CYPRUS UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF COMMERCE, FINANCE AND SHIPPING

PhD Dissertation

Essays on Bank Lending, Output Growth and Implications for Economic Policy

Nektarios Michail

Lemesos, 2016

CYPRUS UNIVERSITY OF TECHNOLOGY

FACULTY OF MANAGEMENT AND ECONOMICS

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ΕΝΤΥΠΟ ΕΓΚΡΙΣΗΣ

Διδακτορική διατριβή

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Παρουσιάστηκε από

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To my mother

ABSTRACT

The relationship between bank lending and output growth, the subsequent policy implications and the effects of policy on this relationship have been in and out of vogue many times in the academic literature. Even though the recent financial crisis has once again turned our attention to the examination of this connection, studies concerning the effects of bank lending on the overall economy and the policy implications these entail have been few since its onset. This dissertation contributes to the literature by providing three interrelated, mainly empirical, chapters which study different aspects of the relationship between bank lending and output growth, as well as the macroeconomic policies associated with them.

The first chapter examines the effect of an increase in total lending in the economy of three euro area countries (Germany, Italy, Spain) by employing a factor-augemented VAR (FAVAR) specification. The benefit of this approach, as evidenced in the literature, is that the inclusion of the factors generates more precise estimates as they incorporate the whole economy into the specification. The contribution is twofold: first, I find that while the average effect of bank lending on output is relatively small, it is always positive with responses varying across countries; second, increases in bank lending, also increase total deposits in the economy, in all sample countries, providing the first macroeconomic evidence for the credit creation theory, i.e. that bank lending creates deposits. In addition, the results suggest that large changes in deposits unrelated to changes in lending can potentially signal distress, a channel policymakers can focus on as a leading indicator.

In the second chapter, I examine the effects of private bank lending in the economy using both theory and empirical evidence supplementing the evidence presented in the first chapter. Through a two-period model, I find that even when changes in lending are due to monetary

easing, a positive relationship between finance and growth exists, while this relationship exhibits diminishing returns after a certain threshold. Furthermore, the theoretical conclusions are tested by employing a smooth transition conditional correlation (STCC) model. The empirical evidence also suggests that the finance-growth relationship is always positive and exhibits diminishing returns after country-specific thresholds. Overall, the results suggest that, other things being constant, private lending promotes GDP growth, at any debt-to-GDP ratio. As such, macro-prudential policies should not emphasise on the level of lending, but how the allocation of these loans affects the workings of the economy.

The third chapter focuses on policy issues. The first two chapters establish that the relationship between bank lending and output growth is positive, and more so that there are no thresholds after which it becomes negative, the third chapter asks whether monetary policy has a persistent effect on bank lending behaviour. To answer this question I employ macroeconomic data for 10 euro area (EA) countries and, through the shock persistence methodology developed by Lee et *al.* (1993), I examine whether monetary policy has persistent effects on bank lending behavior, both directly through the credit channel and indirectly through the risk-taking and liquidity channels. The findings suggest that policy actions aimed at affecting credit risk and bank lending do not have any persistent effects if only the interest rate is employed. Consequently, macro-prudential policy should focus on other factors which affect lending decisions, most notably the liquidity channel as an important determinant of the level of lending.

Keywords: bank lending, output growth, economic policy, monetary policy, macro-prudential, STCC, Factor-Augmented VAR, persistence.

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INTRODUCTION

The recent financial crisis, which led to what is now referred to as the "Great Recession", has clearly demonstrated that there exists a strong relationship between bank lending and output growth. The relationship has been extensively studied in the past (see Levine, 2005 for a detailed review of the literature), but it has not however provided clear evidence about the nature and magnitude of this relationship, nor about the possible policy implications. In addition, countries other than the United States (for example, the euro area and developing countries) have received even less attention from the existing literature.

Given that research in this area can provide important guidance for policymakers and central banks, further research on this connection is required. This dissertation aims at filling this gap in the existing literature by focusing on the examination of the nexus between bank lending and real GDP growth in a variety of settings.

The first chapter aims at measuring the extent of bank lending shocks on output growth. As is well known, these effects are of great policy importance. Not only is this area the primary focus of macro-prudential policy in order to limit financial distress with minimum output costs (Borio, 2003), but it also matters for monetary policy, given the importance of determining the existence and size of the bank lending (or credit) channel (Bernanke and Gertler, 1995).

To test for the magnitude and direction of these effects, the first chapter employs a factor-augemented vector autoregression (FAVAR) specification to examine the effect of an increase in total lending in the economy of three euro area countries. As suggested by various authors (e.g. Bernanke et al, 2005; Boivin et al, 2009; Mumtaz and Surico, 2009), the inclusion of a small number of factors generates more precise estimates as they incorporate the whole economy into the specification. In addition, as Forni et al. (2009) and Alessi et al. (2011), show, the inclusion of more information about the economy through the factors avoids potential VAR non-fundamentalness issues, such as those presented in Lippi and Reichlin (1993).

The contribution of the first chapter is two-fold: first I find that while the average effect of bank lending on output is relatively small, it is always positive with responses varying across countries. Second, increases in bank lending also increase total deposits in the economy in all sample countries, providing the first macroeconomic evidence for the credit creation theory, i.e. that bank lending creates deposits. Subsequently, an important policy implication is that large changes in deposits unrelated to changes in lending can potentially signal distress. A further conclusion of the results is that inflation increases in most sample countries after a positive shock in lending.

Chapter two examines whether the relationship between bank lending and output is always positive or whether this relationship is subject to thresholds, as it has recently been suggested by Cechetti et al (2011), Cechetti and Kharroubi (2012) and Law and Singh (2014). These authors caution that after a threshold of 85% of GDP for household debt and 90% for corporate debt, the relationship between private debt and output becomes negative. These results appear counter-intuitive given that many countries record high loan rates and still maintain positive growth rates.

To re-examine whether such thresholds exist, I put forth a two-period model in which banks make one-period loans to farmers which they use in the production of crops. At equilibrium, the bank lending rate is simply a mark-up over the bank deposit rate. In addition, the lending rate has a positive relationship with the probability of default, which is itself a function of the collateral required, and the production function parameter, and becomes constant at equilibrium. Examining the effects of an increase in lending in the economy suggests that the first derivative is positive and the second derivative is negative, i.e. bank lending increases output but faces diminishing returns.

The empirical part of the second chapter tests the theoretical conclusions using a smooth transition conditional correlation (STCC) model, as proposed by Berben and Jansen (2005) and Silvennoinen and Teräsvirta (2005). I estimate the model for the G7 countries and the results confirm that the correlation between lending to the private sector and GDP growth is always positive but exhibits diminishing returns. The relationship holds in six of seven countries and is constant in the other. As such, emphasis should not be placed on the amount of lending *per se* as it does not harm growth at any debt-to-GDP ratio, even after the threshold value is exceeded. Consequently, if the amount of lending is not harmful to the economy, then macro-prudential policy should aim at the allocation of lending in the economy and prevent over-heating in specific sectors.

Finally, Chapter three examines whether monetary policy can indeed affect the banking sector and control its expansion or contraction. Given that the first two chapters establish that the relationship between bank lending and output growth is positive, and that there are no thresholds after which it becomes negative, the question which arises is whether monetary policy can have a persistent effect on bank lending behaviour. In other words, the chapter examines whether monetary policy can be used to exploit the relationship between the banking sector and the economy.

As has been suggested (e.g. De Nicolo et al, 2010; Maddaloni and Peydró, 2011; Jiménez et al, 2014), monetary policy drives risk appetite and lower interest rates soften lending standards. In addition, a reduction in policy rates can decrease price stability and increase risk appetite. However, the persistence of these changes of the policy rate on bank lending behaviour has not been examined in the literature. To complement short-run studies and further explore these aspects of monetary policy transmission, I empirically examine whether monetary policy has any persistent effects on bank lending behaviour, both directly through the bank lending/credit channel and indirectly through the risk-taking and liquidity channel.

To study this behaviour, chapter three uses macro data for ten euro area (EA) countries and the shock persistence methodology developed by Lee et al (1992) and Pesaran et al (1993), Lee and Pesaran (1993) and Antonini et al (2013). The results from the estimation method provide evidence against the existence of direct, persistent effects of EA monetary policy on bank lending. In addition, the findings indicate that there are no persistent effects of the policy rate on credit risk. On the whole, the results indicate that the interest rate, as previously suggested in the literature (Blanchard et al 2010), does not have a persistent impact on the variables affecting bank behaviour. This outcome implies that policies aimed at affecting credit risk and bank lending behaviour will have no persistent effects if only the interest rate is employed. Instead, macro-prudential policy actions should be directed to the liquidity channel, which appears to be an important determinant of the level of lending.

1 An analysis of the effects of bank lending in three Euro Area economies

1.1 Introduction

In the years following the recent global financial crisis, the Euro Area economy experienced deep slumps, both in the real and the financial sector. The significant drop in the annual growth rate of bank lending (European Central Bank, 2009 and figure 1) brought up questions regarding the linkages and the magnitude of changes in loan granting on output developments.

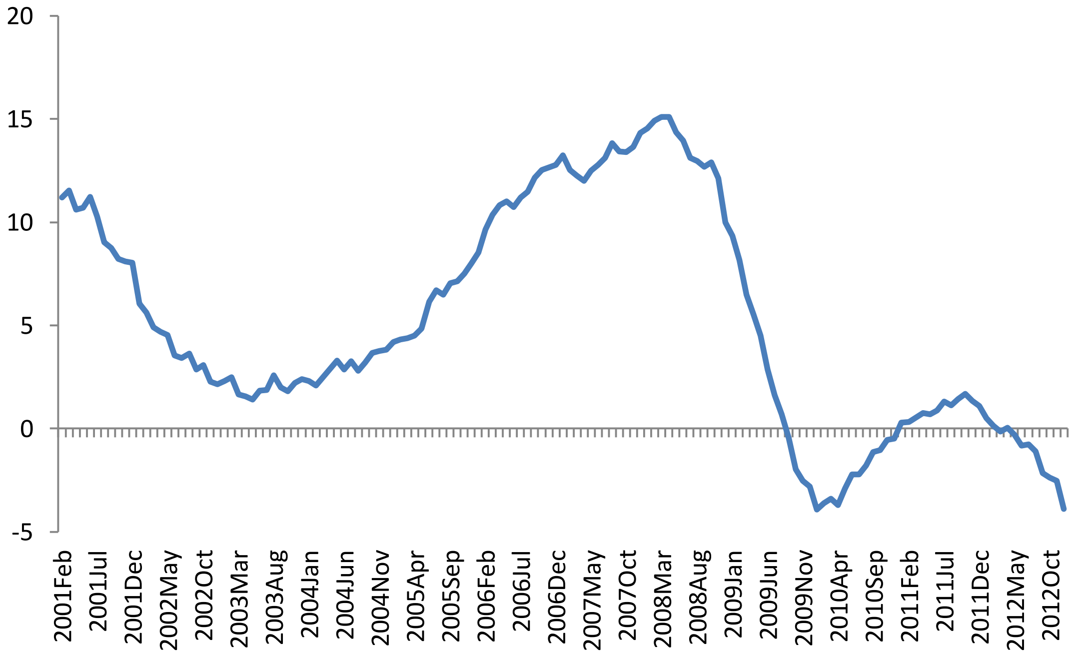

Figure 1: Growth of lending to Non-Financial Corporations
The figure reports the year-on-year growth rates of lending to non-financial corporations in the euro area. Source: ECB Statistical Data Warehouse.

As is well known, the correct measurement of the effects of bank lending is of great policy importance. On one hand, macro-prudential policy focuses almost entirely on the banking sector as it seeks to limit financial distress with minimum output costs (Borio, 2003). On the other, the extent of the effects of bank lending on output is significant also for monetary policy, given the importance of determining the existence and magnitude the bank lending (or credit) channel.[1] Thus, assessing whether banks play a special role in the propagation of economic fluctuations and, more significantly, the extent of this role is crucial for policy evaluation.

To evaluate the outcome of changes in bank lending on output growth, this chapter examines empirically the magnitude of a shock to bank lending in the economy of three euro area (EA) countries through a Factor-Augmented VAR (FAVAR) approach. The FAVAR approach has the benefit of including important pieces of information which assist in capturing the workings of both the domestic as well as the global economy, through the incorporation of a small number of factors in the estimation. In addition, the inclusion of factors assists in avoiding misspecification issues and provides more precise estimates.

The main results from the estimation suggest that a positive shock to loans has a positive effect on real GDP growth in two out of three countries. This effect is idiosyncratic and varies across the three countries, in line with other studies. In addition, loan supply shocks also affect bank deposits positively, again with the magnitude being country-specific, providing the first macroeconomic evidence for the credit creation theory of banking.

Policy implications arising from this study are clear-cut: the growth of lending highly affects the growth of output and thus underlines the importance which should be placed to the banking sector. Thus, the need for more macro-prudential policies which would safeguard lending in the economy is currently more pertinent than ever. In addition, more emphasis should be placed on

[1] See *inter alia* Bernanke and Gertler (1995), Iacoviello and Minetti (2008), Atta-Mensah and Dib (2008), Perez (1998) and Boivin et al (2010).

bank deposits and specifically to persistent changes unrelated to changes in lending as these could potentially signal future distress.

The rest of the chapter is organised as follows: the next section presents a review of the existing literature, section 1.3 presents the empirical specification and the data, section 1.4 presents the results from the estimation and final section presents the policy implications and concludes.

1.2 Literature Review

A number of studies investigating the effects of bank lending on output focus on the United States. For example, one of the most influential studies is that of Driscoll (2004) whose findings suggest that loans have small and statistically insignificant effects on output. Ashcraft (2006) also supports this result showing that there is no significant evidence of a strong causal relationship between credit supply and real output.

On the other hand, Caldara et al (2014) find support for the hypothesis that financial shocks have a significant adverse effect on economic outcomes, while Bassett et al (2014), using data from bank-level responses to the Federal Reserve's Loan Officer Opinion Survey, find evidence that tightening shocks to their credit supply indicator lead to a substantial decline in output. Furthermore, Prieto et al (2013), analyse the contribution of the credit spread (defined as the difference between a portfolio of corporate bonds from the government bond) and suggest that the contribution of financial shocks to GDP growth fluctuates from about 20 percent in normal times to 50 percent during the global financial crisis[2].

In the relatively small number of studies focusing on the euro area, Cappiello et al (2010), using Driscoll's (2004) methodology find evidence that a change in loan growth has a positive and

[2] See also Gilchrist et al (2009) and Boivin et al (2013) who support these findings for the US under a more general factor-augmented VAR framework.

statistically significant effect on GDP growth. Rondorf (2012) finds that the supply of bank loans is a significant determinant of output growth in the euro area and similarly, Hristov et al (2012) highlight that the evolution of bank loans in the euro area member countries was significantly affected by loan supply shocks, while the euro area is characterized by a considerable degree of cross–country heterogeneity. Further support is provided by Gambetti and Musso (2012) and Bijsterboscha and Falagiarda (2015) who present empirical evidence that loan shocks have a significant effect on economic activity and credit market variables, and to some extent also inflation. In addition, country heterogeneity is also underlined in their results.

As this short review indicates, empirical findings for the United States present contradictory results, while out of the few studies focusing on the Euro Area, all rely on aggregate or panel data in which no heterogeneity between countries is allowed even though it has been proven to be important in the finance and growth relationship (Owen and Temesvary, 2014). In addition, the majority of Euro Area studies employ a sign restriction approach, which specifies the specific sign of the response to be employed, which is known to face limitations (Fry and Pagan, 2005, 2011; Kilian and Murphy, 2012). Most importantly, the specifications employed for these studies consist of only a macroeconomic series, leaving out important pieces of information and resulting in misspecification issues (Alessi et al, 2011). As several studies have suggested (Sims, 1992; Bernanke et al, 2005), many puzzles could be due to a deficient information set: if the VAR includes less information than that used by Central Banks and private economic agents, empirical results can be misleading.

In order to avoid the deficiency in information through the selection of just a few variables, information from a large dataset of indices is pooled in order to construct what is known in the literature as an approximate factor model (Stock and Watson, 1998, 2002, 2005) and provide a more precise estimate of the effects of bank lending on the economy. Factors are a statistical instrument utilised to reduce the dimensionality of a large dataset and at the same time exploit all the available information about its co-variation. In essence, the factors are expected to capture all aggregate fluctuations in a large panel of economic and financial series.

The benefits of incorporating a much larger information set than the (very) limited one usually employed in the empirical literature are plenty. As early as 1977, Sargent and Sims showed that the inclusion of just two dynamic factors can explain approximately 80% of the variation of major economic variables. In addition, Forni et al. (2009) and Alessi et al. (2011), present evidence that the inclusion of more information about the economy through the factors avoids potential VAR non-fundamentalness issues, such as the ones presented in Lippi and Reichlin (1993). Furthermore, studies such as Bernanke et al (2005) and Boivin et al (2009) have shown that incorporating information through a small number of factors corrects for various empirical puzzles when estimating the effects of monetary policy shocks. Complementing these results, Forni and Gambetti (2010) have shown that both the price and the delayed overshooting puzzles disappear in a factor model while Mumtaz and Surico (2009) also find that open economy puzzles documented in earlier empirical contributions can be explained by the limited information in small scale VARs.

1.3 Empirical Specification and Data

1.3.1 Empirical Specification

The FAVAR can be viewed as a VAR model which includes a vector of observed variables and a vector of unobserved variables (i.e. the factors). The factors summarise the information in a large set of economic series with a smaller number of variables. By augmenting the VAR with a small number of factors, the information set is enhanced considerably without greatly increasing the dimensionality of the model. I propose the examination of the transmission mechanism of lending shocks on the economies of the sample countries using a VAR model with five endogenous variables: total loans to residents (L), total resident deposits (D), consumer price index (P), a benchmark interest rate[3] (R) and real GDP (I).

Let X_t denote a $N \times 1$ matrix that contains a large number of economic time series; Y_t is a $M \times 1$vector of endogenous variables that are a subset of X_t. The usual approach is to employ a VAR or structural VAR using data for Y_t alone to estimate various macroeconomic relationships. Nevertheless, in many applications, additional economic information (not fully captured by Y_t) may be relevant to modelling the dynamics of the series in Y_t. Therefore, suppose that F_t, a $K \times 1$ vector of unobserved factors, can summarize most of the information contained in X_t, i.e. K is "much smaller" than *N*. The unobserved factors can be viewed as reflecting concepts that cannot be easily represented by specific series but are captured by a wide range of economic variables (see e.g. Bernanke et al. 2005; Stock and Watson 2005).

The joint dynamics of (F_t', Y_t') and the static representation of a dynamic factor model (X_t, F_t, Y_t) are given by the following equations:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \upsilon_t \tag{1.1}$$

[3] The literature on the effects of bank lending shocks has employed the 3-month Euribor interest rate, the Eonia rate or a composite interest rate. While the use of any of the three may be justified, the high correlation coefficient between these (approximately 0.9 in our sample), resulting from the actions of monetary policy makes the choice either of the three not important. For simplicity, I employ the 3-month Euribor rate.

$$X_t = \Lambda^f F_t + \Lambda^y Y_t + e_t \quad (1.2)$$

where $\Phi(L)$ is a $(K+M)\times(K+M)$ matrix lag polynomial of finite order d, whose parameters could be subject to a priori restrictions as in a structural VAR setup. The error term υ_t has mean zero and variance-covariance matrix Q. Λ^f is a matrix of factor loadings with dimensions $N\times K$, Λ^y is $N\times M$; e_t is a mean zero vector of errors exhibiting some degree of cross-correlation.[4]

Factors F_t are unobserved and must therefore be estimated jointly with or prior to the estimation of equation (1). The dynamic evolution of each economic series in X_t is governed by the K factors and the M elements of the variables of interest Y_t, which are common to all elements of X_t, plus an idiosyncratic component. The static representation of the dynamic factor model described by equation (1) and (2) where F_t can also include lags of the factors allows the estimation of the space spanned by the factors by application of the principal components method (see Stock and Watson 1998, 2002 and 2005). Then the FAVAR model (1) can be estimated using a smaller number of variables ($K+M$) than the dimension of X_t; in essence, the FAVAR model nests the simple VAR model. Equations (1) and (2) are estimated using a two-step procedure based on principal components and (Bernanke et al. 2005).

In the first step of the two-step procedure, the space spanned by the factors of the data matrix X_{0t}, denoted by $\tilde{F}_{0t}$ is estimated by the first K principal components of X_{0t}, where X_{0t} is

[4] The principal component method employed for the estimation of factors implies that the cross-correlation between error terms in e_t tends to zero as the number of series in X_t (i.e. N) becomes large (Stock and Watson 2002).

the part of the matrix X_t that does not include Y_t, as the latter is treated as being directly observable. Stock and Watson (2002) show that the principal components method yields consistent estimators when both cross section and time series dimensions are sufficiently large.

In the second step $\widetilde{F}_{0t}$ can replace F_t in the FAVAR model and subsequently equation (1) can be estimated as a standard VAR. In order to obtain distinct representations of the various aspects of the economy through the factors, these are estimated from two different blocks of data. One set of factors is extracted from a dataset of domestic series and another from a group of foreign and international variables. The number of domestic and foreign factors included in the FAVAR is chosen using Bai and Ng (2002) information criteria. The benefit of this procedure is that we rely on the interpretation of a particular latent factor to characterize the responses of economic indicators to structural shocks.

Just like a standard VAR, the FAVAR model requires assumptions/restrictions for the identification of shocks. Similar to other studies in the literature, identification is achieved by employing a recursive ordering of the variables (i.e. Cholesky identification scheme) where output and prices are ordered first, followed by the 3-month Euribor rate, loan volume, deposits volume, domestic economy and foreign factors.

This identification strategy, analogous to Bernanke et al (2005) and Walsh and Wilcox (1995) restricts output and inflation from having a contemporaneous response to changes in the monetary policy and, in addition, allows us to specify a loan supply shock as an exogenous shock to the loan volume, i.e. an increase in the amount of new loans to the economy supplied by the bank.

This recursive ordering is in accordance with the current view of the transmission of monetary policy and the creation of money as presented by McLeay et al (2014), who argue that banks decide how much to lend depending on the profitable lending opportunities available to them which crucially depend on the interest rate set by the Central Bank. As such, the lending rate is set in accordance with monetary policy changes and while these changes affect the volume of lending, there is no contemporaneous feedback from the volume of loans to the lending rate. This can be intuitively understood by thinking that profitable lending opportunities can be affected by a change in the lending rate but profitable opportunities do not themselves affect policy. Consequently, any additional shocks to loan volumes can be easily seen as exogenous to the model.

In more detail, the decision of whether to tighten or loosen the amount of new loans offered to businesses or households, is exogenous to the monetary policy stance or the state of economy.[5] As such, this exogenous relaxing or tightening of credit conditions with respect to the amount of loans offered can again be viewed as a shock to the supply of credit. An additional benefit of utilising the aforementioned identification is that it is easy to distinguish between the source of shock and thus provides valuable insight to its effects.

Furthermore, by employing the aforementioned identification we can empirically test whether macroeconomic evidence supporting the credit creation theory of banking (see Werner 2014a, 2014b; Disyatat, 2011 and McLeay et al, 2014) exists. Specifically, the theory suggests that when creating a new loan, banks simultaneously create a matching deposit in the borrower's bank account, thus creating new money. In essence, an increase in lending should correspond to

[5] This exogeneity appears also in the actions of the European Central Bank (ECB). In order to boost bank lending the euro area, the ECB uses quantitative easing policies which are not linked to monetary policy as the latter does not appear to have an influence on bank behaviour.

an increase in deposits. Even though the matching should not be one-to-one due to factors such as investing the money abroad, deposits leaving and entering the country and loans by one individual used to repay another's past lending (e.g. a loan for house purchase might be used by the land developer to repay the loan granted to build the property) an increase in lending should be associated with an increase in deposits. Since we expect deposits to respond contemporaneously to a change in lending, we order them last in the identification. The extent of their response to a shock in loans should be indicative of whether macroeconomic evidence can be found for the credit creation theory.

1.3.2 Data

The estimation sample comprises of three Euro Area economies (Germany, Italy and Spain) in order to estimate the effects of a shock in bank lending on real GDP. The choice of the countries is constrained by data availability. The sample period employed starts in the 1998Q1 and ends by 2012Q3 in order to avoid conditions which are unrelated to bank-related developments in the economy but have an effect on output (e.g. the European sovereign debt crisis). As such, the developments in the countries during the sample period are unrelated to other major macroeconomic developments and thus allow the estimates to be more precise.

As suggested in the previous sub-Section, the main variables used are real GDP, the CPI index, the Euribor interest rate, total lending to residents and total resident deposits. These are augmented by local factors obtained from 83 time-series variables for Germany 84 for Italy and 62 for Spain. In addition another 74 variables are used in order to capture the international effects. The variables and transformations for all sample countries can be found in the Appendix. In addition, to allow for comparability of results, all variables are standardized prior to the model estimation, therefore, all responses account for elasticities. A lag length order of one was selected for Italy and Spain while two lags were optimal for Germany on basis of the BIC criterion, and the stability of the models was confirmed prior to the implementation of the shock.

1.4 Empirical Findings

The estimated FAVAR model is used to simulate the responses of macroeconomic variables to a one percent shock to total lending. All responses reflect cumulative values and confidence intervals are created via the Kilian (1998) bootstrap method. To avoid unnecessary complexity in the figures which follow, confidence intervals for each individual country response are not reported; however, they can be presented upon request. The coefficients and relative sizes of the effects are always referred to in absolute values.

Figure 1 presents the real GDP growth response to the lending shock. In Italy and Spain the first quarter response is small, positive and statistically significant (0.03 and 0.13 respectively), while Germany records a small negative but insignificant response. In the subsequent periods, responses are positive, with the exception of Germany in the short-run. However, the country's response again appears to be statistically insignificant. On the contrary, Spain's response is significant until period four, where the response is increasing, while Italy's appears to be relatively stable and small through time.

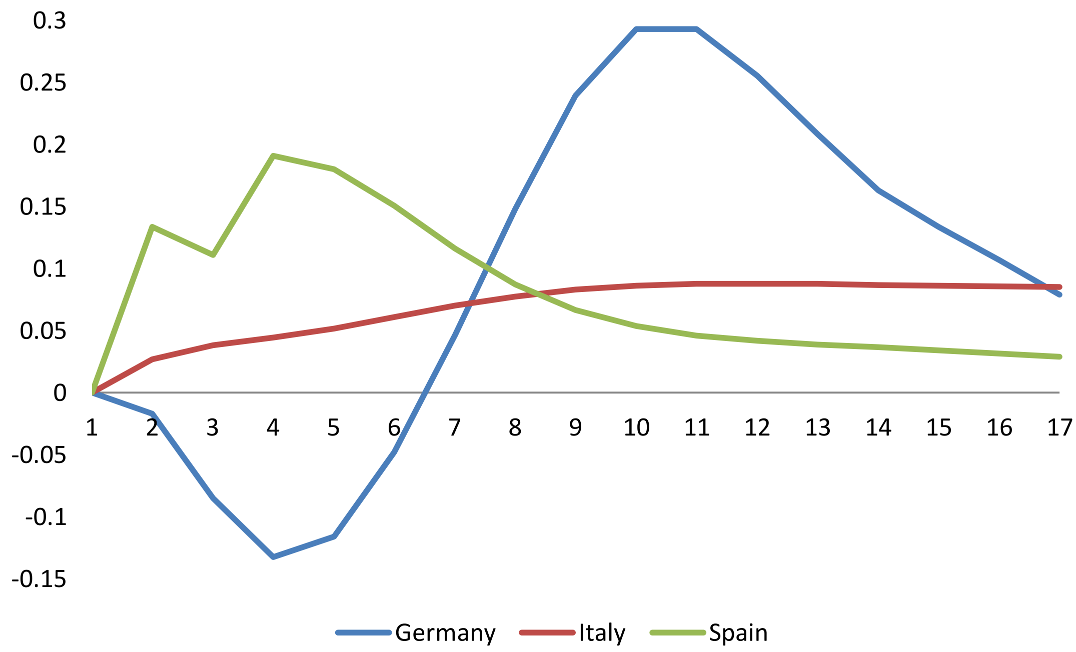

Figure 2: Real GDP response to a positive loan supply shock
The figure reports the real GDP response after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of real GDP to the shock since both variables are standardised. It can be observed that an increase in lending increases real GDP overall in all countries. Horizontal axis reflects quarters.

In contrast, the response of Germany suggests that an increase in lending is prone to idiosyncratic peculiarities which cannot always be captured by statistical models. A source of potential explanation of this phenomenon is that since Germany is major foreign direct investment country, much of the lending in the economy could be channelled abroad.[6] Thus, the increase in the GDP response after the eighth period could be considered as returns from lending used to finance projects abroad.

Figure 1 also suggests that the response of Italy, while small compared to the values observed the other two countries, is persistent and increasing over time, with very little variation. In contrast, the bulk of the effect in Spain occurs in the first eight quarters and slowly diminishes afterwards.

[6] Source: CIA Factbook. For an interesting discussion of German trade, including foreign investment see Gross (2013).

Overall, it appears that in the two countries where the response is statistically significant, the effect of a lending shock on output is positive and persistent.

On the whole, the results of figure 1 show that a positive shock in loans has a positive effect throughout the response horizon on real GDP growth in two out of three countries, with the other registering a statistically insignificant response. This effect is quite idiosyncratic and varies across the countries in the sample, in line with other country-specific studies on the subject (see Hasanov and Huseynov, 2013).

In addition, it appears that a drop in the supply of loans would subsequently cause a contraction in real GDP, other things constant. The importance of safeguarding the banking sector is underlined in the results of figure 1 since, as the experience of the Great Recession showed, its issues are much more difficult to deal with and, most importantly, more harmful to the economy. Thus, the need for more macro-prudential policies which would safeguard lending in the economy is currently more germane than ever.

The effects of a lending shock on deposits can be viewed in figure 2. In Germany, a relatively stable increase of approximately 0.40 is recorded, while overall increases close to unity are observed in Spain and Italy. It should be noted that all responses are statistically significant, with the exception of Gemany in the medium- and long-run. The behaviour of Germany can again be justified through the high foreign direct investment volumes it records, which forces the deposits created through bank lending not remain in the country.

The results of figure 2 provide the first empirical macroeconomic evidence of the credit creation theory (see Werner, 2014a,b), i.e. that banks can create bank loans without needing funding from deposits and that subsequently, an increase in bank lending would mean an increase in the stock of deposits in an economy. The evidence in Figure 2 suggests that an increase in lending does in fact coincide with an increase in deposits, with the magnitude of this effect being highly country-specific.

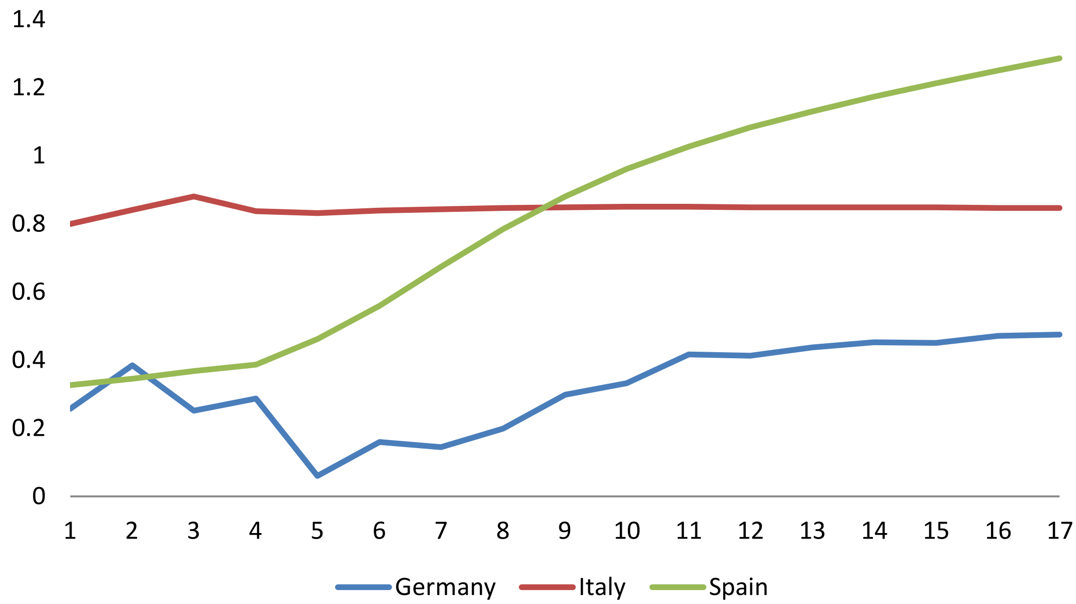

Figure 3: Deposits response to a positive loan supply shock
Figure 2 reports the response of deposits after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of deposits to the shock since both variables are standardised. Deposits are increased by almost one-to-one after a positive loan shock showing the first macroeconomic evidence for the credit creation theory.

As suggested in the previous section, a one-to-one increase is not to be expected due to numerous reasons which affect the level of deposits but are unrelated to an increase in lending. However, it appears that countries like Italy (and Spain to a lesser extent) register overall values which are close to unity, further strengthening the argument in favour of the credit creation theory.

An interesting complication of the credit creation theory, is that it partially suggests that changes in the stock of deposits which are disproportionate to the change in bank lending could perhaps issue a warning sign about the future path of the economy. However, country idiosyncrasies should also be considered as they can have a strong effect on the path of deposits as the example of Germany suggests.

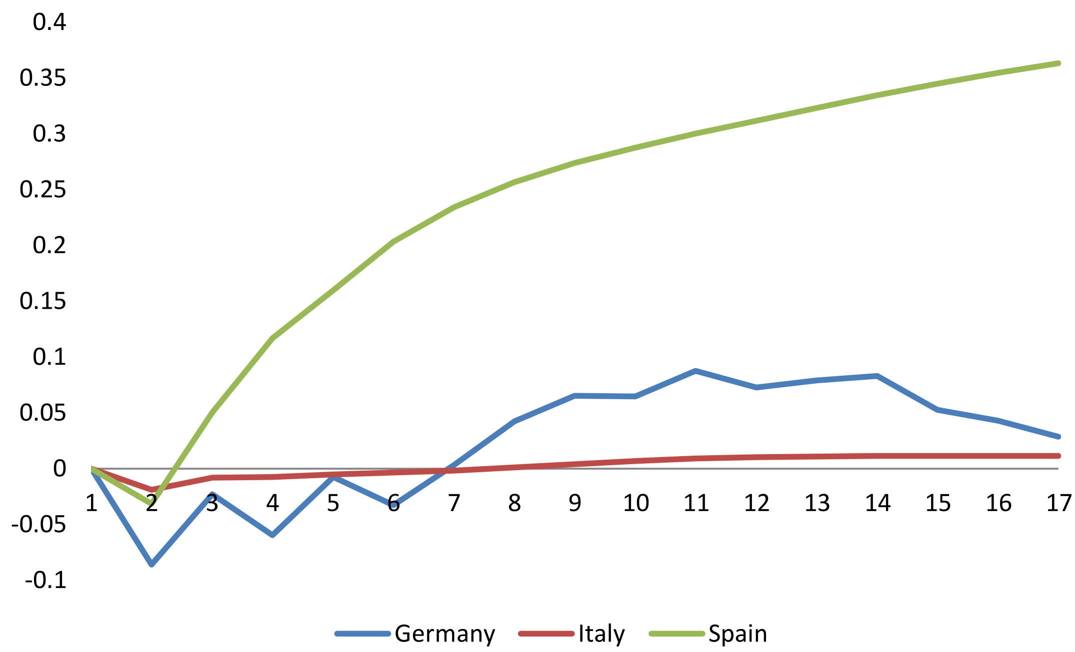

Figure 4: CPI response to a positive loan supply shock
The figure reports the Consumer Price Index (CPI) response after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of the CPI to the shock since both variables are standardised. According to theory, inflation increases with a lag after a shock.

In figure 3, the CPI response to a lending shock is plotted. An increase in the amount of loans does not increase inflation in any country. In fact, inflation in all countries rises only after a lag, the duration of which is country-specific. For example, in Germany and Italy the inflation rate becomes positive only after the seventh quarter, while in Spain the inflation rate becomes positive after the second period.

While the overall effect is positive in all countries, there is no unique response. For example, Spain records a relatively strong and significant increase in inflation reaching 0.36 in the final period. In contrast, Italy records very small increases in inflation after the seventh period, with the overall effect being slightly positive while Germany demonstrates increases after the seventh quarter. Overall, the responses suggest that while in countries such as Spain the effect is more pronounced than in others, the overall change in inflation from a positive shock in bank lending is positive, even though not large.

Qualitatively, the inflation response is in line with the increase in GDP observed after a positive bank loan supply shock in figure 1, however with the magnitude being country-specific. An increase in bank lending has a positive effect on inflation in at least some countries. As such, a decrease in bank lending can be expected to have a negative effect on inflation which will lead to deflationary pressures. If the decrease in lending occurs during a period of low overall inflation or during a recession then can exacerbate the problem. Consequently, the low inflation numbers observed in the countries which faced banking crises should not come as a surprise. However, the good news for policymakers is that it requires no additional measures since it will be dealt with as soon as loan supply problems are addressed and the banking sector functions smoothly again.

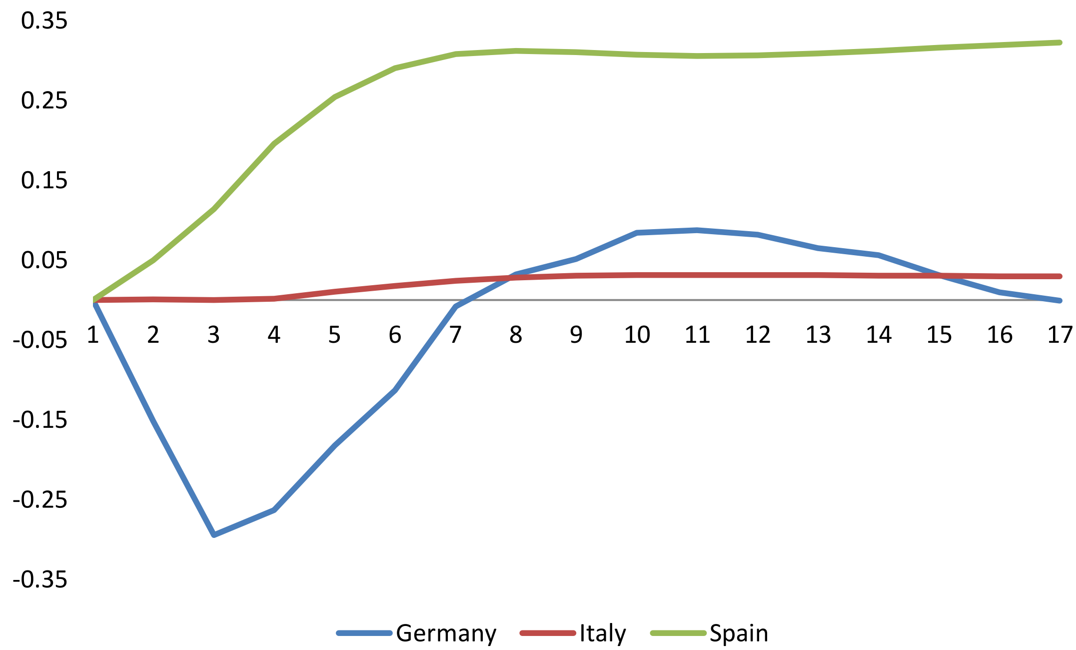

Figure 5: Interest rate response to a positive loan supply shock
The figure reports the interest rate (Euribor) response after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of the interest rate to the shock since both variables are standardised. As expected, an increase in bank lending increases interest rates.

The interest rate response in figure 4 is the variable where the most idiosyncratic responses appear. While the expected positive results can be found in Spain and Italy, negative effects are observed in Germany, at least until the medium-run. An increase in lending is associated with an increase in the bank lending rate in Spain with the effect remaining stable after the sixth period. In Italy, the effect is effectively zero until the fourth quarter, and slightly positive afterwards.

Drawing from these responses, it can be seen that since an increase in bank loan supply can increase interest rate, a deterioration in the banks' ability to grant loans can have a negative effect on the interest rate. Depending on the country, a drop in bank lending can actually push the interest rate to the zero lower bound (ZLB) which has been shown to hamper growth (see Eggertson *et al*, 2014).

Table 1: Responses to a positive loan supply shock

Panel a: GDP				
Timing	Germany	Spain	Italy	Simple Average
1st Quarter	-0.02	0.13	0.03	0.05
4th Quarter	-0.13	0.19	0.04	0.03
17th Quarter	0.08	0.03	0.09	0.07
Panel b: Deposits				
Timing	Germany	Spain	Italy	Simple Average
1st Quarter	0.38	0.34	0.89	0.54
4th Quarter	0.29	0.39	0.83	0.50
17th Quarter	0.47	1.29	0.85	0.87
Panel d: CPI				
Timing	Germany	Spain	Italy	Simple Average
1st Quarter	-0.09	-0.03	-0.02	-0.05
4th Quarter	-0.06	0.11	-0.01	0.01
17th Quarter	0.03	0.36	0.01	0.13
Panel e: Interest Rate				
Timing	Germany	Spain	Italy	Simple Average
1st Quarter	-0.15	0.05	0.00	-0.03
4th Quarter	-0.26	0.19	0.00	-0.02
17th Quarter	0.00	0.32	0.03	0.12

The Table indicates the impulse response value for each variable (GDP, Deposits, CPI, Interest Rate), after a one percent shock to bank lending in a FAVAR model, for 17 periods (quarters) ahead. For brevity not all response values are reported. All variables are standardised and thus responses can be viewed as elasticities. The last column reports the simple average of the three countries, per variable and for each period in the response and can be viewed as an aggregate effect.

The wide spectrum of the responses points out the differences between the country-specific estimates and should thus be considered as a warning against the use of euro-area wide data for country-specific policy recommendations. To sum and to provide a clearer view of the effects, Table 1 presents the numerical values of each response and an overall average.[7]

[7] Robustness and sensitivity tests of the results to changes in the VAR order and to altering total lending to private sector lending can be found in Appendix IV of this thesis. Overall, the findings are qualitatively similar.

1.5 Conclusions and Policy Implications

The most straightforward finding of this Chapter is that a positive shock in loans has a positive effect on real GDP growth in two out of three countries. This effect is quite idiosyncratic and varies across the countries in the sample, in line with other studies on the subject. The estimates imply a positive relationship between output and bank lending, similar to what Hasanov and Huseynov (2013) find in another country-specific study outside the Euro Area. Consequently, it can be deduced that a deterioration in the latter can have an effect on the former, as the recent financial crisis has proved.

The second important conclusion reached is that loan supply shocks also positively affect bank deposits, again with the magnitude being country-specific, as suggested by the credit creation theory of banking (see Werner, 2014a). Country idiosyncrasies are also evident in this case as Figure 2 suggests, with some countries experiencing higher growth rates of deposits. This effect suggests that changes in the stock of deposits which are disproportionate to the change in bank lending could perhaps issue a warning sign about the future path of the economy.

The rationale behind this suggestion is that a large, sustained, unexpected increase of bank deposits not related to an increase in lending could only materialise when an inflow of funds from abroad occurs (see for example Cyprus in the years 2006-2008). In contrast, a large, persistent, decrease in deposits, unrelated to bank lending, can suggest a flight of funds (again Cyprus shortly before and shortly after the 2013 depositor bail-in). In both circumstances, these changes should alarm policymakers. In the first case, banks are found with an abundance of funds which have to be lent out (to perhaps riskier projects) as otherwise they will reduce profits (due to interest paid on deposits). In other words, a large, sustained, increase in deposits unrelated to increases in lending could lead to a credit boom. In the second case, the persistent drop in deposits unrelated to changes in lending could signal that banks may require more Central Bank funding, i.e. it could signal a shortage of liquidity. As a side-result, the estimations suggest that loan shocks have a positive effect on inflation, with the effect lagging a few quarters in all countries.

Overall, the policy implications of this study are clear: the growth of lending affects the growth of output and thus underlines the importance which should be placed on the banking sector. As recent experience suggests, banking sector issues are much more difficult to deal with and, most importantly, more harmful to the economy. Thus, the need for more macro-prudential policies which would safeguard lending is currently more pertinent than ever. In addition, more emphasis should be placed on bank deposits and specifically to persistent changes unrelated to changes in lending as these could potentially signal future distress. The good news is that perhaps addressing loan supply problems could take care of low inflation issues since increases in bank lending will increase inflation, with the magnitude of this effect being country-specific.

Consequently, the response of policy to changes in bank lending should not focus on aggregate response but should be tailored to the needs of each individual country. As the response of one country differs from another so should the measures addressing each economy. Finally, policies which aim to withhold the expansion of credit should also take into consideration possible negative effects such measures can have on economic growth.

2 Bank lending to the private sector and GDP growth: thresholds and returns

2.1 Introduction

Finance is one of the leading, if not the leading, economic sectors: it allows agents both to invest and consume beyond their current means, with the promise to return the funds steadily across time. As a consequence, increased availability of credit can lead to increased investment and boost economic growth.

Nevertheless, one of the questions which has concerned researchers is whether bank lending is always beneficial to the economy or whether too much finance can actually harm growth? The question, addresses both intellectual as well as policy issues. For example, the European Commission scoreboard indicators consider a country to be over-indebted if it exceeds the 130% private debt to GDP ratio. However, the issue of whether a ratio of 100% is actually better (or worse) than a 140% ratio and how much is growth affected by an increase in the stock of loans has yet to be clarified.

In this chapter, I fill this gap by examining the effects of bank lending to the private sector in the economy through a two-period model. Theory suggests that even when changes in lending are due to monetary easing, a positive relationship between finance and growth exists, while this relationship exhibits diminishing returns after a certain threshold. This threshold can be viewed as the point where new projects are either not as promising as those already funded or they lack collateral to attract a loan. Subsequently, more funds are channelled to existing projects, thus lowering returns.

Furthermore, the theoretical conclusions are tested by employing a smooth transition conditional correlation (STCC) model which enables us to test the time-varying relationship between finance and growth. The empirical evidence confirms that the finance-growth relationship is always positive but exhibits diminishing returns after country-specific thresholds. Both the theoretical and the empirical exercises conclude that there is a positive correlation between finance and growth, with the relationship exhibiting diminishing returns. Overall, the results suggest that, other things being constant, private lending promotes GDP growth, at all levels. As such, macro-prudential policies should not emphasise how much lending exists in an economy, but how the allocation of these loans affects the workings of the country, preventing over-heating of specific sectors by lending to already existing projects instead of funding new ones.

This work empirically supports some of the most important theoretical contributions in the literature such as Eggertson and Krugman (2012) who suggest what really matters is the distribution of debt and not its level. As the rest of the chapter demonstrates, the level of debt makes a difference only in the size of its relationship to the real economy but it still retains the same (positive) effect. Thus, it can be inferred that if the stock of loans does not affect growth all that is left is that the distribution of this stock matters. This conclusion holds important policy implications, in that macro-prudential regulation should emphasise how loans are distributed in the economy and not simply focus on their level.

Other empirical studies in this area have, over time, come out with conflicting results. One of the first studies was that of King and Levine (1993) who show that higher rates of financial development are positively correlated with higher growth in the short-run, while the predetermined component of financial development is a good predictor of long-run growth over a 10 to 30 year horizon. In addition, they note that higher rates of financial development are strongly associated with future rates of capital accumulation and improve capital efficiency. Complementing their results, DeGregorio and Guidotti (1995) find that the proxy of bank credit to GDP is positively correlated with growth. The authors use a large cross-country sample and attribute the negative correlation in a Latin America panel to financial liberalisation in a poor regulatory environment.

In contrast to these, Demetriades and Hussein (1996), and Arestis and Demetriades (1997), show that the causality of the relationship between financial development and economic growth is highly country-specific. In addition, they provide little support that finance is a leading sector, even though they find evidence of bi-directionality and reverse causation. The bi-directionality of the relationship was further examined in Shan et al (2001) who also find little evidence that finance leads growth using Granger causality tools. Diverging from these results, Calderón and Liu (2003) find that financial development generally leads to economic growth while the longer the sampling interval, the larger the effect of financial development on economic growth.

Arestis et al (2001), using data from five developed economies, find that even though both banks and stock markets are able to promote financial development, the former have a much stronger effect and the latter's contribution may have been exaggerated in cross-country studies. In addition, Demetriades and Luintel (1996) suggest that financial deepening may also have an influence on economic growth. These results are supported by other studies, such as Odedokun (1996), who demonstrates that financial intermediation promotes growth in 85% of the sample countries employed, and Hassan et al (2011) who find a positive correlation between finance and growth in developing countries. A review of the literature by Levine (2005) suggests that financial intermediaries matter for growth and that reverse causality alone does not drive this relationship.

Policy issues, on the other hand, have put forth the question of whether a limit exists after which financial growth can harm economic growth. To address this question, Cechetti et al (2011) use a panel of 18 OECD countries from 1980 until 2010 and find that the thresholds for household and corporate debt are at 85% and 90%, respectively. Similar threshold levels (of less than 100% of GDP) are further supported in Cechetti and Kharroubi (2012) as well as Law and Singh (2014) using a similar methodology.

However, this result appears rather counter-factual: the majority of developed countries record private debt to GDP ratios higher than this level while still registering positive growth rates. In addition, the use of just one methodology to gauge a result which affects policy is by no means enough to justify a conclusion. In the Sections which follow, I present, in contrast to other authors, a two-period model and results from an empirical specification which show that debt does not harm growth at any given private sector debt to GDP ratio.[8]

2.2 Theory: a two-period model

Suppose there is an island which lives for two periods. There are households which are both savers and farmers. Some households produce in the first period and thus enjoy income from farming while the rest can produce in period two. The ones that produce in the first period deposit some of this income in a bank, to transfer part of their wealth to the following period where they will have no other sources of income. These deposits are transferred by the bank to the households that are capable of producing in the current period, in the form of loans. Bank lending in the initial period comes from bank reserves. The farmers simply plant crops, relying on bank loans and on the tools each one possesses, which can also be used as collateral for the

[8] It should be emphasised here that the rest of the paper deals with the examination of whether growth in lending affects the growth of output differently after a threshold. The analysis does not deal with the issue of indebtedness and the consequences this has on an economy.

loans. The households do not bail out insolvent farmers and thus collateral goes to the bank upon default.

2.2.1 Households

In the first period, the households that are both producers and savers decide upon how much to consume and how much to save, i.e. transfer to the second period through bank deposits which pay a rate of R_t^d for the period. Initial wealth comes from deposits along with interest payments, income from farming and profit from banks. Thus, all income in each period goes to the households which are currently producing. The producing households maximise utility for two periods

$$\max U(x_t) + \beta E_t U(x_{t+1}) \tag{2.1}$$

subject to the constraints

$$x_t + D_t = \Pi_t \tag{2.2}$$

where x_t denotes consumption and D_t denotes deposits at the bank. As stated before, initial wealth comes from current production (Π_t). In the following period, consumption can be at most what has been saved in the previous period when income was available, times gross interest on deposits R_t^d:

$$x_{t+1} = R_t^d D_t \tag{2.3}$$

In the second period, all income is accumulated by households which produce, creating an incentive for some households to save and an incentive for other households to take loans. The first order condition for consumption and deposits in the two periods produces the following Euler equation:

$$U'(x_t) + \beta E_t U'(x_{t+1}) R_t^d \tag{2.4}$$

Assuming that the utility function is

$$U(x_t) = \frac{x^{1-\sigma}}{1-\sigma} \tag{2.5}$$

Substituting the utility function (2.5) in the Euler equation (2.4) yields

$$\frac{1}{(\Pi_t - D_t)^{\sigma}} = \beta \frac{1}{(R_t^d D_t)^{\sigma}} R_t^d \tag{2.6}$$

If we assume for simplicity, and without any loss of generality, that $\sigma = \frac{1}{2}$ then we get

$$R_t^d = \frac{1}{\beta^2} \frac{D_t}{\Pi_t - D_t} \tag{2.7}$$

2.2.2 Farmers

The farmers (i.e. the households which produce in the current period) borrow from the banks an amount L_{it} of the real good which is used to produce $F(L_{it})$ units of the real good in the following period. The production function exhibits diminishing returns to scale

$$F(L_{it}) = z_{it} A L^{a}{}_{it} \tag{2.8}$$

where A is a productivity parameter common to all farmers, the value of which is known to everyone. The idiosyncratic productivity parameter, z_{it}, is a draw from a known distribution.

The only uncertainty in the model comes from this parameter. Households (and banks) are entitled to a continuum of such assets and thus *ex ante* and ex *post* returns are entirely the same.

Households which seek loans are by assumption the ones which are entitled to farmers' profits. Farmers eligible for bank loans need to provide some form of collateral. Given collateral values and the lending rate, the farmers maximise the expected profit by choosing the loan amount they seek:

$$E_t\Pi_{t+1} = \max_{L_{it}} \int_{\hat{z}_t}^{\infty} \left[F(L_{it}) - R_t^L L_{it} \right] dF(z) - \int_{-\infty}^{\hat{z}_t} C_{t+1} dF(z) \qquad (2.9)$$

If the productivity value drawn is high enough and the no-default state is realised, the farmer produces $F(L_{it})$ and repays the whole amount back. In the default state, the farmer can expect to lose no more than his own collateral C_{t+1}, no matter what the draw from the productivity distribution might have been. The default state is defined through the productivity reservation point $\hat{z}_t$, where the lender starts to take part on the loss. The reservation productivity point is where the loss from the production ($z_{it}AL^a{}_{it} - R_t^L L_{it}$) equals $-C_{t+1}$. Solving this for $\hat{z}_t$ implies that

$$\hat{z}_t = \frac{R_t^L L_{it} - C_{t+1}}{AL^a{}_{it}} \qquad (2.10)$$

If we define the probability of no default as p_{it} and the truncated mean of productivity given that we are in the no default zone (i.e. $E_t\left(z_{it} \mid z_{it} < \hat{z}_t\right)$) as $\overline{z}_t^e$ then the expected profit in equation (2.9) becomes

$$\max p_{it}\overline{z}_t^e AL^a{}_{it} - p_{it}R_t^L L_{it} - (1-p_{it})C_{t+1} \tag{2.11}$$

Supposing that z_{it} is drawn from the uniform distribution $U(0,1)$, this implies that

$$\overline{z}_t^e \equiv E\left(z_{it} \middle| z_{it} < \hat{z}_t\right) = \frac{1}{2}(1+\hat{z}_t) \tag{2.12}$$

In a similar manner, the expected productivity in the default state ($\overline{z}_t^d$) is:

$$\overline{z}_t^d \equiv E\left(z_{it} \middle| z_{it} < \hat{z}_t\right) = \frac{1}{2}\hat{z}_t \tag{2.13}$$

Another implication of the uniform distribution is that the productivity of default is linear in the reservation productivity $\hat{z}_t$. That is

$$p_{it} = 1 - \hat{z}_t \tag{2.14}$$

Using these, the first order condition of the farmers' maximization problem (equation 2.11) is

$$a\overline{z}_t^e AL_{it}^{a-1} = R_t^L \tag{2.15}$$

Substituting (2.10) in (2.15), the reservation productivity which is also the probability of default under a uniform distribution becomes

$$\hat{z}_t = a\overline{z}_t^e A - \frac{E_t C_{t+1}}{L_{it}^a} \tag{2.16}$$

2.2.3 Banks

The banks make one period loans and get deposits of the same maturity. Initially, bank capital V_t is exactly equal to bank reserves. Banks constitute the only source of financing to the private sector and thus lending defines the output of the economy as firms need loans to be able to produce. Output, Y_t is related to loans L_{it} to each of the N_t farmers (firms) created last period as follows:

$$Y_t = N_{t-1} F\left(L_{it-1}\right) \tag{2.17}$$

The banks start the period with bank capital V_t, which as stated in the previous paragraph, also represents the reserves in the banking system[9]. The central bank can also boost lending in the economy by injecting fresh money in banks at the beginning of the period. Increases in V_t by the Central bank thus increase the lending capacity of the bank. If the bank can adjust both the number of loans and the amount lent to each firm then increases in liquidity in banks are going to increase income in the economy. However, lending is concentrated to those that possess valid collateral and even though bank reserves can freely expand, the lending opportunities will eventually become exhausted. Inequality in the distribution of assets that can be used as collateral is important for the point beyond which new loans cannot be made. We are interested in investigating what happens if bank liquidity increases while the number of new loans, N_t, is fixed. We assume the number of loans is controlled by the bank headquarters while the amount available for lending to each farmer is controlled by a loan officer. The aggregate number of loans, Γ_t, depends on deposits and capital according to

$$\Gamma_t = D_t + V_t \tag{2.18}$$

[9] Since contracts are fully repaid and last for a period, the bank capital in the end of the period is actually the bank reserves in the bank's balance sheet, for the asset side to equal the liability side.

As stated before, in the event of default, the bank gets the collateral. The objective of the loan officer is to maximise profits from granting a single loan, i.e.

$$\max_{L_{it}} p_{it} R_t^L L_{it} + (1 - p_{it}) \bar{z}_t^d A L_{it}^a + (1 - p_{it}) E_t C_{it+1} - L_{it} R_t^d \tag{2.19}$$

This implies that in a no default state which happens with probability p_{it}, the bank gets $R_t^L L_{it}$ and in the default state it gets all the firm's revenue which in expectation equals to $\bar{z}_t^d A L_{it}^{\alpha}$, where $\bar{z}_t^d$ is as stated in equation (2.13), and the bank also gets the collateral of the firm that is expected to be worth $E_t C_{it+1}$. Each loan officer receives from headquarters an amount L_{it} at cost R_t^d. The first order condition which determines loan supply is

$$p_{it} R_t^L + a(1 - p_{it}) A \bar{z}_t^d L_{it}^{a-1} = R_t^d \tag{2.20}$$

Rearranging it we get that

$$L_{it} = \left[\frac{a(1 - p_{it}) A \bar{z}_t^d}{R_t^d - p_{it} R_t^L} \right]^{\frac{1}{1-a}} \tag{2.21}$$

2.2.4 Equilibrium in the Market for Loans

To solve the loan supply and loan demand problem, we substitute equation (2.15) into (2.21) to obtain

$$L_{it} = \left[\frac{a(1 - p_{it}) A \bar{z}_t^d}{R_t^d - p_{it} \bar{z}_t^e A L_{it}^{a-1}} \right]^{\frac{1}{1-a}}$$

and substituting the definitions of $\bar{z}_t^e$ and $\bar{z}_t^d$ from equations (2.12) and (2.13) we get

$$L_{it}=\left[\frac{a(1-p_{it})A\frac{1}{2}\hat{z}_t}{R_t^d-p_{it}\frac{1}{2}(1+\hat{z}_t)aAL_{it}^{a-1}}\right]^{\frac{1}{1-a}}$$

If we also substitute (2.14) in the above we get that

$$L_{it}=\left[\frac{a(\hat{z}_t)A\frac{1}{2}\hat{z}_t}{R_t^d-(1-\hat{z}_t)\frac{1}{2}(1+\hat{z}_t)aAL_{it}^{a-1}}\right]^{\frac{1}{1-a}}\Rightarrow L_{it}^{1-a}R_t^d-L_{it}^{1-a}(1-\hat{z}_t)\frac{1}{2}(1+\hat{z}_t)aAL_{it}^{a-1}=a(\hat{z}_t)A\frac{1}{2}\hat{z}_t$$

which simplifies to $L_{it}^{1-a}R_t^d-\frac{1}{2}(1-\hat{z}_t^2)aA=aA\frac{1}{2}\hat{z}_t^2$ and further to $L_{it}^{1-a}R_t^d-\frac{1}{2}(1-\hat{z}_t^2)aA=aA\frac{1}{2}\hat{z}_t^2$

and to $L_{it}^{1-a}R_t^d=\frac{1}{2}aA$, finally yielding that

$$L_{it}=\left[\frac{1}{2}\frac{aA}{R_t^d}\right]^{\frac{1}{1-a}} \tag{2.22}$$

As the above suggests, the amount of loans to each agent is a decreasing function of the deposit rate. The equilibrium lending rate (2.15) after substituting (2.22) is:

$$a\overline{z}_t^eA\left[\frac{1}{2}\frac{aA}{R_t^d}\right]^{\frac{a-1}{1-a}}=R_t^L$$

which simplifies to $a\overline{z}_t^eA\left[2\frac{R_t^d}{aA}\right]=R_t^L$ and further to $2R_t^d\overline{z}_t^e=R_t^L$, which after using the definition of $\overline{z}_t^e$ in (2.12) reduces to:

$$R_t^L = (1+\hat{z}_t)R_t^d \tag{2.23}$$

suggesting that the lending rate is simply a markup over the deposit rate. In addition, the markup is increasing in the probability of default.

Since the collateral cannot be of arbitrary value, the loan collateral is a percentage of the lending amount and has to follow the evolution of the amount due, i.e.

$$E_t C_{t+1} = (1-\phi)R_t^L L_{it} \tag{2.24}$$

where $(1-\phi)$ can be viewed as the loan to value ratio. To get the value of the probability of default, we substitute (2.23) and (2.25) into (2.10):

$$\hat{z}_t = \frac{(1+\hat{z}_t)R_t^d L_{it} - (1-\phi)(1+\hat{z}_t)R_t^d L_{it}}{AL^a{}_{it}}$$

which simplifies into $\hat{z}_t = \frac{(1+\hat{z}_t)R_t^d L_{it} - (1-\phi)(1+\hat{z}_t)R_t^d L_{it}}{AL^a{}_{it}} = \frac{\phi(1+\hat{z}_t)R_t^d L_{it}}{AL^a{}_{it}} = \frac{\phi(1+\hat{z}_t)R_t^d L_{it}^{1-a}}{A}$

Substituting (2.22) into the above we get $\hat{z}_t = \frac{\phi(1+\hat{z}_t)R_t^d \left[\frac{1}{2}\frac{aA}{R_t^d}\right]^{\frac{1-a}{1-a}}}{A}$ and simplifying yields

$$\hat{z}_t = \frac{1}{2}a\phi(1+\hat{z}_t)$$

Then solving for $\hat{z}_t$, the probability of default becomes:

$$\hat{z}_t = \frac{\phi\alpha}{2-\phi\alpha} \tag{2.25}$$

i.e. the probability of default is a function of the collateral required, and the production function parameter. Thus, the probability of default becomes a constant at equilibrium.

2.2.5 The effects of an increase in lending

Imagine that the central bank is printing money to boost initial reserves in the banking system. This monetary easing can be viewed as a change in policy and not in the fundamentals of the economy, in which case an increase in lending would obviously be growth-enhancing. The model is a two-period model and thus inflation is by assumption fixed as this is the short run. If the bank can grant more loans that are not subject to diminishing returns and also adjust the amount to be granted to each individual then the question is trivial. More lending is going to promote higher growth. To make the exercise both more challenging and more realistic, too much lending eventually is going to deplete new lending opportunities (or simply loan seekers would lack valid collateral) and thus N_t is going to become fixed. In a realistic situation, an increase in the ability of the bank to grant loans (in this case, an increase in bank capital or reserves) does not mean that it will offer a loan to every person in the economy but it would rather choose to ration credit and thus be bound by those persons which have the ability to borrow, i.e. possess collateral. Plugging (2.18) into (2.7) and we get:

$$R_t^d = \frac{1}{\beta^2} \frac{\Gamma_t - V_t}{\Pi_t - \Gamma_t - V_t}$$

and using the fact that $\Gamma_t = N_t L_{it}$ i.e. that the aggregate number of loans equals the amount lent to each agent multiplied by the number of agents, and that $\Pi_t = sY_t$, i.e. that household wealth is a fraction of output, yields

$$R_t^d = \frac{1}{\beta^2} \frac{N_t L_{it} - V_t}{sY_t - N_t L_{it} + V_t} \tag{2.26}$$

and differentiating it with respect to bank capital V_t yields (after simplifications)[10],

$$\frac{dR_t^d}{dV_t} = \frac{-sY_t}{\beta^2 \left(sY_t - N_t L_{it} + V_t\right)^2 + \frac{1}{1-a}\left[\frac{aA}{2}\right]^{\frac{1}{1-a}} N_t \left[R_t^d\right]^{\frac{-1}{1-a}-1} sY_t} < 0 \tag{2.27}$$

Through the chain rule, it is known that $\frac{dY_{t+1}}{dV_t} = aN_t AL_{it}^{a-1} \frac{dL_{it}}{dR_t^d} \frac{dR_t^d}{dV_t}$ and thus the derivative of output with respect to bank capital is positive,

$$\frac{dY_{t+1}}{dV_t} = 2\frac{1}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}} \frac{sY_t N_t}{\left(D_t\right)^2 \left(R_t^d\right)^{\frac{-3-2a}{1-a}} + \frac{1}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}} sY_t N_t \left(R_t^d\right)^{-1}} > 0 \tag{2.28}$$

and the second derivative of output with respect to bank capital after simplifying with (2.7) and the derivative of deposits with respect to bank capital $\left(\frac{dD_t}{dV_t}\right)$ becomes:

[10] Full mathematical workings for the calculation of the first derivative are found in Appendix Supplement 1, while workings for the calculation of the second derivative are found in Supplement 2.

$$\frac{d^2Y_{t+1}}{dV_t^2}=\frac{\frac{2sY_tN_t}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-4-a}{1-a}}\left[\frac{1+4a}{1-a}\left(D_t\right)^2+\frac{sY_tN_t}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{6-a}{1-a}}+2\frac{\left(D_t\right)^3}{sY_t}\right]\frac{dR_t^d}{dV_t}}{\left[\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}}+\frac{1}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}}sY_tN_t\left(R_t^d\right)^{-1}\right]^2} \quad (2.29)$$

which is negative since $\frac{dR_t^d}{dV_t}<0$.

Overall, the effects of an increase in lending, unrelated to the fundamentals of the economy, can be summarised as follows: the first derivative suggests that the effect of an increase in bank lending on growth (measured through an increase in bank capital since lending is an endogenous variable) is positive. However, this effect has diminishing returns as the second derivative suggests. By and large, the model indicates that there is no point after which private bank lending growth is harmful to the economy, but the effect of each subsequent loan differs, since diminishing returns are expected after some point. In the section which follows, I present an empirical investigation of these results using data from the G7 countries through a Smooth Transition Conditional Correlation (STCC) model.

2.3 Data and Empirical Methodology

2.3.1 Data

To empirically examine the theoretical results, I use data on nominal GDP and nominal lending for the G7 countries to construct the private debt to GDP ratio, to examine the relationship between this ratio and growth. Data for total credit to the private sector were obtained from the

BIS (Dembiermont et al, 2013), who construct a long series on total and domestic bank credit to the private non-financial sector.

I employ total credit instead of credit from domestic banks, since the latter may not be representative. More specifically, in the sample of developed economies there is a large deviation between the two. Additional support for the selection of total credit in the economy is that in common policy evaluations where credit is considered, such as the EU Scoreboard Indicators, this selection better characterises the policy evaluation. [11,12]

2.3.2 Econometric Methodology

In this Section I introduce the bi-variate GARCH model with Smooth Transition Conditional Correlation (STCC), proposed by Berben and Jansen (2005) and Silvennoinen and Teräsvirta (2005). This model enables us to test the time-varying relationship between finance and growth.

Consider a time series of two variables (in this case the private debt to GDP and economic growth) is $\{\boldsymbol{y}_t\}$, $t = 1, \ldots, n$, $y_t = (y_{1,t}, y_{2,t})'$, the stochastic properties of which are assumed to be described by the following model

$$\mathbf{y_t} = c_0 + \sum_{k=1}^{p} \phi^k y_{t-k} + \varepsilon_t \tag{2.30}$$

where $\phi^k = \begin{bmatrix} \phi_{11}^k & \phi_{12}^k \\ \phi_{21}^k & \phi_{22}^k \end{bmatrix}$, $k = 1, \ldots, p$ captures any possible own past effects and any past effects from one variable to the other. The error process of (2.30) is assumed to be time varying

[11] For robustness purposes, I have also tested for thresholds by employing the amount of credit supplied by domestic banks as well as real GDP and have found very similar responses. Results are available upon request.
[12] http://ec.europa.eu/economy_finance/economic_governance/macroeconomic_imbalance_procedure/mip_scoreboard/index_en.htm

$$\varepsilon_t \mid I_{t-1} \sim N(0, \Sigma_t), \tag{2.31}$$

where I_{t-1} is the information set consisting of all relevant information up to and including time $t-1$, and N denotes the bivariate normal distribution. The conditional covariance matrix of ε_t, Σ_t, is assumed to follow a time-varying structure given by

$$\Sigma_t = E[\varepsilon_t \varepsilon_t' \mid I_{t-1}] \tag{2.32}$$

$$\sigma_{11,t} = \omega_1 + \alpha_1 \varepsilon^2_{1,t-1} + \beta_1 \sigma_{11,t-1} \tag{2.33}$$

$$\sigma_{22,t} = \omega_2 + \alpha_2 \varepsilon^2_{2,t-1} + \beta_2 \sigma_{22,t-1} \tag{2.34}$$

$$\sigma_{12,t} = \rho_t (\sigma_{11,t} \sigma_{22,t})^{1/2} \tag{2.35}$$

$$\rho_t = \rho_0 (1 - G(s_t;\gamma,c)) + \rho_1 G(s_t;\gamma,c) \tag{2.36}$$

where it is assumed that the conditional variances $\sigma_{11,t}$ and $\sigma_{22,t}$ both follow a GARCH(1,1) specification.

To capture temporal changes in the contemporaneous conditional correlation ρ_t the logistic function is employed, in line with Berben and Jansen (2005) and Silvennoinen and Teräsvirta (2005).

$$G(s_t;\gamma,c) = \frac{1}{1 + \exp(-\gamma(s_t - c))}, \quad \gamma > 0, \tag{2.37}$$

where s_t is the transition variable, and γ and c determine the smoothness and location, respectively, of the transition between the two correlation regimes.[13] The starting values of γ and c are determined by a grid search while the transition variable is initially (for a sample size n) described as a function of the debt to GDP ratio, with the likelihood function maximised in one step.

The resulting STCC-GARCH model is able to capture a wide variety of patterns of change. ρ_0 and ρ_1 represent the two extreme states of correlations between which the conditional correlations can vary over time according to the transition variable s_t. Differing ρ_0 and ρ_1 imply that the correlations increase ($\rho_0 < \rho_1$) or decrease ($\rho_0 > \rho_1$), with the pace of change determined by the slope parameter γ. This change is abrupt for large γ, and becomes a step function as $\gamma \rightarrow \infty$, with more gradual change represented by smaller values of this parameter (in the estimation, the maximum value of the γ parameter is set to be 100). Parameter c defines the location of the transition. When the transition variable has values less (greater) than c, the correlations are closer to the state defined by ρ_0 (ρ_1).

To test whether the STCC specification is an adequate one, a Lagrange Multiplier (LM) test is employed for the validity of this model against a constant conditional correlation model (CCC) as per Berben and Jansen (2005) and Silvennoinen and Teräsvirta (2009). The results of the test show that the constant correlation null hypothesis is rejected in all countries except Japan and thus STCC models are estimated for the rest of the G7 countries.

Subsequently, I examine whether a second change is needed, again using an LM test as suggested by Silvennoinen and Terasvirta (2007). The estimation finds no evidence of a need for

[13] The transition function $G(s_t;\ \gamma,\ c)$ is bounded between zero and one, so that, provided there are valid correlations lying between -1 and +1, the conditional correlation ρ_t will also lie between −1 and +1.

a double smooth transition conditional correlation (DSTCC), thus I do not proceed with the estimation of this model.[14]

2.4 Empirical Results

Table 2: Descriptive Statistics

Country Name	Sample Correlations	Sample Size	Source
Canada	0.416	1970Q1-2013Q4	BIS and globalfinancialdata.com
France	0.644	1969Q4-2013Q4	BIS and globalfinancialdata.com
Germany	0.552	1961Q1-2013Q4	BIS and globalfinancialdata.com
Italy	0.363	1989Q4-2013Q4	BIS and globalfinancialdata.com
Japan	0.561	1981Q1-2013Q4	BIS and globalfinancialdata.com
United Kingdom	0.354	1963Q1-2013Q4	BIS and globalfinancialdata.com
United States	0.412	1952Q1-2013Q4	BIS and globalfinancialdata.com

The Table reports simple sample correlation coefficients obtained through the overall sample.

Table 2 presents the descriptive statistics for the G7 countries in the sample. Overall, all simple sample correlation coefficients in the G7 are greater than 0.35, with the largest value recorded in France (0.64) followed by Japan (0.56). As expected, the finance-growth relationship does not exhibit a one-to-one correlation however, it is positive across the sample countries. Thus, the next step is the estimation of the threshold values after which the correlation between finance and growth switches.

The results of the empirical estimation for the G7 can be found in table 3. All countries exhibit a similar pattern of responses to the private debt-to-GDP ratio, with correlations higher before the threshold and lower after it. The only exception is Japan which reports a constant correlation coefficient across all debt-to-GDP ratios. This result confirms the findings in Section 2.2.5, suggesting that even increases in lending attributed to monetary easing and not changes in the fundamentals of the economy can be growth-enhancing. The size of this correlation is, however,

[14] Constant correlation and DSTCC test results can be presented upon request.

highly country-specific and ranges from almost 98% change in the correlation in Germany to approximately 52% in Italy.

Table 3: STCC Results

	Canada	France	Germany	Italy	Japan (CCC)	United Kingdom	United States
Correlation before the threshold (p0)	0.712	0.419	0.557	0.335	0.024	0.316	0.444
Correlation after the threshold (p1)	0.179	0.064	0.011	0.152	N/A	0.057	0.214
Threshold value (% of GDP)	85.3%	65.9%	106.6%	50%	N/A	38.7%	105.4%
Smoothness of transition (γ)	100	100	43.49	100	N/A	100	100
Change in correlation	0.533	0.355	0.546	0.183	N/A	0.259	0.230
%change in correlation	74.8%	84.7%	97.9%	54.6%	N/A	81.9%	51.9%
Double threshold test	rejected at 5%	rejected at 5%	rejected at 5%	rejected at 5%	N/A	rejected at 5%	rejected at 5%

Table 3 reports correlations obtained by the Smooth Transition Conditional Correlation (STCC) model. Smoothness of transition is at its maximum and denotes that there is an abrupt change after the threshold. Threshold value reflects the debt-to-GDP ratio after which the correlation changes. The double STCC hypothesis is rejected at the 5% level for all sample countries. The change in correlation measures the difference between the correlations in the two regimes whereas the percent change in correlation reflects the percentage change from p0 to p1 after the threshold value.

It can also be observed that the abruptness in the change of these correlations is not related to the size of the change. In Germany, for example, where the largest change in correlation is recorded, the abruptness is approximately half of that in the other countries, as figure 5 also indicates. The abruptness in the change is blunter in the cases of Canada, France, Italy, the UK and the US, where there appears to be a regime switch.

With regards to the point of change (i.e. the threshold values) the change in correlation for most countries occurs after relatively low values (for France, Italy and the UK the threshold is lower than 66% of GDP), whereas for Canada the value stands at approximately 85.3%. For the remaining two countries the threshold value appears at relatively higher levels of the ratio such as 105.4% for the US and 106.6% for Germany. The idiosyncratic nature of the results and low values recorded in all sample countries underline the fact that threshold and correlation values differ across countries but still the change in correlation occurs at very low levels compared to those currently observed.

The link between the results of this Section's findings and the ones of Section 2.2 is straightforward. The threshold level can be viewed as the point where either new projects are not as promising (high-return) as those already funded or the entrepreneurs promoting them lack collateral. As such, credit is rationed and more funds are channelled to already existing projects, causing diminishing returns to get underway.

From the above results, it can be inferred that since the growth of loans does not hamper growth at any debt-to-GDP ratio, the only things which remain are how these loans are distributed across the economy or how indebtedness affects systematic riskiness. Consequently, a suggestion would for macro-prudential policy to examine how the allocation of loans affects the workings of the country. This would assist in avoiding over-lending to specific sectors in the economy due to an excess amount of funds channelled to them.[15]

2.5 Policy Implications

The common element from this analysis is that the correlation between the growth of private lending and growth is always positive under every private debt to GDP value. Theory suggests that after a threshold value, diminishing returns exist, while the empirical results confirm that the

[15] Sensitivity and robustness tests of the results to other definitions of growth and to the incorporation of additional countries can be found in Appendix V of this thesis. Overall, the findings are qualitatively similar.

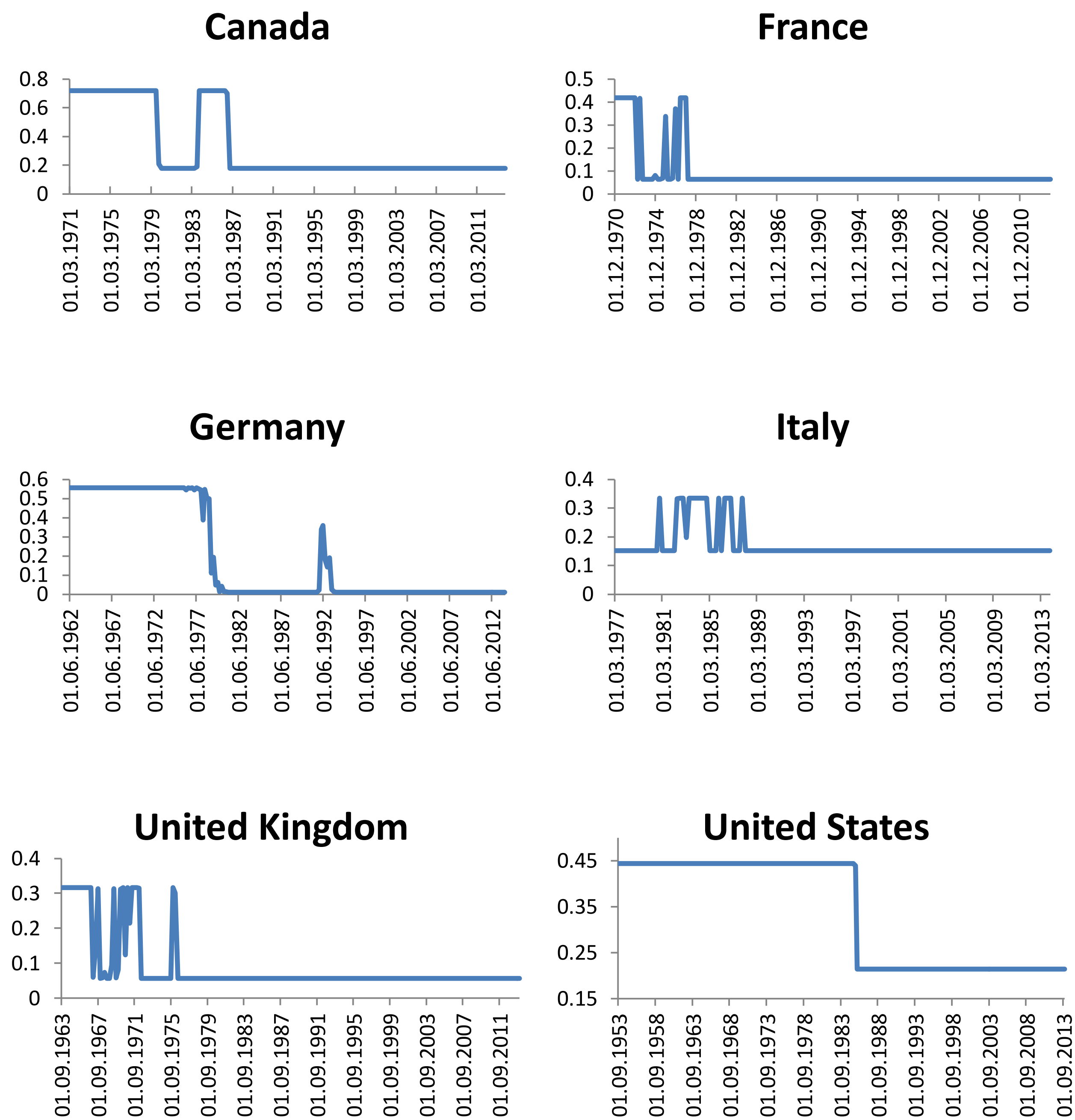

Figure 6: Transition of Correlations (Y-axis reflects correlation value)

The figure reports the values of correlations and their transition values after the threshold is exceeded. As indicated in Table 3 the change after the threshold is abrupt. If the debt-to-GDP ratio is maintained then the change is permanent (see United States). If values fluctuate around the threshold then ups and downs are observed (see United Kingdom). Japan is not reported in this Figure as it has a constant correlation.

correlation decreases in 6 out of 7 countries (and is constant in the other), but is never negative. Instead of the specific numbers, emphasis should be placed on the result which, in accordance to the two-period model of Section 2.2, suggests that the level of lending *per se* does not harm growth at any threshold, but instead shows diminishing returns to scale.

These points justify important policy implications: as the results indicate, if the level of the stock of loans does not matter thus the distribution or the riskiness arising from indebtedness are important. As such, macro-prudential policies should examine how the allocation of loans affects the workings of the country. For example, diminishing returns can take effect not because new projects have lower returns but because the entrepreneurs backing them do not possess collateral to attract a loan.

2.6 Conclusions

This chapter suggests that there is a positive correlation between bank credit to the private sector and growth, with this relationship exhibiting diminishing returns, after a certain threshold. This threshold can be viewed as the point where new projects are either not as promising as those already funded or they lack collateral to attract a loan. Thus, more funds are channelled to already existing projects lowering returns. Empirical evidence also suggests that, in accordance with the theory, there is no threshold after which an increase in the amount of loans is harmful to economic growth *per se*.

In addition, the empirical exercise confirms that thresholds exist, but the relationship between bank lending and growth remains positive, albeit exhibiting diminishing returns. The results also suggest that the determination of a threshold value is country-specific and does not affect the size of the change in correlation. This stresses the fact that policies aimed at safe-guarding the economy from potential pitfalls should not aim at retaining the level of lending under some specific threshold but, instead, aspire to monitor the allocation of this debt in the economy in order to prevent over-heating of specific sectors by lending to already existing projects instead of new ones. Similarly, an examination the effects of indebtedness in the economy in order to limit systemic risk bears more consideration.

3 The lack of persistence of interest rate changes on banks' lending and risk taking behaviour

3.1 Introduction

Through the manipulation of interest rates, monetary policy functions have the ability to make investment opportunities appear less appealing when the economy is booming and more appealing when in a downturn (Bernanke and Gertler, 1995). This has been described in the literature as the "credit channel" or the "bank lending channel" (Mishkin, 1995). Even though the short-run properties of this pass-through of monetary policy have been extensively studied, this is not the only interest rate channel which matters for macro-prudential purposes.

Apart from the direct influence of monetary policy on the economy there are also some indirect but important effects through the "risk taking channel of monetary policy transmission", i.e. the link between monetary policy and the perception and pricing of risk by economic agents. Borio and Zhu (2012), who introduced this term, suggest that changes in interest rates and the characteristics of the central bank's reaction function can influence risk-taking, both directly and indirectly, by imposing perceptions of risks and risk tolerance.

Since excess bank risk-taking has been pointed out as the culprit for the financial crisis, a recent line of debate has posed the question of whether the relatively low interest rates of the early- to mid-2000s, when most economies were recording high growth rates, increased the risk-taking appetite of banks. If this premise holds, then the formation of credit bubbles and the over-investment in risky products (Asset Backed Securities, Mortgage Backed Securities, etc.), which have increased the overall fragility of both banks and the economy, can be attributed to policy effects. In addition, an examination of any persistent direct effects of monetary policy through the bank lending channel is also of importance. To assess these aspects of monetary policy transmission, this chapter empirically examines whether monetary policy has any persistent effects on bank lending behaviour, both directly through the bank lending/credit channel and indirectly through the risk-taking and liquidity channel.

The large literature on the bank lending channel of monetary policy (see Bernanke and Gertler, 1995 for an introduction and an early review), has provided evidence on its existence but the results have been unclear about the size of the effect. For example, Kashyap and Stein (2000) show that such a channel exists but they are unable to make precise statements about its quantitative importance. Complementing these findings, Lown and Morgan (2002) report results which suggest that even though bank lending may have an important role in macroeconomic fluctuations, the bank lending channel of monetary policy changes may be quite small. In addition, Iacoviello and Minetti (2008) present results that suggest the presence of a bank-lending channel for households in countries where mortgage finance is more bank dependent. In a country-specific example, Frühwirth-Schnatter and Kaufmann (2006) find that, the evidence for a bank lending channel is quite weak in Austria since most of the banks fall into one single group that displays only a minor reaction to interest rate changes.

Other authors find evidence that the bank lending channel has diminished in recent years. For example, Perez (1998) finds that while a bank lending channel existed in the 1960s, it was no longer operative by the 1990s. Boivin *et al* (2010) support this view and also find that the bank lending channel has been more muted in recent years since credit appears to respond more slowly and by a smaller amount to policy shifts after 1982. An earlier example of this behaviour can be found in Miron *et al* (1994) who also suggest that model failure to find systematic changes to monetary contractions in the indicators they examine is an indicator that the bank lending channel is very weak.

Recent contributions to the field of monetary policy transmission, mostly stem from the literature on the effects of interest rate changes to bank risk aversion. Since this channel has not received as much attention as the bank lending/credit channel a short review of the literature is justified. Of the early contributors to the risk taking channel were Altunbas *et al* (2010) and De Nicolo *et al* (2010), who support the view that the easing of monetary policy has important effects on risk taking, suggesting that a reduction in policy rates can increase risk appetite.

Country-specific studies such as Ioannidou *et al* (2014) show that a decrease in the US Federal Funds rate increases bank risk taking in Bolivia. Jiménez *et al* (2014) examine how policy rates affect lending in Spain, with their findings indicating that lower overnight rates lead lower-capitalised banks to grant loans to *ex-ante* riskier firms, and commit large loan volumes with fewer collateral requirements to them. As such, the authors conclude that monetary policy drives risk appetite thus assigning more responsibility to the macroeconomic supervisor. Their results complement those of Diamond and Rajan (2012) who suggest that raising the policy rate in normal times can offset the Central Bank’s propensity to lower them during downturns.

Euro area studies provide evidence which are supportive of the risk taking channel. For example, Maddaloni and Peydró (2011) study the responses of the Bank Lending Survey in the euro area and provide evidence that lower interest rates soften lending standards for both businesses and households. In addition, they suggest that rates which are too low for too long further soften these standards, a finding also presented by Altunbas *et al* (2014). Similarly, Ehrmann *et al* (2003), Dell’Ariccia *et al* (2008) and Delis and Kouretas (2011), support these conclusions and suggest that non-traditional bank activities such as securitization play a central role in the banks’ risk appetite.

A different view is presented by Guerello (2014), who employs data from a panel of euro area countries and finds that monetary policy does not have an effect on bank credit risk. This result supports the Blanchard *et al* (2010) argument that the policy rate is probably a weak and costly tool to deal with excessive risk taking and regulatory policy may be more effective in dealing with excessive risk-taking.

Given that studies aiming to examine whether changes in monetary policy have any permanent effects, both through the bank lending as well as through the risk taking channel, do not exist, this aspect of the transmission mechanism deserves further exploration. More specifically, this study uses macro data on 10 euro area countries to examine, whether monetary policy has any persistent effects on bank lending and bank risk taking. Specifically, through the shock persistence methodology developed by Lee *et al* (1992), I provide evidence against the existence of persistent direct effects of euro area monetary policy on bank lending. Overall, the findings in this chapter suggest that interest rates have no persistent impact on bank lending or bank credit risk-taking either directly or indirectly. Instead, it is the liquidity channel (i.e. deposits in the economy), which appears to be an important determinant of the level of lending.

The rest of the chapter is structured as follows: the next section provides details on the empirical specification and the methodology employed. Section 3 presents the results while section 4 refers to policy implications and concludes.

3.2 Empirical Specification and Methodology

3.2.1 Data and Methodology

I propose the examination of the relationship between monetary policy and bank lending using the shock persistence method presented in Lee *et al* (1992) and further utilized by Pesaran *et al*

(1993), Lee and Pesaran (1993) and Antonini *et al* (2013). The examination of the persistent effects of bank lending (L) will be undertaken by studying both the effects of its own lags as well as those of other macroeconomic variables. More specifically, and in accordance with the literature on the effects of monetary policy on bank behaviour, the other macro variables will be real GDP (Y), the policy interest rate (I), the level of bank deposits (D) and credit risk (R) as a proxy for bank risk-taking behaviour in the euro area countries.

The existing literature on bank risk-taking and monetary policy (e.g. Delis and Kouretas, 2013) has usually employed two different measures of bank risk-taking behaviour: the ratio of risk weighted assets (RWA) to total assets (TA) and the ratio of non-performing loans (NPLs) to total loans. However, the second measure presents some obvious caveats: while non-performing loans do indicate banks' exposure to risk, they do not signify the current risk appetite as this is purely a backward-looking item, reflecting past decisions on loan granting. For example, while risk taking during recessions and banking crises is (usually) reduced, NPLs could rise due to, *inter alia*, the banks' past policies, macroeconomic developments and strategic defaults. As such, the ratio does not depend solely on bank decisions: while a specific loan could have been a good choice at the time of granting, it may have moved into the non-performing territory by changes in the macroeconomic environment, unrelated to banks' attitude towards risk.

Even though the ratio of risk-weighted assets as a share of total assets is a better proxy for risk appetite than the share of NPLs, unavailability of such data at the country level prior to 2014Q2 from the ECB database[16], provides an obstacle to its use. However, the availability of data on outstanding loans and assets allows us to construct a close alternative, namely a credit risk index,

[16] Data from 2010H1 exist on a bi-annual basis, with a total of 7 observations until 2014Q2.

defined as the ratio of outstanding loans to outstanding assets. According to the BIS[17], "credit risk is the risk of default on a debt that may arise from a borrower failing to make required payments". Thus, an increase in bank lending is expected to increase credit risk since these loans are assigned a specific risk weight. In the standardized (and also the Internal Ratings-Based-IRB) approach to credit risk, this weight is by definition greater than zero for private sector loans. Obviously, the caveat that more loans do not necessarily mean riskier loans exists, both in the case of the RWA to TA ratio as well as the credit index. However, higher bank lending growth rates tend to be associated with riskier loans, or at least in this case, an increase in the credit risk of the bank.

While a bi-annual comparison of the two indices shows that the RWA to TA and the credit risk index are very close in values, it can be argued that a credit risk index is an even better proxy for risk appetite. The rationale is that total risk-weighted assets include other items such as government or corporate bonds, which, in most cases (at least in the majority of euro area countries) carry less risk than lending to the private sector. Consequently, given that credit risk is the dominant risk for banks (see Schuermann, 2004) and that the risk-taking behaviour this chapter aims to examine is precisely lending to the private sector, there is no reason to obscure the relationship between monetary policy and bank lending by including other items.

Data on total banking assets and total loans to the private sector are obtained from the ECB Statistical Data Warehouse while macroeconomic data are obtained from Eurostat. For the policy rate, the main refinancing operations (MRO) rate is employed. Given that this measure of monetary policy is highly correlated with the other measures, namely the Eonia rate (correlation of 0.99) and the 3-month Euribor rate (correlation of 0.98), the use of any alternative is expected

[17] http://www.bis.org/publ/bcbs75.htm (accessed: 20 November 2015)

to have no significant effect on the results.[18] The data span from 1999Q1 to 2014Q4 and the sample includes Germany, Belgium, Ireland, Spain, France, Italy, Netherlands, Austria, Portugal and Finland (henceforth EA10). A detailed presentation of the data and their sources can be found in the Appendix.

3.2.2 Empirical Specification and Shock Identification

The dynamics of bank lending in a group of countries can be modelled through a vector autoregression (VAR), explaining the growth of each country's loan stock in terms of its recent path and past values of growth in other countries. The stock of loans usually follows a unit root process and, in addition, loans of different countries are related to each other, as Figure 6 and the unit root tests in sub-Section 3.2.3 suggest. An economically important feature of the series is their long-run properties and thus the persistence of shocks (i.e. the infinite-horizon effect of a shock to the ratio) is a key statistic.

Denoting the (logarithm of) bank lending in country i at time t by l_{it} and assuming that l_{it} is integrated of order 1 (i.e. I(1)), we can characterize the time series of the countries' stock of loans through the Wold representation:

$$\Delta l_t = \mu + C(L)\varepsilon_t \tag{3.1}$$

where $l_t = (l_{1t}, l_{2t}, ..., l_{mt})'$ is the $m \times 1$ vector containing the loan stocks for the m countries of interest, μ is a vector of constants representing mean growth rates, $C(L) = I + C_1 L + ... + C_p L^p$ is a p-order polynomial in the lag operator L, $\boldsymbol{C}_j$ are $m \times m$ matrices of parameters and ε_t is the vector of $m \times 1$ one-step-ahead forecast errors in Δl_t given information on lagged values of Δl_t. The ε_t are serially uncorrelated with mean zero and covariance Ω.

[18] Indeed changing the policy rate only alters the second decimal point of the results presented in this chapter.

As also suggested by Antonini *et al* (2013), equation (3.1) can capture complicate cross-country interdependencies, including the effect of innovations to countries' stock of loans that are correlated contemporaneously through the covariance matrix Ω. In addition, the specification can capture feedback effects across countries' stock of loans over time through $\boldsymbol{C_i}$. Therefore, it provides a useful tool to capture the dynamics of loan evolution.[19]

Following Lee and Pesaran (1993), important features of loan dynamics will be captured by the $m \times m$ matrix **P** whose (i, j)-th element is given by

$$\rho_{ij} = \frac{e_i^{'} C(1)\Omega C(1)' e_j}{\sqrt{(e_i^{'} C(0)\Omega C(0)' e_i)(e_j^{'} C(0)\Omega C(0)' e_j)}}, \quad i, j = 1, ..., m \tag{3.2}$$

where e_i is the $m \times 1$ selection vector with unity in its i-th element and zeros elsewhere. P is the "persistence matrix" that provides a variance-based measure of the infinite-horizon effect of shocks to the system. It can be most easily interpreted by considering the measures of $P_i = \sqrt{\rho_{ii}}$ based on its diagonal elements. These measures show the size of the permanent effect on the loan stock in country *i* of a shock to the system that causes loans in that country to rise by 1% on impact. This can be considered as an "impulse-based" measure of persistence in the univariate case, describing the effect of a 1% shock to the variable.

An advantage of this variance-based measure is that it does not require, and is in fact invariant to, the identifying assumptions necessary to provide structural meaning to the shocks in an impulse response analysis conducted in a multivariate setting (Lee and Pesaran, 1993). The

[19] Nevertheless, despite all its advantages, the specification is subject to the usual limitation of multivariate time series, i.e. that there exist an infinite number of MA representations of this type and a structural interpretation of the innovations or parameters requires a usually large, number of identifying restrictions provided by economic theory.

moving average representation of (3.1) takes into account the possibility that the instantaneous effect of shocks is gradually eroded over time and thus persistence can be close or equal to zero, as for example, in the case where the loan stock series is stationary.

The derivation of P_i suggests two extensions, described in detail in Lee and Pesaran (1993). First, the time-profile of the effect of the shocks can be readily traced over time, defining $P(n)$ as the matrix whose (i, j)-th element is given by

$$\rho_{ij}(n) = \frac{e_i' H(n)' e_j}{\sqrt{(e_i' C(0)\Omega C(0)' e_i)(e_j' C(0)\Omega C(0)' e_j)}} \quad (3.3)$$

where $H(n) = \left(\sum_{i=0}^{n} Ci\right)\Omega\left(\sum_{i=0}^{n} Ci\right)'$ for $n = 0,1,...$

In this case, *H(n)* captures the size of the permanent effects of the shocks as they accumulate over time, up to period n. As $n \to \infty$ the $P(n)$ converges to the persistence matrix P. Similarly, the persistence profiles defined by the individual country-specific measures $P_i(n) = \sqrt{\rho_{ii}(n)}$ also converge to P_i. These profiles provide a useful characterisation of loan dynamics which again avoids the need for any structural assumptions.

The second extension, allows for a decomposition of the shocks to loans in the simple Wold representation in (3.1) to provide us a way to describe how different system-wide shocks impact the loan stock and their effects are propagated through time. Suppose that X_t is a vector of EA-wide aggregates, which impact in distinct way and over different time-frames, loans in the EA economies. Specifically, in this case there are four types of shocks, i.e. output, credit risk, deposits and the policy rate. We assume that innovations in these aggregates are given by

$$v_t = x_t - \Gamma z_t \tag{3.4}$$

with mean zero and variance Ψ, with x_t being an $m \times 1$ vector of macroeconomic variables, Γ being fixed parameters and z_t being a set of predetermined variables (in this case the other macroeconomic shocks in each equation). Then, equation (3.1) can be generalized to

$$\Delta l_t = \mu + D(L)v_t + C(L)\varepsilon_t \tag{3.5}$$

where $D(L) = I + D_1 L + ... + D_q L^q$ is a matrix of lag polynomials capturing the effects of the identified system-wide shocks and the ε_t are now interpreted as "other, unidentified" innovations to loans, which are assumed to be uncorrelated with the v_t. In this case, the *P(n)* matrix is defined by its *(i,j)-th* element in a way that can be decomposed as:

$$\rho_{ij}(n) = \rho_{Sj}(n) + \rho_{Oij}(n) \tag{3.6}$$

with $\rho_{Sij}(n) = \dfrac{e_i' F(n)' e_j}{\sqrt{(e_i' H(0)' e_i)(e_j' H(0)' e_j)}}$, $\rho_{Oij}(n) = \dfrac{e_i' G(n)' e_j}{\sqrt{(e_i' H(0)' e_i)(e_j' H(0)' e_j)}}$

and specifying $F(n) = \left(\sum_{i=0}^{n} Di\right)\Psi\left(\sum_{i=0}^{n} Di\right)'$, $G(n) = \left(\sum_{i=0}^{n} Ci\right)\Omega\left(\sum_{i=0}^{n} Ci\right)'$ and

$$H(n) = \left(\sum_{i=0}^{n} Di\right)\Psi\left(\sum_{i=0}^{n} Di\right)' + \left(\sum_{i=0}^{n} Ci\right)\Omega\left(\sum_{i=0}^{n} Ci\right)' \text{ for } n = 0,1,...$$

In this case, the profiles described by $P_{Si}(n) = \sqrt{\rho_{Sii}(n)}$ and $P_{Oi}(n) = \sqrt{\rho_{Oii}(n)}$ summarise the effects of the identified EA-wide shocks and the unidentified shocks on each country's loans while the scaling reflects the size of the identified and unidentified shocks on impact.

3.2.3 Model Specification

The characterisation of the EA-10 loan data and the analysis of the persistence of the shocks to these is provided by the following two regression models estimated for each country and stacked in each case to obtain a multi-country VAR.

$$M_1 : \Delta l_{it} = a_i + \sum_{s=1}^{r} \beta_{s,ii} \Delta l_{i,t-s} + \sum_{s=1}^{r} \gamma_{s,i} \Delta l_{-i,t-s} + \varepsilon_{it}, \quad i = 1,...,m \tag{3.7}$$

Similar to in Lee *et al* (1992), Pesaran *et al* (1993), Lee and Pesaran (1993) and Antonini *et al* (2013), a restricted version of M1 where variables with coefficients with a |t-ratio| <1 are excluded is used. As already discussed, the models are estimated for the EA10 over the period after the introduction of the euro, (1999q1-2014q3), using Full Information Maximum Likelihood (FIML). Lag order is set by information criteria (BIC) which suggest that two lags are sufficient (i.e. r=2 while m=10).

In specifying the source of shocks, we use model M_2 where shock is decomposed according to equation (3.4) into p different types of identified shocks, $v_{j,t}, j = 1,..., p$ and unidentified shocks $\tilde{\varepsilon}_{it}$ as follows:

$$M_2 : \ \Delta l_{it} = a_i + \sum_{s=1}^{r} \tilde{\beta}_{s,ii} \Delta l_{i,t-s} + \sum_{s=1}^{r} \tilde{\gamma}_{s,i} \Delta l_{-i,t-s} + \sum_{j=1}^{p} \ \sum_{j=1}^{p} \delta_{i,js} v_{j,t-s} + \tilde{\varepsilon}_{it}, \quad i = 1,...,m \tag{3.8}$$

We employ four types of shocks which affect the evolution of bank lending, namely, shocks to EA10 output (Y), shocks to the credit risk (R), shocks to deposits (D) and shocks to the policy rate (P). The shocks are to be inferred as system-wide ones, estimated as error from a first order autoregressive order:

$$\Delta x_{j,t} = \lambda_{0j} + \lambda_{1j}\Delta x_{j,t-1} + v_{j,t}, \quad j = 1,...,4 \qquad (3.9)$$

In this case, the $x_{j,t}$ denotes Y, R, I and P in turn. As the sources of shocks do not rely on any short-run identifying assumptions (e.g. Cholesky decompositions), they are invariant to the ordering of the variables in the VAR. Similar to the above, to test the effects of policy on credit risk (deposits) in order to capture possible indirect effects of policy on the level of bank lending, we modify model M_1 to treat the values of R (D) as the dependent variable and the shocks now becoming output, deposits (credit risk), lending in the economy and the policy rate.

3.2.4 Data Overview

Figure 7 plots the evolution of loans in the 10 EA countries since the euro adoption. The amount of lending in each individual country has increased over time, with a slowdown observed after the global financial crisis and especially after the European sovereign crisis.

Tests for unit roots in the loan stock of each country can be found in Tables 4 and 5. More specifically, Table 4 suggests that the unit root hypothesis cannot be rejected for any country and for any order of the augmented Dickey-Fuller test. In addition, the IPS test (Im *et al*., 2003) shows the standardized value of the mean of the ADF statistics across countries. When compared to a standard normal distribution, the IPS statistic provides a panel test for the presence of unit root. In our case, the IPS blurs the picture as it contrasts the individual ADF results, i.e. the presence of a unit root is rejected. However, Table 5 indicates that the unit root null can be rejected in the growth of bank lending, as suggested by most individual country ADF tests as well as the overall IPS tests.

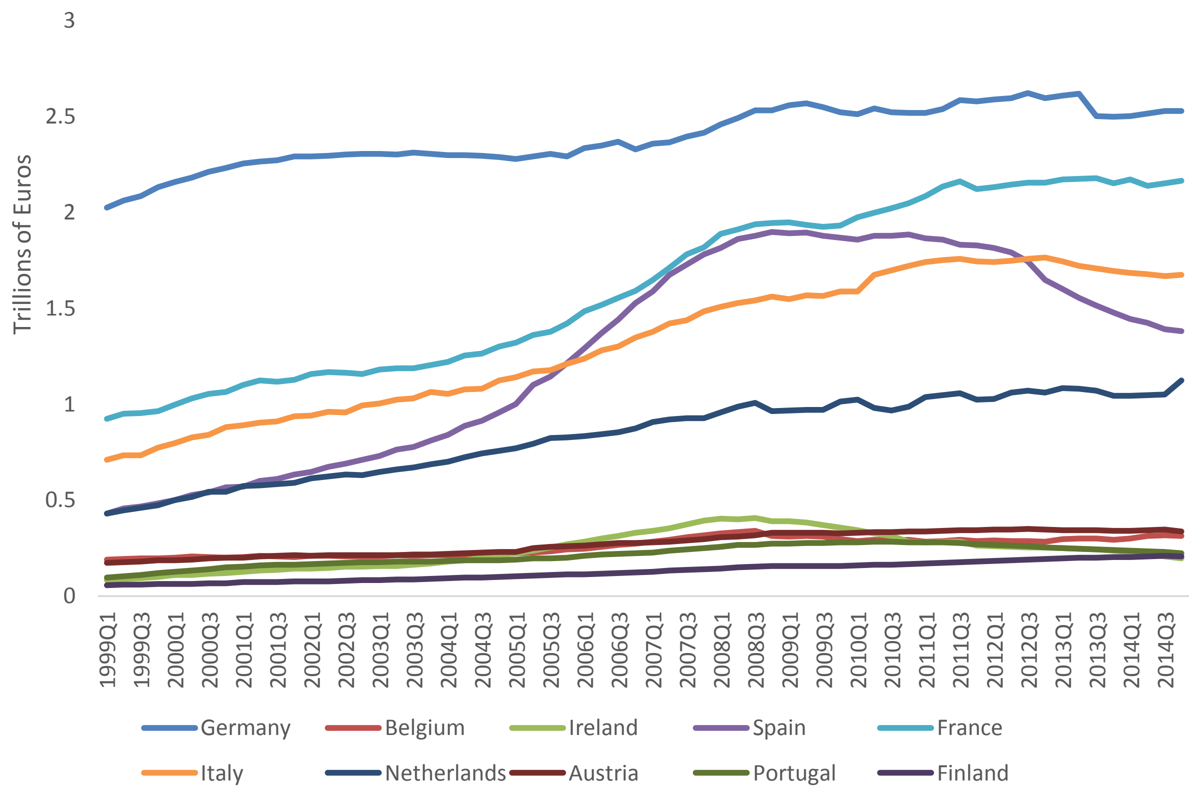

Figure 7: Individual Country Total Lending levels
The figure indicates individual country total lending to the private sector by monetary financial institutions (MFIs) in trillions of euros for the whole sample period. As evident, series have a unit root.

In Tables 6 and 7 the corresponding cross-sectional ADF (CADF) tests are presented.[20] These tests augment the ADF regressions with lagged differences of the cross-sectional average, taking into consideration the cross-sectional dependencies among countries' lending stocks.

The tables confirm the simple ADF results. The unit root hypothesis cannot be rejected by either the individual ADF tests or the CIPS test in the levels, but is rejected by both tests for the growth rate. In addition, there is now no contradiction between the IPS and the individual ADF tests, as they both support the same view. Taken together, the results of tables 4 to 7, provide evidence that the bank lending stock level is a difference-stationary variable in the EA-10 countries.

[20] See Pesaran (2007) for more details.

Table 4: Augmented Dickey-Fuller Tests for Unit roots in bank lending levels

	ADF(1)	ADF(2)	ADF(3)	ADF(4)
Germany	-1.53	-1.85	-2.11	-1.96
Belgium	-1.23	-1.27	-1.62	-1.59
Ireland	0.02	-0.35	-0.54	-0.38
Spain	0.81	-1.22	-1.01	-1.05
France	-0.17	-0.58	-0.95	-0.95
Italy	1.88	0.26	0.69	0.58
Netherlands	-1.64	-1.46	-1.22	-0.73
Austria	0.41	0.12	-0.1	0.04
Portugal	0.97	0.8	0.62	0.41
Finland	-0.11	0.04	0.03	0
Mean	**-0.06**	**-0.55**	**-0.62**	**-0.56**
(IPS test stat)	**7.80**	**5.61**	**5.17**	**4.98**

Note: The variables are all in logarithms. ADF(p) statistics are computed using ADF regressions with an intercept a linear trend and p lagged differences of the dependent variable. The 10% critical value is -3.18 the 5% value is -3.50 and the 1% value is -4.15. The IPS test statistic is the normalized value of the mean of the ADF statistics and is compared to a normal standard distribution. ** denotes significance at the 5% level.

Table 5: Augmented Dickey-Fuller Tests for Unit roots in the growth of bank lending

	ADF(0)	ADF(1)	ADF(2)	ADF(3)
Germany	-7.05***	-4.55***	-3.67***	-3.77***
Belgium	-5.69***	-4.43***	-3.15**	-3.1**
Ireland	-2.38	-1.31	-0.84	-1.02
Spain	-2.49	-0.9	-0.98	-0.91
France	-4.53***	-3.28**	-2.47	-2.42
Italy	-6.32***	-2.4	-2.51	-2.32
Netherlands	-6.13***	-5.1***	-4.84***	-5.32***
Austria	-5.05***	-3.31**	-2.57	-2.81*
Portugal	-3.23**	-2.59	-2.35	-1.87
Finland	-4.22***	-3.54**	-2.79*	-2.71*
Mean	**-4.71*** **	**-3.14** **	**-2.62***	**-2.62***
(IPS test stat)	**-12.11**	**-5.99**	**-4.21**	**-4.12**

Note: The variables are all in logarithms. ADF(p) statistics are computed using ADF regressions with an intercept and p lagged differences of the dependent variable. The 10% critical value is -2.60 the 5% value is -2.93 and the 1% value is -3.58. The IPS test statistic is the normalized value of the mean of the ADF statistics and is compared to a normal standard distribution. ** denotes significance at the 5% level.

Table 6: Cross-Sectionally Augmented Dickey-Fuller Tests for Unit roots in bank lending levels

	CADF(1)	CADF(2)	CADF(3)	CADF(4)
Germany	-0.39	-1.7	-1.65	-1.74
Belgium	-1.23	-0.74	-0.33	-0.5
Ireland	-0.84	-1.4	-1.45	-1.68
Spain	-0.14	-1.38	-1.21	-1.1
France	-0.53	-0.11	-0.23	-0.8
Italy	-1.29	-2.16	-1.76	-2.82
Netherlands	-3.76*	-3.34	-2.69	-2.01
Austria	-1.37	-1.02	-0.93	-1.6
Portugal	-3.29	-4.12	-3.63	-3.87
Finland	-3.43	-3.15	-3.03	-2.81
Mean (CIPS test stat)	**-1.63**	**-1.91**	**-1.69**	**-1.89**

Note: The variables are all in logarithms. CADF(p) statistics are computed using ADF regressions with an intercept a linear trend and p lagged differences of the dependent variable. The 10% critical value is -3.44 the 5% value is -3.78 and the 1% value is -4.69. The CIPS test statistic is the cross-sectional mean compared to the distribution in Pesaran (2007) where the 1% 5% and 10% critical values are -3.06 -2.84 and -2.73 respectively. ** denotes significance at the 5% level.

Table 7: Cross-Sectionally Augmented Dickey-Fuller Tests for Unit roots in the growth of bank lending

	CADF(0)	CADF(1)	CADF(2)	CADF(3)
Germany	-6.95***	-3.08*	-2.66	-2.12
Belgium	-5.1***	-4.15***	-3.39**	-1.88
Ireland	-5.54***	-3.39**	-2.73	-2.17
Spain	-4.72***	-1.46	-1.83	-1.47
France	-6.52***	-4.62***	-3.17*	-2.04
Italy	-8.9***	-3.59**	-3.79**	-2.6
Netherlands	-6.59***	-5.6***	-5.98***	-4.7***
Austria	-6.7***	-5.57***	-3.82**	-2.7
Portugal	-5.45***	-3.6**	-3.68**	-3.18*
Finland	-6.11***	-5.85***	-4.84***	-4.71***
Mean (CIPS test stat)	**-6.26*****	**-4.09*****	**-3.59*****	**-2.76*****

Note: The variables are all in logarithms. CADF(p) statistics are computed using ADF regressions with an intercept a linear trend and p lagged differences of the dependent variable. The 10% critical value is -2.94 the 5% value is -3.29 and the 1% value is -3.94. The CIPS test statistic is the cross-sectional mean compared to the distribution in Pesaran (2007) where the 1% 5% and 10% critical values are -2.55 -2.33 and -2.21 respectively. ** denotes significance at the 5% level.

3.3 Results

3.3.1 Baseline Specification

Table 8 presents the aggregate persistence of the total system-wide shocks in model M_2. In the specification, total persistence is strong and statistically significant. Specifically, the combination of all shocks in M_2 (i.e. policy, credit risk, GDP and deposits) would have a persistent effect of 7.28 across the EA10.

To place the value of 7.28 in perspective, the combination of all shocks in the model would translate into a long-term rise in lending by 7.28% if the whole of the initial change was the result of unanticipated shocks, assuming that there are no further shocks and that the EA10's macroeconomic response is the same as it has been in the past. The statistical significance of the persistence can be examined as usual through the standard errors. In M_2, persistence is statistically significant. Individual country effects vary in size, while the effect is statistically significant for all countries excluding Germany, Ireland and Portugal.

The breakdown of the aggregate macro system-wide shocks both at the country as well as the EA level, using the M_2 specification, are presented in Table 9. As the estimates suggest, the effects of policy rate shocks do not exhibit significant persistence in any country, while there exists no statistically significant persistence for the EA aggregate either. On the contrary, a system-wide credit risk shock provides significant persistence at the EA level and it is mostly insignificant at the country level, with the exception of Belgium, Spain, France and the Netherlands. System-wide output shocks are not statistically significant at the aggregate or at the country level.

The persistent effects of a system-wide deposits shock are very strong both in the aggregate and individual level (except Germany, Belgium, Ireland and Portugal) and, along with the credit risk shock, capture most of the persistence caused by macro shocks. This suggests that in the occurrence of a bank liquidity unanticipated shock a persistent change in lending should be expected.

Table 8: Total Persistence Measures

	Model M_2
Germany	17.2 (12.94)
Belgium	1.61 (0.3)
Ireland	8.47 (5.31)
Spain	7.8 (2.51)
France	11.82 (6.00)
Italy	3.64 (1.88)
Netherlands	2.38 (0.67)
Austria	35.58 (15.41)
Portugal	11.98 (9.51)
Finland	2.49 (0.59)
EA-10	**7.28** **(2.01)**

Note: Individual country persistence measures are estimated using equation (2) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j . Figures in brackets represent asymptotic standard errors. Model M_2 includes only those variables with a t-statistic greater than unity. Values can be interpreted and the persistence of all shocks in each model if the whole of the initial change was the result of unanticipated shocks, assuming that there are no further shocks and that the EA10's macroeconomic response is the same as it has been in the past.

Table 9: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Bank Lending as a dependent variable

	Policy	Credit Risk	GDP	Deposits	Total Macro	Other Shocks	Total
Germany	0.77 (1.25)	66.83 (58.98)	0.84 (2.07)	59.89 (55.75)	62.88 (55.65)	1.38 (0.18)	17.2 (12.94)
Belgium	1.91 (1.62)	2.91 (1.16)	1.23 (3.15)	2.51 (3.02)	1.61 (0.30)	1.61 (0.30)	1.61 (0.30)
Ireland	0.06 (0.10)	6.82 (5.92)	0.35 (0.46)	10.01 (6.12)	8.49 (5.37)	3.55 (1.47)	8.47 (5.31)
Spain	0.04 (0.03)	9.07 (2.83)	0.02 (0.06)	3.82 (1.79)	7.80 (2.51)	4.93 (2.17)	7.8 (2.51)
France	0.07 (0.15)	12.20 (7.09)	0.14 (0.27)	12.72 (6.48)	12.21 (6.50)	1.72 (0.28)	11.82 (6.00)
Italy	0.03 (0.03)	3.13 (2.15)	0.02 (0.05)	4.09 (1.95)	3.64 (1.89)	1.37 (0.24)	3.64 (1.88)
Netherlands	0.00 (0.02)	1.92 (0.76)	0.00 (0.03)	2.71 (0.72)	2.39 (0.68)	0.95 (0.13)	2.38 (0.67)
Austria	0.76 (0.61)	60.64 (35.79)	2.11 (1.09)	56.78 (34.47)	56.74 (33.56)	1.72 (0.29)	35.58 (15.41)
Portugal	0.05 (0.13)	10.27 (10.86)	0.08 (0.22)	13.4 (9.82)	12.04 (9.68)	4.39 (1.32)	11.98 (9.51)
Finland	0.02 (0.02)	0.47 (1.15)	0.01 (0.03)	2.71 (0.91)	2.49 (0.59)	1.78 (0.33)	2.49 (0.59)
EA-10	**0.04** **(0.04)**	**7.66** **(2.75)**	**0.08** **(0.09)**	**7.19** **(1.6)**	**7.29** **(2.02)**	**2.68** **(0.59)**	**7.28** **(2.01)**

Note: Results refer to Model M_2 as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j. Figures in brackets represent asymptotic standard errors. Values can be interpreted as the persistence of each shock if the whole of the initial change was the result of unanticipated shocks, assuming that there are no further shocks and that the EA10's macroeconomic response is the same as it has been in the past.

The permanent effects of a change in deposits can be viewed as the contemporaneous impact of this shock on bank lending and its subsequent propagation through time. Similar to Bernanke (1983), this result suggests that lack of liquidity during downturns can further deteriorate future prospects about the state of the economy. Thus, macro-prudential policies aiming at controlling the level of lending should also emphasise in the liquidity aspect and not just credit risk or lending itself.

There is no significant persistence in the specific macroeconomic shocks for Austria, Ireland, Portugal or Germany. In these three countries, bank lending exhibits significant persistence only to other, unspecified, shocks. In Belgium, the results indicate that credit risk is a more important driver than the level of deposits (which is insignificant), while in Finland, France and Italy deposits have significant persistence while credit risk does not. Both credit risk and liquidity shocks register significant persistence in the cases of Spain and the Netherlands.

Overall, the findings presented in this Section suggest that monetary policy, as proxied by the policy rate, has no direct persistent effects on bank lending either on the EA or the country level. The results are supportive the findings of Miron *et al* (1994), Perez (1998), Boivin *et al* (2010) and Disyatat (2011) who conclude that no bank lending channel exists or if it does it is so weak it cannot be captured by models. On the other hand, deposit and credit risk shocks appear to be much more important in determining the persistence of changes in bank lending. Since the results show no direct effect of policy on bank lending, to study whether any other transmission channels of monetary policy exist the next Section tests for the presence of any persistent indirect effects on the macroeconomic variables of the model.

3.3.2 Indirect effects of monetary policy

The results in Table 9 provide an estimate of the direct effects of monetary policy. However, it can be argued that changes in the policy rate may have indirect effects on the level of lending. In this respect, the effect of the policy rate on the level of two variables which affect lending decisions, the level of deposits and credit risk, is examined.

Table 10: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock –Credit Risk as dependent variable

	Policy	Deposits	GDP	Loans	Total Macro	Other Shocks	Total
Germany	0.22 (0.34)	1.63 (1.52)	2.26 (1.25)	1.64 (0.51)	1.26 (0.33)	0.74 (0.07)	0.92 (0.24)
Belgium	0.56 (0.73)	3.98 (1.00)	3.23 (1.53)	0.19 (1.03)	0.89 (0.23)	0.9 (0.1)	0.9 (0.1)
Ireland	0.11 (1.04)	2.81 (2.38)	2.06 (2.57)	0.1 (1.33)	1.04 (0.32)	1.04 (0.05)	1.04 (0.05)
Spain	0.46 (1.31)	1.28 (3.52)	0.17 (3.26)	1.5 (1.03)	1.02 (0.4)	1.2 (0.15)	1.19 (0.15)
France	0.43 (0.86)	0.32 (1.78)	0.71 (1.85)	2.88 (1.4)	2.21 (0.96)	0.88 (0.1)	1.13 (0.32)
Italy	1.87 (2.33)	1.37 (6.76)	3.41 (6.8)	1.09 (3.33)	1.53 (0.71)	1.39 (0.19)	1.39 (0.19)
Netherlands	1.24 (0.49)	1.52 (1.07)	0.95 (1.04)	0.4 (0.48)	1.67 (0.22)	1.00 (0.00)	1.2 (0.14)
Austria	1.23 (0.31)	0.05 (0.83)	0.66 (0.75)	0.3 (0.31)	1.58 (0.14)	1.00 (0.00)	1.28 (0.11)
Portugal	1.06 (0.83)	2.43 (2.41)	1.73 (2.48)	1.84 (0.86)	1.33 (0.21)	1.31 (0.17)	1.31 (0.17)
Finland	0.22 (0.49)	1.31 (2.20)	3.71 (1.75)	0.59 (1.79)	2.27 (0.49)	1.37 (0.22)	1.79 (0.45)
EA 10	**0.85 (0.89)**	**2.60 (1.79)**	**3.89 (1.85)**	**1.91 (1.91)**	**1.27 (0.87)**	**1.20 (0.13)**	**1.21 (0.18)**

Results refer to Model M_2 as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j . Figures in brackets represent asymptotic standard errors. Values can be interpreted as the persistence of each shock if the whole of the initial change was the result of unanticipated shocks, assuming that there are no further shocks and that the EA10's macroeconomic response is the same as it has been in the past.

Table 10 presents estimates of persistence to credit risk, through the system-wide macro shocks of policy rate, deposits, output and lending. Again, in this specification, the policy rate does not have statistically significant persistence in the EA aggregate and neither at the country level with the exception of Netherlands and Austria. These findings are similar to Guerello (2014) who shows that monetary policy does not have any effects on bank credit risk.

Another interesting finding of Table 10 is that credit risk is not affected by lending itself as the level of loans is not statistically significant persistent in the aggregate or the country level (exceptions are Germany, France and Portugal). The main driver of credit risk persistence is output shocks which are significant at the aggregate level. Overall, system-wide macroeconomic shocks have approximately the same persistence as other, “unidentified” shocks at the EA level, however, with considerable variation in country responses and with only the latter being statistically significant. This provides support to the view that country idiosyncrasies are important determinants of outcomes and, in addition, also supports the proposition that monetary policy is not a persistent determinant of credit risk.

In Table 11, the effects of system-wide macro shocks to the level of deposits are presented. Again, the policy rate is statistically insignificant both at the EA as well as the country level. Furthermore, system-wide shocks in credit risk and GDP are insignificant. At the country level, output shocks have significant persistence on deposits only in Ireland and Austria. In contrast, system-wide loan shocks present significant persistence on deposits at the aggregate level and are significant at the country level for half of the sample countries (Belgium, Ireland, the Netherlands, Austria and Portugal).

These findings complement those of Table 9 in that monetary policy does not have an indirect effect on lending through deposits, and are in accordance with the credit creation theory (see Werner, 2014a; Disyatat, 2011). In addition, the bi-directionality of the lending and deposit relationship is also suggested: while an increase in lending increases deposits (Werner, 2014a) a change in deposits, i.e. the liquidity in the system, also affects lending capability. As such, the importance of liquidity during downturns is especially emphasised.

Table 11: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Deposits as the dependent variable

	Policy	Loans	Credit Risk	GDP	Total Macro	Other Shocks	Total
Germany	0.58 (0.77)	0.85 (0.76)	1.63 (1.04)	1.70 (1.12)	0.84 (0.07)	0.84 (0.07)	0.84 (0.07)
Belgium	0.00 (0.01)	1.31 (0.18)	0.02 (0.03)	0.69 (0.65)	1.13 (0.15)	0.74 (0.06)	1.13 (0.15)
Ireland	0.02 (0.07)	1.41 (0.56)	0.25 (0.35)	3.75 (0.92)	3.04 (0.71)	1.74 (0.38)	3.02 (0.71)
Spain	0.16 (0.47)	0.47 (10.02)	0.03 (0.3)	7.43 (13.5)	7.11 (9.00)	2.47 (0.86)	6.91 (7.81)
France	0.64 (1.34)	34.07 (35.10)	2.65 (1.34)	25.43 (37.36)	31.65 (29.45)	1.00 (0.09)	5.84 (3.4)
Italy	0.90 (2.25)	20.58 (30.07)	1.05 (2.81)	17.16 (29.77)	19.03 (26.56)	0.79 (0.07)	2.57 (1.69)
Netherlands	0.02 (0.01)	1.80 (0.47)	0.00 (0.02)	0.21 (0.72)	1.72 (0.36)	0.96 (0.18)	1.72 (0.36)
Austria	0.01 (0.02)	0.96 (0.14)	0.07 (0.07)	1.83 (0.22)	1.51 (0.16)	0.91 (0.04)	1.51 (0.16)
Portugal	0.00 (0.01)	0.98 (0.13)	0.01 (0.02)	1.00 (0.07)	1.73 (0.06)	1.00 (0.00)	1.73 (0.06)
Finland	0.21 (0.84)	10.53 (10.73)	1.93 (1.19)	9.89 (11.68)	9.22 (8.87)	0.69 (0.05)	2.02 (1.31)
EA 10	**0.01 (0.03)**	**1.27 (0.68)**	**0.05 (0.06)**	**1.05 (0.92)**	**1.14 (0.34)**	**0.91 (0.07)**	**1.14 (0.33)**

Results refer to Model M_2 as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j . Figures in brackets represent asymptotic standard errors. Values can be interpreted as the persistence of each shock if the whole of the initial change was the result of unanticipated shocks, assuming that there are no further shocks and that the EA10's macroeconomic response is the same as it has been in the past.

Overall, the findings presented in Tables 10 and 11 suggest that changes in the interest rate do not have a permanent effect on the variables which affect bank lending, i.e. there are no permanent indirect effects of monetary policy. In the countries where credit risk is permanently affected by monetary policy changes (Austria and the Netherlands), there is only significant indirect feedback from credit risk to lending in the case of the Netherlands in Table 9. Similarly, the policy rate does not have a permanent effect on deposits. On the whole, as the aggregate results of sections 3.3.1 and 3.3.2 suggest, there are no persistent effects, either direct or indirect, of the policy rate on bank lending either at the aggregate or at the country level, with the Netherlands posing the only exception through an indirect channel of transmission.[21,22]

3.4 Policy Implications and Conclusions

As the previous section has shown, there are no direct, persistent effects of the policy rate on bank lending in the euro area. In addition, the policy rate does not have significant aggregate persistence in either credit risk or the level of deposits, with the exception of the Netherlands in the former case. The results are supportive the findings of Miron *et al* (1994), Perez (1998), Boivin *et al* (2010) and Disyatat (2011) who conclude that no bank lending channel exists or if it does it is so weak it cannot be captured by models.

The combination of direct and indirect effects does not yield a statistically significant effect for any country in the sample (other than the Netherlands for the indirect case), while it is insignificant in the aggregate. Overall, while the policy rate may have very limited and idiosyncratic effects in specific economies, its persistence is insignificant in the aggregate both directly and indirectly. Furthermore, these idiosyncratic effects on bank lending are weak and limited to countries where a persistent change in credit risk occurs.

The findings suggest that since changes in the policy rate do not have persistent effects, then they either affect decisions only in the very short-run, (which, as O'Rourke and Taylor, 2013, comment is the time-frame of policy) or have very little (if any) effect on lending decisions in general. As such, a loose monetary policy is not harmful by itself. In other words, changes in monetary policy should not be expected to provide persistent changes in bank lending behaviour.

[21] Netherlands is an exception since the policy rate is significant for credit risk (table 10) and credit risk is significant for bank lending (table 9), indicating that an indirect channel could exist.
[22] Sensitivity and robustness tests of the results regarding different definitions of the policy rate and to interbank lending instead of lending to the private sector can be found in Appendix VI of this thesis. Overall, the findings are qualitatively similar.

While the interest rate can be important for inflation targeting, it appears that it does not have persistent effects on bank risk taking, an argument similar to Blanchard *et al* (2010) who also suggest the policy rate is a weak tool to deal with excessive risk taking. The results are supportive of Blanchard *et al* (2010), as well as Guerello (2014) since only one out of ten sample countries has persistent indirect effects on credit risk resulting from a change in the policy rate.

Another important implication is that deposits have a persistent effect on bank lending behaviour, opening a channel for potential macro-prudential policy actions. For example, regulation on the sources of bank liquidity (be it central banking, inter-banking or deposit-taking), could perhaps be useful in preventing excess lending in the economy since deposits have a significant effect on bank lending. In the opposite case, where the economy faces a downturn, macro-prudential policy can be aimed at increasing liquidity in the economy to boost future prospects. Here it should again be mentioned that the policy rate does not have a statistically significant, persistent effect on deposits in any specific country and is insignificant in the aggregate.

Summing up, this chapter macro data were employed in order to examine whether monetary policy, measured through changes in the policy rate, has any persistent effects on bank lending. There were no statistically significant aggregate effects and very limited and weak idiosyncratic indirect effects. In addition, the results indicate that there is no aggregate persistence in the effects of the policy rate on credit risk. On the whole, the evidence presented in this chapter indicates that the policy interest rate, as previously suggested in the literature, is not very well suited to have persistent effects on credit risk. This outcome implies that policies aimed at affecting credit risk and bank lending behaviour would have no persistent effects if only the interest rate is employed. Macro-prudential policy should perhaps focus on other factors which affect lending decisions and notably the liquidity channel, which appears to be an important determinant of the level of lending.

Summary and Discussion

The aim of this dissertation has been to examine the effects of bank lending on output growth and the subsequent policy implications. I have focused on areas of relevance for policymakers, which are directly derived from the main results presented in the chapters above.

The first chapter examined the effects of a change in total lending in the economy, in three euro area countries, by employing a factor-augmented VAR (FAVAR) specification. The results indicate that while the average effect of bank lending on output is relatively small, it is always positive with responses varying across countries. Furthermore, increases in bank lending also increase total deposits in the economy in all sample countries, providing the first macroeconomic evidence for the credit creation theory, i.e. that bank lending creates deposits.

Chapter two further examined the effects of bank lending to the private sector on real GDP growth using both theory and empirical evidence to back up the evidence of the first chapter. Using a two-period model, I find that even when changes in lending are due to monetary easing, a positive relationship between finance and growth exists, with the relationship exhibiting diminishing returns after a certain debt-to-GDP ratio. Furthermore, the theoretical conclusions are tested by a smooth transition conditional correlation (STCC) model. The empirical evidence confirms that the relationship between bank lending to the private sector and output growth is always positive and exhibits diminishing correlation after country-specific debt-to-GDP ratios. Overall, the results suggest that, other things being constant, private lending promotes GDP growth, at any debt-to-GDP ratio.

The third chapter focused on policy actions. Specifically, it examined whether monetary policy has persistent effects on bank lending behaviour by employing macroeconomic data for 10 euro area (EA) countries. Through the shock persistence methodology developed by Lee et al (1992), I provide evidence against the existence of persistent, direct effects of euro area monetary policy on bank lending, in contrast to what some short-run studies have suggested. Overall, the findings in the third chapter suggest that interest rates have no persistent effects on bank lending or bank credit risk-taking either directly or indirectly. Instead, it is the liquidity channel (i.e. the level of deposits in the economy), which appears to drive persistent changes in the level of lending.

Generally, all three chapters have underlined the importance of the banking sector in the economy. Specifically, chapters one and two point out that banking activity, measured through bank lending to the private sector, has important positive effects on output growth. In addition, this effect is present, at any bank lending-to-GDP ratio. We can thus conclude that banks have important effects on growth and thus the ability of the authorities to control them are the foundations for financial stability. Chapter three examines whether this is possible by observing the banking sector through the lens of the policymaker, testing whether monetary policy can have persistent effects on banks' behaviour and thus influence their decisions. I find that monetary policy does not have any direct or indirect effect on bank lending and conclude, as does Blanchard *et al* (2010), that the policy rate is a weak tool for dealing with excessive risk taking, and hence persistently influence bank behaviour. Nevertheless, as mentioned above, there are other channels through which policy can have an effect on bank lending.

There are, of course, some limitations one has to keep in mind when interpreting the above findings. Moreover, there is room for further improvements and additional research in order to better understand the results.

For instance, the incorporation of a larger sample of variables in the first chapter, as well as a longer time-series could better assist researchers in providing more precise estimates of the effects of bank lending on output. Currently, the lack of larger number of series as well as the small (common) sample size for the variables leads us to interpret the results as only indicative of the relationship between the two variables. This difficulty cannot be currently dealt, since a larger number of series and a larger common sample size for all variables is not available.

In the second chapter, the empirical estimation takes into account just the relationship between two variables (bank lending-to-GDP ratio and GDP growth rate) to test for any thresholds. Potentially, the inclusion of other variables in such estimations could assist researchers to pin-point the exact threshold values. Unfortunately, such methods are not available for STCC models at the moment. Furthermore, the results are only indicative of the behaviour of the two variables using the values found within the sample. We are unaware of whether, for example, a bank lending-to-GDP ratio higher than those in the sample countries is harmful for growth. However, this is a limitation present not only to this study but to all empirical findings. In addition, a high amount of debt may not be harmful in the short to medium term but become unsustainable in the longer term.

Finally, in chapter three the result regarding the lack of persistence of monetary policy on bank lending does not necessarily mean that the same conclusion holds for the short-run. While we can conclude that monetary policy does not have a persistent effect on bank lending decisions, short-run effects are still being studied by researchers.

The results of this dissertation along with the above limitations provide an opportunity for more research. Extensions of the FAVAR model presented in chapter one as well as theoretical justifications of the credit creation theory would further enhance our knowledge on the subject. In addition, higher frequency data (for example at the monthly level) could perhaps be more indicative of the exact relationship of bank lending on output. Testing whether the growth rate of deposits, when significantly different from the growth rate of lending, is helpful in predicting credit booms or liquidity problems is also very appealing for future research. This effect could be connected with work on emerging economies, as well as with the literature on leading indicators.

Another possible extension of this work, connected with the findings of chapter two, is to study the allocation of loans in the economy as an indication of whether over-heating in one sector can potentially affect the economy as a whole. Even though there does not exist an overall threshold after which lending harms the economy, this may not be the case for sector-specific debt-to-GDP ratios. Finally, following the conclusion that policy does not have any persistent effects on bank lending behaviour, examining whether short-run effects of policy can be observed is again a significant direction for future research.

Summing up, this dissertation has employed mainly empirical econometric estimations but has also used a theoretical model to examine the effects of bank lending on output growth and the subsequent policy implications. It has provided conclusions which can be of importance to policymakers and central banks in their effort to promote growth and limit downturns and crises. Given the importance of the subject for policymaking and the significance of financial development for the economy, studying the effects of this relationship will continue to remain in the spotlight of future research.

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Appendix I

This appendix lists all the variables used to construct the World and country-specific factors. All variables were obtained from globalfinancialdata.com unless otherwise specified. Transformation codes are: 1 = No Transformation, 2 = First Difference, 5 = First Difference of Logarithms. The following abbreviations appear: SA = Seasonally Adjusted, NSA = Not Seasonally Adjusted, EU = European Union, EA = Euro Area

Variables Employed for World Factors

No	Series	Variable Name	Transformation Code
		Real Output and Income Indices	
1	GDPEU27	EU27-Gross Domestic Product (€mn - c.p.) - SA	5
2	GDPEA17	EA-Gross Domestic Product (€mn - c.p.) - SA	5
3	GDPUKSA	UK-Gross Domestic Product (€mn - c.p.) - SA	5
4	MQEU27	Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply EU27	5
5	MQEA17	Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply EA	5
6	MQCEU27	Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; construction EU27	5
7	MNQCEA	Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; construction EA	5
8	MNQCUK	Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; construction UK	5
		Exchange Rate Indices	
9	USDOLL	US dollar	5
10	GBPOUND	Pound sterling	5
11	CHFRNC	Swiss franc	5
12	CANDOL	Canadian dollar	5
13	JAPYEN	Japanese yen	5

14	RRUBLE	Russian rouble	5
		Price Indices	
15	UKCPIM	Consumer Price Index - UK	5
16	EUHCPI	Europe Harmonised Consumer Price Index	5
		Stock Price Indices	
17	FTSE100	FTSE 100 - Price Index	5
18	FRCAC40	France CAC 40 - Price Index	5
19	SNP500	S&P 500 Composite - Price Index	5
20	SNP100	S&P 100 - Price Index	5
21	NYSECOMP	NYSE Composite - Price Index	5
22	NIKKEI	Japan, Japanese yen, Nikkei 225 Stock Average Index	5
23	EUDOW50	Europe, Euro, Dow Jones Stoxx 50 Price Index	5
24	EUDOWXX	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Price Index	5
25	DOWMAT	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Basic Materials E Index	5
26	DOWCONSG	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Consumer Goods Index	5
27	DOWCONS	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Consumer Services Index	5
28	DOWFIN	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Financials Index	5
29	DOWTECH	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Technology E Index	5
30	DOWHEALTH	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Healthcare Index (S1ESH1E)	5
31	DOWINDST	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Industrials Index	5
32	DOWOIL	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Oil & Gas Energy Index	5
33	DOWTELE	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Telecommunications Index	5
34	DOWUTILIT	Euro area (changing composition), Euro, Dow Jones Euro Stoxx Utilities E Index	5
35	DJ50EU	Dow Jones STOXX 50 (Europe)	5
36	DJEU50	Dow Jones EURO STOXX 50	5
37	DOWBROAD	Dow Jones STOXX Broad (Europe)	5
38	DJEUBR	Dow Jones EURO STOXX Broad	5
39	DOWJIA	Dow Jones Industrial Average	5
40	USSNP500	United States, US dollar, Standard & Poors 500 Composite Index (S_PCOMP)	5

		Interest Rates Indices	
41	GBYUK10	UK 10 -year Government Bond Yield	2
42	EURIBOR3	Europe 3-month EURIBOR	2
43	EURIBOR6	Europe 6-month EURIBOR	2
44	EURIBOR12	Europe 12-month EURIBOR	2
45	MACYBOND	Moody's Aaa Corporate Yield	2
46	MBCYBOND	Moody's Baa Corporate Yield	2
47	IGFRA10D	France 10-year Government Bond Yield	2
48	ITFRA3D	France 3-month Treasury Bill Yield	2
49	ITGBR3D	UK 3-month Treasury Bill Yield	2
50	SUKG10	Spread UK (GBYUK10 - ITGBR3D)	1
51	SFRAG10	Spread France (IGFRA10D - ITFRA3D)	1
		Commodity Price Indices	
52	BRENTOIL	Brent Crude Oil (€)-Commodity Prices	5
53	GOLDBUL	Gold Bullion Price-New York (€/Ounce) -Commodity Price	5
54	SLVERCASH	Silver Cash Price (€/Ounce) -Commodity Prices	5
		Miscellaneous	
55	EUINDU	EU Industry Confidence Indicator	2
56	EUSERV	EU Services Confidence Indicator	2
57	EUCONS	EU Consumer Confidence Indicator	2
58	EURETA	EU Retail Trade Confidence Indicator	2
59	EUBUIL	EU Construction Confidence Indicator	2
60	ESIEUM	EU Economic Sentiment Indicator	2
61	EAINDU	EA Industry Confidence Indicator	2
62	EASERV	EA Services Confidence Indicator	2
63	EACONS	EA Consumer Confidence Indicator	2
64	EARETA	EA Retail Trade Confidence Indicator	2
65	EABUIL	EA Construction Confidence Indicator	2
66	ESIEAM	EA Economic Sentiment Indicator	2

67	UKINDU	UK Industry Confidence Indicator	2
68	UKSERV	UK Services Confidence Indicator	2
69	UKCONS	UK Consumer Confidence Indicator	2
70	UKRETA	UK Retail Trade Confidence Indicator	2
71	UKBUIL	UK Construction Confidence Indicator	2
72	ESIUKM	UK Economic Sentiment Indicator	2

Variables Employed for German Domestic Factors

No	Series	Variable Name	Transformation Code
		Real Output and Income Indices	
1	DEE0177	Construction Production Index (Construction)	5
2	DEE0258	Industry Production Index (Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply)	5
3	DEE0259	Industry Turnover Index (MIG - Capital goods)	5
4	DEE0260	Industry Turnover Index (MIG - Consumer goods)	5
5	DEE0261	Industry Turnover Index (MIG - Intermediate goods)	5
6	DEE0263	Industry Turnover Index (MIG - Energy (except D and E))	5
7	NDDEUM	Industrial Production Index	5
8	NDWDEUM	Industrial Production Volume SA	5
		Labour Market Indices	
9	DEE0166	Real Unit Labour Cost Index, NSA	5
10	DEE0181	Industry Labor Input Index (MIG - Capital goods) Employment	5
11	DEE0182	Industry Labor Input Index (MIG - Consumer goods) Employment	5
12	DEE0184	Industry Labor Input Index (MIG - Durable consumer goods) Employment	5
13	DEE0185	Industry Labor Input Index (MIG - Intermediate goods) Employment	5
14	DEE0186	Industry Labor Input Index (MIG - Non-durable consumer goods) Employment	5
15	DEE0187	Industry Labor Input Index (MIG - Energy) Employment	5
16	DEE0188	Industry Labor Input Index (MIG - Energy (except D and E)) Employment	5
17	DEE0192	Industry Labor Input Index (MIG - Capital goods) Hours Worked	5
18	DEE0193	Industry Labor Input Index (MIG - Consumer goods) Hours Worked	5
19	DEE0195	Industry Labor Input Index (MIG - Durable consumer goods) Hours Worked	5
20	DEE0196	Industry Labor Input Index (MIG - Intermediate goods) Hours Worked	5
21	DEE0197	Industry Labor Input Index (MIG - Non-durable consumer goods) Hours Worked	5
22	DEE0198	Industry Labor Input Index (MIG - Energy) Hours Worked	5
23	DEE0199	Industry Labor Input Index (MIG - Energy (except D and E)) Hours Worked	5

24	DEE0200	Industry Labor Input Index (Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply) Gross Wages and Salaries	5
25	DEE0201	Industry Labor Input Index (Industry (except construction), sewerage, waste management and remediation activities) Gross Wages and Salaries	5
26	DEE0203	Industry Labor Input Index (MIG - Capital goods) Gross Wages and Salaries	5
27	DEE0204	Industry Labor Input Index (MIG - Consumer goods) Gross Wages and Salaries	5
28	DEE0206	Industry Labor Input Index (MIG - Durable consumer goods) Gross Wages and Salaries	5
29	DEE0207	Industry Labor Input Index (MIG - Intermediate goods) Gross Wages and Salaries	5
30	DEE0208	Industry Labor Input Index (MIG - Non-durable consumer goods) Gross Wages and Salaries	5
31	DEE0209	Industry Labor Input Index (MIG - Energy) Gross Wages and Salaries	5
32	DEE0210	Industry Labor Input Index (MIG - Energy (except D and E)) Gross Wages and Salaries	5
33	DEE0153	Real Labour Productivity Per Person Employed Index, NSA	5
34	DEE0306	Unemployment Rate Total From 25 to 74 years (SA)	2
35	DEN0079	Gross wages and salaries (Millions of national currency NSA) Total	5
		Price Indices	
36	DEE0246	Industry Producer Prices Index (Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply)	5
37	DEE0247	Industry Producer Prices Index (Industry (except construction), sewerage, waste management and remediation activities)	5
38	DEE0248	Industry Producer Prices Index (Industry (except construction, sewerage, waste management and remediation activities), except food, beverages and tobacco)	5
39	DEE0250	Industry Producer Prices Index (MIG - Consumer goods)	5
40	DEE0252	Industry Producer Prices Index (MIG - Durable consumer goods)	5
41	DEE0253	Industry Producer Prices Index (MIG - Intermediate goods)	5
42	DEE0254	Industry Producer Prices Index (MIG - Intermediate and capital goods)	5
43	DEE0256	Industry Producer Prices Index (MIG - Energy)	5
44	DEE0257	Industry Producer Prices Index (MIG - Energy (except D and E))	5
45		Industry Producer Prices Index (MIG - Consumer goods)	5
46	EXPDEUM	Export Price Index	5

47	IMPDEUM	Import Price Index	5
		Stock Market Indices	
48	CXKBXD	CDAX Banks Price Index	5
49	DE1	Dow Jones Germany Stock Index	5
		Banking Sector Indices	
50	DEE0079	Deposits with agreed maturity up to 2 years (Millions of euro NSA)	5
51	DEE0080	Deposits redeemable at notice up to 3 months (Millions of euro NSA)	5
52	DEE0088	Total deposits of residents held at monetary financial institutions (non-consolidated) (Millions of euro NSA)	5
53	DEE0089	Central government deposits held at monetary financial institutions (Millions of euro NSA)	5
54	DEE0090	Deposits of monetary financial institutions held at monetary financial institutions (Millions of euro NSA)	5
55	DEE0091	Deposits of other residents held at monetary financial institutions (Millions of euro NSA)	5
56	DEE0092	Total deposits of residents held at monetary financial institutions (consolidated) (Millions of euro NSA)	5
57	DEE0093	Loans to total residents granted by monetary financial institutions (non-consolidated) (Millions of euro NSA)	5
58	DEE0094	Loans to general government granted by monetary financial institutions (Millions of euro NSA)	5
59	DEE0095	Loans to monetary financial institutions granted by monetary financial institutions (Millions of euro NSA)	5
60	DEE0096	Loans to other residents granted by monetary financial institutions (Millions of euro NSA)	5
61	DEE0097	Loans to total residents granted by monetary financial institutions (consolidated) (Millions of euro NSA)	5
62	DEE0103	Overnight deposits (Millions of euro NSA)	5
63	DEE0106	Deposits with agreed maturity up to 2 years (Millions of national currency NSA)	5
64	DEE0107	Deposits redeemable at notice up to 3 months (Millions of national currency NSA)	5
65	DEE0115	Total deposits of residents held at monetary financial institutions (non-consolidated) (Millions of national currency NSA)	5
66	ILDEUBM	Business Loans to 1 Year	5
67	DEE0081	Money market paper and debt securities up to 2 years (Millions of euro NSA)	5
68	DEE0105	Money market funds shares/units (Millions of euro NSA)	5

69	DEE0108	Money market paper and debt securities up to 2 years (Millions of national currency NSA)	5
70	DEE0129	Money market funds shares/units (Millions of national currency NSA)	5
		External Sector	
71	DET0025	Quarterly Exports Of Goods (Current Prices, Millions Of National Currency, Not Seasonally Adjusted Data)	5
72	DET0026	Quarterly Exports Of Services (Current Prices, Millions Of National Currency, Not Seasonally Adjusted Data)	5
73	DET0038	Quarterly Imports Of Goods (Current Prices, Millions Of National Currency At Prices Of The Previous Year, Not Seasonally Adjusted Data)	5
74	DET0039	Quarterly Imports Of Services (Current Prices, Millions Of National Currency At Prices Of The Previous Year, Not Seasonally Adjusted Data)	5
75	DET0019	Net Current Account (Millions Of Euro, Quarterly)	2
76	DEN0032	Imports of goods and services (Millions of national currency NSA)	5
		Miscellaneous	
77	CCDEUM	Consumer Confidence Index	5
78	DEN0042	Gross capital formation (Millions of national currency SA)	5
79	DEN0094	Household and NPISH final consumption expenditure (Millions of national currency NSA)	5
80	IGDEU35D	3-5 Year Government Bond Yield	2
81	GOVREV	Central Government Revenue (Source: Thomson Datastream)	5

Variables Employed for Italy Domestic Factors

No	Series	Variable Name	Transformation Code
		Real Output and Income Indices	
1	ITE0169	Industry Production Index (Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply)	5
2	ITE0170	Industry Turnover Index (MIG - Capital goods)	5
3	ITE0171	Industry Turnover Index (MIG - Consumer goods)	5
4	ITE0172	Industry Turnover Index (MIG - Intermediate goods)	5
5	ITE0173	Industry Turnover Index (MIG - Intermediate and capital goods)	5
6	ITE0174	Industry Turnover Index (MIG - Energy (except D and E))	5
7	NDITAM	Industrial Production Index SA	5
8	NDWITAM	Industrial Production Volume SA	5
		Labour Market Indices	
9	ITE0130	Nominal Unit Labour Cost Index, NSA	5
10	ITE0132	Real Unit Labour Cost Index, NSA	5
11	ITE0119	Real Labour Productivity Per Person Employed Index, NSA	5
12	ITE0211	Unemployment Rate Total Less than 25 years (NSA)	2
13	ITE0176	Unemployment Long-term unemployment in % of active population (Females)	2
14	ITE0181	Unemployment Very long-term unemployment in % active population (Males)	2
15	ITE0182	Unemployment Long-term unemployment in % of active population (Total)	2
16	ITE0188	Unemployment Females From 25 to 74 years (NSA)	5
17	ITE0193	Unemployment Total Less than 25 years (NSA, no of persons)	5
18	ITE0218	Unemployment Rate Females Less than 25 years (SA)	2
		Price Indices	
19	CPHITAM	Harmonized Consumer Price Index	5
20	EXPITAM	Export Price Index	5
21	IMPITAM	Import Price Index	5
		Stock Market Indices	

22	FTIT13D	FTSE Italia All-Share Chemicals Index	5
23	FTIT20D	FTSE Italia All-Share Industrials Index	5
24	FTIT23D	FTSE Italia All-Share Construction and Materials Index	5
25	FTIT33D	FTSE Italia All-Share Automobiles and Parts Index	5
26	FTIT50D	FTSE Italia All-Share Consumer Services Index	5
27	FTIT53D	FTSE Italia All-Share Retail Index	5
28	FTIT55D	FTSE Italia All-Share Media Index	5
29	FTIT70D	FTSE Italia All-Share Utilities Index	5
30	FTIT80D	FTSE Italia All-Share Financial Index	5
31	FTIT83D	FTSE Italia All-Share Banks Index	5
32	FTITMCD	FTSE Italia All-Share Midcap Index	5
33	IT1	Dow Jones Italy Stock Index	5
		Banking Sector Indices	
34	ITE0081	Total deposits of residents held at monetary financial institutions (non-consolidated) (Millions of euro NSA)	5
35	ITE0082	Central government deposits held at monetary financial institutions (Millions of euro NSA)	5
36	ITE0086	Loans to total residents granted by monetary financial institutions (non-consolidated) (Millions of euro NSA)	5
37	ITE0083	Deposits of monetary financial institutions held at monetary financial institutions (Millions of euro NSA)	5
38	ITE0084	Deposits of other residents held at monetary financial institutions (Millions of euro NSA)	5
39	ITE0085	Total deposits of residents held at monetary financial institutions (consolidated) (Millions of euro NSA)	5
40	ITE0087	Loans to general government granted by monetary financial institutions (Millions of euro NSA)	5
41	ITE0088	Loans to monetary financial institutions granted by monetary financial institutions (Millions of euro NSA)	5
42	ITE0089	Loans to other residents granted by monetary financial institutions (Millions of euro NSA)	5
43	ITE0090	Loans to total residents granted by monetary financial institutions (consolidated) (Millions of euro NSA)	5
44	ITE0093	Overnight deposits (Millions of euro NSA)	5
45	ITE0072	Deposits with agreed maturity up to 2 years (Millions of national currency NSA)	5

46	ITE0073	Deposits redeemable at notice up to 3 months (Millions of national currency NSA)	5
47	ITG0124	General Government, Currency And Deposits Millions Of National Currency	5
48	ITG0125	Central Government, Currency And Deposits Millions Of National Currency	5
49	ITG0128	General government Transferable deposits; other deposits (Millions of national currency)	5
50	ITG0139	General government Loans (Millions of national currency)	5
51	ITG0140	Central government Loans (Millions of national currency)	5
52	ITG0141	Local government Loans (Millions of national currency)	5
53	ITG0142	Social security funds Loans (Millions of national currency)	5
54	ITG0143	General government Short-term - Loans (Millions of national currency)	5
55	ITG0144	Central government Short-term - Loans (Millions of national currency)	5
56	ITG0145	Local government Short-term - Loans (Millions of national currency)	5
57	ITG0146	Social security funds Short-term - Loans (Millions of national currency)	5
58	ITG0147	General government Long-term - Loans (Millions of national currency)	5
59	ITG0148	Central government Long-term - Loans (Millions of national currency)	5
60	ITG0149	Local government Long-term - Loans (Millions of national currency)	5
61	ITG0150	Social security funds Long-term - Loans (Millions of national currency)	5
		External Sector	
62	ITT0184	Quarterly Exports Of Goods (Current Prices, Millions Of National Currency, Not Seasonally Adjusted Data)	5
63	ITT0185	Quarterly Exports Of Services (Current Prices, Millions Of National Currency, Not Seasonally Adjusted Data)	5
64	ITT0197	Quarterly Imports Of Goods (Current Prices, Millions Of National Currency At Prices Of The Previous Year, Not Seasonally Adjusted Data)	5
65	ITT0198	Quarterly Imports Of Services (Current Prices, Millions Of National Currency At Prices Of The Previous Year, Not Seasonally Adjusted Data)	5
66	ITT0178	Net Current Account (Millions Of Euro, Quarterly)	2
67	ITX0008	Real Effective Exchange Rate (deflator: consumer price indices - 16 trading partners - Euro Area)	2
68	ITD0382	Energy Supply: Total imports (Natural Gas) (Terajoules (Gross calorific value = GCV))	5
		Miscellaneous	
69	CCITAM	Consumer Confidence Index	5

70	ITN0046	Gross capital formation (Millions of national currency SA)	5
71	ITN0107	Household and NPISH final consumption expenditure (Millions of national currency NSA)	5
72	IGITA1D	1-year Government Note Yield	2
73	IGITA30D	30-Year Government Bond Yield	2
74	IGITA3D	3-year Government Notes Yield	2
75	IGITA5D	5-Year Government Note Yield	2
76	IGITAID	Variable Rate Coupon Government Bond Yield	2
77	ITITA3D	3-month Treasury Bill Yield	2
78	ITITA6D	6-month Treasury Bill Yield	2
79	IGITAZD	Zero Coupon Government Bond Yield	2
80	INITAM	Average Corporate Bond Yield	2
81	ITD0381	Energy Supply: Primary production (Natural Gas) (Terajoules (Gross calorific value = GCV))	5
82	ITD0414	Gross consumption Electrical Energy	5
83	ITD0415	Total gross electricity generation Electrical Energy	5
84	GOVREV	Government Revenue Total (Source: Thomson Datastream)	5

Variables Employed for Spain Domestic Factors

No	Series	Variable Name	Transformation Code
		Real Output and Income Indices	
1	ESE0190	Industry Production Index (Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply)	5
2	NDESPM	Industrial Production Index	5
3	NDWESPM	Industrial Production Volume SA	5
		Labour Market Indices	
4	ESE0130	Nominal Unit Labour Cost Index, NSA	5
5	ESE0132	Real Unit Labour Cost Index, NSA	5
6	ESN0086	Gross wages and salaries (Millions of national currency NSA) Total	5
7	ESE0119	Real Labour Productivity Per Person Employed Index, NSA	5
8	ESE0238	Unemployment Rate Total From 25 to 74 years (SA)	2
9	ESE0031	Employment rate (25 to 54 years) (Total)	2
10	ESE0036	Agriculture in % of total employment (Total)	2
11	ESE0037	Total employment (domestic concept - ESA) (Total)	5
12	ESE0201	Unemployment Long-term unemployment in % of unemployment (Males)	2
13	ESE0202	Unemployment Very long-term unemployment in % active population (Males)	2
14	ESE0214	Unemployment Total Less than 25 years (NSA)	5
15	ESE0233	Unemployment Rate Females Total (SA)	2
16	UNESPM	Unemployment Rate	2
		Price Indices	
17	EXPESPM	Export Price Index	5
18	IMPESPM	Import Price Index	5
19	CPEESPM	Spain Consumer Price Index: Energy	5
		Stock Market Indices	
20	TRESPGVD	10-year Government Bond Total Return Index	5
21	ES1	Dow Jones Spain Stock Index	5

22	SMSID	Madrid SE General Index	5
23	BCNPR30	Barcelona SE-30 Return Index	5
24	IGENVD	Valencia SE General Index	5
		Banking Sector Indices	
25	ESE0044	Deposits with agreed maturity up to 2 years (Millions of euro NSA)	5
26	ESE0053	Total deposits of residents held at monetary financial institutions (non-consolidated) (Millions of euro NSA)	5
27	ESE0054	Central government deposits held at monetary financial institutions (Millions of euro NSA)	5
28	ESE0055	Deposits of monetary financial institutions held at monetary financial institutions (Millions of euro NSA)	5
29	ESE0056	Deposits of other residents held at monetary financial institutions (Millions of euro NSA)	5
30	ESE0057	Total deposits of residents held at monetary financial institutions (consolidated) (Millions of euro NSA)	5
31	ESE0058	Loans to total residents granted by monetary financial institutions (non-consolidated) (Millions of euro NSA)	5
32	ESE0059	Loans to general government granted by monetary financial institutions (Millions of euro NSA)	5
33	ESE0060	Loans to monetary financial institutions granted by monetary financial institutions (Millions of euro NSA)	5
34	ESE0061	Loans to other residents granted by monetary financial institutions (Millions of euro NSA)	5
35	ESE0062	Loans to total residents granted by monetary financial institutions (consolidated) (Millions of euro NSA)	5
36	ESE0091	Overnight deposits (Millions of national currency NSA)	5
37	ILESPBM	Discount Business Loans	5
38	ESE0046	Money market paper and debt securities up to 2 years (Millions of euro NSA)	5
39	ESE0070	Money market funds shares/units (Millions of euro NSA)	5
		External Sector Indices	
40	EST0143	Quarterly Exports Of Goods And Services (Current Prices, Millions Of National Currency, Not Seasonally Adjusted Data)	5
41	EST0144	Quarterly Exports Of Goods (Current Prices, Millions Of National Currency, Not Seasonally Adjusted Data)	5
42	EST0145	Quarterly Exports Of Services (Current Prices, Millions Of National Currency, Not Seasonally	5

		Adjusted Data)	
43	ESN0119	Imports of goods and services (Millions of national currency, chain-linked volumes, reference year 2000 SA)	5
44	EST0157	Quarterly Imports Of Goods (Current Prices, Millions Of National Currency At Prices Of The Previous Year, Not Seasonally Adjusted Data)	5
45	EST0158	Quarterly Imports Of Services (Current Prices, Millions Of National Currency At Prices Of The Previous Year, Not Seasonally Adjusted Data)	5
46	EST0138	Net Current Account (Millions Of Euro, Quarterly)	2
47	ESX0007	Real Effective Exchange Rate (deflator: consumer price indices - 41 trading partners)	2
48	ESD0417	Energy Supply: Total imports (Natural Gas) (Terajoules (Gross calorific value = GCV))	5
		Miscellaneous	
49	CCESPM	Consumer Confidence Index	5
50	ESN0040	Gross capital formation (Millions of national currency SA)	5
51	ESN0101	Household and NPISH final consumption expenditure (Millions of national currency NSA)	5
52	IGESP1D	1-Year Government Bond Yield	2
53	ESD0416	Energy Supply: Primary production (Natural Gas) (Terajoules (Gross calorific value = GCV))	5
54	ESD0418	Energy Supply: Stock change (Natural Gas) (Terajoules (Gross calorific value = GCV))	2
55	ESD0420	Energy Supply: Gross inland consumption (Natural Gas) (Terajoules (Gross calorific value = GCV))	5
56	ESD0449	Gross consumption Electrical Energy	5
57	IGESP2D	2-Year Government Bond Yield	2
58	INESPM	Electric Utility Bond Yield	2
59	ITESP12D	12-month Treasury Bill Yield	2
60	ITESP3M	3-month T-Bill Yield	2
61	ITESP6M	6-month Treasury Bill Yield	2
62	GOVREV	Total Government Revenue (Source: Thomson Datastream)	5

Appendix II

Supplement 1

Mathematical workings for the calculation of the first derivative of output with respect to a change in lending

From equation (2.22) in the Chapter, we have that $L_{it}=\left[\frac{1}{2}\frac{aA}{R_t^d}\right]^{\frac{1}{1-a}}$ or $L_{it}=\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}}$

Differentiating with respect to R_t^d yields: $\frac{dL_{it}}{dR_t^d}=\frac{-1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}-1}$ (A.1)

Using equation (2.26) in the Chapter we know that $R_t^d=\frac{1}{\beta^2}\frac{N_tL_{it}-V_t}{sY_t-N_tL_{it}+V_t}$ which we can differentiate with respect to V_t :

$$\frac{dR_t^d}{dV_t}=\frac{1}{\beta^2}\frac{\left(N_t\frac{dL_{it}}{dV_t}-1\right)\left(sY_t-N_tL_{it}+V_t\right)-\left(N_t\frac{dL_{it}}{dV_t}+1\right)\left(N_tL_{it}-V_t\right)}{\left(sY_t-N_tL_{it}+V_t\right)^2}$$

Or after simplifying:

$$\frac{dR_t^d}{dV_t} = \frac{1}{\beta^2} \frac{N_t \frac{dL_{it}}{dV_t} sY - sY_{tt}}{\left(sY_t - N_t L_{it} + V_t\right)^2} \tag{A.2}$$

From the chain rule, we know that $\frac{dL_{it}}{dV_t} = \frac{dL_{it}}{dR_t^d} \frac{dR_t^d}{dV_t}$ which means that we can substitute (A.1) into (A.2) to get:

$$\frac{dR_t^d}{dV_t} = \frac{1}{\beta^2} \frac{N_t \left(\frac{-1}{1-a} \left[\frac{1}{2} aA \right]^{\frac{1}{1-a}} \left(R_t^d\right)^{\frac{-1}{1-a}-1} \right) \frac{dR_t^d}{dV_t} sY_t}{\left(sY_t - N_t L_{it} + V_t\right)^2} + \frac{1}{\beta^2} \frac{-sY_t}{\left(sY_t - N_t L_{it} + V_t\right)^2}$$

$$\Rightarrow \frac{dR_t^d}{dV_t} \left(1 + \frac{1}{\beta^2} \frac{N_t \left(\frac{1}{1-a} \left[\frac{1}{2} aA \right]^{\frac{1}{1-a}} \left(R_t^d\right)^{\frac{-1}{1-a}-1} \right) sY_t}{\left(sY_t - N_t L_{it} + V_t\right)^2} \right) = \frac{1}{\beta^2} \frac{-sY_t}{\left(sY_t - N_t L_{it} + V_t\right)^2}$$

which can be further simplified to the following

$$\Rightarrow \frac{dR_t^d}{dV_t}\left(\frac{\beta^2\left(sY_t - N_tL_{it} + V_t\right)^2 + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}-1}\right)sY_t}{\left(sY_t - N_tL_{it} + V_t\right)^2}\right) = \frac{1}{\beta^2}\frac{-sY_t}{\left(sY_t - N_tL_{it} + V_t\right)^2}$$

and finally to

$$\frac{dR_t^d}{dV_t} = \frac{-sY_t}{\beta^2\left(sY_t - N_tL_{it} + V_t\right)^2 + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}-1}\right)sY_t} < 0 \qquad \text{(A.3)}$$

which corresponds to equation (2.27) in the Chapter.

To get the effect of a change in the future level of output from a change in bank capital (i.e. an indirect change to the level of lending) we use:

$$\frac{dY_{t+1}}{dV_t} = aAN_tL_{it}^{a-1}\frac{dL_{it}}{dV_t}$$

Or similarly, through the chain rule used above,

$$\frac{dY_{t+1}}{dV_t} = aAN_t L_{it}^{a-1} \frac{dL_{it}}{dR_t^d} \frac{dR_t^d}{dV_t} \tag{A.4}$$

Plugging (A.1) and (A.3) into (A.4) of this supplement we get that:

$$\frac{dY_{t+1}}{dV_t} = aAN_t L_{it}^{a-1} \left(\frac{-1}{1-a} \left[\frac{1}{2} aA \right]^{\frac{1}{1-a}} \left(R_t^d \right)^{\frac{-1}{1-a}-1} \right) \frac{-sY_t}{\beta^2 \left(sY_t - N_t L_{it} + V_t \right)^2 + N_t \left(\frac{1}{1-a} \left[\frac{1}{2} aA \right]^{\frac{1}{1-a}} \left(R_t^d \right)^{\frac{-1}{1-a}-1} \right) sY_t}$$

After simplifying the signs, it is evident that the first derivative is greater than zero.

$$\frac{dY_{t+1}}{dV_t} = \frac{aAN_t L_{it}^{a-1} \left(\frac{1}{1-a} \left[\frac{1}{2} aA \right]^{\frac{1}{1-a}} \left(R_t^d \right)^{\frac{-1}{1-a}-1} \right) sY_t}{\beta^2 \left(sY_t - N_t L_{it} + V_t \right)^2 + N_t \left(\frac{1}{1-a} \left[\frac{1}{2} aA \right]^{\frac{1}{1-a}} \left(R_t^d \right)^{\frac{-1}{1-a}-1} \right) sY_t} > 0 \tag{A.5}$$

Here, further simplifications are appropriate. From equation (2.7) in the Chapter we have that $R_t^d = \frac{1}{\beta^2} \frac{D_t}{\Pi_t - D_t}$ or

$$R_t^d = \frac{1}{\beta^2} \frac{D_t}{\Pi_t - D_t} \Rightarrow R_t^d \beta^2 \left(\Pi_t - D_t \right) = D_t \Rightarrow \beta^2 \left(\Pi_t - D_t \right) = \frac{D_t}{R_t^d}$$

which after substituting in equation (2.18) in the Chapter and using the facts that $\Gamma_t = N_t L_{it}$ and t $\Pi_t = sY_t$, we get that:

$$\frac{D_t}{R_t^d} = \beta^2 \left(sY_t - N_t L_{it} - V_t \right) \tag{A.6}$$

Using (A.6) to simplify (A.5), we have that:

$$\frac{dY_{t+1}}{dV_t} = \frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} \frac{aAN_t L_{it}^{a-1}\left(R_t^d\right)^{\frac{-1}{1-a}-1} sY_t}{\left(D_t\right)^2\left(R_t^d\right)^{-2} + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}-1}\right)sY_t} > 0$$

In addition, substituting the loan equation (2.22) from the main text into the above we get that,

$$\frac{dY_{t+1}}{dV_t} = \frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} \frac{aAN_t\left[\frac{1}{2}\frac{aA}{R_t^d}\right]^{-1}\left(R_t^d\right)^{\frac{-1}{1-a}-1} sY_t}{\left(D_t\right)^2\left(R_t^d\right)^{-2} + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}-1}\right)sY_t} > 0$$

which simplifies to,

$$\frac{dY_{t+1}}{dV_t} = \frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} \frac{N_t\left(R_t^d\right)^{\frac{-1}{1-a}} sY_t}{\left(D_t\right)^2\left(R_t^d\right)^{-2} + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-1}{1-a}-1}\right)sY_t} > 0$$

and further to, $\frac{dY_{t+1}}{dV_t} = \frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} \frac{N_t\left(R_t^d\right)^{\frac{-1}{1-a}} sY_t}{\left(R_t^d\right)^{\frac{-1}{1-a}}\left(\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}} + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1}\right)sY_t\right)} > 0$

while finally we find $\frac{dY_{t+1}}{dV_t} = \frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} \frac{N_t sY_t}{\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}} + N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1} sY_t} > 0$

which corresponds to equation (2.28) in the Chapter.

Supplement 2

Mathematical workings for the calculation of the second derivative of output with respect to a change in lending

From equation (2.28) in the Chapter, we know that

$$\frac{dY_{t+1}}{dV_t} = \frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} \frac{N_t sY_t}{\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}} + N_t\left(\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1}\right)sY_t} > 0$$

To get the second derivative, we again differentiate the above, with respect to V_t , i.e.

$$\frac{d^2Y_{t+1}}{dV_t^2} = \frac{-2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} N_t sY_t \frac{2D_t\left(R_t^d\right)^{\frac{-3-2a}{1-a}}\frac{dD_t}{dV_t} - \left[\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}} + N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2} sY_t\right]\frac{dR_t^d}{dV_t}}{\left(\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}} + N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1} sY_t\right)^2}$$

or, simply

$$\frac{d^2Y_{t+1}}{dV_t^2}=\frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}N_t sY_t\frac{-2D_t\left(R_t^d\right)^{\frac{-3-2a}{1-a}}\frac{dD_t}{dV_t}+\left[\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t\right]\frac{dR_t^d}{dV_t}}{\left(\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1}sY_t\right)^2} \tag{A.7}$$

We know from (2.7) in the Chapter that $R_t^d=\frac{1}{\beta^2}\frac{D_t}{\Pi_t-D_t}$, and thus if we differentiate it with respect to V_t we get:

$$\frac{dR_t^d}{dV_t}=\frac{1}{\beta^2}\frac{\frac{dD_t}{dV_t}\left(\Pi_t-D_t\right)-\left(-\frac{dD_t}{dV_t}\right)D_t}{\left(\Pi_t-D_t\right)^2}\Leftrightarrow\frac{dR_t^d}{dV_t}\beta^2\left(\Pi_t-D_t\right)^2=\frac{dD_t}{dV_t}\Pi_t$$

which suggests that $\frac{dD_t}{dV_t}=\frac{dR_t^d}{dV_t}\frac{\beta^2\left(\Pi_t-D_t\right)^2}{\Pi_t}$, or, after using the fact that $\Pi_t=sY_t$, it becomes

$$\frac{dD_t}{dV_t}=\frac{dR_t^d}{dV_t}\frac{\beta^2\left(sY_t-D_t\right)^2}{sY_t} \tag{A.8}$$

Substituting (A.8) into the equation for the second derivative (A.7) yields that

$$\frac{d^2Y_{t+1}}{dV_t^2} = \frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}} N_t sY_t \frac{\left[-2D_t\left(R_t^d\right)^{\frac{-3-2a}{1-a}}\frac{\beta^2\left(sY_t-D_t\right)^2}{sY_t}+\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t\right]\frac{dR_t^d}{dV_t}}{\left(\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1}sY_t\right)^2} \quad \text{(A.9)}$$

To check the sign of the second derivative, we need to examine the numerator of the fraction in (A.9), i.e.

$$-2D_t\left(R_t^d\right)^{\frac{-3-2a}{1-a}}\frac{\beta^2\left(sY_t-D_t\right)^2}{sY_t}+\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t$$

Or,

$$-2D_t\left(R_t^d\right)^{\frac{-3-2a}{1-a}}\frac{\beta^2\left(sY_t-D_t\right)}{sY_t}\left(sY_t-D_t\right)+\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t \quad \text{(A.10)}$$

We know again from equation (2.7) in the Chapter that $R_t^d = \frac{1}{\beta^2}\frac{D_t}{\Pi_t - D_t} = \frac{1}{\beta^2}\frac{D_t}{sY_t - D_t}$ and thus,

$$\frac{D_t}{R_t^d\beta^2} = sY_t - D_t \quad \text{(A.11)}$$

Substituting (A.11) into the numerator equation (A.10) yields

$$-2D_t\left(R_t^d\right)^{\frac{-3-2a}{1-a}}\frac{\beta^2\left(sY_t-D_t\right)}{sY_t}\frac{D_t}{R_t^d\beta^2}+\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t$$

or

$$-2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}\frac{\left(sY_t-D_t\right)}{sY_t}+\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t \qquad \text{(A.12)}$$

Equation (A.12) can be further simplified to

$$2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}\frac{D_t}{sY_t}-2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+\frac{3+2a}{1-a}\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t$$

Using the common terms, the above becomes

$$2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}\frac{D_t}{sY_t}+\left(\frac{3+2a}{1-a}-2\right)\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t$$

while we can simplify it to

$$2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}\frac{D_t}{sY_t}+\left(\frac{3+2a-2+2a}{1-a}\right)\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t$$

and further to

$$2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}\frac{D_t}{sY_t}+\left(\frac{1+4a}{1-a}\right)\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t>0 \tag{A.13}$$

which is positive.

Substituting (A.13) into the second derivative equation (A.9) we get that

$$\frac{d^2Y_{t+1}}{dV_t^2}=\frac{2}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}N_tsY_t\frac{\left[2D_t^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}\frac{D_t}{sY_t}+\left(\frac{1+4a}{1-a}\right)\left(D_t\right)^2\left(R_t^d\right)^{\frac{-4-a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-2}sY_t\right]\frac{dR_t^d}{dV_t}}{\left(\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}}+N_t\frac{1}{1-a}\left[\frac{1}{2}aA\right]^{\frac{1}{1-a}}\left(R_t^d\right)^{-1}sY_t\right)^2} \tag{A.14}$$

where, after taking out the common terms, we get

$$\frac{d^2Y_{t+1}}{dV_t^2}=\frac{\frac{2sY_tN_t}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{-4-a}{1-a}}\left[\frac{1+4a}{1-a}\left(D_t\right)^2+\frac{sY_tN_t}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}}\left(R_t^d\right)^{\frac{6-a}{1-a}}+2\frac{\left(D_t\right)^3}{sY_t}\right]\frac{dR_t^d}{dV_t}}{\left[\left(D_t\right)^2\left(R_t^d\right)^{\frac{-3-2a}{1-a}}+\frac{1}{1-a}\left(\frac{aA}{2}\right)^{\frac{1}{1-a}}sY_tN_t\left(R_t^d\right)^{-1}\right]^2}$$

which corresponds to equation (2.29) in the Chapter.

Appendix III

Variable Description

The data source for all series is the European Central Bank's Statistical Data Warehouse (SDW) and Eurostat. Definitions of the variables referred to in the Chapter are presented below.

1. Bank lending (L) is defined as total maturity, outstanding amounts at the end of the period, in all currencies, by euro area (changing composition) monetary financial institutions (MFIs) excluding ESCB reporting sector, denominated in euros (balance sheet code: A20). Counterpart sector is non-MFIs excluding general government. Monthly data were aggregated at the quarterly level using the end-of-quarter values.
2. Real GDP (Y) is defined as the seasonally adjusted real output in millions of euros using non-transformed data under the ESA 2010 statistical definition.
3. Policy rate (I) is created using the ECB's main refinancing operations (MRO) rate. In the case where there has been more than one change in the rate during the same month the average rate has been used. A quarterly average of the policy rate was then employed in the estimation.
4. Deposits (D) are defined as total maturity outstanding amounts at the end of the period (stocks) by MFIs, excluding ESCB reporting sector, all currencies combined - euro area (changing composition) denominated in euros. Counterpart sector is non-MFIs. Monthly data were aggregated at the quarterly level using the end-of-quarter values.
5. Credit risk (R) is defined as the ratio of bank lending (L) to total bank assets as obtained by the ECB's SDW. The ratios were created at a monthly frequency and then averaged at the quarterly level.

Appendix IV: Sensitivity analysis for the results of chapter one

This appendix provides a sensitivity analysis for the results presented in chapter one of this thesis. Firstly, evidence is presented that the conclusions of the model hold qualitatively even when the VAR order is altered. Second, I show that the conclusions also hold when total lending and total deposits are replaced with lending to the private sector, i.e. excluding lending to the government and to other monetary financial institutions.

Sensitivity to changes in the VAR order

First Alternative Specification

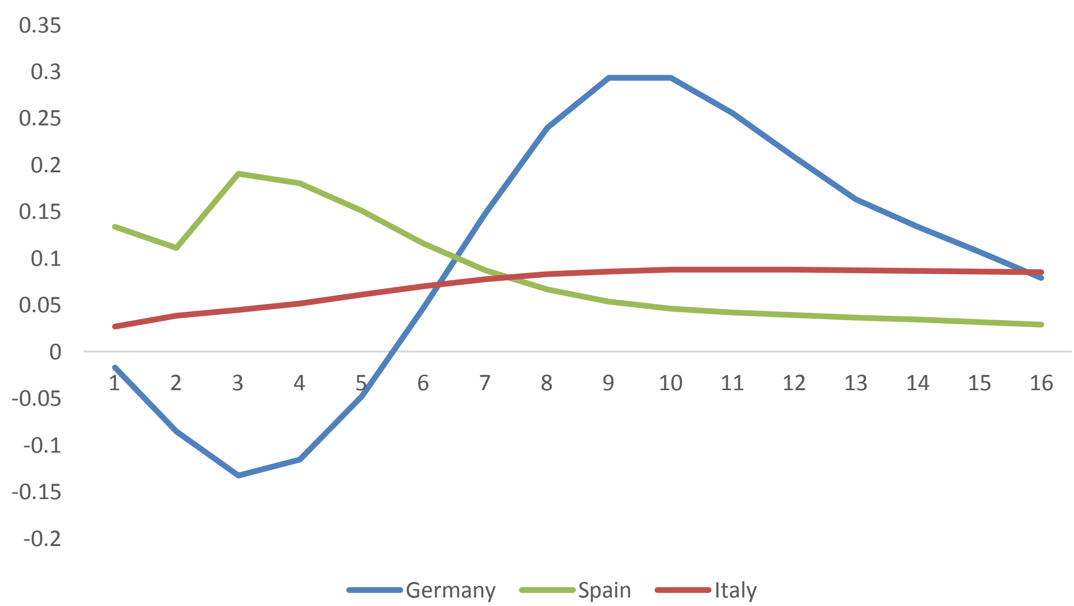

Figure 8: Real GDP response to a positive loan supply shock – first alternative
The figure reports the real GDP response under the first alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to CPI, GDP, Euribor, Loans and Deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of real GDP to the shock since both variables are standardised. It can be observed that an increase in lending increases real GDP overall in all countries.

As the reader may recall, the baseline ordering was GDP, CPI, Euribor, Loans and Deposits followed by local and foreign factors. In the first alternative, the position of CPI and GDP is reversed and thus the ordering now becomes CPI, GDP, Euribor, Loans and Deposits. In essence, the change implies that prices affect output contemporaneously while output cannot have a same-period effect on prices. The results from this identification scheme can be found in figures 7 to 9.

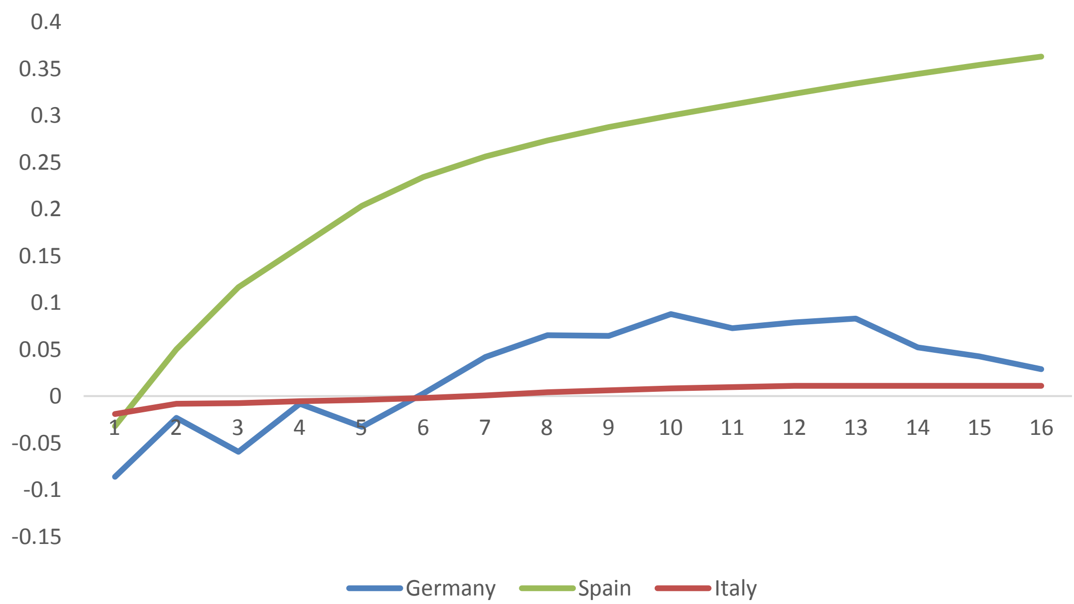

Figure 9: CPI response to a positive loan supply shock – first alternative
The figure reports the Consumer Price Index (CPI) response under the first alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to CPI, GDP, Euribor, Loans and Deposits), after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of the CPI to the shock since both variables are standardised. According to theory, inflation increases with a lag after a shock.

As the figures suggest, the responses to the loan supply shock are very similar to ones presented in the baseline ordering. The change in ordering does not create any large change in the values of the responses, while the shape of the reactions is identical to the ones presented in figures 1 to 3 in chapter one.

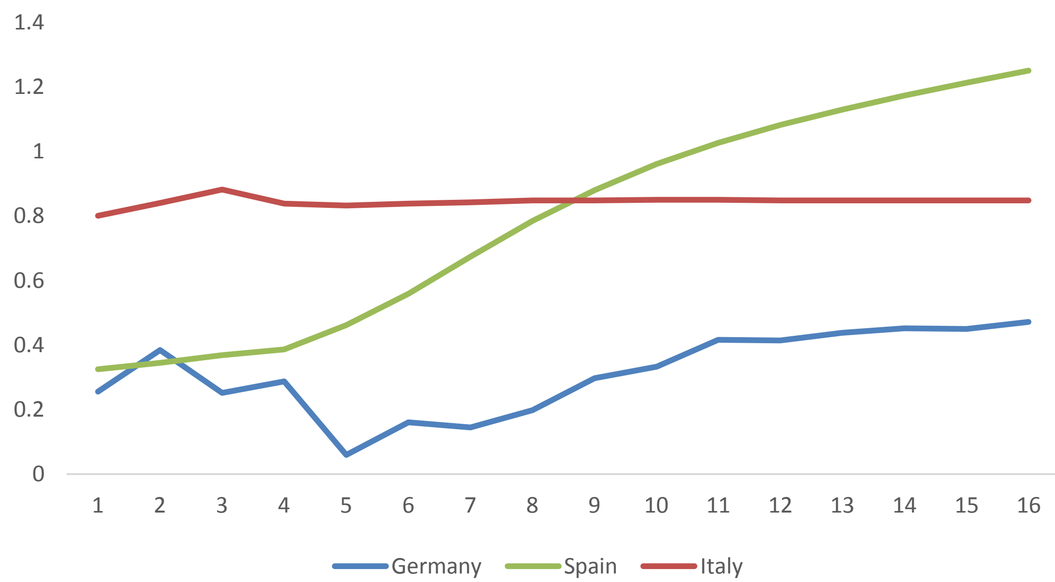

Figure 10: Deposits response to a positive loan supply shock – first alternative
Figure 9 reports the response of deposits under the first alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to CPI, GDP, Euribor, Loans and Deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of deposits to the shock since both variables are standardised. Deposits are increased by almost one-to-one after a positive loan shock showing the first macroeconomic evidence for the credit creation theory.

Second Alternative Specification

In the second alternative, the position of the Euribor rate is altered and placed first in the identification, implying that while monetary policy has a contemporaneous effect on real variables the reverse does not hold. As such, the second alternative ordering becomes Euribor, CPI, GDP, Loans and Deposits. Results from the second alternative identification scheme can be found in figures 10 to 12.

Figures 10 to 12 suggest that the responses to the positive loan supply shock are again very similar to ones presented in the baseline ordering. The change did not create any large change in the values of the responses and the shape of the reactions is identical to the ones presented in figures 1 to 3 in chapter one.

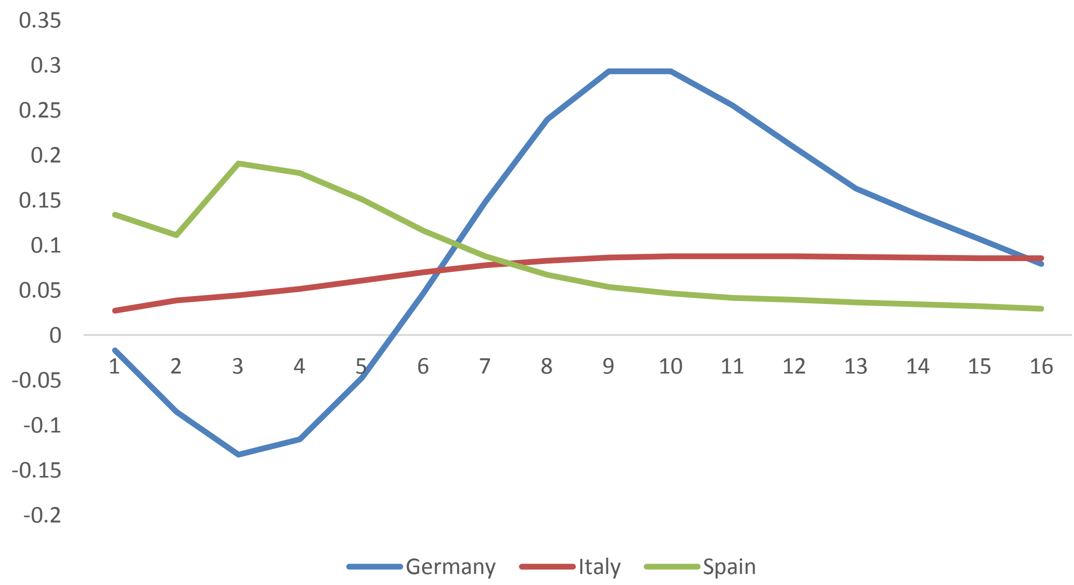

Figure 11: Real GDP response to a positive loan supply shock – second alternative
The figure reports the real GDP response under the second alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to Euribor, CPI, GDP, Loans and Deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of real GDP to the shock since both variables are standardised. It can be observed that an increase in lending increases real GDP overall in all countries.

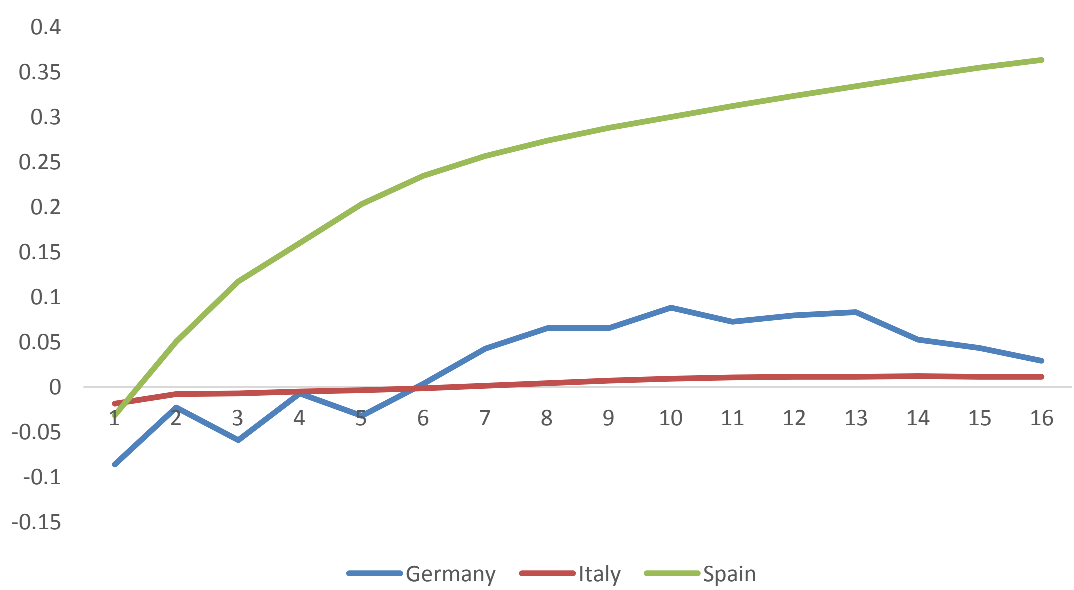

Figure 12: CPI response to a positive loan supply shock – second alternative
The figure reports the Consumer Price Index (CPI) response under the second alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to Euribor, CPI, GDP, Loans and Deposits), after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of the CPI to the shock since both variables are standardised. According to theory, inflation increases with a lag after a shock.

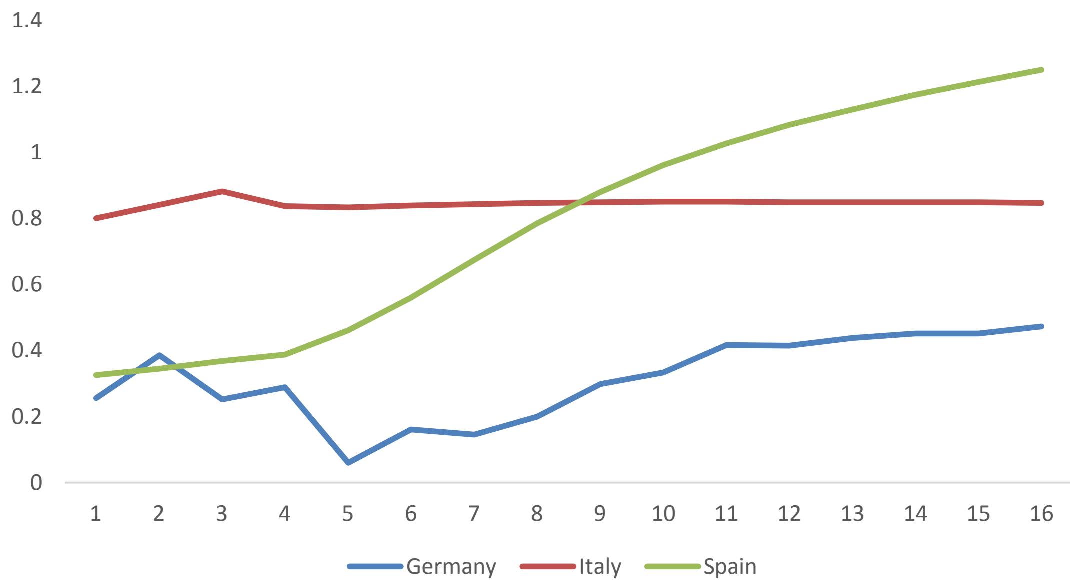

Figure 13: Deposits response to a positive loan supply shock – second alternative
The figure reports the response of deposits under the second alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to Euribor, CPI, GDP, Loans and Deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of deposits to the shock since both variables are standardised. Deposits are increased by almost one-to-one after a positive loan shock showing macroeconomic evidence for the credit creation theory.

As the figures show, the responses to the positive loan supply shock are again very similar to ones presented in the baseline ordering. Thus, we move to testing the third and final alternative order specification.

Third Alternative Specification

In the third alternative identification scheme, real GDP and CPI are placed last in the ordering. The third alternative implies that changes in real variables, i.e. output and prices, do not contemporaneously affect monetary policy, lending and deposit decisions but are however affected by them. Simply put, the third alternative ordering becomes Euribor, Loans, Deposits, GDP and CPI. The results of the third alternative identification are in figures 12 to 14.

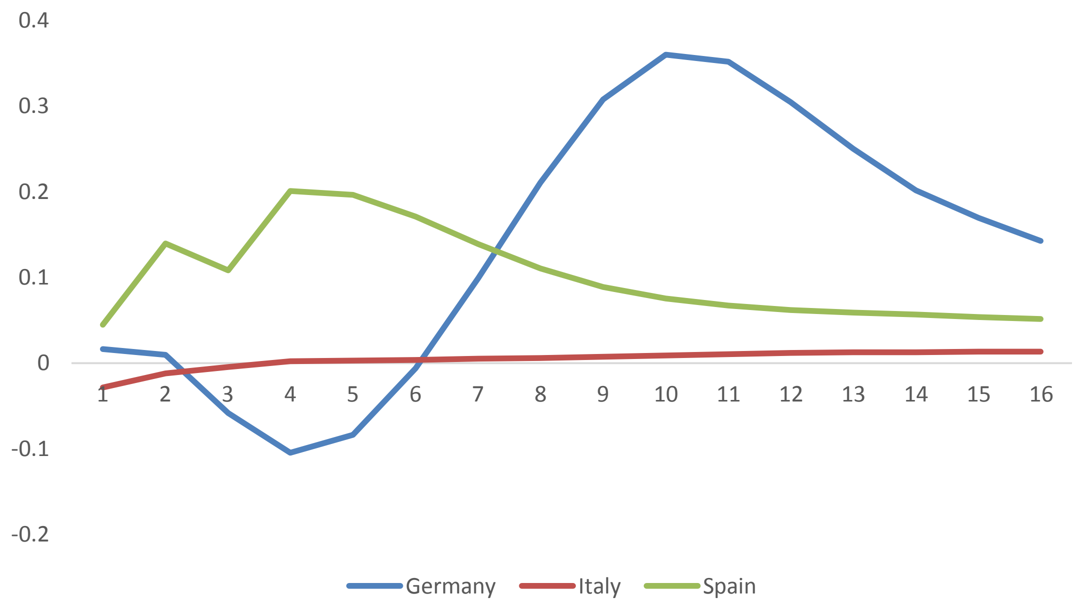

Figure 14: Real GDP response to a positive loan supply shock – third alternative
The figure reports the real GDP response under the third alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to Euribor, Loans, Deposits, GDP and CPI) after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of real GDP to the shock since both variables are standardised. It can be observed that an increase in lending increases real GDP overall in all countries.

Again, and similar to the other two alternatives previously presented in this appendix, the results are very similar to the baseline ones, with only minor quantitative changes (as expected) distinguishing between the four different schemes. Thus, we can safely conclude that the results presented in chapter one are robust to different orderings of the variables within the VAR model. Subsequently, the policy implications and conclusions reached in chapter 1 are also valid across different variable ordering in the model.

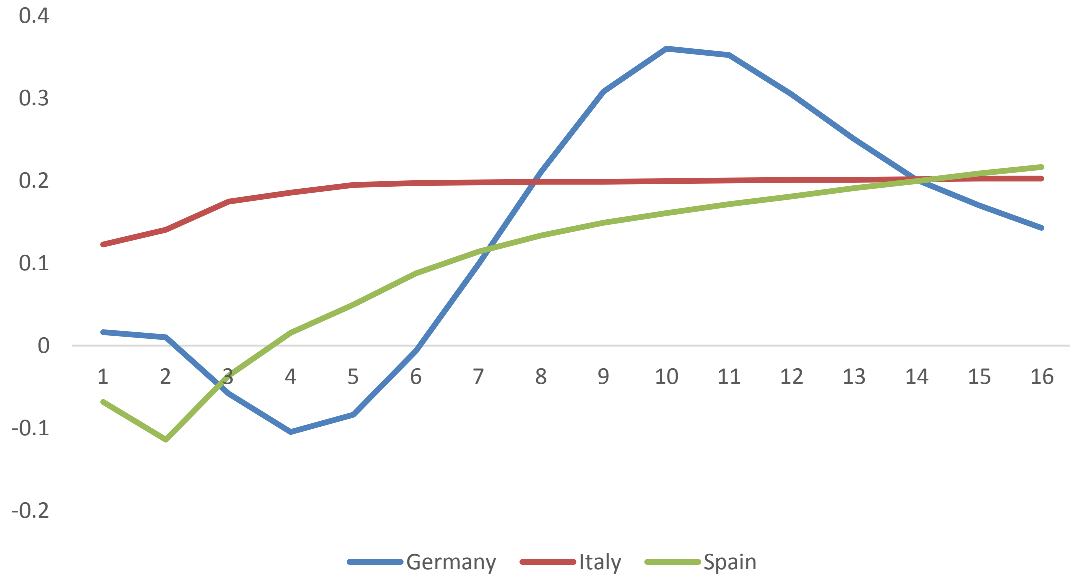

Figure 15: CPI response to a positive loan supply shock – third alternative
The figure reports the Consumer Price Index (CPI) response under the third alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to Euribor, Loans, Deposits, GDP and CPI), after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of the CPI to the shock since both variables are standardised. According to theory, inflation increases with a lag after a shock. In Italy, the response is however positive throughout.

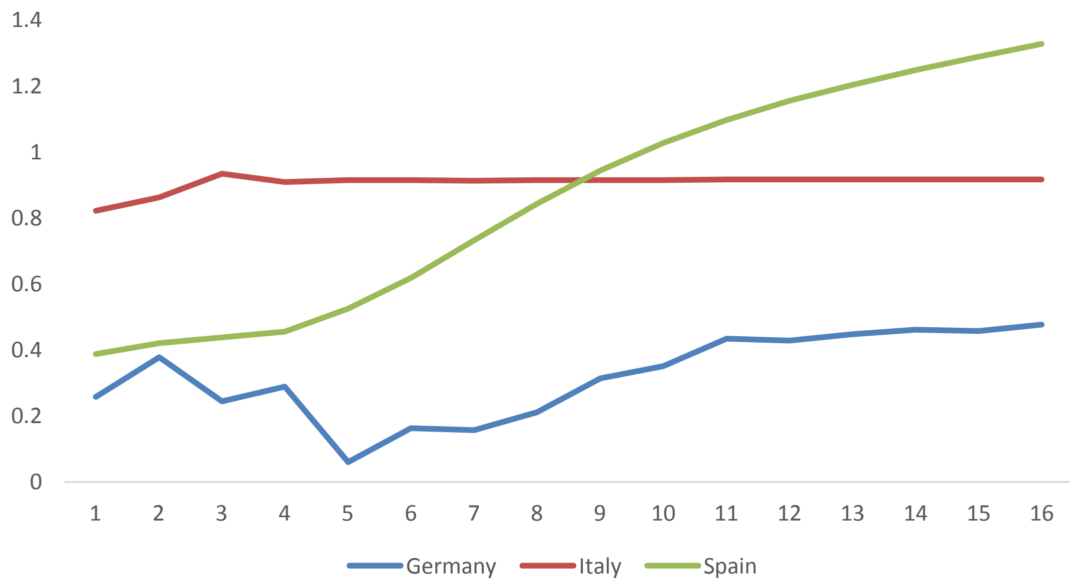

Figure 16: Deposits response to a positive loan supply shock – third alternative
The figure reports the response of deposits under the third alternative (change in the order from GDP, CPI, Euribor, Loans and Deposits to Euribor, Loans, Deposits, GDP and CPI) after a positive one percent shock to the supply of bank lending in a FAVAR model. The left-hand-side axis can be viewed as the elasticity of deposits to the shock since both variables are standardised. Deposits are increased by almost one-to-one after a positive loan shock again presenting macroeconomic evidence for the credit creation theory.

Sensitivity to changes in variable definitions

As the previous section has shown, the results of chapter one are robust to changes in variable ordering within the VAR model. However, it is useful to show that the results are also robust to different proxies of lending and deposits in the economy. In this section, I replace total resident lending and total resident deposits with total resident private sector lending and deposits. Resident private sector is defined as total resident lending (deposits) minus total government lending (deposits) and total lending (deposits) to other Monetary Financial Institutions. The ordering of the variables is the same as in the baseline model as well as the lags in the VAR model. Results from this estimation can be found in figures 16 to 19.

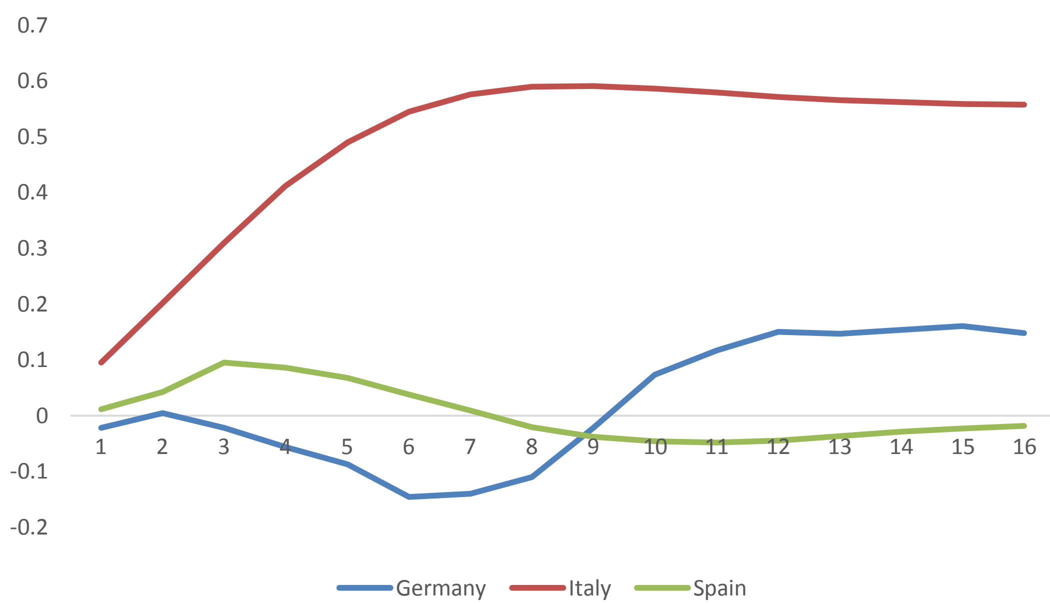

Figure 17: Real GDP response to a positive shock in private sector loan supply
The figure reports the real GDP response under different variable specifications (loans and deposits to the private sector instead of total loans and deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The variable ordering is the same as the baseline one (GDP, CPI, Euribor, Loans and Deposits). The left-hand-side axis can be viewed as the elasticity of real GDP to the shock since both variables are standardised. It can be observed that an increase in lending increases real GDP overall in all countries. Again, Germany records an insignificant response while the other two countries show a positive and significant increase in real GDP (overall for Italy, in the short-term for Spain).

Figure 16 suggests that an increase in lending has a negative, and insignificant, effect in real GDP growth in Germany in the short-term but becomes positive in the longer-term. In Spain, the response is the reverse, i.e. positive in the short-term but slightly negative, with values very close to zero in the longer-run. Italy is the only country in which a positive (and statistically significant) response is recorded, plateauing at approximately 0,5 percentage points in the medium term.

The above figure bears many similarities with figure 1 in the main text. The response of Germany is again negative and insignificant in the short-term, but becomes positive in the longer-term. Similarly, in Spain the response is positive in the short-term, just like figure 1 in the text, with the difference that instead of closing to zero from the positive side, it closes to zero from the negative. In Italy, the effect is more pronounced than in the text, perhaps suggesting that lending to the private sector has a greater effect on the Italian economy than in the other two countries.

In figure 17, the response of private sector deposits is presented after a positive private sector loan supply shock. In general, the figure is similar to figure 2 in the text, differing in just two aspects: first, the response of Germany, while positive and significant in the short-run becomes negative and insignificant in the medium-run. In contrast, in figure 2 the response was positive overall. Furthermore, the short-run response is smaller in value than the one in figure 2. Second, the responses of both Italy and Spain, albeit positive and significant at all periods, are less pronounced than in the case where total loans were employed.

Nevertheless, the findings still point out that in accordance to the credit creation theory, deposits rise after a positive loan supply shock, even though the increase is not one-to-one in the macro data. Most likely, the less pronounced response of all countries can be attributed to the higher volatility of private sector deposits which usually move faster than the public sector's (which is absent from this estimation) after the loan has been created.

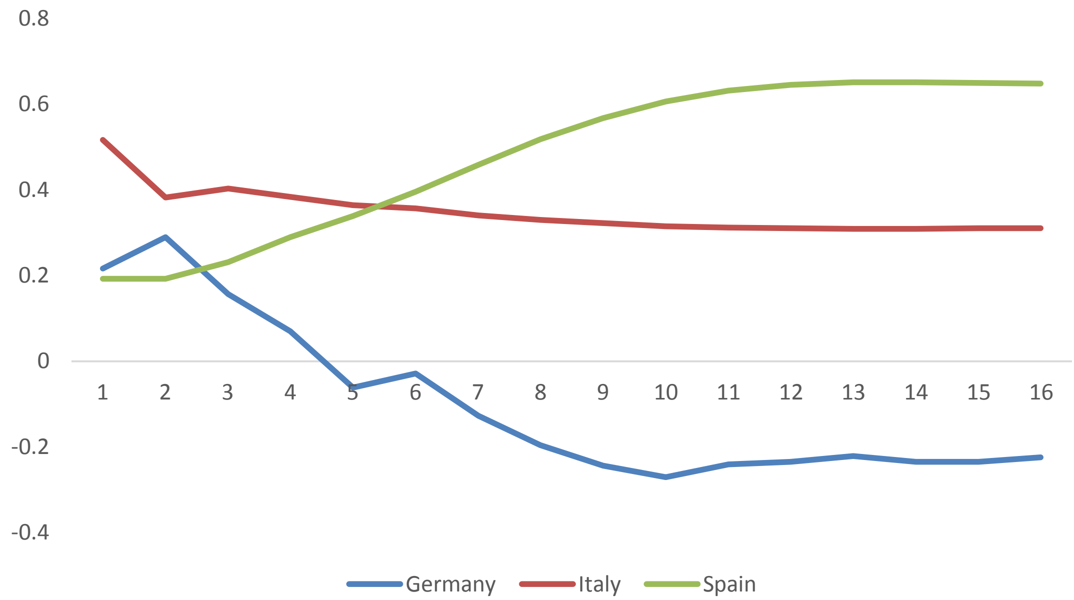

Figure 18: Private sector deposits response to a positive shock in private sector loan supply
The figure reports the deposits response under different variable specifications (loans and deposits to the private sector instead of total loans and deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The variable ordering is the same as the baseline one (GDP, CPI, Euribor, Loans and Deposits). The left-hand-side axis can be viewed as the elasticity of deposits to the shock since both variables are standardised. Deposits are increased by almost one-to-one after a positive loan shock again presenting macroeconomic evidence for the credit creation theory. In Germany, the response is insignificant after the first two periods.

The response of CPI index to a positive private sector loan supply shock is similar to figure 3 for the case of Italy, in which prices increase after a lag. In the case of Spain the CPI responds positively from the first period and retains a positive effect throughout the periods. The only difference is in the case of Germany where the response is negative and insignificant throughout the response periods.

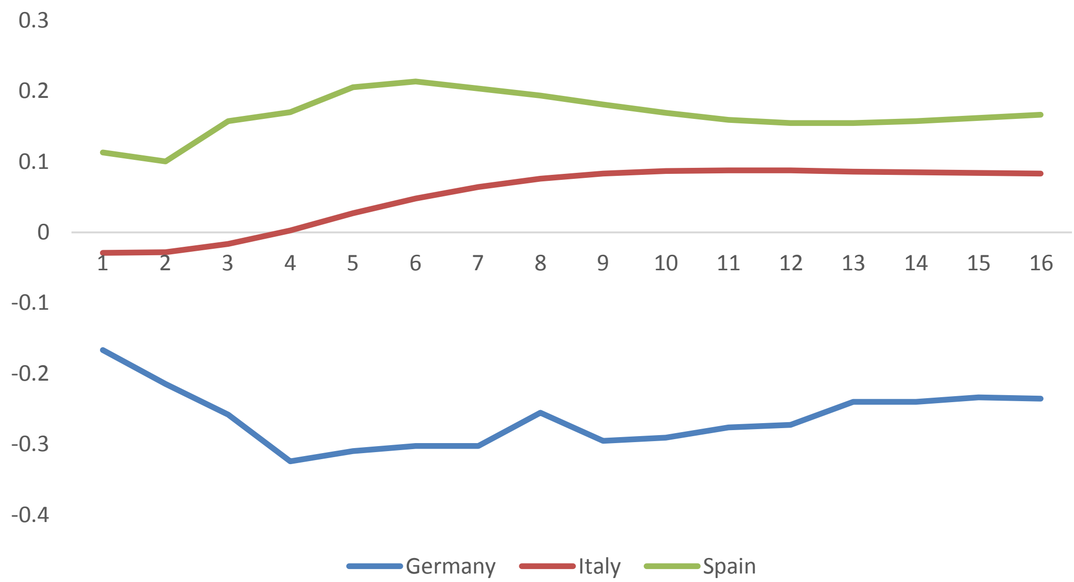

Figure 19: CPI response to a positive shock in private sector loan supply
The figure reports the CPI response under different variable specifications (loans and deposits to the private sector instead of total loans and deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The variable ordering is the same as the baseline one (GDP, CPI, Euribor, Loans and Deposits). The left-hand-side axis can be viewed as the elasticity of inflation to the shock since both variables are standardised. The CPI behaves according to theory in Italy and Spain, while it records a statistically insignificant response in Germany.

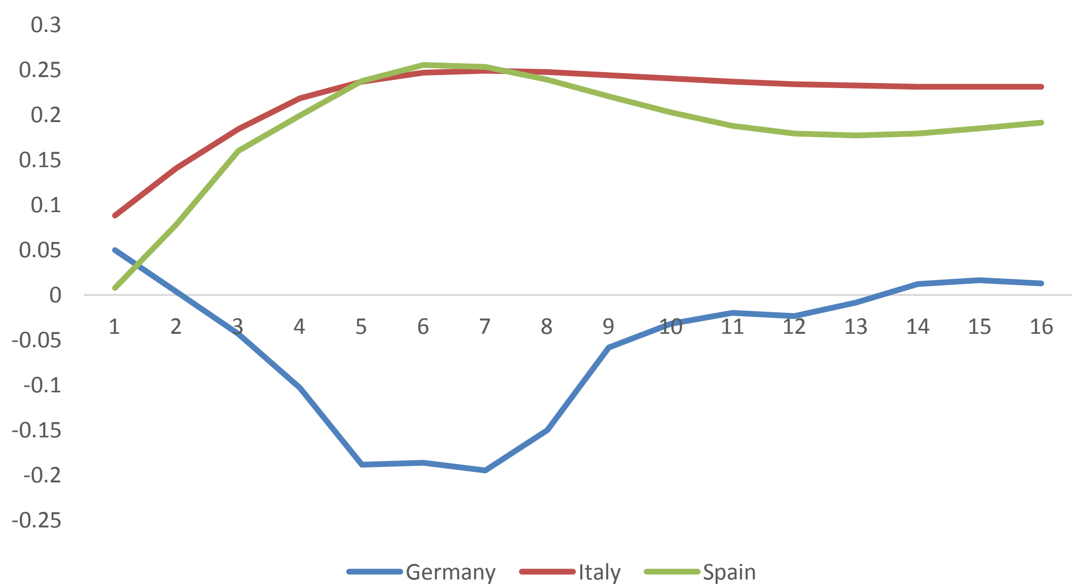

Figure 20: Interest rate response to a positive shock in private sector loan supply
The figure reports the Euribor response under different variable specifications (loans and deposits to the private sector instead of total loans and deposits) after a positive one percent shock to the supply of bank lending in a FAVAR model. The variable ordering is the same as the baseline one (GDP, CPI, Euribor, Loans and Deposits). The left-hand-side axis can be viewed as the elasticity of the Euribor rate to the shock since both variables are standardised. The interest rate rises in Italy and Spain, as expected, while in Germany the response is statistically insignificant overall.

Germany is the only exception in figure 19, recording a negative and insignificant response after the first positive and significant one, in line with the CPI and GDP paths. In contrast, Italy and Spain record similar responses. Spain’s response resembles that of figure 4 while Italy’s is more pronounced in this setting.

Overall, the change from total resident lending and deposits to total resident private sector lending and deposits has provided no qualitative changes to the conclusions reached at the first chapter. Even after changing the deposits and loans variables, real GDP, CPI and deposits response is positive in two out of three countries, while it is insignificant after the short-run in the other. As such, the robustness of the results is further confirmed.

Appendix V

Chapter two sensitivity analysis

In this appendix, a sensitivity analysis of the STCC results presented in chapter 2, section 2.4 in conducted. Specifically, the definition of growth is changed from nominal GDP to real GDP growth and the sample is enlarged with the addition of three more European countries (Austria, Belgium and the Netherlands). The selection of the additional countries stems from data availability.

Table 12: STCC results from three additional countries

	Austria	**Belgium**	**Netherlands**
Correlation before the threshold (p0)	0.446	0.251	0.295
Correlation after the threshold (p1)	0.102	0.083	0.247
Threshold value (% of GDP)	72.5%	85.8%	35.1%
Smoothness of transition (γ)	100	100	3.25
Double threshold test	rejected at 5%	rejected at 5%	rejected at 5%
%change in correlation	77.7%	66.9%	16.2%

Table 12 presents results from an STCC model on three additional countries, which are selected based on data availability. As can be observed, correlations drop after the threshold but never become negative. The drop in the value of the correlation is highly idiosyncratic while the smoothness of transition ranges from regime-switch (Austria, Belgium) to smooth in the case of the Netherlands. The main conclusions of chapter two also hold for this case as well.

Table 12 presents results from an STCC model on three additional sample countries. As in the case of the G7, the additional sample countries exhibit a similar pattern of responses to the private debt-to-GDP ratio, with correlations being higher before the threshold and reducing after it. Similar to table 3, the abruptness in the change of these correlations is not related to the size of the change. In the Netherlands, for example, there is a relatively smooth transition to the lower correlation regime while in Austria and Belgium an abrupt change takes place. With regards to the threshold values, the change in correlation for the Netherlands occurs at a relatively low value while for Austria and Belgium the change occurs at higher ones.

Table 13: STCC results for the G7 using real GDP as the definition of growth

	Canada	France	Germany	Italy	Japan	United Kingdom	United States
Correlation before the threshold (p0)	0.451	0.534	0.514	0.722	0.286	0.998	0.394
Correlation after the threshold (p1)	0.202	0.058	0.073	0.145	0.018	0.017	0.235
Threshold value (% of GDP)	41.4%	60.1%	107.6%	85.8%	50.7%	21.1%	105.6%
Smoothness of transition (γ)	100	100	100	100	1.74	100	100
Double threshold test	rejected at 5%	rejected at 5%	rejected at 5%	rejected at 5%	rejected at 5%	rejected at 5%	rejected at 5%
%change in correlation	55.2%	89.1%	85.9%	79.8%	93.6%	98.3%	40.5%

Table 13 presents results from an STCC model with real GDP used as the measure of growth in the sample countries, which are selected based on data availability. While the values are different from the ones reported in chapter two the main argument remains the same: correlations drop after the threshold but never become negative. The drop in the value of the correlation is highly idiosyncratic while the smoothness of transition ranges from regime-switch (Austria, Belgium) to smooth in the case of the Netherlands.

Tables 13 and 14 present the results from estimations in which the definition of growth is switched from nominal GDP to real GDP growth. As the reader may observe, while the values of tables 13 and 14 are different from the ones of tables 3 and 12 the same conclusions hold: correlations are higher before the threshold value and they decrease afterwards presenting evidence of diminishing returns. In addition, both the abruptness of change and the threshold value change however not to a great extent.

Table 14: STCC results for the three additional countries using real GDP as the definition of growth

	Austria	Belgium	Netherlands
Correlation before the threshold (p0)	0.400	0.294	0.505
Correlation after the threshold (p1)	0.057	0.063	0.202
Threshold value (% of GDP)	72.5%	82.2%	47.2%
Smoothness of transition (γ)	100	100	14.8
Double threshold test	rejected at 5%	rejected at 5%	rejected at 5%
%change in correlation	85.6%	78.5%	60.0%

The table reports correlations obtained by the Smooth Transition Conditional Correlation (STCC) model. Smoothness of transition is at its maximum and denotes that there is an abrupt change after the threshold. Threshold value reflects the debt-to-GDP ratio after which the correlation changes. The double STCC hypothesis is rejected at the 5% level for all sample countries. The change in correlation reflects the percentage change from p0 to p1 after the threshold value.

From the above results, it can be inferred that the stock of loans does not hamper growth at any debt-to-GDP ratio even when additional countries are included in the sample or when the definition of growth is changed. In addition as already discussed in the policy conclusions of chapter two, stress should not be placed on the specific values of the thresholds nor on values of the estimated correlations as these may change with sample and definitional changes. Instead, emphasis should be placed on the broader picture which, in accordance to the two-period model of section 2.2 and the empirical results of section 2.4, suggests that the level of lending *per se* does not harm growth at any threshold, but instead shows diminishing returns to scale. Consequently, special care should be given on how the allocation of loans affects the workings of the country in order to avoid over-lending to specific sectors in the economy due to an excess amount of funds channelled to them.

Appendix VI

This appendix covers two types of sensitivity tests for the results presented in chapter three of this thesis. Specifically, the first type of sensitivity test employs the use of MFI loans to other MFIs and examines whether changes in the policy rate can have a persistent effect on interbank lending. The second type of sensitivity test employs two different definitions of the policy rate, namely the Eonia rate and the 3-month Euribor rate to test for robustness of the results to the choice of the policy rate.

Overall, the results from the sensitivity and robustness tests of this appendix suggest that the conclusions reached in the main text of chapter three of this thesis hold. Namely, the interest rate does not have a persistent effect on bank lending behaviour, either directly, or indirectly, regardless of the type of loans or the definition of the policy rate. Consequently, the policy implications and suggestions presented in chapter three are also robust to these tests.

A change in the type of loans

Changing the type of loans employed in the estimation is good test to examine the overall stability of the results. As such, given that chapter three has examined the effects of the policy rate on bank lending to the private sector, it is advisable to examine what happens to the other important constituent of total loans, lending to other MFIs, or interbank lending. If the policy rate is to have a persistent effect on bank behaviour, then it should be the case that interbank lending, accounting for excess lending or excess liquidity should be affected through changes in monetary policy.

The results presented in this appendix point to the other direction and are supportive of the main arguments presented in the main body of the text: the policy rate does not have a persistent, direct impact on lending to other MFIs. In addition, it appears that indirect effects, through credit risk and deposits are also absent. Importantly, and as expected, the liquidity channel is also again found to be an important determinant of the level of lending to other MFIs. Consequently, the results and policy implications in chapter three are further underlined. The results of the specification can be found in Tables 15 to 17.

Table 15: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Loans represent interbank lending.

	Policy	Credit Risk	GDP	Deposits	Total Macro	Other Shocks	Total
Germany	0.24 (0.13)	0.08 (0.15)	0.12 (0.12)	1.01 (0.21)	1.06 (0.15)	0.80 (0.06)	0.95 (0.09)
Belgium	0.08 (0.17)	0.10 (0.17)	0.24 (0.13)	0.55 (0.14)	0.57 (0.11)	0.98 (0.05)	0.74 (0.04)
Ireland	0.74 (1.31)	1.02 (1.47)	0.61 (0.85)	0.84 (0.78)	2.05 (1.06)	1.77 (0.30)	1.80 (0.32)
Spain	0.27 (0.20)	0.28 (0.26)	0.27 (0.20)	0.57 (0.20)	0.81 (0.16)	0.67 (0.07)	0.71 (0.07)
France	0.41 (0.24)	0.26 (0.22)	0.29 (0.20)	0.87 (0.23)	1.09 (0.14)	0.99 (0.00)	1.03 (0.05)
Italy	0.33 (0.31)	1.18 (0.44)	0.01 (0.31)	0.27 (0.32)	1.35 (0.31)	0.85 (0.08)	0.95 (0.09)
Netherlands	0.15 (0.21)	0.28 (0.25)	0.27 (0.20)	0.96 (0.18)	0.84 (0.08)	0.84 (0.08)	0.84 (0.08)
Austria	0.23 (0.30)	0.84 (0.33)	0.02 (0.29)	1.44 (0.16)	1.11 (0.10)	1.33 (0.20)	1.25 (0.16)
Portugal	0.32 (0.67)	1.39 (1.19)	1.06 (0.57)	0.22 (0.92)	1.75 (0.86)	0.81 (0.08)	0.88 (0.11)
Finland	0.11 (0.24)	0.41 (0.21)	0.07 (0.20)	0.09 (0.28)	0.48 (0.13)	1.05 (0.03)	0.85 (0.05)
EA-10	**0.05 (0.11)**	**0.21 (0.11)**	**0.124 (0.087)**	**0.71 (0.11)**	**0.86 (0.08)**	**0.94 (0.05)**	**0.88 (0.06)**

Results refer to Model 2, as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j. Figures in brackets represent asymptotic standard errors. Loans represent interbank lending instead of lending to the private sector. The hypothesis that the interest rate (and subsequently monetary policy) has a persistent effect on bank lending is rejected both at the national as well as the euro area level. However, changes in deposits and changes in credit risk do have a persistent effect.

Table 16: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Credit risk as the dependent variable. Loans represent interbank lending.

	Policy	**Deposits**	**GDP**	**Loans**	**Total Macro**	**Other Shocks**	**Total**
Germany	0.56 (0.24)	0.75 (0.68)	0.18 (0.18)	0.75 (0.74)	1.48 (0.16)	0.95 (0.02)	1.19 (0.07)
Belgium	0.21 (0.23)	0.18 (0.46)	0.61 (0.16)	0.46 (0.43)	0.91 (0.11)	1.15 (0.05)	1.02 (0.05)
Ireland	0.80 (0.78)	1.19 (1.90)	0.15 (0.84)	1.70 (1.74)	0.81 (0.42)	0.97 (0.04)	0.97 (0.05)
Spain	0.19 (0.19)	1.45 (0.75)	0.05 (0.19)	2.00 (0.73)	0.78 (0.21)	0.53 (0.04)	0.58 (0.06)
France	0.78 (0.24)	0.49 (0.78)	0.17 (0.31)	1.22 (0.75)	0.88 (0.14)	0.85 (0.08)	0.86 (0.08)
Italy	0.56 (0.41)	2.41 (0.61)	0.55 (0.38)	1.81 (0.87)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Netherlands	0.11 (0.33)	0.67 (1.32)	0.41 (0.29)	0.19 (1.26)	0.86 (0.23)	1.08 (0.11)	1.03 (0.09)
Austria	0.15 (0.26)	0.81 (0.61)	0.11 (0.25)	1.74 (0.52)	1.01 (0.03)	1.01 (0.02)	1.01 (0.02)
Portugal	0.27 (0.49)	1.50 (0.91)	0.45 (0.42)	1.96 (0.73)	0.86 (0.19)	0.79 (0.08)	0.79 (0.08)
Finland	0.28 (0.23)	1.19 (0.82)	0.09 (0.19)	0.60 (0.84)	0.74 (0.22)	0.89 (0.13)	0.83 (0.12)
EA 10	**0.23 (0.15)**	**0.52 (0.50)**	**0.07 (0.13)**	**0.40 (0.48)**	**0.90 (0.12)**	**1.07 (0.10)**	**0.96 (0.08)**

Results refer to Model 2, as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j. Figures in brackets represent asymptotic standard errors. Loans represent interbank lending instead of lending to the private sector. The hypothesis that the interest rate (and subsequently monetary policy) has a persistent effect on bank credit risk is rejected both at the national as well as the euro area level.

Table 17: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Deposits as the dependent variable. Loans represent interbank lending.

	Policy	Loans	Credit Risk	GDP	Total Macro	Other Shocks	Total
Germany	0.12 (0.22)	0.39 (0.28)	0.55 (0.22)	0.75 (0.32)	1.19 (0.25)	1.01 (0.15)	1.11 (0.17)
Belgium	0.10 (0.23)	0.17 (0.31)	0.34 (0.23)	1.03 (0.31)	1.04 (0.26)	0.91 (0.14)	0.97 (0.15)
Ireland	1.35 (0.60)	0.32 (0.91)	1.08 (0.74)	3.44 (1.12)	3.46 (1.08)	1.57 (0.33)	2.13 (0.46)
Spain	0.52 (0.36)	0.72 (0.47)	0.35 (0.38)	1.25 (0.53)	1.83 (0.43)	1.41 (0.27)	1.60 (0.29)
France	0.04 (0.16)	0.13 (0.20)	0.26 (0.16)	0.93 (0.234)	0.99 (0.19)	0.64 (0.07)	0.83 (0.10)
Italy	0.72 (0.46)	0.72 (0.57)	0.36 (0.48)	1.40 (0.62)	1.98 (0.51)	1.15 (0.23)	1.43 (0.23)
Netherlands	0.53 (0.36)	0.15 (0.50)	0.13 (0.39)	0.46 (0.47)	0.66 (0.30)	1.05 (0.18)	0.94 (0.16)
Austria	0.57 (0.56)	0.80 (0.70)	0.13 (0.58)	2.09 (0.71)	1.95 (0.60)	1.55 (0.43)	1.68 (0.42)
Portugal	0.86 (0.46)	0.23 (0.63)	0.85 (0.40)	1.06 (0.72)	1.47 (0.51)	0.96 (0.17)	1.06 (0.20)
Finland	0.08 (0.48)	0.97 (0.66)	0.70 (0.38)	0.49 (0.76)	0.96 (0.46)	0.88 (0.16)	0.89 (0.17)
EA 10	**0.09** **(0.16)**	**0.16** **(0.21)**	**0.35** **(0.16)**	**1.24** **(0.24)**	**1.42** **(0.22)**	**1.09** **(0.18)**	**1.34** **(0.19)**

Results refer to Model 2, as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j. Figures in brackets represent asymptotic standard errors. Loans represent interbank lending instead of lending to the private sector. The hypothesis that the interest rate (and subsequently monetary policy) has a persistent effect on bank deposits is rejected both at the national as well as the euro area level. Deposits are, however, affected by output changes and by the credit risk of the bank, again presenting evidence for the credit creation theory.

A change in the definition of the policy rate

The previous part of this appendix has demonstrated that changes in the interest rate do not have a persistent effect on interbank lending, supporting the conclusions reached in chapter three. In this part, I replace the definition of the policy rate (as presented in appendix III) to examine whether the results are sensitive such changes. As such, the baseline policy rate definition is replaced with the Eonia rate (table 18) and the Euribor 3-month rate (table 19).

Table 18: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Eonia rate as the proxy for policy rate.

	Policy	Credit Risk	GDP	Deposits	Total Macro	Other Shocks	Total
Germany	0.78 (1.24)	66.78 (58.81)	0.85 (2.06)	59.96 (55.68)	62.88 (55.53)	1.38 (0.18)	17.24 (12.95)
Belgium	1.90 (1.61)	2.90 (1.16)	1.35 (3.11)	2.62 (2.97)	1.61 (0.3)	1.61 (0.3)	1.61 (0.30)
Ireland	0.06 (0.1)	6.79 (5.89)	0.36 (0.48)	10.03 (6.12)	8.49 (5.35)	3.56 (1.48)	8.47 (5.3)
Spain	0.04 (0.03)	9.08 (2.84)	0.02 (0.06)	3.81 (1.80)	7.81 (2.52)	4.94 (2.18)	7.81 (2.52)
France	0.07 (0.14)	12.12 (7.01)	0.14 (0.27)	12.68 (6.42)	12.15 (6.43)	1.72 (0.28)	11.76 (5.94)
Italy	0.03 (0.03)	3.13 (2.15)	0.02 (0.05)	4.09 (1.95)	3.64 (1.89)	1.37 (0.24)	3.63 (1.88)
Netherlands	0.00 (0.02)	1.92 (0.76)	0.00 (0.03)	2.71 (0.72)	2.39 (0.68)	0.95 (0.13)	2.38 (0.67)
Austria	0.77 (0.63)	62.22 (37.34)	2.10 (1.12)	58.35 (36.07)	58.3 (35.09)	1.72 (0.29)	35.93 (15.55)
Portugal	0.05 (0.13)	10.19 (10.69)	0.07 (0.22)	13.32 (9.69)	11.96 (9.53)	4.37 (1.31)	11.91 (9.37)
Finland	0.02 (0.02)	0.46 (1.14)	0.01 (0.03)	2.71 (0.90)	2.49 (0.59)	1.79 (0.33)	2.49 (0.58)
EA-10	**0.04** **(0.04)**	**7.64** **(2.74)**	**0.08** **(0.09)**	**7.19** **(1.60)**	**7.28** **(2.01)**	**2.68** **(0.59)**	**7.27** **(2.01)**

Results refer to Model 2, as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j. Figures in brackets represent asymptotic standard errors. The eonia rate is employed as the proxy for the policy rate. The hypothesis that the interest rate (and subsequently monetary policy) has a persistent effect on bank lending is rejected both at the national as well as the euro area level. Loans are, however, affected by deposit and credit risk changes as in chapter 3.

Table 19: Aggregate and decomposition of Individual Country and Aggregate Persistence Measures by Type of Shock – Euribor 3-month rate as the proxy for policy rate.

	Policy	Credit Risk	GDP	Deposits	Total Macro	Other Shocks	Total
Germany	0.74 (1.23)	66.13 (58.13)	0.96 (1.99)	59.06 (54.79)	62.23 (54.78)	1.38 (0.18)	17.24 (12.95)
Belgium	1.92 (1.61)	2.94 (1.16)	1.30 (3.09)	2.59 (2.97)	1.61 (0.3)	1.61 (0.3)	1.61 (0.3)
Ireland	0.06 (0.1)	6.88 (6.03)	0.35 (0.46)	10.05 (6.2)	8.54 (5.45)	3.54 (1.46)	8.51 (5.39)
Spain	0.04 (0.03)	9.08 (2.84)	0.02 (0.06)	3.82 (1.79)	7.81 (2.52)	4.94 (2.18)	7.81 (2.52)
France	0.07 (0.15)	12.18 (7.07)	0.13 (0.27)	12.69 (6.44)	12.19 (6.48)	1.72 (0.28)	11.8 (5.98)
Italy	0.03 (0.03)	3.15 (2.18)	0.02 (0.05)	4.10 (1.97)	3.66 (1.91)	1.37 (0.24)	3.65 (1.9)
Netherlands	0.00 (0.02)	1.92 (0.76)	0.00 (0.03)	2.71 (0.72)	2.39 (0.68)	0.95 (0.13)	2.38 (0.67)
Austria	0.77 (0.63)	62.23 (36.81)	2.09 (1.1)	58.12 (35.34)	58.17 (34.49)	1.73 (0.29)	36.00 (15.51)
Portugal	0.04 (0.13)	10.25 (10.8)	0.09 (0.22)	13.36 (9.74)	12.02 (9.61)	4.39 (1.32)	11.96 (9.44)
Finland	0.02 (0.02)	0.47 (1.15)	0.01 (0.03)	2.71 (0.91)	2.49 (0.59)	1.79 (0.33)	2.49 (0.59)
EA-10	**0.03** **(0.04)**	**7.69** **(2.77)**	**0.08** **(0.09)**	**7.19** **(1.61)**	**7.31** **(2.03)**	**2.68** **(0.59)**	**7.30** **(2.03)**

Results refer to Model 2, as defined in the text and are estimated in the 1999q1 – 2014q3 period. Individual country persistence measures are estimated using equation (5) and the aggregate persistence measures is obtained using a vector of ones in the place of e_i and e_j. Figures in brackets represent asymptotic standard errors. The euribor 3-month rate is employed as the proxy for the policy rate. The hypothesis that the interest rate (and subsequently monetary policy) has a persistent effect on bank lending is rejected both at the national as well as the euro area level. Loans are, however, affected by deposit and credit risk changes as in chapter 3.

As the reader may observe, differences between these two tables and the ones in table 9 in the main text are very small and by no means alter the conclusions reached. Therefore, as the evidence in this appendix underlines, the conclusions and policy implications presented in chapter three hold both under different selections of the policy rate as well as for other loan categories.