010) claim that financial intermediaries, although they were supposed to have dispersed their credit risk through securitization, they have borne credit losses during recent crisis, which led to the downturn of the real economy, and hence, need to be separately researched. Moreover, it has not been examined whether financial frictions play any role in the bank lending channel and how (if any) affect the response of banks to a monetary policy tightening (Ashcraft, 2006).

The question examined in this paper is whether disturbances, such as those described in Woodford (2010) [3] – that is, frictions in the supply of intermediated credit – should be included into the bank lending channel, for it to better conform to current institutional realities. Woodford claims that credit frictions is an important indicator of the financial situation and since variation in interest rate spreads indicates that there are disruptions in the supply of intermediated credit, they should be incorporated into the model for the estimation of the bank lending channel. This paper investigates the impact credit frictions have on the operation of the bank lending channel across European countries. The results of the paper indicate that this approach provides a more thorough understanding of loan supply changes.

As mentioned before, not taking into account financial intermediation comprises a weakness of conventional macroeconomic models as it was revealed by the recent crisis and the disruptions of financial and real activity. Standard models of monetary transmission mechanisms assume frictionless financial markets. They use a single

[3] A more analytical description of his model is given in Chapter 2.

interest rate, which simultaneously represents the policy rate, the rate of return that households receive on savings and the rate at which anyone can borrow. In real economies, however, more than a single interest rate exists. Furthermore, these multiple rates are different from each other, allowing for the presence of spreads. Any variation in spreads can be considered as an indicator of changes in financial conditions. Conventional models, which use a single interest rate, are not consistent with actual conditions and they prove inadequate to comprehend the implications of recent crisis.

Woodford (2010) sketches a theory, in which intermediation plays a crucial role and credit frictions are able to impede the supply of loans. First, he describes the conventional macroeconomic model, which provides a straightforward way of how a central bank's target rate policy affects the level of economic activity. This model uses a single interest rate, the equilibrium value of which is determined in the credit market. In this model savers lend directly ultimate borrowers, implying that no financial intermediation exists. A shift in the level of the savers and borrowers' income modifies both the supply of funds and the demand for them. Therefore, at each level of income, a different equilibrium interest rate exists, at which the supply of funds equals the demand for them. Furthermore, a monetary policy reaction function indicates the relationship between the central bank's policy rate and the level of economic activity.

Then, the author introduces multiple interest rates, a feature of actual financial systems, as well as financial intermediaries, which acquire funds from savers and lend them, in turn, to ultimate borrowers. In this case, loan supply represents the supply of funds for the financial intermediaries, contrary to the simple model, in which the supply concerns the funding to ultimate borrowers. An additional implication of introducing financial intermediation is that the interest rate is distinguished into the rate which is paid by the intermediaries to savers and the rate at which borrowers finance their additional expenditure needs.

The degree to which borrowers are willing to pay a higher interest rate than the one required by savers indicates the demand for intermediation, whereas the supply of intermediation indicates the spread at which financial intermediaries are induced to intermediate a specific volume of credit between savers and borrowers. Therefore, there is a specific volume of lending, in which demand for intermediation equals the supply of intermediation, for each "pair" of saving and lending rate. Alternatively, there is a unique volume of intermediated credit for any given spread, which is the difference between the rates. As in the case of the simple model, every specific value of income determines the unique volume of credit and equilibrium spread. Therefore, a change in the level of economic activity causes a shift in the equilibrium value of the interest rate spread and the intermediated credit.

Woodford (2010) claims that an important implication of this extended model is that shifts in the supply of intermediated credit constitute an additional source of variation in economic activity – that is, a disruption in the supply of intermediation implies that financial institutions supply less credit at every given spread. This disruption may be caused by a change in the determinants of the intermediated supply, such as the marginal cost of lending of financial institutions, as well as their capital or leverage (Adrian *et al*., 2010; Zigrand *et al*., 2010). Therefore, such a disruption would result in higher equilibrium credit spread for any given level of income, that is, a widening in spread, which consequently implies lower interest rate to savers and higher borrowing rate. This spread can be used as a proxy for the disturbances in the credit, which is intermediated by financial institutions. Hence, under the assumption that monetary policy reaction function does not change, the disruption in the supply of intermediated credit would result in an interest rate widening, implying a decline in the saving rate[4], as well as a contraction in economic activity.

This study, following Woodford (2010), uses the spread between saving and lending interest rates as a proxy for disruptions in the supply of intermediated credit to investigate whether loan supply responds to monetary policy activities alone or to other variables as well. It should be noted that the paper attempts to capture, as closely as possible, the credit frictions that each country faces separately, and therefore country-specific saving and lending interest rates are used.

The remainder of the paper is organized as follows: Section 2 describes the traditional bank lending channel as well the credit frictions literature. Section 3 presents and analyses the data set, Section 4 describes the econometric model. Section 5 reports the empirical findings and, finally, Section 6 concludes.

2. Literature review

2.1. The bank lending channel

The impact of monetary policy on the economy is widely recognized by policymakers, who identify two main channels, through which monetary policy affect the economy: the interest rate channel and the credit channel. The former, also known as money channel, constitutes the traditional framework and is based on the notion that monetary authorities are able to manipulate interest rates to affect aggregate money demand. In

[4] Although, Woodford (2010) solves for both borrowing and saving rates as a function of income, it is the relation between the saving rate and income that concerns him more, since it is assumed to be the rate at which intermediaries finance themselves in the model.

particular, a contractionary monetary policy increases real interest rates, which affects consumer and investment spending negatively, leading to a reduction in aggregate output.

The credit view incorporates two channels: the balance sheet and the bank lending channel. As far as the first channel is concerned, monetary policy can affect the balance sheet of the borrowers and modify their net worth. For instance, deterioration in the borrowers' balance sheet positions, caused by a tightening in monetary conditions, decreases the collateral value of their assets. As a consequence, lending declines and hence investment projects funding decreases as well. On the contrary, the bank lending channel, which this study examines, investigates the responsiveness of loan supply to changes in the stance of monetary policy. Specifically, central banks implement monetary policy by modifying bank reserves and interest rates, which in turn alter deposits and loans and hence investment and output (Golodniuk, 2006). More analytically, contractionary monetary policy drains bank reserves – through open market operations – and therefore deposits decrease. Banks are forced to reduce credit, which consequently drives borrowers to diminish their purchases of durable goods and capital for investment. The opposite happens when monetary policy is characterized as expansionary. In both cases, though, aggregate output is affected.

The existence of the bank lending channel, though, requires three necessary conditions. First, policy changes imposed by monetary authorities are assumed to have a direct impact on bank loans. That is, banks must not be able to insulate their loan supply after a change in monetary policy, by rearranging their portfolio. Second, bank lending must constitute the sole source of external finance for the firms. Alternatively, borrowers must respond differently to different types of finance and particularly, they cannot rely on other types of finance (Oliner and Rudenbusch, 1995). Third, there must exist some imperfections in the adjustment of the aggregate price level (Golodniuk, 2006).

Literature has identified various factors that may weaken the link between bank loans and reserves. Banks use certain liquid assets as a buffer against the possibility of deposit withdrawals. This gives them the ability to react to changes in reserves by adjusting their holdings in liquid assets. However, this buffer is considered to not fully offset the effects of contractionary policy, since it is costly. Furthermore, banks may be able to find additional sources for funding their lending, besides reserve requirements, such as the issuance of long-term debt, certificates of deposits (CDs), commercial paper and so on (Romer and Romer, 1990). Nevertheless, for this opportunity to exist – that is, the access to non-reservable external finance – banks must pay an extra premium.

Many studies investigate the existence of the bank lending channel and examine whether monetary policy affects differently banks of specific characteristics, such as capitalization, size and liquidity. Empirical support to the presence of the channel is provided by most studies concerning the euro area economies, whereas those concerning the US case provide mixed results (Ehrmann *et al.*, 2003; Gambacorta, 2005). The empirical evidence on the bank lending channel support the idea that banks with low capital and liquidity ratios respond more to monetary policy changes than well capitalized and liquid banks. In addition, the majority of studies show that small banks exhibit almost the same level of sensitivity to monetary policy shocks as large banks (Peek and Rosengren, 1995; Gambacorta, 2005; Golodniuk, 2006). Other empirical studies, however, find that large banks, with high capitalization ratios, respond less to monetary policy shocks (Kishan and Opiela, 2000).

The empirical implementation should cope with a certain identification problem. It must be recognized whether a decrease in both output and bank loans after a negative change in monetary policy, reflects a contraction in loan supply or loan demand (Oliner and Rudenbusch, 1995; Brissimis *et al.*, 2001). To face this problem, the literature uses a number of macroeconomic control variables, i.e. GDP and inflation, which have impact on the demand for loans (Kashyap *et al*., 1993).

2.2. Credit frictions

As mentioned in the introduction, this paper investigates the frictions imposed to the supply of intermediated credit and the inclusion of interest rate spread into the lending channel model. The incorporation of the interest rate spread in the basic New Keynesian model of the transmission mechanism is also attempted by Cúrdia and Woodford (2008), who find that not just a mere presence of the spread, but also the variation in spreads over time makes significant quantitative differences vis-a-vis the standard model. Similarly, a paper by Goodfriend and McCallum (2007) compares a simple New Keynesian model to a new model that allows for multiple interest rates and investigates quantitatively "how much a central bank can be misled by relying on a model without money and banking, when managing its interbank-rate policy instrument".

McCulley and Toloui (2008) and Taylor (2008) use a spread-adjusted Taylor rule, that is, they extend the Taylor rule by including the interest rate spread for the determination of the federal funds rate. They propose that the target rate should be adjusted to variations in spreads at any given level of inflation and output. Specifically, in the case of monetary policy tightening that is not justified by any changes in inflation or the output gap, they argue that the target rate should be lowered when spreads increase.

The study by Gertler and Kiyotaki (2010) focuses on two aspects of the current recession: first, on the disruption of financial intermediation and second, on the unconventional policy measures that monetary and fiscal authorities have employed. Under the assumption that financial institutions are able to evaluate and monitor the borrowers, the authors argue that the ability of intermediaries to acquire funds from depositors begins to face constraints. This implies that the balance sheet of the financial intermediary narrows its ability to obtain deposits and hence, this constraint introduces a wedge between the deposit and lending rates, which widens during a crisis, and consequently raises the cost of credit that borrowers (non-financial) face. To the extent that non-financial institution can only obtain funds from intermediaries, this disruption would result in a contraction in real activity.

Furthermore, financial intermediaries may have difficulties in acquiring funds not only from deposits, but also from the interbank market – a significant source that supplies banks with wholesale funding. Indeed, the strains in the interbank market may comprise the first signals of a crisis. Specifically, the crisis beginning in August 2007 squeezed liquidity in the interbank market and led the spread between secured and unsecured funding to historically high levels. As DeSocio (2013) argues the disruption in the interbank markets affect the real economy as well, since the price that is determined in this market has impact on the borrowing conditions for households and firms. The spread that the author examines is the three-month Euribor - Eonia swap spread, which is disentangled in the paper into two components: the credit risk of the banks in the Euribor panel and the liquidity risk.

During recent crisis, central banks employed policies that can be characterized as unconventional, since authorities avoid to make use of such powers in the normal times. Gertler and Kiyotaki (2010) in their study that concerns the US describe three types of central banks' interventions. The first is direct lending, that is, the Fed employed specific facilities for direct acquisition of high grade private securities. Another facility was the discount window that the central bank uses to lend funds to banks, which consequently lend them to non-financial borrowers, and finally, equity injections to large financial institutions were involved. Gertler and Karadi (2011) analyze also the Fed's credit market interventions and capture the relevant key elements. Particularly, they describe the direct injection of credit into the markets, aiming to offset a disruption of private financial intermediaries. Furthermore, they argue that recent crisis deteriorated the balance sheet of financial intermediaries, increasing in turn credit spreads and tightening lending standards. This decline in lending raised the cost of borrowing and had negative effects on real activity, as mentioned before. Although central banks are not as efficient as private financial intermediaries, the authors claim that unconventional monetary policy should be used in periods of crisis, since, unlike financial intermediaries that face constraints in their balance sheet, central banks can obtain funds by issuing riskless government debt. They argue, however, that this policy should be reversed, when the economy turns to normal and financial intermediaries re-capitalize.

Additional financial frictions – which, however, are beyond the scope of this paper – are mentioned in the following paragraph. As aforementioned, changes in financial conditions need to be taken explicitly into consideration. Prior to recent crisis, securitization has proved to have led to a laxer screening of borrowers. Banks' business model has changed from "originate and hold" to "originate, repackage and sell". In this way, they transfer the risk from their balance sheet to other economic agents. Therefore, banks have fewer incentives to screen borrowers. That is, in the pre-crisis period, borrowers who would, otherwise, be denied credit, are able to get loans (Gambacorta and Marques-Ibanez, 2011). It is obvious that the development of financial markets provided banks with additional sources of liquidity and hence banks were more sheltered from the impact of monetary authorities' decisions. However, in a situation of financial distress, the role of securitization and non-interest income is reversed and they are not able to play the role of shock absorber, which consequently has an impact on banks' performance and loan supply. During the current crisis, banks are neither able to transfer their credit risk to markets nor obtain liquidity as easily as they used to in the past. Therefore, they are "obliged" to take into consideration credit frictions and the effects of asymmetric information and scrutinize borrowers, certain classes of whom – due to the current financial situation – rely on the bank credit again. The recent literature on macroeconomic analysis and monetary policy takes into account credit frictions and investigates monetary implications.

Overall, it is of great significance to take into consideration credit frictions, because they create additional uncertainty to the conduct of monetary policy and to the effect that interest rate changes have on economic activity. According to Bean *et al*. (2002) and based on their New Keynesian macroeconomic model, financial frictions tend to amplify the impact of variations in official interest rates and their presence makes monetary policy to be more aggressive.

3. Data description

Annual[5] balance sheet data for 616 European commercial and savings banks[6,7] over the period 1999-2010 are obtained from the Bankscope database. The sample of countries consists of Austria, Belgium, France, Germany and Luxembourg, which are used as the group of European countries with common currency – hereafter referred as the Euro-group – whereas the U.K. is examined separately. The countries and the corresponding number of banks are presented in Table 5.1.

The balance sheet data[8] are the following: we use total loans as the dependent variable, whereas the strength of each bank in our analysis is measured by certain bank-specific characteristics. More specifically, size is defined as the log of total assets, capitalization is measured by the ratio of total equity to total assets and liquidity is computed by dividing liquid to total assets.

To account for the monetary policy indicator, the EONIA interest rate for the ECB on main refinancing operation (MRO) is used for the countries-members of the European Monetary Union (EMU). This is a short-term open market operation in form of reverse transactions that allows it to control the degree of liquidity in the interbank market. The bank rate of the Bank of England is used as the interest rate for the UK, correspondingly. Data on short-term interest rates were obtained from the Bloomberg database.

Real GDP and inflation rates are used to isolate changes in total loans that are caused by movements in loan demand. To calculate inflation rates, we use the

[5] The BankScope database does not report quarterly data for our purposes.
[6] The sample consists of banks that exist over the full sample period.
[7] We omitted investment banks, due to their high dependence on non-interest sources of income. They may be more profitable compared to commercial banks, prior to periods of crisis, but their earnings turn out to be more volatile.
[8] Balance sheet data are deflated using the GDP deflator of each country.

percentage changes of the Consumer Price Index (CPI) as well as the harmonized index (HICP) – to check robustness. These data are derived from Datastream.

Credit frictions are measured by the interest rate spread, that is, the difference between two interest rates, the interest rate charged to borrowers and the interest rate paid to lenders. In our analysis, we construct the lending rate, because it is provided separately for households and corporations for each country. Specifically, the lending interest rate is the weighted sum of lending rates paid to households and corporations. As a weight, we use the outstanding amount of the loans to households and the loans to corporations both divided with total loans.

In particular, the specific lending rates are the rates charged on consumer loans to households, housing loans to households and loans to corporations. On the other hand, the deposit rates refer to the deposits with agreed maturity, which account for the largest outstanding amounts[9]. These data are obtained from Datastream. However, this database does not provide data for Luxembourg (before 2003) and the UK (the full sample period); hence, we obtain them from the central banks of each country.

Finally, real consumption spending (from Datastream database), as well as Euribor, Libor and OIS on Eonia (from Bloomberg) are additional variables used to implement robustness checks. Table 5.2 presents the summary statistics of the model variables (the balance-sheet data, the inflation and the interest rates in levels, whereas GDP and real consumption spending in first differences).

[9] This category also exists in all countries.

4. The econometric specifications

We investigate the bank lending channel using the following baseline equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt} \quad (1)$$

where k = 1, …, K and t = 1, …, T, k denotes the country, K equals five when we estimate the bank lending channel for the Euro-group and one when we estimate the lending channel for the United Kingdom, L_{mkt} denotes the loans of the mth bank of country k in year t, i_{kt} denotes the monetary policy indicator of country k in year t, GDP_{kt} denotes the GDP of country k in year t, π_{kt} denotes the inflation rate of country k in year t, and u_{mkt} denotes the error term.

In equation (1) we examine the reaction of loan growth to the actual short-term interest rate, the monetary policy indicator. To control for country-specific loan demand changes due to macroeconomic activity, we regress the growth rate of a country's lending (*ΔlnL*) on the real GDP growth rate (*ΔlnGDP*) and on the inflation rate (π). In other words, we isolate shifts in total loans caused by movements in loan demand and hence, identify the supply relationship. Additionally, we include lagged values of the dependent variable, because lagged loans affect current loans in an environment where banks establish continuing relationships with their customers. In other words, the bank acquires "informational monopoly over its clients." Hence, customers encounter large costs to change their banks, because new banks will need to collect costly information about their new customers in the provision of banking services (Golodniuk, 2006). According to the bank lending channel, the negative coefficient on the interest rate causes loans to fall after a monetary tightening. We estimate the model using the panel GMM estimator, suggested by Arellano and Bond (1991), where we only include statistically significant lags in the estimation.

To examine the impact of changes in interest rate spreads on the growth of loans, we incorporate this variable into the model:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{ikt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt} \quad (2)$$

where $Spread_{kt}$ denotes the interest rate spread of country k in year t. We consider that the changes in spreads are more important than their corresponding levels, as they incorporate more information about the economic situation. Spreads are not constant over time, but alter due to changing financial conditions. Therefore, increases in spreads indicate financial distress, which is associated with lower levels of employment and economic output (Cúrdia and Woodford, 2008; Woodford, 2010).

4.1. Bank-specific characteristics

In the bank lending channel literature, banks with different characteristics react differently to a monetary shock. To test this, we construct a similar model, which takes the following form:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}. \quad (3)$$

This specification differs from equation (1), since it incorporates two additional terms – a bank-specific characteristic and its interaction with the monetary policy indicator. More specifically, we introduce three separate bank-specific characteristics (BS_{mk}) – bank capitalization, asset size, and liquidity – and the interaction terms (

$\Delta i_{kt-j} BS_{mkt-1} : j = 1, \ldots, n$). Following Gambacorta (2005), we define the BS_{mk} as deviations from their respective means. Thus, the effect of the BS_{mk} on the growth rate of lending evaluated at the mean of the BS_{mk} equals γ. When we incorporate financial frictions into the model, the above equation yields:

$$\begin{aligned}\Delta \ln L_{mkt} &= \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} \\ &+ \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.\end{aligned} \tag{4}$$

In addition to the model which tests the bank-specific characteristics separately, we also design a model that incorporates all the characteristics in one equation and takes the following form:

$$\begin{aligned}\Delta \ln L_{mkt} &= \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} \\ &+ \sum_{j=0}^{n} \lambda_j^{size} \Delta i_{kt-j} Size_{mkt-1} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1} \\ &+ \sum_{j=0}^{n} \lambda_j^{cap} \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{liq} \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.\end{aligned} \tag{5}$$

where $Size_{mkt}$ denotes the size of the mth bank in country k in year t, Cap_{mkt} denotes the capitalization of the mth bank in country k in year t and Liq_{mkt} denotes the liquidity of the mth bank in country k in year t. Equation (5) incorporates the interaction terms between the monetary policy indicator and each of the bank-specific characteristics. Similarly to previous equations, the interest rate spread term is also added to the model to illustrate the incorporation of financial frictions:

$$\begin{aligned}\Delta \ln L_{mkt} &= \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} \\ &+ \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{size} \Delta i_{kt-j} Size_{mkt-1} \\ &+ \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{cap} \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} \\ &+ \sum_{j=0}^{n} \lambda_j^{liq} \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.\end{aligned} \tag{6}$$

4.2. Robustness tests

4.2.1. Alternative variables to control for demand effects

We also examine the robustness of the results concerning the bank lending channel, excluding the bank-specific characteristics. In previous equations, we control for demand effects using two particular variables – the real GDP growth rate and the inflation rate. In this specification, we consider alternative control variables as a robustness check. We replace the real GDP growth rate and the inflation rate with the growth rate of real consumption spending. Now, equation (1) yields the following form:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln Con_{kt-j} + u_{mkt} \tag{7}$$

where *Con* is real consumption spending. Similar to equation (1), the bank lending channel operates when the monetary policy indicator affects loan supply in a negative manner. In this case, we isolate changes in total loans caused by movements in loan demand by consumption spending. Thus, for changes in consumption, we expect a positive coefficient. Equation (7) takes the following form, when frictions are also included in the model:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln Con_{kt-j} + u_{mkt} \quad (8)$$

Finally, we examine the robustness of the results, by substituting the inflation calculated as the percentage change of the Consumer Price Index (CPI) with the one that is derived by the Harmonized Index (HICP). This substitution takes place in equations (1) to (6), in which inflation is included.

4.2.2. Alternative variables to proxy for credit frictions

As mentioned already in the introduction, this paper uses each country's spread between saving and lending interest rates as a proxy for disruptions in the supply of intermediated credit to investigate whether loan supply responds to monetary policy activities alone or to other variables as well. The reason for using each country's deposit and borrowing rates is to account for "country-specific frictions". However, it is further attempted to investigate whether frictions in the interbank market have any impact on the loan supply as well. The difference, that should be emphasized, is that frictions observed in the interbank market are common for all European banks.

Gertler and Kiyotaki (2010) refer to the difficulty that financial intermediaries have in obtaining funds from the interbank market and not only from depositors. A measure that is widely used to describe disturbances in the interbank market is the spread between unsecured and secured funding. Specifically, Libor (London Interbank Offered Rate) is the rate at which a bank considers that it could be offered unsecured funds in the London interbank rate, whereas the overnight index swap (OIS) on Eonia, is the weighted average of overnight unsecured lending transactions in the interbank market. The OIS transaction represents the risk of overnight failure and is used as a proxy for secured transactions. However, apart from the spread between Libor and OIS on Eonia that is used as a proxy for frictions in the interbank market, the spread between Euribor and OIS on Eonia is also employed. According to De Socio (2013), Euribor is preferable, due to the distortions, which potentially affect Libor, as well as due to the stronger impact on the economy, since interest payment on mortgages, loans and bonds are indexed to the three-month Euribor rate – a duration on which this paper focuses as well. Therefore, the robustness tests employ the spread between Euribor and OIS on Eonia[10], as well the spread between Libor and OIS on Eonia for the Eurogroup and the U.K. The checks are performed in equations (2), (4) and (6), which refer respectively to the baseline model of the bank lending channel, the model which incorporate each of the bank-specific characteristics separately and the model that includes all the specific characteristics, simultaneously.

5. Empirical analysis

The entries in all tables report the coefficients of the variables and their corresponding p-values estimated for the Eurogroup and the UK. The first two columns indicate the results of the bank lending channel model that does not incorporate financial frictions, whereas the last two columns report the results of the model that includes them. As

[10] De Socio (2013) disentangles the spread into two components: the credit risk, by using CDSs of the banks included in the Euribor panel, and liquidity risk, which is derived as the residual component of the Euribor-OIS spread and the credit risk. However, in this paper, credit risk remains as a component in both the main results and the robustness checks concerning the interbank market, due to unavailability of CDS data for the whole period under examination.

previously described, financial frictions are captured into the model by incorporating the interest rate spread.

5.1. Bank lending channel results

The findings of the benchmark model expressed in equation (1) are reported in Table 5.3. The monetary policy indicator has the expected negative sign for all countries and is statistically significant at the 10-percent level in the Eurogroup and at the 5-percent level in the UK. This implies that an increase in the monetary policy rates leads to a reduction in loan growth, implying that the response of bank lending to a monetary policy shock has the expected negative sign. Specifically, for the Eurogroup, a one percent increase in the policy indicator, declines loan supply by 0.52 percent, whereas in the U.K. the decrease is larger, that is, by 4.63 percent. The coefficient of the monetary policy indicator also keeps its negative sign in the model that includes financial frictions, as is reported in the third and fourth column. The policy interest rate exerts its influence with a lag in both models and across all cases and the respective coefficients are almost the same in absolute numbers.

Table 5.3 also reports the coefficients and their corresponding p-values for real GDP growth and inflation. These two variables control for the loan demand effects and exert their influence with a lag. The coefficients of GDP growth exhibit a positive sign and are statistically significant at the 5 percent level across all cases and all countries, implying that changes in economic activity affect bank lending in a positive way. Regarding the Eurogroup, a one percent change in the GDP growth, leads to a 0.59 percent increase in bank lending in the model without the spread, whereas in the case when the spread is included into the model, the corresponding change in the loan supply is 0.45 percent. In the U.K. a one percent increase in the GDP growth causes a larger impact, that is, almost a 2.2 percent increase in bank lending. By contrast, the coefficient for inflation exhibits a negative sign and is statistically significant, except for the UK and particularly in the model, in which frictions are included.

As previously mentioned, there are small differences between the monetary policy coefficients of the two models, whereas it is obvious that loan supply is negatively affected by another variable. All tables present the results of the two models: the second and third columns report the results of the model that does not incorporate frictions, whereas the entries in the fourth and fifth column show the results of the model, which includes frictions as an additional variable. This variable is the change in the interest rate spread, which exhibits a negative and statistically significant sign. In the UK the coefficient of the interest rate spread is larger than that of the monetary policy indicator, but smaller in the case of the Eurogroup.

Furthermore, in order to compare the effect of spreads on the loan supply, against the effect of the monetary policy indicator we computed a Wald test for the null hypothesis H_0: $\beta=\xi$. This statistic tests how close the unrestricted estimates come to satisfying the restrictions under the null hypothesis. In our case, the null hypothesis concerns the coefficients of the monetary policy indicator and the interest rate spread, which are assumed to be equal. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions. The results of the test are presented in the last row of each country and each table and the entries report the value and the probability of the Wald test. We accept the null hypothesis in all cases, implying that the effect of spreads on the loan supply is equal with that of the monetary policy indicator. In the Eurogroup and the UK, the p-value is greater than 0.05 and, therefore, we do not reject the null hypothesis.

5.2. Results with bank-specific characteristics

The entries of Tables 5.4 – 5.6 present the results from the estimation of equations (3) and (4), which differ from the baseline equation in the incorporation of two additional variables that concern the bank-specific characteristics and its interaction terms with the monetary policy indicator. As previously mentioned, we use three different bank-specific characteristics, i.e. capitalization, size and liquidity. These variables are used in the bank lending literature (Gusio *et al*., 2002; Altunbas *et al*., 2009) as proxies for banks' health and indicate their ability to confront with changes in the policy rate and rearrange their loan supply.

Tables 5.4, 5.5 and 5.6 report the results from the model that includes capitalization, size and liquidity, correspondingly as the bank-specific characteristic. The entries in these tables indicate that well-capitalized banks are better able to buffer their lending activity from changes in monetary policy. The coefficient of this specific characteristic – capitalization – is positive and statistically significant across all specifications and countries. Particularly, a one percent increase in banks' capitalization in the Eurogroup increases bank lending by almost 0.06 percent in both models – excluding and including frictions. The interaction term between capitalization and the change of the monetary policy rate is also positive, when statistically significant, which means that higher bank capitalization smoothes the negative effects on loan supply caused by a restrictive monetary policy.

Regarding the second bank-specific characteristic, size, the results coincide with the controversial conclusions to which previous research has reached. Although the credit channel theory predicts that a bank's reaction to monetary policy depends on size, this is not always the case. Particularly, the coefficient of size in Table 5.5 is statistically significant across all countries, but exhibits a positive sign in the Eurogroup, implying that a one percent increase in the size of European banks leads to a 0.02 percent increase in loan supply, whereas in the UK the coefficient exhibits negative sign. The results concerning the interaction term between size and the policy rate indicate that larger banks have a greater bank lending effect in the case of the Eurogroup. The exception concerns the UK in which the coefficient turns out to be insignificant.

Table 5.6 presents the results from the estimation of the bank lending channel, when liquidity and its interaction term with the monetary policy indicator are incorporated into the model. Liquidity has a negative sign, when statistically significant, with the exception of the UK and the model that does not include the interest rate spread. This result implies that less liquid banks do not necessarily suffer from a sharper decline in lending than more liquid banks. The interaction term, though, proves statistically significant only in the case of the Eurogroup and exhibits negative signs.

The coefficient of the monetary policy indicator has the expected negative sign, when statistically significant. Specifically, in the Eurogroup, monetary policy decisions about the interest rate affect loan supply negatively. In the UK, the coefficient of policy indicator is insignificant, except when size is used as a bank-specific characteristic in the model without the spread term. The signs of the GDP growth and inflation are positive and negative correspondingly, when statistically significant, with the exception of the UK (the coefficient of inflation is positive) and with capitalization as characteristic in the model that includes frictions.

As previously mentioned, the last two columns of Tables 5.4 – 5.6 report the results of the model that incorporates the interest rate spread. This parameter has negative coefficient across almost all cases and countries. The exception concerns the UK, when capitalization is used as the bank-specific characteristic, in which case the sign remains negative, but proves statistically insignificant. Across all the other cases, both the coefficients of the interest rate spread and the monetary policy indicator prove statistically significant, indicating that they both affect lending.

Finally, regarding the bank-specific characteristics, Table 5.7 reports the results of the estimation when all the characteristics as well as their interaction terms with the monetary policy indicator are included in the model. The incorporation of all the characteristics reports the same positive sign for the coefficient of capitalization in the Eurogroup, but the respective interaction term coefficient does not prove statistically significant. The sign of the size coefficient is also positive in the Eurogroup case, but negative in the case of the UK, adding to the controversial conclusions previously mentioned. The negative sign of the interaction term indicates that large banks do not differ from small ones in their lending response to a monetary policy action. No particular differences in their lending response appear across banks of various liquidity levels as well.

In the Eurogroup the coefficients of both the monetary policy indicator and spread change are negative and significant, whereas in the UK the corresponding coefficients prove statistically insignificant. The p-value of the Wald test is larger than 0.05, therefore the null hypothesis – that is, the coefficient of the monetary policy indicator equals that of the interest rate spread – is not rejected. Overall, in the UK, only the coefficients of size and of the interaction term between liquidity and the monetary policy indicator – the latter in the model that includes the spread variable – prove statistically significant, whereas the rest of the parameters are insignificant.

5.3. Robustness tests

5.3.1. Results with alternative variables that control for demand effects

The entries of Table 5.8 are the outcomes of the estimation of equations (7) and (8) – the latter incorporates frictions, as previously mentioned. In these equations, we replace real GDP growth and inflation with the growth rate of real consumption as a robustness test. The policy indicator affects loan supply negatively, when it is statistically significant. Concerning the rest of the parameters in the equations, consumption generates a positive effect on loan supply – its coefficient is positive and statistically significant across all countries, i.e. a one percent increase in consumption affects loan growth positively by 0.78 percent in the Eurogroup and the model without the frictions, and 0.69 percent in the model that incorporates credit frictions. The coefficient of the interest rate spread in the Eurogroup exhibits almost the same behavior as the monetary policy indicator, that is, it has negative sign, implying that an increase in the interest rate spread by one percent causes a 0.7 percent decrease in bank lending.

Moreover, Tables 5.9 to 5.13 report the results of equations (1) – (6), when we calculate inflation as the percentage change of the Harmonized Index of Consumer Price (HICP). Specifically, in Table 5.9, the findings of the benchmark model are reported. The coefficient of the monetary policy indicator is not statistically significant in the case of the Eurogroup, contrary to the results concerning the UK (a one percent increase in the policy indicator leads to a 4.7 decrease in bank lending, which is similar to the model, in which the inflation is derived by the CPI). In both cases, though, the coefficient of the spread proves statistically significant. When the Wald test is computed for the UK, the null hypothesis is not rejected. Regarding the GDP growth and the inflation, the signs are positive and negative correspondingly, in accordance to the findings in Table 5.3, in which the CPI-inflation is used.

Tables 5.10 – 5.12 present the results of equations (3) and (4) when HICP-inflation is used in the model. The results are almost similar to the corresponding findings reported in Tables 5.4 – 5.6. Specifically, the positive impact of bank capitalization on loan growth is reinforced, that is banks, which are better-capitalized are less sensitive to negative monetary shocks. Concerning size as the bank-specific characteristic, its coefficient is positive and statistically significant in the case of the Eurogroup, whereas negative, but also significant for the UK. As already mentioned, previous studies present controversial results regarding size, which are confirmed in this paper, as well. The findings concerning liquidity and its interaction term with the monetary policy indicator, when HICP-inflation is used for the estimation of the bank lending channel are compatible with those, when CPI-inflation is used. Finally, the monetary policy indicator exhibits negative coefficient, when it is statistically significant, as well as the coefficient of the interest rate spread. The Wald test is computed in all cases and the null hypothesis is rejected in the case of the Eurogroup, when bank capitalization is used as the bank-specific characteristic and in the case of the UK, when size and liquidity are included in the model.

In Table 5.13 the bank specific characteristics are used jointly for the estimation of the bank lending channel using the HICP-inflation. The coefficients of the monetary policy indicator and the spread are both negative and statistically significant in the case of the Eurogroup. The same occurs when we use the percentage change of the Consumer Price Index. The difference, though, is that in Table 5.13 we reject the null-hypothesis, which assumes the two coefficients to be equal. Regarding the bank-specific characteristics, only the capitalization coefficient is positive and in accordance to the findings of previous studies, whereas the impact of size on loan growth is negative.

5.3.2. Results with alternative variables that proxy for credit frictions

Table 5.14 – 5.18 report the results of the estimation of the bank lending channel, when frictions in the interbank market are included into the model. Specifically, Table 5.14 presents the findings of the benchmark model expressed in equation (2), whereas the results of equation (4) – in which every bank-specific characteristic is included into the model separately – are reported in Tables 5.15 to 5.17. Finally, the findings of equation (6), which estimates the lending channel, with all bank-specific characteristics incorporated into the model, are presented in Table 5.18. The second and third columns indicate the results when the Libor – OIS on Eonia spread represents the friction, whereas the fourth and fifth columns present the results when the spread between Euribor and the OIS on Eonia reflects the frictions in the interbank market.

The results appear to be robust in the case of the Eurogroup and particularly when capitalization and liquidity are included into the model separately (Tables 5.15 and 5.17 respectively), as well as in the case in which capitalization, size and liquidity are incorporated as bank-specific characteristics for the estimation of the bank lending channel (Table 5.18). The coefficient of the monetary policy indicator is statistically significant and negative as expected, across all tables; for instance, in Table 5.18 (that includes all bank-specific characteristics), a one percent increase in the policy indicator leads to 0.89 percent reduction in loan growth, in the model with Libor-OIS spread, and to a 0.87 percent decline in the model with the Euribor-OIS spread. Furthermore, the decrease in loan supply caused by a one percent increase in Libor-OIS spread is 0.06 percent, whereas the respective reduction caused by a one percent increase in the Euribor-OIS spread is 0.07 percent.

The sign of the GDP growth coefficient remains positive and statistically significant across all tables in the case of the Eurogroup. The coefficient of inflation exhibits negative sign, which is in accordance to the previous results of this paper, as well. Furthermore, the results concerning capitalization (Tables 5.15 and 5.18), indicate that well capitalized banks are more capable of buffering their loan supply from changes in monetary policy, i.e. a one percent increase in banks' capitalization leads to about 0.06 percent increase in bank lending. Moreover, the results concerning size coincide with the controversial conclusions of previous studies as well, whereas the negative sign of the coefficient of liquidity indicates that more liquid banks are not necessarily better able to buffer against monetary shocks. Overall, the robustness checks support the results especially for the Eurogroup[11]; however, this is not the case for the U.K, which, however, supports the results concerning the policy indicator, the spread and liquidity, as well its interaction with the policy indicator, only in the case when all bank-specific characteristics are included into the model for the specification of the bank lending channel.

[11] In Tables 5.14 and 5.16 the coefficients of the monetary policy indicator and the spread are not statistically significant; the rest of the variables, though, exhibit the expected signs.

6. Conclusions

Disruptions in economic activity have imposed the need for conventional monetary policy to take credit frictions into consideration. Their role has become prominent, since standard models fail to incorporate or explain the consequences of recent economic crisis. This paper examines frictions caused by distrubances in the supply of intermediated credit. Monetary authorities should explicitly take into account these frictions and include them into their analysis, in order to effectively transmit their decisions to real economy.

In this paper we investigate the performance of the bank lending channel under the presence of credit frictions in the Eurogroup and the UK over the period 1999-2010. These frictions are specified by the variation in the interest rate spreads, that is, the difference between the borrowing and the saving rate. The empirical findings indicate that the bank lending channel exists in all cases. The difference between the traditional model and the one that incorporates credit frictions is that the latter also affect loan growth. In other words, the change in lending cannot be merely explained by alteration in the monetary policy indicator. This suggests that monetary authorities should take explicitly into consideration the spread variable to understand the way their actions affect loan growth and implement a more effective monetary policy.

The paper also examines whether bank lending responses to monetary policy shocks vary across banks with different strength – the latter being described by size, capitalization and liquidity. The empirical results indicate that well-capitalized banks are able to buffer against monetary shocks. This is not the case, however, with large or more liquid banks, the results of which can be characterized as controversial, even when credit frictions are included into the analysis. These findings could be justified if we take into consideration the developments of financial markets and the alternative ways of financing. As a consequence, some of the indicators of banks' strength may have become quite inadequate for the accurate assessment of their ability to provide loans.

Although, financial innovations necessitate the modification of traditional bank-specific characteristics, it is obvious from the empirical analysis, that the capital to asset ratio maintains its informative power and is an important parameter for banks to be able to confront with changes in monetary policy. This result is in accordance to the finding by Gambacorta and Marques-Ibanez (2011), who argue that capitalization influences changes in loan supply, since it is perceived as a measure of bank risk by financial markets. The changing conditions in financial markets, though, impose the modification of this characteristic as well, to include more information, since its importance both as a cushion and a measure of creditworthiness to financial markets has increased, especially during the recent crisis.

During recent crisis, it has become evident that the transmission of monetary decisions comprises a more complex mechanism than implied so far. Financial disturbances play an important role in macroeconomic analysis and therefore, conventional models should adapt to current institutional realities. Future research should further investigate financial frictions when analyzing various aspects of macroeconomy and specifically, a combination of country-specific disturbances in depositors' funds with frictions in the interbank market.

Table 5.1. Number of banks in each country

Country	Number of banks
Austria	63
Belgium	12
France	62
Germany	430
Luxembourg	30
Total (Eurogroup)	**597**
United Kingdom	**19**

Table 5.2. Summary statistics

Summary statistics for the Bank Lending Channel Variables

Eurogroup

	Loans	**GDP Growth**	**Inlation$_{cpi}$**	**Policy Rate**	**Lending Rate**	**Deposit Rate**	**Total Assets**	**Total Equity**	**Liquid Assets**	**Interest Rate Spread**	**Deposits**	**Consumption Growth**
Mean	1386.31	0.014	1.508	2.692	5.497	2.927	2676.36	134.87	656.65	2.570	1529.58	0.013
Std.Deviation	2243.79	0.024	0.687	1.039	1.276	0.628	4711.61	220.05	1265.43	1.069	2272.79	0.016
Max	28100.5	0.081	4.402	4.750	7.610	4.390	72525.4	2881.5	17366.6	4.530	26956.2	0.068
Min	0.30000	-0.053	-0.100	1.000	2.380	0.840	31.5900	3.2800	0.10000	0.440	0.1000	-0.090

UK

	Loans	**GDP Growth**	**Inlation$_{cpi}$**	**Policy Rate**	**Lending Rate**	**Deposit Rate**	**Total Assets**	**Total Equity**	**Liquid Assets**	**Interest Rate Spread**	**Deposits**	**Consumption Growth**
Mean	1188.92	0.021	1.878	4.019	6.665	3.964	4942.24	302.38	2080.32	2.702	1321.38	0.000
Std.Deviation	2416.40	0.022	0.793	1.842	1.253	1.161	8579.77	393.03	6160.14	0.568	2196.70	0.081
Max	17028.9	0.041	3.565	6.250	8.360	5.550	43274.4	1905.2	42225.1	3.880	12824.9	0.125
Min	1.25000	-0.041	0.863	0.500	4.310	1.580	13.4100	4.5100	0.50000	1.620	2.8700	-0.164

Table 5.3. The bank lending results for Eurogroup and the United Kingdom. The inflation is calculated as the percentage change of the Consumer Price Index.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**0.0414**	0.0000	**0.0384**	0.0000
Δi_{kt-1}	**-0.5243**	0.0808	**-0.4078**	0.0693
$\Delta \ln GDP_{kt-1}$	**0.5992**	0.0006	**0.4544**	0.0000
π^{cpi}_{kt-1}	**-0.0219**	0.0000	**-0.0175**	0.0000
$\Delta spread_{kt}$			**-0.3950**	0.0363
Chi-square			0.0029	0.9567
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**-0.0650**	0.0000	**-0.0605**	0.0000
Δi_{kt-1}	**-4.6273**	0.0000	**-4.7100**	0.0000
$\Delta \ln GDP_{kt-1}$	**2.1074**	0.0000	**2.2396**	0.0000
π^{cpi}_{kt-1}	**-0.0606**	0.0001	-0.0261	0.1238
$\Delta spread_{kt}$			**-10.4411**	0.0092
Chi-square			1.9464	0.1647

Note: Coefficient and p-value estimates for the group of European countries and the United Kingdom, according to the model that does not include and the one that includes the interest rate spread. Bolded coefficients prove statistically significant at 5 and 10 percent level. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}$$

whereas, the model with the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}$$

with k = 1, …, K, where *k* denotes the country and *K*=5 for the group of European countries and *K*=1 for the United Kingdom, t=1,…T, L_{mkt} denotes the loans of the mth bank of country *k* in year *t*, i_{kt} denotes the monetary policy indicator of country *k* in year *t*, GDP_{kt} denotes the GDP of country *k* in year *t*, π_{kt} denotes the inflation rate of country *k* in year t, and u_{mkt} denotes the error term. The inflation is calculated as the percentage change of the Consumer Price Index. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991).

Table 5.4. Bank lending channel results for the Eurogroup and the United Kingdom including capitalization as bank-specific characteristic. The inflation is calculated as the percentage change of the Consumer Price Index.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**0.0634**	0.0000	**0.0620**	0.0000
Δi_{kt-1}	**-1.2825**	0.0002	**-2.1221**	0.0000
$\Delta \ln GDP_{kt-1}$	**1.5823**	0.0000	**2.0234**	0.0000
$\pi^{cpi}{}_{kt-1}$	**-0.0392**	0.0000	**-0.0479**	0.0000
Cap_{ikt-1}	**0.0613**	0.0000	**0.0617**	0.0000
$\Delta_{ikt-1}*Cap_{mkt-1}$	0.6503	0.1428	0.4878	0.2647
$\Delta spread_{kt}$			**-1.2390**	0.0000
Chi-square			**8.0339**	0.0046
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**-0.0556**	0.0000	**-0.0538**	0.0000
Δi_{kt-1}	-1.9926	0.2222	-0.9597	0.6738
$\Delta \ln GDP_{kt-1}$	**5.7091**	0.0074	**5.0176**	0.0530
$\pi^{cpi}{}_{kt-1}$	0.0472	0.4422	**0.1195**	0.0471
Cap_{mkt-1}	**0.0305**	0.0115	**0.0370**	0.0010
$\Delta_{ikt-1}*Cap_{mkt-1}$	0.6888	0.2665	**1.7225**	0.0161
$\Delta spread_{kt}$			-16.458	0.1492
Chi-square			1.4754	0.2261

Note: See Table 5.3. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.3. The difference is that two additional terms appear – a bank-specific characteristic (capitalization) and its interaction with the monetary policy indicator.

Table 5.5. Bank lending channel results for the Eurogroup and the United Kingdom including size as bank-specific characteristic. The inflation is calculated as the percentage change of the Consumer Price Index.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**0.0731**	0.0000	**0.0758**	0.0000
Δi_{kt-1}	-0.3710	0.2947	**-0.7491**	0.0989
$\Delta lnGDP_{kt-1}$	**0.4053**	0.0606	**0.5953**	0.0210
$\pi^{cpi}{}_{kt-1}$	**-0.0188**	0.0009	**-0.0216**	0.0005
$Size_{mkt-1}$	**0.0147**	0.0051	**0.0170**	0.0017
$\Delta_{ikt-1}*Size_{mkt-1}$	**-1.1825**	0.0047	**-0.9705**	0.0374
$\Delta spread_{kt}$			**-1.0036**	0.0550
Chi-square			0.3598	0.5486
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**-0.0506**	0.0000	**-0.0421**	0.0000
Δi_{kt-1}	**-3.9291**	0.0081	-1.2901	0.6547
$\Delta lnGDP_{kt-1}$	**5.2649**	0.0000	**5.4378**	0.0000
$\pi^{cpi}{}_{kt-1}$	-0.0645	0.1148	0.0189	0.7409
$Size_{mkt-1}$	**-0.1321**	0.0000	**-0.1304**	0.0000
$\Delta_{ikt-1}*Size_{mkt-1}$	-0.0895	0.8291	-0.5535	0.5275
$\Delta spread_{kt}$			**-25.695**	0.0118
Chi-square			4.1369	0.0434

Note: See Table 5.3. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$

$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.3. The difference is that two additional terms appear – a bank-specific characteristic (size) and its interaction with the monetary policy indicator.

Table 5.6. Bank lending channel results for the Eurogroup and the United Kingdom including liquidity as bank-specific characteristic. The inflation is calculated as the percentage change of the Consumer Price Index.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**0.0395**	0.0000	**0.0403**	0.0000
Δi_{kt-1}	**-0.6240**	0.0372	**-0.9671**	0.0051
$\Delta lnGDP_{kt-1}$	**0.5834**	0.0009	**0.7443**	0.0001
π^{cpi}_{kt-1}	**-0.0223**	0.0000	**-0.0247**	0.0000
Liq_{mkt}	**-0.0107**	0.0002	**-0.0121**	0.0000
$\Delta_{ikt-1}*Liq_{mkt}$	**-1.5120**	0.0000	**-1.6028**	0.0000
$\Delta spread_{kt}$			**-0.7111**	0.0018
Chi-square			0.8142	0.3669
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**-0.0181**	0.0006	-0.0094	0.1926
Δi_{kt-1}	-2.4619	0.2589	-1.8889	0.4144
$\Delta lnGDP_{kt-1}$	**5.2217**	0.0024	**5.9546**	0.0008
π^{cpi}_{kt-1}	-0.0335	0.5409	0.0210	0.6810
Liq_{mkt-1}	**0.0269**	0.0290	0.0185	0.2022
$\Delta_{ikt-1}*Liq_{mkt-1}$	-1.4240	0.1786	-1.3492	0.1937
$\Delta spread_{kt}$			**-16.934**	0.0445
Chi-square			2.7135	0.1012

Note: See Table 5.3. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$
$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.3. The difference is that two additional terms appear – a bank-specific characteristic (liquidity) and its interaction with the monetary policy indicator.

Table 5.7. Bank lending channel results for the Eurogroup and the United Kingdom including capitalization, size and liquidity as bank-specific characteristics. The inflation is calculated as the percentage change of the Consumer Price Index.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**0.1236**	0.0000	**0.1233**	0.0000
Δi_{kt-1}	**-1.0903**	0.0711	**-1.5483**	0.0289
$\Delta lnGDP_{kt-1}$	**1.3515**	0.0002	**1.5736**	0.0002
π^{cpi}_{kt-1}	**-0.0355**	0.0000	**-0.0385**	0.0000
$Size_{mkt-1}$	**0.0408**	0.0004	**0.0440**	0.0002
$\Delta_{ikt-1}*Size_{mkt-1}$	**-3.0891**	0.0001	**-3.0269**	0.0002
Cap_{mkt-1}	**0.0655**	0.0000	**0.0677**	0.0000
$\Delta_{ikt-1}*Cap_{mkt-1}$	0.1417	0.8928	-0.0357	0.9725
Liq_{mkt}	-0.0007	0.8717	-0.0022	0.6344
$\Delta_{ikt-1}*Liq_{mkt}$	**-2.4009**	0.0000	**-2.4210**	0.0000
$\Delta spread_{kt}$			**-0.8244**	0.0375
Chi-square			1.9746	0.1600
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	-0.0619	0.1581	-0.0718	0.0956
Δi_{kt-1}	-1.7566	0.6368	-2.5651	0.7703
$\Delta lnGDP_{kt-1}$	3.4047	0.4960	2.2038	0.6392
π^{cpi}_{kt-1}	-0.0009	0.9903	-0.0037	0.9731
$Size_{mkt-1}$	**-0.1667**	0.0025	**-0.1690**	0.0012
$\Delta_{ikt-1}*Size_{mkt-1}$	2.1257	0.6806	1.7877	0.7209
Cap_{mkt-1}	-0.0452	0.2421	-0.0444	0.2539
$\Delta_{ikt-1}*Cap_{mkt-1}$	1.6800	0.6794	1.4853	0.6968
Liq_{mkt}	-0.0487	0.1993	-0.0548	0.1472
$\Delta_{ikt-1}*Liq_{mkt}$	**-4.2260**	0.0319	-4.2403	0.1001
$\Delta spread_{kt-1}$			-7.3216	0.8476
Chi-square			0.0249	0.8749

Note: See Table 5.3. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{size} \Delta i_{kt-j} Size_{mkt-1} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{cap} \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{liq} \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{size} \Delta i_{kt-j} Size_{mkt-1} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{cap} \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{liq} \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.3. The difference is that two additional terms appear – a bank-specific characteristic and its interaction with the monetary policy indicator. Capitalization, size and liquidity are used as bank-specific characteristics.

Table 5.8. The bank lending channel results for the Eurogroup and the United Kingdom including consumption.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta\ln L_{mkt-1}$	**0.0412**	0.0000	**0.0438**	0.0000
Δi_{kt-1}	**-0.3658**	0.0735	**-0.4853**	0.0274
$\Delta consumption_{kt}$	**0.7838**	0.0000	**0.6893**	0.0000
$\Delta spread_{kt}$			**-0.7011**	0.0386
Chi-square			0.4285	0.5128
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta\ln L_{mkt-1}$	**-0.0506**	0.0000	**-0.0658**	0.0000
Δi_{kt-1}	**-1.7461**	0.0000	-4.5843	0.2147
$\Delta consumption_{kt}$	**0.7850**	0.0000	**0.8710**	0.0000
$\Delta spread_{kt-1}$			-15.496	0.3051
Chi-square			0.9153	0.3400

Note: See Table 5.3. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln Con_{kt-j} + u_{mkt}$$

Whereas the model with the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln Con_{kt-j} + u_{mkt}$$

The notation and the rest of the notes are similar to Table 5.3. We do not include the inflation rate and real GDP growth rate, replacing them with the growth rate of real consumption spending, $\Delta lnCon_{kt-j}$.

Table 5.9. The bank lending results for Eurogroup and the United Kingdom. The inflation is calculated as the percentage change of the Harmonized Index of Consumer Price.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**0.0431**	0.0000	**0.0407**	0.0000
Δi_{kt-1}	-0.1392	0.4935	-0.3690	0.1050
$\Delta \ln GDP_{kt-1}$	**0.3584**	0.0001	**0.4486**	0.0000
π^{hicp}_{kt-1}	**-0.0153**	0.0000	**-0.0166**	0.0000
$\Delta spread_{kt}$			**-0.3752**	0.0472
Chi-square			0.0007	0.9791
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**-0.0644**	0.0000	**-0.0604**	0.0000
Δi_{kt-1}	**-4.6063**	0.0000	**-4.7517**	0.0000
$\Delta \ln GDP_{kt-1}$	**2.0882**	0.0000	**2.2319**	0.0000
π^{hicp}_{kt-1}	**-0.0585**	0.0001	-0.0271	0.1000
$\Delta spread_{kt}$			**-10.5831**	0.0083
Chi-square			2.0444	0.1545

Note: Coefficient and p-value estimates for the group of European countries and the United Kingdom, according to the model that does not include and the one that includes the interest rate spread. Bolded coefficients prove statistically significant at 5 and 10 percent level. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}$$

whereas, the model with the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}$$

with k = 1, …, K, where k denotes the country and K=5 for the group of European countries and K=1 for the United Kingdom, t=1,…T, L_{mkt} denotes the loans of the m^{th} bank of country k in year t, i_{kt} denotes the monetary policy indicator of country k in year t, GDP_{kt} denotes the GDP of country k in year t, π_{kt} denotes the inflation rate of country k in year t, and u_{mkt} denotes the error term. The inflation is calculated as the percentage change of the Harmonized Index of Consumer Price. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991).

Table 5.10. Bank lending channel results for the Eurogroup and the United Kingdom including capitalization as bank-specific characteristic. The inflation is calculated as the percentage change of the Harmonized Index of Consumer Prices.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**0.0692**	0.0000	**0.0688**	0.0000
Δi_{kt-1}	**-0.9286**	0.0059	**-1.5111**	0.0002
$\Delta \ln GDP_{kt-1}$	**1.4168**	0.0000	**1.7141**	0.0000
π^{hicp}_{kt-1}	**-0.0334**	0.0000	**-0.0387**	0.0000
Cap_{mkt-1}	**0.0617**	0.0000	**0.0617**	0.0000
$\Delta_{ikt-1}*Cap_{mkt-1}$	**0.9828**	0.0340	**0.8760**	0.0563
$\Delta spread_{kt}$			**-0.9779**	0.0002
Chi-square			2.8507	0.0914
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{mkt-1}$	**-0.0549**	0.0000	**-0.0538**	0.0000
Δi_{kt-1}	-1.6235	0.4027	-0.6700	0.7890
$\Delta \ln GDP_{kt-1}$	**5.9627**	0.0087	**5.3935**	0.0412
π^{hicp}_{kt-1}	0.0522	0.4229	**0.1180**	0.0661
Cap_{mkt-1}	**0.0305**	0.0122	**0.0370**	0.0012
$\Delta_{ikt-1}*Cap_{mkt-1}$	0.7429	0.2666	**1.7363**	0.0217
$\Delta spread_{kt}$			-15.710	0.1744
Chi-square			1.3677	0.2437

Note: See Table 5.9. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.9. The difference is that two additional terms appear – a bank-specific characteristic (capitalization) and its interaction with the monetary policy indicator.

Table 5.11. Bank lending channel results for the Eurogroup and the United Kingdom including size as bank-specific characteristic. The inflation is calculated as the percentage change of the Harmonized Index of Consumer Prices.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{ikt-1}	**0.0769**	0.0000	0.0796	**0.0000**
Δi_{kt-1}	-0.1111	0.7442	-0.3420	0.3518
$\Delta lnGDP_{kt-1}$	0.2453	0.2582	0.2573	0.1509
π^{hicp}_{kt-1}	**-0.0138**	0.0114	**-0.0144**	0.0003
$Size_{mkt-1}$	**0.0154**	0.0042	**0.0165**	0.0023
$\Delta_{ikt-1}*Size_{mkt-1}$	**-1.2781**	0.0020	**-1.0147**	0.0344
$\Delta spread_{kt}$			-0.8091	0.1159
Chi-square			1.3894	0.2385
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**-0.0507**	0.0000	**-0.0419**	0.0000
Δi_{kt-1}	**-3.8246**	0.0226	-1.2355	0.6877
$\Delta lnGDP_{kt-1}$	**5.2937**	0.0000	**5.6116**	0.0000
π^{hicp}_{kt-1}	-0.0620	0.1367	0.0171	0.7671
$Size_{ikt-1}$	**-0.1319**	0.0000	**-0.1305**	0.0000
$\Delta_{ikt-1}*Size_{mkt-1}$	-0.1990	0.6539	-0.5547	0.5336
$\Delta spread_{kt}$			**-25.718**	0.0121
Chi-square			**4.1002**	0.0443

Note: See Table 5.9. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$
$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.9. The difference is that two additional terms appear – a bank-specific characteristic (size) and its interaction with the monetary policy indicator.

Table 5.12. Bank lending channel results for the Eurogroup and the United Kingdom including liquidity as bank-specific characteristic. The inflation is calculated as the percentage change of the Harmonized Index of Consumer Prices.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**0.0427**	0.0000	**0.0437**	0.0000
Δi_{kt-1}	**-0.4732**	0.0893	**-0.7049**	0.0251
$\Delta lnGDP_{kt-1}$	**0.5334**	0.0016	**0.6317**	0.0006
$\pi^{hicp}{}_{kt-1}$	**-0.0193**	0.0000	**-0.0203**	0.0000
Liq_{ikt}	**-0.0097**	0.0006	**-0.0108**	0.0002
Δ_{ikt-1}*Liq_{mkt}	**-1.4207**	0.0000	**-1.4989**	0.0000
$\Delta spread_{kt}$			**-0.5657**	0.0107
Chi-square			0.2619	0.6088
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**-0.0177**	0.0004	**-0.0297**	0.0020
Δi_{kt-1}	-2.3828	0.2872	-2.1533	0.2659
$\Delta lnGDP_{kt-1}$	**5.3638**	0.0028	1.8106	0.5756
$\pi^{hicp}{}_{kt-1}$	-0.0333	0.5275	-0.0047	0.9050
Liq_{mkt-1}	**0.0270**	0.0261	**-0.0121**	0.0978
Δ_{ikt-1}*Liq_{mkt-1}	-1.3873	0.1729	**-3.5202**	0.0216
$\Delta spread_{kt}$			**-20.482**	0.0359
Chi-square			**2.8225**	0.0947

Note: See Table 5.9. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$
$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.9. The difference is that two additional terms appear – a bank-specific characteristic (liquidity) and its interaction with the monetary policy indicator.

Table 5.13. Bank lending channel results for the Eurogroup and the United Kingdom including capitalization, size and liquidity as bank-specific characteristics. The inflation is calculated as the percentage change of the Harmonized Index of Consumer Prices.

Dependent variable: annual growth rate of lending				
	Model without spread		**Model with spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	**-0.0780**	0.0000	**-0.0611**	0.0000
Δi_{kt-1}	**-2.2787**	0.0000	**-2.9379**	0.0000
$\Delta lnGDP_{kt-1}$	**2.4180**	0.0000	**2.6975**	0.0000
π^{hicp}_{kt-1}	**-0.0598**	0.0000	**-0.0618**	0.0000
$Size_{mkt-1}$	**-0.2351**	0.0000	**-0.2137**	0.0000
$\Delta_{ikt-1}*Size_{mkt-1}$	**-2.1872**	0.0077	**-1.6635**	0.0587
Cap_{mkt-1}	**0.0174**	0.0233	**0.0287**	0.0041
$\Delta_{ikt-1}*Cap_{mkt-1}$	**-1.7937**	0.0136	**-1.2188**	0.0837
Liq_{mkt}	-0.0025	0.4511	-0.0018	0.5878
$\Delta_{ikt-1}*Liq_{mkt}$	**-0.8982**	0.0444	**-1.0724**	0.0180
$\Delta spread_{kt}$			**-1.9217**	0.0000
Chi-square			**8.2350**	0.0041
	Model without spread		**Model with spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{mkt-1}	-0.0174	0.5793	-0.0360	0.2838
Δi_{kt-1}	-3.5369	0.4429	-2.2625	0.8162
$\Delta lnGDP_{kt-1}$	**6.9787**	0.0467	**5.2404**	0.0962
π^{hicp}_{kt-1}	-0.1136	0.1712	-0.1202	0.2626
$Size_{mkt-1}$	**-0.1145**	0.0000	**-0.1208**	0.0000
$\Delta_{ikt-1}*Size_{mkt-1}$	-0.4562	0.9313	-1.6964	0.7363
Cap_{mkt-1}	-0.0070	0.8361	-0.0093	0.7451
$\Delta_{ikt-1}*Cap_{mkt-1}$	0.0782	0.9860	-0.5625	0.8876
Liq_{mkt}	-0.0082	0.7753	-0.0215	0.5428
$\Delta_{ikt-1}*Liq_{mkt}$	-1.9124	0.4227	-1.7329	0.5166
$\Delta spread_{kt-1}$			-2.3736	0.9544
Chi-square			0.0000	0.9973

Note: See Table 5.9. The model without the spread is given by the following equation:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} Size_{mkt-1} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1}$$
$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.$$

The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} Size_{mkt-1}$$
$$+ \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} + \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.9. The difference is that two additional terms appear – a bank-specific characteristic and its interaction with the monetary policy indicator. Capitalization, size and liquidity are used as bank-specific characteristics.

Table 5.14. The bank lending results for Eurogroup and the United Kingdom. The inflation is calculated as the percentage change of the Consumer Price Index. The spread represents frictions in the interbank market.

Dependent variable: annual growth rate of lending				
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{ikt-1}	**0.0391**	0.0000	**0.0390**	0.0000
Δi_{kt-1}	-0.2320	0.2864	-0.2288	0.2934
$\Delta lnGDP_{kt-1}$	**0.3484**	0.0005	**0.3535**	0.0004
$\pi^{cpi}{}_{kt-1}$	**-0.0169**	0.0000	**-0.0168**	0.0000
$\Delta spread_{kt}$	0.0090	0.2439	0.0086	0.2656
Chi-square	1.2036	0.2726	1.1661	0.2802
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{ikt-1}	-0.0506	0.4758	-0.0507	0.4747
Δi_{kt-1}	-0.5151	0.9063	-0.5513	0.8997
$\Delta lnGDP_{kt-1}$	**4.2522**	0.0516	**4.0146**	0.0565
$\pi^{cpi}{}_{kt-1}$	-0.0074	0.9186	-0.0087	0.9036
$\Delta spread_{kt}$	-0.3689	0.1152	-0.3633	0.1174
Chi-square	0.0010	0.9742	0.0017	0.9668

Note: Coefficient and p-value estimates for the group of European countries and the United Kingdom, according to the model that includes the spread between secured and unsecured funding. Bolded coefficients prove statistically significant at 5 and 10 percent level. The model with the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + u_{mkt}$$

with k = 1, …, K, where *k* denotes the country and *K*=5 for the group of European countries and *K*=1 for the United Kingdom, t=1,…T, L_{mkt} denotes the loans of the m^{th} bank of country *k* in year *t*, i_{kt} denotes the monetary policy indicator of country *k* in year *t*, GDP_{kt} denotes the GDP of country *k* in year *t*, π_{kt} denotes the inflation rate of country *k* in year t, and u_{mkt} denotes the error term. The spread represents frictions in the interbank market (Libor-OIS on Eonia spread and Euribor-OIS on Eonia spread).The inflation is calculated as the percentage change of the Consumer Price Index. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991).

Table 5.15. Bank lending channel results for the Eurogroup and the United Kingdom including capitalization as bank-specific characteristic. The inflation is calculated as the percentage change of the Consumer Price Index. The spread represents frictions in the interbank market.

Dependent variable: annual growth rate of lending				
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{ikt-1}$	**0.0624**	0.0000	**0.0624**	0.0000
Δi_{kt-1}	**-1.2696**	0.0001	**-1.2598**	0.0002
$\Delta \ln GDP_{kt-1}$	**1.8351**	0.0000	**1.8306**	0.0000
π^{cpi}_{kt-1}	**-0.0444**	0.0000	**-0.0446**	0.0000
Cap_{ikt-1}	**0.0628**	0.0000	**0.0629**	0.0000
$\Delta_{ikt-1}*Cap_{ikt-1}$	1.0221	0.0125	1.0373	0.0112
$\Delta spread_{kt}$	**-0.0287**	0.0037	**-0.0307**	0.0021
Chi-square	**13.9065**	0.0002	**13.6242**	0.0002
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{ikt-1}$	-0.0476	0.4233	-0.0476	0.5075
Δi_{kt-1}	-1.1885	0.7934	-1.1885	0.7885
$\Delta \ln GDP_{kt-1}$	**4.4165**	0.0108	**4.4165**	0.0476
π^{cpi}_{kt-1}	0.0148	0.8046	0.0148	0.8455
Cap_{ikt-1}	0.0397	0.1852	**0.0397**	0.0411
$\Delta_{ikt-1}*Cap_{ikt-1}$	0.3614	0.7889	0.3614	0.7577
$\Delta spread_{kt}$	-0.321	0.1412	-0.321	0.1885
Chi-square	0.0341	0.8535	0.0359	0.8497

Note: See Table 5.14. The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$

$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.14. The difference is that two additional terms appear – a bank-specific characteristic (capitalization) and its interaction with the monetary policy indicator.

Table 5.16. Bank lending channel results for the Eurogroup and the United Kingdom including size as bank-specific characteristic. The inflation is calculated as the percentage change of the Consumer Price Index. The spread represents frictions in the interbank market.

Dependent variable: annual growth rate of lending				
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{ikt-1}	**0.0735**	0.0000	**0.0733**	0.0000
Δi_{kt-1}	-0.3924	0.2614	-0.3911	0.2792
$\Delta lnGDP_{kt-1}$	**0.4601**	0.0411	**0.4574**	0.0691
π^{cpi}_{kt-1}	**-0.0201**	0.0003	**-0.0201**	0.0019
$Size_{ikt-1}$	**0.0151**	0.0005	**0.0151**	0.0041
$\Delta_{ikt-1}*Size_{ikt-1}$	**-1.1518**	0.0001	**-1.1498**	0.0060
$\Delta spread_{kt}$	-0.0068	0.4596	-0.0069	0.5223
Chi-square	1.2215	0.2691	1.1466	0.2843
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
ΔlnL_{ikt-1}	-0.0406	0.5623	-0.0408	0.5605
Δi_{kt-1}	-1.5041	0.7312	-1.5624	0.7205
$\Delta lnGDP_{kt-1}$	**6.5414**	0.0029	**6.3267**	0.0029
π^{cpi}_{kt-1}	-0.0446	0.5575	-0.0465	0.5376
$Size_{ikt-1}$	**-0.1374**	0.0001	**-0.1375**	0.0001
$\Delta_{ikt-1}*Size_{ikt-1}$	-0.2471	0.9154	-0.2344	0.9197
$\Delta spread_{kt}$	-0.344	0.1442	-0.339	0.1472
Chi-square	0.0657	0.7977	0.0736	0.7862

Note: See Table 5.14. The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$
$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.14. The difference is that two additional terms appear – a bank-specific characteristic (size) and its interaction with the monetary policy indicator.

Table 5.17. Bank lending channel results for the Eurogroup and the United Kingdom including liquidity as bank-specific characteristic. The inflation is calculated as the percentage change of the Consumer Price Index. The spread represents frictions in the interbank market.

Dependent variable: annual growth rate of lending				
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{ikt-1}$	**0.0375**	0.0000	**0.0374**	0.0000
Δi_{kt-1}	**-0.6347**	0.0365	**-0.6285**	0.0372
$\Delta \ln GDP_{kt-1}$	**0.7261**	0.0003	**0.7193**	0.0003
π^{cpi}_{kt-1}	**-0.0249**	0.0000	**-0.0249**	0.0000
Liq_{ikt}	**-0.0121**	0.0001	**-0.0121**	0.0001
$\Delta_{ikt-1} {}^{*} Liq_{ikt}$	**-1.6028**	0.0000	**-1.6087**	0.0000
$\Delta spread_{kt}$	**-0.0167**	0.0001	**-0.0175**	0.0775
Chi-square	**4.1509**	0.0416	**4.1292**	0.0422
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{ikt-1}$	-0.0162	0.8229	-0.0165	0.8189
Δi_{kt-1}	-1.2321	0.7821	-1.3497	0.7614
$\Delta \ln GDP_{kt-1}$	**5.8439**	0.0088	**5.5713**	0.0097
π^{cpi}_{kt-1}	-0.0309	0.6777	-0.0340	0.6455
Liq_{ikt-1}	**0.0327**	0.0555	**0.0328**	0.0549
$\Delta_{ikt-1} {}^{*} Liq_{ikt-1}$	-0.9677	0.4462	-0.9774	0.4413
$\Delta spread_{kt}$	**-0.420**	0.0725	**-0.410**	0.0773
Chi-square	0.0312	0.8598	0.0420	0.8376

Note: See Table 5.14. The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \gamma BS_{mkt-1}$$
$$+ \sum_{j=0}^{n} \lambda_j \Delta i_{kt-j} BS_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.14. The difference is that two additional terms appear – a bank-specific characteristic (liquidity) and its interaction with the monetary policy indicator.

Table 5.18. Bank lending channel results for the Eurogroup and the United Kingdom including capitalization, size and liquidity as bank-specific characteristics. The inflation is calculated as the percentage change of the Consumer Price Index. The spread represents frictions in the interbank market.

Dependent variable: annual growth rate of lending				
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
Eurogroup	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{ikt-1}$	**0.1215**	0.0000	**0.1216**	0.0000
Δi_{kt-1}	**-0.8907**	0.0795	**-0.8669**	0.0890
$\Delta \ln GDP_{kt-1}$	**1.7394**	0.0000	**1.7186**	0.0000
π^{cpi}_{kt-1}	**-0.0425**	0.0000	**-0.0426**	0.0000
$Size_{ikt-1}$	**0.0402**	0.0000	**0.0403**	0.0000
$\Delta_{ikt-1}*Size_{ikt-1}$	**-2.6012**	0.0000	**-2.6055**	0.0000
Cap_{ikt-1}	**0.0688**	0.0000	**0.0691**	0.0000
$\Delta_{ikt-1}*Cap_{ikt-1}$	1.2439	0.1350	1.2938	0.1226
Liq_{ikt}	-0.0040	0.3035	-0.0043	0.2777
$\Delta_{ikt-1}*Liq_{ikt}$	**-2.7802**	0.0000	**-2.8150**	0.0000
$\Delta spread_{kt}$	**-0.0640**	0.0000	**-0.0672**	0.0000
Chi-square	2.6252	0.1052	2.4369	0.1185
	Model with Libor-OIS spread		**Model with Euribor-OIS spread**	
UK	**Coef**	**Prob**	**Coef**	**Prob**
$\Delta \ln L_{ikt-1}$	-0.0218	0.7849	-0.0214	0.7893
Δi_{kt-1}	**-8.7058**	0.0907	**-8.7910**	0.0864
$\Delta \ln GDP_{kt-1}$	**9.8142**	0.0270	**9.8355**	0.0248
π^{cpi}_{kt-1}	0.1430	0.2927	0.1460	0.2813
$Size_{ikt-1}$	-0.0699	0.1510	-0.0704	0.1477
$\Delta_{ikt-1}*Size_{ikt-1}$	3.0855	0.2635	3.1070	0.2611
Cap_{ikt-1}	0.0134	0.6085	0.0133	0.6109
$\Delta_{ikt-1}*Cap_{ikt-1}$	0.2414	0.8597	0.2411	0.8600
Liq_{ikt}	**-0.0438**	0.0056	**-0.0437**	0.0057
$\Delta_{ikt-1}*Liq_{ikt}$	**-2.6395**	0.0104	**-2.6643**	0.0099
$\Delta spread_{kt-1}$	**-0.7974**	0.0783	**-0.8195**	0.0729
Chi-square	2.6959	0.1006	2.7635	0.0964

Note: See Table 5.3. The model that includes the spread is as follows:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^{n} \beta_j \Delta i_{kt-j} + \sum_{j=0}^{n} \xi_j \Delta Spread_{kt-j} + \sum_{j=0}^{n} \delta_j \Delta \ln GDP_{kt-j} + \gamma Size_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{size} \Delta i_{kt-j} Size_{mkt-1}$$
$$+ \sum_{j=0}^{n} \omega_j \pi_{kt-j} + \eta Cap_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{cap} \Delta i_{kt-j} Cap_{mkt-1} + \theta Liq_{mkt-1} + \sum_{j=0}^{n} \lambda_j^{liq} \Delta i_{kt-j} Liq_{mkt-1} + u_{mkt}.$$

The notation and the rest of the notes are similar to Table 5.14. The difference is that two additional terms appear – a bank-specific characteristic and its interaction with the monetary policy indicator. Capitalization, size and liquidity are used as bank-specific characteristics.

Chapter 6: Conclusion

Motivated by the increasing importance of the role of banks as financial intermediaries and the fact that the bank lending channel has been overlooked until recently, this thesis has contributed to the lending channel literature by addressing three research questions. First, it has examined whether efficiency, as a qualitative characteristic, has any impact on the bank lending channel in European countries. Second, it has examined whether the central bank's monetary policy rule and specifically, the target rate emanating from that rule, affects the operation of the bank lending channel. Finally, it investigates whether the inclusion of additional variables that proxy for financial disturbances justifies the change in loan supply, which cannot be explained solely by the shift in monetary policy indicator.

Regarding the first question, traditional literature has examined whether bank-specific characteristics have any impact on loan supply. However, it focuses on quantitative, rather than qualitative characteristics, such as the efficiency of the banking system. By contrast, the first part of this thesis (Chapter 3) focuses on estimating the bank lending channel using this qualitative variable as bank-specific characteristic in a panel of European banks. The results indicate that efficient banks, that is, sound banks are more resistant to changes in monetary policy, since they may be considered as more capable of managing their own resources in a more productive way. Therefore, this characteristic should be taken into account, when monetary authorities need to transmit their decisions into the economy, through the bank lending channel.

With respect to the second research question, the role of target interest rates (emanating from the central bank's monetary policy rule) to the operation of the bank lending channel was investigated for the first time (Chapter 4). The results suggest that the monetary authorities use interest rate rules and particularly forward-looking rules as the policy indicator, since the latter, by incorporating inflationary expectations, seem to affect the decisions for the target rate and therefore, for the monetary policy. Hence, monetary policy decisions become more effective, since banks alter their loan supply according to expectations, which are formed and guided by monetary policy actions and announcements.

As far as the third question is concerned, the impact of financial disturbances on the operation of the bank lending channel is examined (Chapter 5). Recent crisis has revealed the weakness of traditional macroeconomic models, which is the neglect of the significant role of banks as financial intermediaries, and imposed the necessity of reformulating these models. In this context, I have examined whether the transmission of monetary policy decisions is affected, when a proxy for financial disturbances is incorporated into the lending channel model. It is concluded from the analysis that the shift in loan supply cannot be explained only by the change in monetary policy, but also by disturbances in the intermediated credit.

Future research should further investigate the impact of efficiency of other banking systems as well, on the operation of the bank lending channel. Moreover, concerning monetary policy rules and their impact on loan supply, it should be noted that the analysis in this thesis abstracts form the zero lower bound hypothesis on nominal interest rates and therefore, future empirical research should modify policy rules to account for such an environment. Further investigation on different measures of financial disturbances and their impact on the lending channel should be conducted. Finally, with regard to monetary policy rules and their impact on the lending channel, future research should focus on target rates emanating from policy rules that are adjusted for financial frictions, such as the spread-adjusted Taylor rule that McCulley and Toloui (2008) and Taylor (2008) propose.

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