The bank lending channel: An empirical analysis of EU accession countries from 2004-2013

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Abstract:

In this paper a methodical empirical analysis of the bank lending channel of monetary transmission in the European Union's 10 new member states is conducted. We specifically investigate the influence of monetary policy changes on bank lending activity and if this potential influence is contingent on bank characteristics, such as banks' size, capital, liquidity and risk factor. Panel data compiled from a large number of banks from 2004 to 2013, and dynamic panel estimation methods are used. The results indicate the existence of a bank lending channel through bank liquidity; however, while liquidity and GDP growth maintain a beneficial and substantial impact on bank loan growth, the other bank characteristics are not considered to be important factors. Additionally, there is an indication of the effect of bank risk and liquidity from 2008 to 2010. Nevertheless, the lending channel has been weakened, serving as an additional refutation of bank-specific traits in allowing banks to maintain lending activity and growth during a financial crisis.

JEL classification: C23, E51, E52, G21.

Keywords: Bank lending channel, EU-10 countries, Monetary policy transmission, Panel data.

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1. Introduction

During the evolving process of fully integrating each of its member nations, the European Union (EU) commenced its eastern expansion strategy by including nations from Central and Eastern Europe (CEE). The EU officially initiated a changeover process in March 1998 which produced the larger Union by May 1st 2004. Substantial political and economic transformation have occurred in each of the ten new EU member states. CEE nations in particular have transitioned from a centrally-planned to a free-market structured economy (Koutsomanoli-Filippaki *et al*., 2009a). Moreover, a sequence of amendments directed at the banking supervision structure were established in keeping with the rules of the EU regulatory system (Koutsomanoli-Filippaki, 2009a; 2009b).

In light of the post-crisis credit crunch, monetary authorities and the academic world have experienced a resurrection of interest in evaluating the role of banks in the monetary transmission mechanism (MTM), especially the bank lending channel (BLC) which assumes that changes in monetary policy alter the supply schedules of bank loans (Bernanke and Gertler, 1995). As stated by Matousek and Sarantis (2009) and Akinci *et al*. (2013) the BLC arises from a combination of a deposit market constraint and a binding lending constraint.

The number of empirical studies[2] that are attempting to investigate the effect of monetary policy shocks on bank lending activity and behaviour via the BLC is rapidly increasing; such papers include Kashyap and Stein (1995; 2000), Peek and Rosengren (1995), Kishan and Opiela (2000, 2006 and 2012), Ehrmann et al. (2003), Gambacorta (2005), Matousek and Sarantis (2009), Gambacorta and Marques-Ibanez (2011), Akinci, *et al.* (2013), Fungáčová, *et al.* (2014) and Leroy (2014) among others. Yet, having noted a gap in the existing literature, this paper attempts to add to the current research through concentrating on the effect of monetary policy specifically in the newly accessed EU states.

Our aim in this study is to investigate the BLC of MTM by focusing on the 10 European new member states that joined the EU in 2004 following the agreement by the Treaty of Accession 2003 in Athens. The aforementioned objective is consequently evaluated in further detail with reference to these countries: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia, hereafter EU-10.[3]

[2] It must be stated here that the empirical studies conducted in the US are more conclusive than studies based in Europe.

[3] This paper utilises an unbalanced panel data set of banks in EU-10 nations spanning the time frame from 2004-2013; this time selection is most appropriate for analysing the BLC since five nations were initiated into the European monetary union (EMU) during this period. Following this, the capability of these nations to direct

It is important to note that the BLC in EU-10 has not been previously tested before, although there have been several empirical studies that examined individual EU nations for its existence. However, Matousek and Sarantis (2009) is the only study that examined the BLC with reference to the panel of 8 CEE countries from 1994-2003. The data was sampled to take into account the decade following the accession, presenting the researcher with a novel benefit to reveal potential alterations regarding the BLC within the EU-10 compared with the seminal study conducted in Matousek and Sarantis (2009) which examines the decade before the accession.

In this study the possibility of the BLC being molded by traditional bank characteristics (size, liquidity and capitalisation) as well as by risk factors is investigated. Evaluating the latter is of particular significance as it permits the development of a more comprehensive analysis of the recent financial crisis of 2007-2008. Additionally, we consider a wide selection of interaction terms between previously stated four bank characteristics and monetary policy with the purpose of ascertaining whether they affect the transmission of monetary policy in the sample examined.

Conclusively, this paper contributes on the available literature through a specific focus on the prospective role of banking in MTM in order to reveal any clear trends in banks' lending behaviour in the periods before, during and after the financial turmoil.

This paper encounters an identification issue with respect to the disentanglement of loan supply from loan demand given that the BLC is only relevant to the bank lending supply. This problem is tackled by utilising the fundamental approach employed by Fungáčová *et al.* (2014) which accepts that all banks experience homogenous loan demand.[4] Such an assumption can be condemned, particularly as the recent credit crunch began, which has fostered a different, novel approach employed by Jimenez et al. (2012) which necessitates loan level data. As a result of the lack of extensive loan level data for the EU-10 countries, implementation of the aforementioned methodology is not possible in this study.

During the course of the investigation, the following is demonstrated: the results based upon inference from system GMM specification do not specify direct correlation between monetary policy and bank loans via the money lending channel.

monetary policy has been given to the ECB. As a result, these countries are largely excluded from the sample during the period of their accession into the EU because in a practical sense they have left the EU-10 '*club*'.

[3] Fungáčová, *et al.* (2014) rationalised for the problem inherent on looking at actual loans supplied (and thus demanded) at prevailing interest rates using Kashyap and Stein (1995, 2000) approach which is based on the assumption that every bank experiences identical loan demand and also that if bank lending variations are different between different types of banks, this must be a result of the different bank types changing their supplies of credit in dissimilar ways.

For this reason the theory of a direct correlation is unsubstantiated, nevertheless an indirect influence through the BLC is supported through bank liquidity. Similar corroborating data concerning the impact of bank liquidity is reported in Matousek and Sarantis (2009), Altunbas, *et al.* (2010), and Leroy (2014). Moreover, contrary to the conclusions in Matousek & Sarantis (2009) for 8 CEE countries, we find no evidence to support the role of bank size in EU-10 nations. This deduction is in keeping with the literature that investigated the BLC, specifically in the context of banks in Western Europe (Ehrmann, *et al.,* 2003, Altunbas *et al.*, 2010 and Gambacorta and Marques-Ibanez (2011). Furthermore, the model used in this study is constructed to consider any distinct movement on banks' lending behaviour for the periods before, during and after the financial turmoil. The results reveal that the lagged value of loan growth is insignificant when evaluating the sub-samples models; this offers a persuasive argument from the inclusion of the variable as a regressor. As a result, the model is tested via the fixed effect as our preferred specification for the aforementioned periods. The BLC is determined to have declined from 2008-2010, a conclusion derived from the fact that the majority of bank characteristics were ultimately determined to either not be significant or to have surprising negative values; these conclusions can be viewed as a further negation of the assumed function of such characteristics in maintaining bank lending activity and growth over the course of a credit crisis which evidently excludes the positive lagged value of bank's risk and liquidity.

This paper is organised as follows: Sector 2 offers an in-depth investigation of the developing EU-10 banking system. Section 3 presents a review of the literature on the BLC. Section 4 explains the data and methodological framework. Section 5 discusses the empirical results, while section 6 concludes.

2. A summary analysis of the financial framework in the recently accessed EU states

Apart from Cyprus and Malta, the majority of the new EU states experienced financial reforms over the course of their transition on account that their banking sectors share several structural traits (Mamatzakis *et al*., 2008). These states have also seen increased domestically-sourced credit to the private sector during the sampled period. Yet, in spite of the aforementioned increase, the extent of financial intermediation in this set of countries remained below the average value in the EU. Furthermore, noteworthy efforts to reform were aimed at advancing banking sector-related legislation.

Table 1 illustrates the fact that the majority of countries saw substantial enhancements in banking reform practices; this has especially been the case since 2004. The rate of interest liberalisation and banking reforms was comparable between the nations. Enhanced banking reform practices are reflected at the financial deepening level. From 2004 to the end of period sampled, the average M2/GDP ratio increased from 70.8% to 91.2%. The same period also saw an increased rate of domestic credit to GDP from 63.8% to 93.3%.

Table 1: Banking sector indicators[5]

Country	Credit to the private sector		M2/GDP		EBRD banking index	
	2004	2013	2004	2013	2004	2010
Cyprus	208	301	171	214	na	na
Czech Republic	31	58	56	81	3.7	4*
Estonia	61	75	58	68	4	4
Hungary	46	52	49	63	4	3.7
Latvia	51	61	38	43	3.7	3.7
Lithuania	29	46	35	47	3.3	3.7
Malta	106	119	151	171	na	na
Poland	28	55	40	60	3.3	3.7
Slovak Republic	30	45*	57	55*	3.7	3.7
Slovenia	48	73	53	74	3.3	3.3
EU-10	63.8	93.3	70.8	91.2		

Note: **Table 1** presents the domestic credit to the private sector (as a percentage of GDP), the M2/GDP ratio and the EBRD banking reform index. The EBRD banking reform measure offers a classification of advancement for liberalisation and institutional reform of the banking sector. The lowest value for the ranking index is 1, denoting minimal advancement in changing the socialist banking system and the highest rank is 4 which is characterised by changes which are in keeping with a market economy that is functional. Source: The World Bank, EBRD Transition Report.

2.1 The Fraser Index of Economic Freedom and its constituents:

The Fraser Index of Economic Freedom is made up of five elements characterised as: size of government: expenditures, taxes, and enterprises (GOV-F_{index}); legal system and property rights (LSP-F_{index}); access to sound money (SMO-F_{index}); freedom to trade internationally (FTI-F_{index}); and regulation of credit, labour, and business (REG-F_{index}). The aforementioned components are weighted to produce a composite index t; this index is measured from 0-10 in order of ascending levels of economic freedom as conducted in Gwartney *et al.* (2014). The mean scores for the economies of EU-10 nations from 2004-2012 are outlined in **Table 2**.

Whilst examining the regional mean values, the degree of general economic freedom (OVR-F_{index}) is 7.37, a value which is lower than several of the other components of the economics freedom, for example access to sound money (SMO-F_{index}) and freedom to trade internationally (FTI-F_{index}) which yields values of 9.21 and 8.01 respectively. When analysing the sample taken, the data suggests that reforms corresponding to size of government (GOV-F_{index}) and legal system and property rights (LSP-F_{index}) occur less frequently as the regional averages for these indices are calculated at 5.86 and 6.56 respectively. At the domestic level, the standout nations with respect to the (OVR-F_{index}) are Estonia (7.82), Cyprus (7.66) and Slovakia (7.50);

[5] The EBRD banking index most recent analysis of the Czech Republic is 2007 whereas Credit to private sector in addition to M2/GDP ratio data gathered for the Slovak Republic is limited up to 2008.

the aforementioned countries produces a higher score when compared with the regional mean value in the majority of the main components in the overall index of economic freedom. In **Table 3** the economic freedom variables over time in EU-10 are illustrated.

Table 2: Progress of economic freedom in the EU-10 markets (2004-2012)

Country	GOV-F_{index}	LSP-F_{index}	SMO-F_{index}	FTI-F_{index}	REG-F_{index}	OVR-F_{index}
Cyprus	7.20	7.05	9.40	8.14	6.49	7.66
Czech Republic	4.96	6.19	9.30	7.93	7.39	7.15
Estonia	6.41	7.22	9.25	8.48	7.72	7.82
Hungary	4.95	6.41	9.42	7.96	7.38	7.22
Latvia	5.83	6.55	8.87	8.15	7.41	7.36
Lithuania	6.78	6.46	8.99	7.86	7.32	7.48
Malta	5.80	7.44	9.29	8.26	7.02	7.56
Poland	5.49	6.03	9.33	7.39	7.04	7.05
Slovak Republic	6.44	6.10	9.35	8.15	7.45	7.50
Slovenia	4.71	6.16	8.87	7.75	6.81	6.86
Average EU-10	5.86	6.56	9.21	8.01	7.20	7.37

Notes: Figures correspond to average values, ranging from 0–10. Larger values signify a more liberal economic environment. Source: The 2014 version of the Fraser index of economic freedom.

The time frame examined in this paper reveals modest growth for the bulk of components of economic freedom in addition to the (OVR-F_{index}). Most remarkably, (LSP-F_{index}) shows the highest increase from 6.33 in 2004 to 6.56 in 2012. Yet, it is also worth mentioning that just (FTI-F_{index}) undergoes a modest reduction during the time frame sampled (see **Table 3**).

Table 3: Development of economic freedom over a period in the EU-10 markets (2004-12)

Year	GOV-F_{index}	LSP-F_{index}	SMO-F_{index}	FTI-F_{index}	REG-F_{index}	OVR-F_{index}
2004	5.84	6.33	9.10	8.31	7.14	7.34
2005	5.88	6.65	9.10	8.07	7.12	7.36
2006	5.88	6.70	9.10	8.02	7.09	7.36
2007	5.99	6.70	9.19	8.09	7.25	7.45
2008	5.91	6.62	9.19	8.01	7.27	7.40
2009	5.67	6.60	9.41	7.96	7.22	7.37
2010	5.70	6.54	9.32	7.94	7.06	7.31
2011	5.89	6.50	9.27	7.87	7.26	7.36
2012	5.96	6.40	9.19	7.79	7.40	7.35
Average EU-10	5.86	6.56	9.21	8.01	7.20	7.37

Notes: Figures correspond to average values, ranging from 0–10. Larger values signify a more liberal economic environment. Source: The 2014 version of the Fraser index of economic freedom.

3. Literature review

It is very challenging to determine the scale, temporal incidence and components involved in the reaction of the economy to significant changes in monetary policy if only the traditional interest-rate (neoclassical cost-of-capital) effects are considered. The credit channel and its endogenous mechanisms can be used in this case to bridge the gap in our understanding of these phenomena (Bernanke and Gertler, 1995).

Following the influential conclusions derived from Benanke and Blinder (1988) which discovers the existence of a transmission channel through the credit supply, several studies have endeavoured to differentiate between the various channels involved in the MTM.

A study conducted by Matousek and Sarantis (2009) highlights that during a tight monetary policy, a central bank indirectly forces banks to switch primarily from insured funds and reserves to uninsured and non-reservable sources of capital. Accordingly, adverse-selection problems may occur as a result which could influence a bank's lending position and activity (Stein, 1998).

Market constraints limit the amount of debt that the bank can issue (Van Hoose, 2007). Romer and Romer (1990) stresses that, if necessary, banks are capable of self-financing using funding that is independent from deposit sources; therefore, banks are able to offset the effects of monetary policy constriction to their lending activity by simply offering more certificates of deposits (CDs). In view on that, the BLC could theoretically be ineffective if banks were allowed to offer unchecked amounts of CDs, or bonds immune to reserve requirements (Gambacorta and Marques-Ibanez, 2011).

The available literature stresses three primary bank attributes which can also be considered gauges of balance sheet strength, that have the potential to influence the reaction of bank lending to a change in monetary policy; these characteristics include: bank size, capitalisation and liquidity. It is prudent to note at this stage that the general conclusion that can be deduced using the existing literature as a reference is that the studies appear to support the existence of a BLC in the US which operates via small banks (Kashyap and Stein, 1995), small and poorly capitalised banks (Kishan and Opiela, 2000), or small banks with low liquidity (Kashyap and Stein, 2000).

Indeed the data from the EU Banking system is substantially less convincing than US. De Bont (1999) conducts an analysis of six EU nations and determines that a BLC exists in Belgium, Germany and the Netherlands when the short-term interest rate is essentially utilised as a substitute for monetary policy action. However, there is insufficient evidence to support the existence of a BLC in France, Italy or the UK. Altunbas *et al*. (2002) determines that within the EMU systems, banks that experience suboptimal capitalisation demonstrated a tendency to be more responsive to alterations in monetary policy, irrespective of size. Additionally, Ehrmann *et al*. (2003) examines micro and aggregate data, concentrating on the four biggest economies in the Eurozone. The study determines that banks with lower liquidity showed a tendency to adapt a strong reaction to changes in monetary policy than their more liquid counterparts. Gambacorta (2005) analyses quarterly-derived data taken from Italian banks and determine that the BLC operates via poorly capitalised banks with low liquidity. An extensive paper by Matousek and Sarantis (2009) seeks to determine the role of banks in the monetary transmission mechanism and the existence of a BLC in the eight CEE nations, the study concludes that liquidity and size were the two most relevant bank characteristics that determined a bank's response to the changes in monetary policy.

The BLC assumes that smaller banks are more vulnerable to the issues that arise from information asymmetry when compared with larger banks which are able to provide certificates of deposits and other market instruments. Smaller banks are therefore considered to be more sensitive to expansionary and constrictive monetary policy shocks (Kashyap and Stein, 1995 and 2000; Kishan and Opiela 2000). Poorly-capitalised banks are forced to decrease their loan supply to a greater degree when compared with well-capitalised banks, following a period of tight monetary policy; this ability is a result of the former's limited capacity to access uninsured sources of funding (Peek and Rosengren, 1995, Kishan and Opiela, 2000 and 2006). Liquidity is another important bank characteristic which can be utilised to shield loan portfolios by decreasing their liquid assets. Consequently, banks with lower liquidity are less capable of protecting their loan portfolios (Kashyap and Stein, 2000; Ehrmann *et al*., 2003, Altunbas *et al.*, 2010 and Matousek and Sarantis, 2009). These characteristics are considered to be positively correlated with bank loan activity.

The 2007-08 credit turmoil served to underscore the importance of financial markets' perception of risk with respect to the banks' ability to generate funds. Furthermore, in this regard banks' balance sheets have been vulnerable to credit turmoil in several respects (Altunbas *et al*., 2010). Correspondingly, Gambacorta and Marques-Ibanez (2011) investigate the effect that banking strategy has on the supply of credit and the transmission mechanism of monetary policy within the period of the financial crisis. The paper asserts that banks possessing a larger percentage of profitable, yet high-risk, non-interest income sources exercised more frugal lending to borrowers. A similar study by Kishan and Opiela (2012) investigates the effects of the recent credit crisis on the BLC and established risk factors involved in the monetary transmission mechanism.

Following the failure of the Lehman Brothers investment bank in September 2008, Mullineux (2013) posits that the commencement of the global financial crises produced a greater tightening in bank lending, also known as the '*Credit Cruch'*. This was a result of the understanding that banks should '*deleverage*' by increasing the capital to asset ratios via combining reducing assets and raising new capital. These conclusions are in keeping with Cohen (2013), a study that analyses a sample of 82 large international banks taken from advanced and emerging economies in order to identify banking lending strategies post-crisis. The study notes that banks which emerged from the crisis with higher capital ratios and increased profitability could increase their lending activity to a greater degree.

Comparatively, Bech *et al*. (2012) suggests that deleveraging within a standard downturn does not serve to yield any substantial benefits during the recovery that follows. Alternatively, deleveraging under these crisis conditions had a positive, significant correlation to the magnitude of the following recovery. Given that highly leveraged banks are prone to distorted lending decisions, Adamati, *et al*. (2013) asserts that banks with greater capitalisation make comparatively wiser lending choices. Specifically, such banks are less inclined to assume higher risks and will be accordingly less vulnerable to issues concerning '*debt overhang'* which would precludes them from making loans of high value.

In the context of the post financial crisis period, a study by Mullineux (2013) states that banks endure relatively high '*fixed costs'* when lending. As a result, they prefer to make a few larger loans than many smaller loans. The gaps created and left by traditional commercial banks have fostered a process of disintermediation in which shadow banking and other elements of the financial system can cover these gaps. Adamati *et al*. (2013) argues that this is a consequence of higher capital requirements which would serve to shift key activities from the regulated components to the shadow-banking system in which leverage is commonly even greater than the standard banking system. Notably, shadow banking technology involves less capital and confers safety through issuing collateral to repo investors and can obtain the collateral on short term notice. Consequently, money derived from shadow-banking is far more likely to run when compared with standard bank money, which qualifies the banking model as more suited for investing in illiquid assets (Stein, 2014).

4. Data and model specification

In this analysis, annual data over the period of 2004-2013 is examined. The sample includes commercial, savings and co-operative banks from EU-10. Disaggregated bank data can be obtained from Bankscope, a commercial database maintained by International Bank Credit Analysis Ltd. (IBCA) and the Brussels-based Bureau van Dijk which is the primary source of data for European banks.

Within the available literature, there are two commonly adopted approaches utilised for testing the BLC. The first is to organise banks with respect to the banks characteristics (bank size, liquidity and capital).[6] Such an approach requires that there be a large number of banks available for sampling. While this might not be an issue in countries such as the US, for example, other nations have relatively fewer banks that prohibit this approach. Alternatively, a panel data model that permits the reaction of bank lending to monetary policy shifts to be contingent on bank characteristics can be used, such as seen in Ehrmann *et al*. (2003). The approach used circumvents the aforementioned problem of numbers of banks using a template derived from Bernanke and Blinder (1988). Consequently, their methodology is employed in this research.

The model used in Ehrmann *et al*. (2003) reveals an equation specific to bank loans, which considers the reaction of bank lending to monetary policy both directly via the influence of the money channel and indirectly by bank characteristics through the BLC. Additionally, the original model has been adapted in order to investigate the impact of the recent financial crises on the aforementioned two channels. This is accomplished by dividing said model into three periods consisting of the period before (2004-2007), during (2008-2010) and after the crises (2011-2013). The equation given below represents the original model:

Model. 1

$$\Delta \ln Lit = \alpha i + \beta \Delta \ln Lit - 1 + \sum_{j=0}^{1} \delta j \, \mathrm{GGDP\, t - j} + \sum_{j=0}^{1} \chi j \, \Delta \, \mathrm{R\, t - j} + \sum_{j=0}^{1} \lambda j \, \mathrm{CPI\, t - j}$$
$$+ \sum_{k=1}^{4} \theta k \, Zkit - 1 + \sum_{k=1}^{4} \sum_{j=0}^{1} \theta kj \, Z\, kit - 1 \, \Delta \, \mathrm{R\, t - j}$$
$$+ \sum_{k=1}^{2} \sum_{h=k+1}^{4} \sum_{j=0}^{1} \rho \, khj \, Z\, kit - 1 \, Zhit - 1 \, \Delta \, \mathrm{R\, t - j} + \varepsilon \, it$$

where *i*=1,…, *N* is the number of banks, *t*=1, ….,*T* representing the period of inspection from 2004 to 2013; and, *j* reflects the number of lags. *L**[7] denotes bank loans, R represents the short-term interest rates on money markets and is essentially used to reflect the monetary policy stance, GGDP and CPI reflect the growth rate of GDP and the inflation rate, respectively, which represent the demand for loan proxies. GGDP is the real growth rate-volume in constant prices (2005 base year) and CPI is the harmonised indices of consumer prices and is represented in a similar configuration as GGDP. Additionally, ln is the natural logarithm operator, Δ is the first difference operator, Z_K represents the K=1,2,3,4 bank characteristics variables: size (*S*), capital

6 In order to review research using the first method, consult: Altunbas (2002), Kashyap and Stein (1995, 2000), and Kishan and Opliea (2000, 2006)

7 $\Delta \ln Lit$ represents the difference of the natural logarithm of loans, i.e. the dependent variable.

(*CAP*), liquidity (*LIQ*) and risk *(Risk)*. Traits which are specific to banks are denoted by *t*-1 with the purpose of reducing a potential endogeneity bias. Lastly, possible fixed-effects among the banks were allowed for by αi and *ε it* indicates the error term.
Size *(S)*, capital *(CAP),* liquidity (*LIQ)* and risk (*Risk*) are bank-specific characteristics, which are used to assess the existence of the distributional influences of monetary policy on banks.

$$Sit = \ln Ait - \frac{\sum_{i=1}^{Ni} \ln Ait}{Ni}$$

$$CAPit = \frac{Cit}{Ait} - \frac{\sum_{i=1}^{Ni} \frac{\frac{Cit}{Ait}}{Ni}}{T}$$

$$LIQit = \frac{LAit}{Ait} - \frac{\sum_{i=1}^{Ni} \frac{\frac{LAit}{Ait}}{Ni}}{T}$$

$$Riskit = \frac{(\mathrm{ROA} + \mathrm{CAR})}{(\mathrm{SDROA})} - \frac{\sum_{i=1}^{Ni} \frac{(\mathrm{ROA} + \mathrm{CAR})}{(\mathrm{SDROA})}}{T}$$

Where the size of each bank is represented by the natural logarithm of total assets (*A*). Bank capitalisation is assessed here as a ratio of total equity (*CAP*) to total assets, which is also known as the standard capital ratio, liquidity ratio is defined as cash, trading securities and interbank lending of maturities with less than three months to total assets; and, finally, (*Risk)* is characterised by the Z-score[8] as a ratio of the total sum of return on assets and the capital assets ratio to standard deviation of returns on assets (see **Table 4** for a descriptive analysis).

In order to expand upon the work done in Ehrmann *et al.* (2003) and Gambacorta (2005), in our case each of the four banks characteristics must be normalised in the context of their average across all the banks. This is done with the purpose of producing indicators that equal a value of zero over all observations. Accordingly, in the previously discusses regression **Model. 1**, the average of the interaction terms ($\Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, \mathrm{Size\ it} - 1,\ \Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, Liq\ it - 1$, $\Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, Cap\ it - 1$ and $\Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, Risk\ it - 1$) also produce a value of zero. Furthermore, the monetary policy effect for the average bank can be directly understood by parameters χj. The size indicator has been normalised not only in terms of the average of the entire period of the sample, but also in terms of each solitary period, which eliminates undesirable trends with respect to size; specifically, that which could arise as a result of the premise that size is measured in nominal terms.

[8] All of the sample years are used in the rolling window when computing the SDROA for each bank.

The following are the three primary hypotheses which can be verified utilising the equation outlined in **Model. 1:** (1) Do specific components pertaining to banks, such as size, capital, liquidity and risk factor, influence the loan supply? (2) Is the presence of a BLC for monetary policy substantiated by the data? (3) Do the periods pre-, during and post- financial crisis include movement on the banks' lending behaviour?

The first hypothesis can be tested by adopting the following reasoning: for instance, when examining the influence on bank lending as a consequence of a variation in bank size conveyed via: $\Delta \ln Lit / \Delta S_{t-1}$ (in which θ_S is the designated coefficient for bank size in the vector θ). Given that $\theta_S > 0$, it demonstrates that large banks supply additional loans. Accordingly, through adopting this methodology the validity of the subsequent assumptions can be verified: high risk, less liquid and poorly capitalised banks are more vulnerable to provide loans in relation with their counterparts on the opposite side of the spectrum, i.e., low risk, highly liquid and well capitalised banks.

It is suggested here that the interaction term of the bank-specific characteristics with the short-term interest rate will serve to demonstrate the distributional effects of the monetary policy position.

The second hypothesis is verified using the sub-hypotheses below:

H_1. If $(\partial^2 \Delta \ln Lit \,/\, \partial \Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, Size\ it - 1) > 0$, this means that lending activity present in large banks is less vulnerable to monetary policy changes than that of small banks.

H_2. Banks with higher liquidity can extend credit by reducing their liquid assets supply; this implies that $(\partial^2 \Delta \ln Lit \,/\, \partial \Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, LIQ\ it - 1) > 0$. Therefore, less liquid banks must reduce their loan portfolio.

H_3. Banks possessing higher capitalisation are not as vulnerable to monetary policy changes, which suggests that $(\partial^2 \Delta \ln Lit \,/\, \partial \Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, CAP\ it - 1) > 0$.

H_4. An analogous relationship exists for bank risks. This hypothesis states that low risk banks are less sensitive to monetary policy changes; this means $(\partial^2 \Delta \ln Lit \,/\, \partial \Delta \mathrm{R\,t} - \mathrm{j}\, \partial\, Risk\ it - 1) > 0$.

Therefore, the existence of a BLC implies that the two-way interaction terms will contain positive coefficients in the aforementioned model, i.e, $\emptyset kj > 0$.

H_5. An additional consideration of this study[9] will examine if the following three-way interaction terms are important indicators of loan growth:

$Size\ it-1*LIQ\ it-1*\ \Delta Rt,\ Size\ it-1*LIQ\ it-1*\ \Delta Rt-1,\ Size\ it-1*CAP\ it-1*\ \Delta Rt,\ Size\ it-1*CAP\ it-1*\ \Delta Rt-1,\ Size\ it-1*Risk\ it-1*\ \Delta Rt,\ Size\ it-1*Risk\ it-1*\ \Delta Rt-1,\ LIQ\ it-1*CAP\ it-1*\Delta Rt, LIQ\ it-1*CAP\ it-1*\Delta Rt-1\ , LIQ\ it-1*Risk\ it-1*\Delta Rt,\ LIQ\ it-1*Risk\ it-1*\Delta R\ t-1,\ CAp\ it-1*Risk\ it-1*\Delta Rt,\ CAp\ it-1*Risk\ it-1.$

The third test is conducted through adopting and using the same approach as outlined in the first and second hypotheses; thus, this can be achieved by examining the statistical significance specific to the coefficient found in the sub-samples specific for the time frames pre- (2004-2007), during (2008-2010) and post- (2011-2013) financial crises with the purpose of uncovering the potential role of bank-specific characteristics and possible changes to the BLC of monetary policy during the aforementioned phases.

Given that EU-10 joined the EU in 2004, the sample for this study therefore spans from 2004-2013, which should be an adequate duration of time given that an entire cycle of monetary policy is encompassed in this period.[10] While EU-10 failed to meet the euro area entry requirements when their accession took place, the Treaties of Accession grants them an adjustment period. In other words, they are considered Member States but inclusive of a '*derogation*'. Evaluating the BLC during this specific time frame of this study is also crucial because this period saw the introduction of five nations to the Euro area. The first EU-10 nation to join the Eurozone was Slovenia, in 2007. Malta and Cyprus also followed suit in 2008 as well as Slovakia in 2009 and Estonia in 2011. Subsequently, their ability to dictate monetary policy has been granted to the ECB. Therefore, these nations will be omitted from the sample examined at the period of their accession into the euro area to a great extent since they can no longer really be considered to belong to the EU-10 '*club*'. Furthermore, several of the nations are home to a comparatively small number of total banks.[11] As a result this study chooses to unveil the modifications to the BLC in EU-10 via pooling data, and accomplishes this through amending the records to a unified currency, the euro.

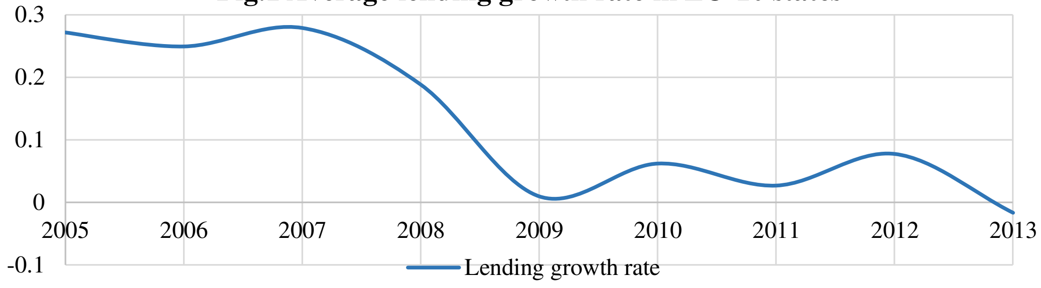
[9] Note that positive coefficients on these three-way interaction terms in the presence of a BLC (i.e., $\rho khj > 0$) are predicted using the same principles and reasoning described for two-way interaction terms (see **Table 13** for a comprehensive synopsis of the predicted signs of coefficients).

[10] The analysed period from 2004-2013 saw a gradual trend in merger and acquisition (M&A) in all EU-10 countries. If bank X is merged with bank Y, we treat them as one single entity from the beginning of sample period.

[11] Matousek and Sarantis (2009) established the existence of the BLC within Baltic estates through combining data sampled from Estonia, Latvia and Lithuania with the purpose of addressing this issue.

Fig. 1 shows the fact that, following 2007, the average lending growth rate in EU-10 states experienced a significant decline and has not since recovered. Since 2009 only volatile, inconsistent growth was reported with the lowest rate measured in 2013.

Fig.1 Average lending growth rate in EU-10 states



Source: (Bankscope, 2014)

This research utilizes the money market interest rates as the monetary policy rate. **Fig. 2** illustrates a comparative analysis of the weighted average of the changes in three month money market rates (ΔR) in EU-10 and the Euro area. The data indicates that the central banks of the nations investigated fix the policy rates based on and very similar to their counterparts' decisions. Moreover, nations that became members of the Euro area, including and after 2007, stopped announcing money market rates individually once they joined the Euro area and the unified interbank market within this union.

Table 4 Descriptive statistics for the main variables

Whole sample		Obs.	Mean	Std.Dev.	Min.	Max.
Δln (Loans)	Lending growth rate	873	0.141	0.347	-3.907	3.183
Size	Log of total assets	873	14.108	1.794	6.331	17.687
Capitalisation	Capital-to-asset ratio	873	0.110	0.099	0	0.987
Liquidity	Liquidity ratio	873	0.245	0.187	0	1
Risk factor	Z-score	873	21.437	24.740	-7.860	174
GGDP	GDP growth rate	873	8.67	7.064	-5.50	17.3
CPI	Inflation rate	873	14.813	11.513	-2.96	30.92
ΔR	Yearly change in the money market rates[12]	873	-0.323	1.613	-4.178	1.392

Notes: **Table 4** illustrates the primary variables employed for the regression regarding the entire representative selection over the period 2004-2013. **Appendix I** offers comparable summary statistics for the sub-samples.

5. Estimation results

Model.1 comprises cross-sectional fixed-effects and a lagged dependent variable. The latter component necessitates the utilisation of a GMM estimation procedure when examining a panel containing a comparatively small time-series dimension, i.e. *T* is at most 10 in our sample. Given that **Model.1** also consists of a lagged dependent variable, GMM must be used in order

[12] This consists of the money market rates on deposit with 3 months maturity.

to estimate it as suggested in Arellano and Bond (1991); specifically, in this case the Arellano and Bond two-step system estimator containing corrected coefficient standard errors from Windmeijer (2005) is appropriate here. The Sargan and Hansen tests are also used to investigate the validity of the over-identifying restrictions. Furthermore, using the Arellano and Bond test, the hypothesis that there is an absence of second-order correlation in the disturbance of the first-difference equation is assessed. When examining GMM regressions on simulated panels, Windmeijer (2005) determines that the two-step efficient GMM is superior to the one-step system, given that it allows for reduced standard errors and bias. Furthermore, Roodman (2009) notes that the two-step system with Windmeijer (2005) correction, yields comparatively accurate modelling, supporting the notion of the superiority of the two-step estimation with corrected standard errors approach over the robust one-step. As a result it produces a system consisting of two equations, the original and transformed equations, which are collectively termed system GMM. The combined two-step estimator holds against any number of cross-correlation and heteroskedastic patterns that the sandwich covariance estimator represents, and is efficient (Roodman, 2009).

We use the dependent variable lagged two periods and deeper *"collapse GMM-style*" in order to reduce the number of instruments and elude the chance of potentially overfitting the endogenous variable; this method of collapsing instruments is accompanied by a small reduction of efficiency. IV-style instruments are also limited to be identical for each model, specifically the current value and first lag of ΔR_t, $GGDP_t$ and CPI_t. In order to restrict the number of instruments to less than the number of cross-sectional units, the IV-style instrument does not include lags of the bank characteristics.

By using the similar methodology adopted from Akinici *et al*. (2013), this study implements a pseudo general-to-specific model reduction approach for its GMM estimator in order to obviate overparameterisation that could result in collinearity issues. In addition to the current value and first lag of ΔR_t, $GGDP_t$ and CPI_t, this pseudo general model also included the first lag of $Size_{it-1}$, LIQ_{it-1} and CAP_{it-1}. Further inclusions are: the two-way interaction of the current value of ΔR_t and the first lag of the aforementioned bank characteristic. Subsequently, this study adopts the general-to-specific approach by successive deletion of insignificant variables until only significant variables are left in the model. Additionally, this study examines additional tests by including a first lag of $Risk_{it-1}$, thus carrying out a wide selection of tests for the remaining two and three way interaction terms in order to ascertain if these terms may be incorporated into the model with a degree of statistical significance.[13]

The primary estimations with respect to the total period analysed are first considered and the results specific for before, throughout and following the financial crisis are subsequently compared with the purpose of elucidating the potential role of banking in monetary policy transmission. Significantly, any distinct movements on banks' lending behaviour within the three previously addressed phases involved in the credit crisis were analysed.

5.1 Does the data support the existence of a BLC for monetary policy in EU-10?

Here the findings of the empirical analysis concerning the BLC of MTM within EU-10 accession nations are outlined (see **Table 5**).[14] As reflected in the parsimonious model, the growth of bank lending in response to the monetary policy stance derived from money market rates in the short term is not significant, i.e. the results indicate no direct correlation between the two via the money lending channel. Hence, the theory of a direct correlation is unsubstantiated, yet an indirect influence through the BLC is supported and documented below. The Arellano Bond test indicates the absence of second-order autocorrelation suggesting that the two-step system GMM estimator is reliable. p[AR(2)] represents the probability value of the Arellano Bond test. Furthermore, the Hansen and Sargan tests confirm the appropriate usage of these instruments.

When evaluating the instances in which each bank-specific trait appears individually, only liquidity is determined to have a significant influence and not bank risk, capital or size. The statistical significance of the first lag of liquidity is ascertained at 5% suggesting a credible hypothesis in which more liquid banks provide loans via a reduction in liquid assets, increasing loans as a result. Yet, with the purpose of evaluating monetary policy and its distributional effects, and establishing the existence of the BLC within EU-10, the coefficients of the interaction terms between the traits specific to banks and the monetary policy measurements require investigation. The interaction terms of bank liquidity on its own with the interest rates are statistically significant at 10%. These finding indicate that bank liquidity is a crucial differentiating factor in the reaction of banks to changes in the monetary policy stance within

[13] In addition this study conducts twelve variable tests for the three way interaction terms when approximating the whole sample selection via the panel fixed effect regression.

[14] Considering the dynamic presented in the levels of data, this paper outlines an analysis considering the GMM approximation in the whole representative sample selection, the panel fixed effect estimator may confer a small deviation with respect to the general results, a consequences suggested here to be a result of the variation of the estimation technique.

the investigated sample. Nevertheless, bank liquidity becomes statistically insignificant when entering along with other bank-specific traits. We can conclude that the remaining bank-specific traits (bank risk, capital and size) do not seem to be crucial factors in evaluating the response of banks to monetary policy stance changes for the total duration of this study. Furthermore, the three-way interaction terms of these bank-specific attributes are evaluated with the purpose of determining the probability of statistically significant incorporation of these bank traits. Their coefficients of interaction terms are determined to be statistically insignificant in this case and could not be included to the model as a result.

Table 5: Main results (GMM)

Variable	Pseudo General	Specific
$\Delta \ln L_{it-1}$	0.141 (0.16)	0.120 (2.31)*
ΔR_t	-0.0114 (-0.09)	
ΔR_{t-1}	0.0357 (0.24)	
$GGDP_t$	0.0123 (0.47)	0.00594 (2.24)*
$GGDP_{t-1}$	-0.0183 (-0.45)	
CPI_t	-0.0128 (-0.25)	-0.00756 (-3.32)***
CPI_{t-1}	0.0113 (0.24)	
$Size_{it-1}$	-0.240 (-0.16)	
$Size_{it-1}\times\Delta R_t$	0.224 (0.19)	
Liq_{it-1}	-0.0181 (-0.01)	0.344 (3.61)***
$Liq_{it-1}\times\Delta R_t$	0.0796 (0.27)	0.0482 (2.32)*
Cap_{it-1}	0.308 (0.05)	
$Cap_{it-1}\times\Delta R_t$	-0.121 (-0.12)	
$Size_{it-1}\times\Delta R_{t-1}$		
$Liq_{it-1}\times\Delta R_{t-1}$		
$Cap_{it-1}\times\Delta R_{t-1}$		
$Risk_{it-1}$		
$Risk_{it-1}\times\Delta R_t$		
$Risk_{it-1}\times\Delta R_{t-1}$		
$Size_{it-1}\times Liq_{it-1}\times\Delta R_t$		
$Size_{it-1}\times Liq_{it-1}\times\Delta R_{t-1}$		
$Size_{it-1}\times Cap_{it-1}\times\Delta R_t$		
$Size_{it-1}\times Cap_{it-1}\times\Delta R_{t-1}$		
$Size_{it-1}\times Risk_{it-1}\times\Delta R_t$		
$Size_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$		
$Liq_{it-1}\times Cap_{it-1}\times\Delta R_t$		
$Liq_{it-1}\times Cap_{it-1}\times\Delta R_{t-1}$		
$Liq_{it-1}\times Risk_{it-1}\times\Delta R_t$		
$Liq_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$		
$Cap_{it-1}\times Risk_{it-1}\times\Delta R_t$		
Intercept	0.263 (0.62)	0.168 (3.81)***
p[AR(2)]	0.822	0.668
p(Sargan)	0.619	0.26
P(Hansen)	0.624	0.418
p(Wald)	0.000***	0.000***
Number of observations	699	699
Number of instruments	15	15

Table 6: Main results (Fixed effects)

Variable	Pseudo General	Specific
ΔR_t	0.0107 (0.73)	
ΔR_{t-1}	0.0224 (1.72)	
$GGDP_t$	0.00733 (1.45)	0.0126 (5.25)***
$GGDP_{t-1}$	-0.0155 (-2.71)**	-0.00625 (-2.72)**
CPI_t	0.00717 (0.56)	-0.00749 (-4.31)***
CPI_{t-1}	-0.00816 (-0.75)	
$Size_{it-1}$	-0.678 (-9.54)***	-0.571 (-10.74)***
$Size_{it-1}\times\Delta R_t$	0.0135 (1.55)	
$Size_{it-1}\times\Delta R_{t-1}$	0.00679 (0.80)	
Liq_{it-1}	0.189 (6.93)***	0.164 (6.96)***
$Liq_{it-1}\times\Delta R_t$	0.00125 (0.16)	
$Liq_{it-1}\times\Delta R_{t-1}$	-0.0123 (-1.60)	
Cap_{it-1}	-0.00778 (-0.16)	
$Cap_{it-1}\times\Delta R_t$	-0.0120 (-1.05)	
$Cap_{it-1}\times\Delta R_{t-1}$	0.0142 (1.04)	
$Risk_{it-1}$	0.0673 (0.76)	
$Risk_{it-1}\times\Delta R_t$	-0.0100 (-1.24)	
$Risk_{it-1}\times\Delta R_{t-1}$	-0.00695 (-0.85)	
$Size_{it-1}\times Liq_{it-1}\times\Delta R_t$		
$Size_{it-1}\times Liq_{it-1}\times\Delta R_{t-1}$		
$Size_{it-1}\times Cap_{it-1}\times\Delta R_t$		0.00973 (2.04)*
$Size_{it-1}\times Cap_{it-1}\times\Delta R_{t-1}$		
$Size_{it-1}\times Risk_{it-1}\times\Delta R_t$		
$Size_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$		
$Liq_{it-1}\times Cap_{it-1}\times\Delta R_t$		
$Liq_{it-1}\times Cap_{it-1}\times\Delta R_{t-1}$		
$Liq_{it-1}\times Risk_{it-1}\times\Delta R_t$		
$Liq_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$		
$Cap_{it-1}\times Risk_{it-1}\times\Delta R_t$		
Intercept	0.235 (5.75) ***	0.216 (9.01)***
$\bar{R}^2$	0.315	0.314
s	0.286	0.287
AIC	0.545	0.517
SIC	1.654	1.469
$P(F,R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.345
Number of observations	760	873

Notes: the symbols represent the subsequent components: $\Delta \ln L_{it}$ = yearly change in loans from the balance sheets of banks i, in year t, ΔR_t = yearly change of the short-term interest rate; $Size_{it-1}$ = log of total assets; Liq_{it-1} = liquidity ratio; Cap_{it-1} = capital to asset ratio and $Risk_{it-1}$ = return on assets (ROA) + equity capital to assets ratio (CAR) divided by standard deviation of return on assets (SDROA). Coefficients for the regressors are observed along with t-ratios on the basis of Windmeijer corrected standard errors for the GMM method and fixed-effects estimator reported within parentheses. $\bar{R}^2$ represents the adjusted coefficient of determination, s denotes the regression standard error, AIC designates Akaike's information criterion and SIC indicates Schwart's information criterion. F-test is modified in order to evaluate joint significance of the slope coefficients $P(F,R^2=0)$, as a result a Wald test estimating the joint significance of the slope coefficients, p(Wald). Furthermore, probability values are reported in a joint test of the exclusion restrictions necessary to attain the specific model through the general specification, p(restrict), in each of the estimation methods. Stata 12 was employed in order to obtain results regarding the GMM method through '*Xtabond 2'* requirement as highlighted by Roodman (2009) whereas the Pooled OLS and fixed effects are both used to approximate the results of the models; these methods are generated via EViews 12.1. Accordingly, 15 identical instruments are utilised in our models estimated by GMM. The symbols ***, **, and ** indicates significance levels of a statistic at the 1%, 5%, and 10% respectively.

With respect to demand which is proxied by both the GDP growth (GGDP) and inflation (CPI), the current value of GGDP is determined to be statistically significant at 10%. Additionally, demand has a conceivable positive coefficient, which implies a significant impact on credit growth. Favourable economic conditions are conducive to expanded loan supply by banks. In contrast, the CPI proxy is statistically significant at 1% while also bearing a negative coefficient.

A sensitivity analysis is also carried out within this study by considering three further variables in the original specification with the purpose of ascertaining whether the aforementioned variables are significant contributors to the bank credit supply; these include the tier-1 ratio, non-performing loans ratio (NPLs) and lastly, loan loss provisions (LLPs) as a percentage of gross loans.

The inclusion of the Tier-1 ratio helps us to fully capture the capital adequacy of banks. Given that standard capital to asset ratio is an accounting-based indicator, it has received lots of criticism, most specifically during the onset of financial crises, for not capturing the risk tailored to the crisis. The data indicates that the role of capital is unrelated to the indicator of capitalisation that was used. In support of the available literature with respect to the BLC, the importance of the tier-1 ratio[15] in a sound banking system must be acknowledged. Here it is suggested that the results found in this study would be inverted, in the instance that unrestricted access to all the bank data from the sample and period evaluated was possible.

Additionally, this research introduces two additional accounting-based risk indicators known as NPLs and LLPs. NPLs show the quality of bank-held assets and the possible negative exposure to asset market values and earnings as a result of a decline in quality of loans, while LLPs are defined as a proportion of loans for an ex-post indicator of credit risk. Yet, when examining non-interacted and two-way interacted variables between these two risk indicators and the monetary policy indicator, no supporting evidence is obtained.

However, we would expect high risk banks to restrict lending by a greater magnitude in comparison with low risks banks, most specifically during the recent financial crisis as hypothesised by Gambacorta and Marques-Ibanez (2011).

[15] The available data on the tier-1 ratio is limited to a quarter of the total sample.

5.2 Sub-sample analysis and results:

Caution must be taken when presupposing the presence of fixed-effects and dynamics because such an assumption could negatively affect inference, which is in keeping with contemporary estimation practices presented in Akinci, *et al.* (2013) and Fungáčová, *et al.* (2014).

The dynamics in the levels of data are not evident since they are not presented in their first differences.[16] Accordingly, the model[17] is tested via the panel fixed effects as our preferred specification while omitting the lagged dependent variable from the sub-samples model. Additionally, we choose to utilise the Pooled-OLS estimator with the purpose of ascertaining and verifying the reliability of the results obtained.

Included in the general specification are the following: the lagged values of the four bank characteristics as well as that of each of the two macroeconomic variables, and finally a selection of two-way and three-way interaction terms specific for interest rate changes and bank-specific variables. The parsimonious models are presented in **Table 7 & 8** are effective interpretations of the general models and it can be understood that the limitations set for general models in order to acquire the parsimonious models are not subject to rejection (refer to p(restrict)). Moreover, these models offer substantial explanatory power in which p(F, R^2=0) represents the probability value of the F-test for the null R^2=0.

As reflected in the model tailored for the pre-crises sample (2004-2007), our results make a moderate case for the existence of the BLC within the EU-10 states. Specifically, monetary-policy interaction terms for liquidity is ascertained at 10%.[18] While the first lag of liquidity is significant at 5%, the first lag of size is significant at 1% and bears a negative coefficient which could support the argument that smaller banks could have more variable lending activity if newly founded, relative to the larger banks. Using the Pooled-OLS methodology in order to check the legitimacy of the results acquired this additionally supports

[16] Given that annual data as opposed to quarterly data is utilised here, the outcome is actually not unexpected. When considering that Fungáčová, *et al.* (2014) underlines the idea that a convincing argument can be made regarding the reason why lending in the previous quarter could affect contemporary lending, the study also suggests that it would be more difficult to find an economic justification that explains why the previous year's lending should affect the present year's lending; this is consistent with the evaluation of Turkish monetary policy seen in Akinci *et al*. (2013).

[17] In this methodology time period fixed-effects cannot be included since macroeconomic variables only show changes in time instead of being spread across banks; therefore, they would be flawlessly collinear with period effects

[18] This result is calculated using the general model. Both general and specific models calculated by the Pooled-OLS support this conclusion.

the premise the three-way interaction terms of ΔR t-1 with lagged size and liquidity, and lagged liquidity and capital are both statistically significant at 1%. These results highlight the significance of the previously mentioned interaction terms by facilitating banks in terms of loans issued as well as their resistance to changes in monetary policy, specifically for the period before the financial crisis.

Table 7: Pre-crisis results

Pooled-OLS estimator:

Variable	General	Specific
ΔR_{t-1}	-5.732 (-0.09)	
Size $_{it-1}$	-0.0478 (-1.90)	
Liquidity $_{it-1}$	0.00494 (0.20)	
Capitalisation $_{it-1}$	-0.0415 (-1.12)	
Risk $_{it-1}$	0.00713 (0.29)	
Size $_{it-1}\times\Delta R_{t-1}$	-0.0106 (-0.33)	
Liq $_{it-1}\times\Delta R_{t-1}$	0.0772 (2.36)*	0.0781 (2.72)**
Cap $_{it-1}\times\Delta R_{t-1}$	-0.0164 (-0.31)	
Risk $_{it-1}\times\Delta R_{t-1}$	0.0131 (0.36)	
Size $_{it-1}\times$Liq $_{it-1}\times\Delta R_{t-1}$	0.150 (4.39)***	0.155 (5.32)***
Size $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	-0.0164 (-0.42)	
Size $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.000925 (0.03)	
Liq $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	0.182 (3.28)**	0.170 (3.60)***
Liq $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	-0.0169 (-0.51)	
Cap $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.00129 (0.05)	
GGDP$_{t-1}$	1.298 (0.09)	
Intercept	-5.950 (-0.09)	0.260 (13.02)***
$\bar{R}^2$	0.081	0.107
s	0.306	0.301
AIC	0.541	0.455
SIC	0.795	0.514
$P(F,R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.923
Number of observations	230	231

Table 8: Pre-crisis results

Panel fixed effects regression:

Variable	General	Specific
ΔR_{t-1}	-1.644 (-0.04)	
Size $_{it-1}$	-1.291 (-7.76)***	-0.731 (-6.65)***
Liquidity $_{it-1}$	0.204 (2.66)**	0.119 (2.61)**
Capitalisation $_{it-1}$	0.0132 (0.08)	
Risk $_{it-1}$	0.189 (0.89)	
Size $_{it-1}\times\Delta R_{t-1}$	-0.0164 (-0.67)	
Liq $_{it-1}\times\Delta R_{t-1}$	0.0580 (2.24)*	
Cap $_{it-1}\times\Delta R_{t-1}$	-0.0754 (-1.94)	
Risk $_{it-1}\times\Delta R_{t-1}$	0.0518 (1.76)	
Size $_{it-1}\times$Liq $_{it-1}\times\Delta R_{t-1}$	0.0470 (1.45)	
Size $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	-0.0504 (-1.63)	
Size $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.00456 (0.16)	
Liq $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	0.0977 (1.87)	
Liq $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	-0.00242 (-0.09)	
Cap $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	-0.0153 (-0.72)	
GGDP$_{t-1}$	0.377 (0.04)	
Intercept	-1.505 (-0.03)	0.264 (15.83)***
$\bar{R}^2$	0.613	0.358
S	0.198	0.255
AIC	0.127	0.390
SIC	1.91365	2.025
$P(F,R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.3642
Number of observations	230	339

*Indicates significance of a statistic at the 10% level.

** Indicates significance of a statistic at the 5% level.

***Indicates significance of a statistic at the 1% level.

In keeping with the deductions and inferences made in the available theoretical models about the BLC, the impact of bank size, liquidity, capital and risk on bank-sourced lending should conceivably bear positive coefficients; this means that large, highly liquid banks, well-capitalised and low risk banks should less likely to change their credit portfolio, especially in the instance of a banking crisis and consequently to monetary policy stance changes. Yet, as our model tailored for the crisis (2008-2010) implies, said coefficients are ultimately not significant; this conclusion serves as an additional refutation of the role of said indicators in allowing banks to maintain lending activity and growth during a financial crisis, which apparently does not include the positive lagged value of risk and liquidity. The data reveals that less risk and highly liquid bank are not disposed to decrease their lending activity relative to the opposite side of the spectrum.

Yet there is no data to indicate the existence of the BLC within the period of the crisis. The result obtained via the three-way interaction terms of ΔR t-1 with lagged size and liquidity is significant at 10%; however it carries a negative coefficient which is inconsistent with the BLC hypothesis and cannot be utilised to determine whether the channel exists; this reasoning also applies to monetary policy interaction terms for both risk and liquidity. For the most part this conclusion is well supported and consistent irrespective of estimation methodologies employed they suggest that the BLC stayed impaired and decreased in effectiveness particularly within the crisis sample. Lastly, varied economic activity, by GDP growth, is also observed to be positively correlated with loan growth.

Table 9: Crisis results

Pooled-OLS estimator:

Variable	General	Specific
ΔR_{t-1}	-0.0730 (-0.47)	
$Size_{it-1}$	-0.0889 (-1.16)	
$Liquidity_{it-1}$	0.0926 (1.35)	
$Capitalisation_{it-1}$	0.152 (1.49)	0.116 (4.86)***
$Risk_{it-1}$	0.208 (2.70)**	0.199 (2.77)**
$Size_{it-1} \times \Delta R_{t-1}$	0.0286 (0.39)	
$Liq_{it-1} \times \Delta R_{t-1}$	-0.109 (-1.66)	
$Cap_{it-1} \times \Delta R_{t-1}$	-0.164 (-1.37)	
$Risk_{it-1} \times \Delta R_{t-1}$	-0.167 (-2.14)*	-0.188 (-2.60)**
$Size_{it-1} \times Liq_{it-1} \times \Delta R_{t-1}$	-0.125 (-4.10)***	-0.111 (-6.59)***
$Size_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$	-0.0549 (-1.62)	
$Size_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$	0.0431 (1.78)	
$Liq_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$	-0.000325 (-0.01)	
$Liq_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$	0.0169 (0.71)	
$Cap_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$	0.0350 (1.24)	
$GGDP_{t-1}$	0.0127 (1.59)	0.0118 (3.92)***
Intercept	-0.0118 (-0.13)	-0.0437 (-1.30)
$\bar{R}^2$	0.308	0.290
s	0.266	0.268
AIC	0.247	0.233
SIC	0.473	0.312
$P(F, R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.0989
Number of observations	271	271

*Indicates significance of a statistic at the 10% level.

** Indicates significance of a statistic at the 5% level.

***Indicates significance of a statistic at the 1% level.

Table 10: Crisis results

Panel fixed effects regression:

Variable	General	Specific
ΔR_{t-1}	-0.0475 (-0.24)	
$Size_{it-1}$	-0.387 (-1.84)	-0.327 (-2.69)**
$Liquidity_{it-1}$	0.377 (4.41)***	0.406 (4.97)***
$Capitalisation_{it-1}$	0.231 (1.15)	
$Risk_{it-1}$	0.393 (1.65)	0.413 (2.76)**
$Size_{it-1} \times \Delta R_{t-1}$	0.0108 (0.13)	
$Liq_{it-1} \times \Delta R_{t-1}$	-0.140 (-2.00)*	-0.182 (-2.84)**
$Cap_{it-1} \times \Delta R_{t-1}$	-0.209 (-1.03)	
$Risk_{it-1} \times \Delta R_{t-1}$	-0.266 (-2.92)**	-0.292 (-3.63)***
$Size_{it-1} \times Liq_{it-1} \times \Delta R_{t-1}$	-0.115 (-1.90)	-0.0857 (-2.29)*
$Size_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$	0.0239 (0.28)	
$Size_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$	-0.0634 (-0.80)	
$Liq_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$	0.0373 (0.36)	
$Liq_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$	0.00881 (0.12)	
$Cap_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$	-0.273 (-1.83)	
$GGDP_{t-1}$	0.00848 (0.94)	0.00649 (2.16)*
Intercept	0.139 (1.17)	0.0682 (1.69)
$\bar{R}^2$	0.493	0.490
S	0.227	0.228
AIC	0.182	0.184
SIC	1.963	1.846
$P(F, R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.377
Number of observations	271	271

The post-crisis sample (2011-2013) indicates a substantial measure of evidence to support the existence of the BLC; this is given through the three-way interaction terms represented in ΔR_{t-1} with lagged size and liquidity. Additionally, it is observed that well-capitalised and highly liquid banks realised more loan growth following the crisis. Furthermore, the monetary policy interaction term for capital has a favourable positive coefficient. As reflected in the parsimonious model by the Pooled-OLS, the general reproducibility and reliability of the results following the crisis should be accepted; yet, it supports a negative coefficient for the three-way interaction terms represented in ΔR_{t-1} with lagged liquidity and capital which is in contrast with the results produced via the Panel fixed effect estimator. As a result this small discrepancy will not be addressed in this analysis.

Table 11 Post-crisis results
Pooled-OLS estimator:

Variable	General	Specific
ΔR_{t-1}	0.0543	0.0195
	(3.47)***	(2.41)*
Size $_{it-1}$	-0.0260	
	(-1.00)	
Liquidity $_{it-1}$	0.0405	0.0403
	(1.87)	(2.37)*
Capitalisation $_{it-1}$	0.150	0.165
	(3.82)***	(4.24)***
Risk $_{it-1}$	0.0355	
	(1.41)	
Size $_{it-1}\times\Delta R_{t-1}$	0.00659	
	(0.59)	
Liq $_{it-1}\times\Delta R_{t-1}$	0.0148	
	(1.46)	
Cap $_{it-1}\times\Delta R_{t-1}$	0.0525	0.0384
	(2.83)**	(2.63) **
Risk $_{it-1}\times\Delta R_{t-1}$	0.0130	
	(0.95)	
Size $_{it-1}\times$Liq $_{it-1}\times\Delta R_{t-1}$	0.0227	
	(2.06)*	
Size $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	0.0168	
	(1.15)	
Size $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	-0.0156	-0.0184
	(-1.68)	(-2.31)*
Liq $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	-0.00810	-0.0348
	(-0.51)	(-3.69)***
Liq $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.0250	0.0247
	(1.75)	(3.19)**
Cap $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.0129	
	(0.60)	
$GGDP_{t-1}$	-0.0422	
	(-1.89)	
Intercept	0.695	0.0744
	(2.12)*	(3.47)***
$\bar{R}^2$	0.254	0.226
s	0.241	0.246
AIC	0.0741	0.0719
SIC	0.336	0.195
$P(F,R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.144
Number of observations	220	220

Table 12 Post-crisis results
Panel fixed effects regression:

Variable	General	Specific
ΔR_{t-1}	0.0224	0.0138
	(2.22)*	(2.77)**
Size $_{it-1}$	-0.232	
	(-1.35)	
Liquidity $_{it-1}$	0.243	0.229
	(5.88)***	(6.09)***
Capitalisation $_{it-1}$	0.335	0.297
	(5.81)***	(6.59)***
Risk $_{it-1}$	-0.0764	
	(-0.45)	
Size $_{it-1}\times\Delta R_{t-1}$	0.00133	
	(0.18)	
Liq $_{it-1}\times\Delta R_{t-1}$	0.0120	
	(1.71)	
Cap $_{it-1}\times\Delta R_{t-1}$	0.0235	0.0371
	(1.81)	(3.95)***
Risk $_{it-1}\times\Delta R_{t-1}$	0.00897	
	(0.99)	
Size $_{it-1}\times$Liq $_{it-1}\times\Delta R_{t-1}$	0.0154	0.0144
	(1.90)	(2.74)**
Size $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	-0.0188	
	(-1.48)	
Size $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.00921	
	(1.16)	
Liq $_{it-1}\times$Cap $_{it-1}\times\Delta R_{t-1}$	0.0157	0.0267
	(1.18)	(2.96)**
Liq $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	0.00527	
	(0.50)	
Cap $_{it-1}\times$Risk $_{it-1}\times\Delta R_{t-1}$	-0.00412	
	(-0.20)	
$GGDP_{t-1}$	-0.0170	
	(-1.11)	
Intercept	0.378	0.113
	(1.64)	(8.47)***
$\bar{R}^2$	0.767	0.770
S	0.135	0.134
AIC	-0.862	-0.872
SIC	0.942	0.777
$P(F,R^2=0)$	0.000***	0.000***
P(restrict)	NA	0.572
Number of observations	220	220

*Indicates significance of a statistic at the 10% level.

** Indicates significance of a statistic at the 5% level.

***Indicates significance of a statistic at the 1% level.

5.3 Discussion of results:

Similar to the previous empirical research conducted by Matousek & Saranatis (2009) which examined the BLC with reference to the panel of 8 CEE countries from 1994-2003, we find liquidly to be an important factor in assessing a bank's ability to provide credits. Furthermore, the existence of the BLC is demonstrated via liquidity which appears to be a significant, contributing bank-specific characteristic when evaluating the banks' response to monetary policy changes. Comparable supporting evidence for the influence of bank liquidity is documented in Ehrmann, *et al*. (2003), Gambacorta (2005), Altunbas, *et al.* (2010), and Leroy (2014), among others.

Additionally, this assessment upholds previous study by Matousek & Saranatis (2009) which suggests that the effect of bank capital on the banks' reaction to monetary policy variation is less important; therefore, capitalisation is not considered a strong contributing factor when assessing the likelihood of a bank's reaction to changes in monetary policy. With respect to the CEE nations, the results here are in contrast to earlier investigations that obtained results supporting the influence of capitalisation in the Czech Republic (Pruteanu, 2004) and Poland (Wróbel and Pawlowska, 2002).

In contrast to the findings in Matousek & Sarantis (2009) for 8 CEE countries, Horváth *et al*. (2006) for Hungary, Pruteanu (2004) for the Czech Republic, and Wróbel and Pawlowska (2002) for Poland, we find no evidence to support the role of bank size in EU-10 countries. This conclusion is in line with studies that examined the BLC with reference to Western European banks (Ehrmann, *et al.,* 2003, Altunbas, *et al*., 2002, Gambacorta, 2005, Altunbas *et al.*, 2010 and Gambacorta and Marques-Ibanez (2011), see among others.

Finally, when examining the total sample, there is little evidence to substantiate the role of bank risk; yet high risk banks would be expected to limit lending to a greater extent than low risk banks, specifically during the crisis period examined. This is in keeping with the postulation made by Altunbas, *et al.,* (2010) and Gambacorta and Marques-Ibanez (2011).

The monetary policy makers reacted to the GFC by slashing interest rates to nearly zero and keeping them there for a record duration of time with the purpose of enabling bank lending activity. Under these circumstances Keynes (1936) characterised monetary policy as similar to '*pushing and string'* while also presenting the idea of a '*liquidity trap'*. With the intention of increasing the rate of economic recovery, the central banks have introduced a several unconventional monetary policy practices coined *"non-standard policy measures, "quantitative easing" and "credit easing"*. When examining the aim of the ECB, Cour-Thimann and Winkler (2013) highlights that the central bank employs non-standard measures that act as a complement to the standard interest rate policy rather than as a replacement for it. Such measures have served to enhance credit flows and financing conditions because they are geared at assisting the effective diffusion of interest rate policies throughout the euro area at a time when other policies and developments have proved ineffective in several areas of Europe's financial sector. As stressed in Mullineux (2013), the central banks' practice of offering an elastic supply of liquidity could therefore be similar to '*pushing on a string'*; yet, in order to sufficiently stimulate the economy, banks need to begin lending idle cash to investment firms utilising this capital.

As reflected in the model specific for during and after crisis, the growth of bank lending in response to the monetary policy stance derived from money market rates in the short term is not significant yet again. Considering substantially reduced monetary policy rates within the crisis period, an inverse correlation between interest rates and bank lending growth would be predicted; yet, this hypothesis is unsupported by the estimated data. In contrast to the theoretical justification for the money channel, which endorses a concept of an indirect relationship between bank lending growth and monetary policy stance, in the model that evaluates the period following the crisis it is suggested that an unanticipated positive relation exists possibly a consequence of a '*pushing on a string effect'*.

What this really highlights is that notwithstanding the labours of the national central banks to keep interest rates low and inject liquidity into their economic systems, bank lending has stayed subdued. This result can be correlated with that seen when examining the critical investigation of the Japanese economy in Werner (2012) which highlights that continuous interest rate reductions for a period spanning over a decade were unsuccessful at stimulating the economy and expanding the money supply. Additionally, the model tailored for the crisis confirms that low risk banks are not disposed to decrease their lending activity relative to the opposite side of the spectrum. Altunbas, *et al.,* (2010) and Gambacorta and Marques-Ibanez (2011) similarly provide evidence for the influence of bank risk in this case.

The data suggests that well-capitalised and highly liquid banks are able to increase their lending activity particularly in the post financial crisis time frame, highlighting the important role that these bank-specific characteristics have during this period. High liquidity or high capitalisation better facilitates bank lending prospects while avoiding statutory limitations (Leroy, 2014).

The estimations made here indicate that the prevalence of BLC was reduced throughout the credit crisis. The influence of the financial crisis is thought to have been more distinct for the credit supply than for the credit demand. Here it is suggested that the effectiveness of monetary policy has been reduced during this period for a variety of reasons, such as bank aversion to increase lending activity and volume irrespective of the monetary policy stance.

In addition, this study also assesses unconventional monetary policy by introducing a further proxy corresponding the ratio between each central bank's total assets and nominal GDP forthe post crisis sample.[19] The previously addressed proxy suggests a similar effect as these measures

[19] The data for constructing this proxy were taken from Bankscope and Eurostat which consists of the following central banks: Czech Republic, Latvia, Lithuania, Hungary and Poland.

seem to be ineffective in covering reduced lending activity by banks following the aftermath of financial turmoil.[20]

The ultimate robustness check includes assessing the possible effect that other nations' factors could have on the results at the bank level. Stated in other terms, this study determines whether solitary bank coefficients may vary in different nations when controls for nation-specific macroeconomic or financial elements are present.[21]Thus a simplified version of model.1 is estimated again utilising the panel fixed estimator, by examining nations that stay in the EU-10 but had not joined the EMU before 2013 with reference to full period of sample including Czech Republic, Hungary and Baltic states and Poland (Estonia was later left out in 2011) in addition to the new EMU countries comprising Slovenia, Slovakia, Cyprus and Malta, prior to the date they adopted the euro as their own currency. The outcomes documented in **Appendix. II** indicated for the most part that the coefficients were not significantly different for national banks in Europe and the deduction resulting from this research. As a result the primary conclusions remain intact.

6. Conclusion

This paper explores the role of the banks with respect to the monetary transmission mechanism; specifically by examining the 10 accession countries which became members of the EU in accordance with the pact stated in the Treaty of Accession from 2004 to 2013. This is in contrast to prior research by Matousek and Sarantis (2009) which used a reference panel of 8 CEE countries, covering the decade preceding the accession (1994-2003). The data indicates that the BLC has experience an evolved development over the period in EU-10, considering the time frame in this research. The existence of the BLC is demonstrated via liquidity which appears to be a significant, contributing bank-specific characteristic when evaluating the banks' response to monetary policy changes. Furthermore, the coefficient on bank size is determined to be statistically insignificant for EU-10. Therefore, the matter of informational asymmetry is not vital in the BLC for EU-10. It is determined that the remaining bank-specific traits (bank risk and capital) appear to be irrelevant considerations when evaluating the response of banks to changes in monetary policy for the total duration of this study.

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[20] The ratio has a predicted negative sign when included in the parsimonious model specific for the post-crisis sample, which is in contrast to a recent study conducted in Fungáčová, *et al.* (2014) and Gambacorta and Marques-Ibanez (2011) in which the direct positive relation was determined for the Euro area and more industrialised countries.

[21]The exceptions we make here is by pooling the three Baltic countries, Estonia, Lithuania and Latvia due to small number of banks in these countries in line with Matousek and Sarantis (2009) study. in addition to the data for (Slovenia and Slovakia) and (Cyprus and Malta)

The model used in this study is constructed to consider any distinct movement on banks' lending behaviour for the periods before, during and after the financial turmoil. Revealing the fact that bank characteristics can change the strength of the BLC during the previously stated three phases. From 2008 to 2010, there is data to support the impact of bank risk and liquidity; however this channel is impaired, which serving as an additional refutation of the role of said indicators in allowing banks to maintain lending activity and growth during a financial crisis. This paper proposes that the effectiveness of monetary policy has been reduced throughout the credit crisis for different reasons, such as bank aversion to increase lending activity and volume irrespective of the monetary policy stance.

Moreover, this study supports the introduction of regulatory capital requirements and suggests that this would not cause reduced lending. Highly liquid, well-capitalised banks demonstrated reduced vulnerability in response to the influence of monetary policy in the period following the financial crisis that was sampled. Accordingly, it is advised that banks fulfil the standards set by these regulations and requirements. In addition, the shadow banking system must also be monitored as a result of more potentially dangerous components native to this system, reinforcing the idea of having regulation procedures that are a good fit with its complementary financial institution. This research recommends widespread data availability on the entire banking system, including more detail. Measurement by tier-1 capital ratio would be particularly useful as it would permit subsequent research to perform a detailed evaluation of the monetary policy transmission mechanism since it considers additional parameters.

Our results reveal that the lagged value of loan growth is insignificant when evaluating the sub-samples models using the Arellano and Bond GMM methodology; this offers a persuasive argument from the inclusion of the variable as a regressor. As a result, the model is tested via the fixed effect model as our preferred specification for the aforementioned periods. Consequently, future research ought to consider this issue, given that incorrect postulations regarding dynamics represented in the evidence could negatively impact inference.

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Appendix I. Data appendix

Country repartition

Country	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Malta	Poland	Slovakia	Slovenia
Number of Banks	15	20	8	26	20	11	9	43	14	16
Number of observations	34	126	31	144	140	77	15	243	39	24

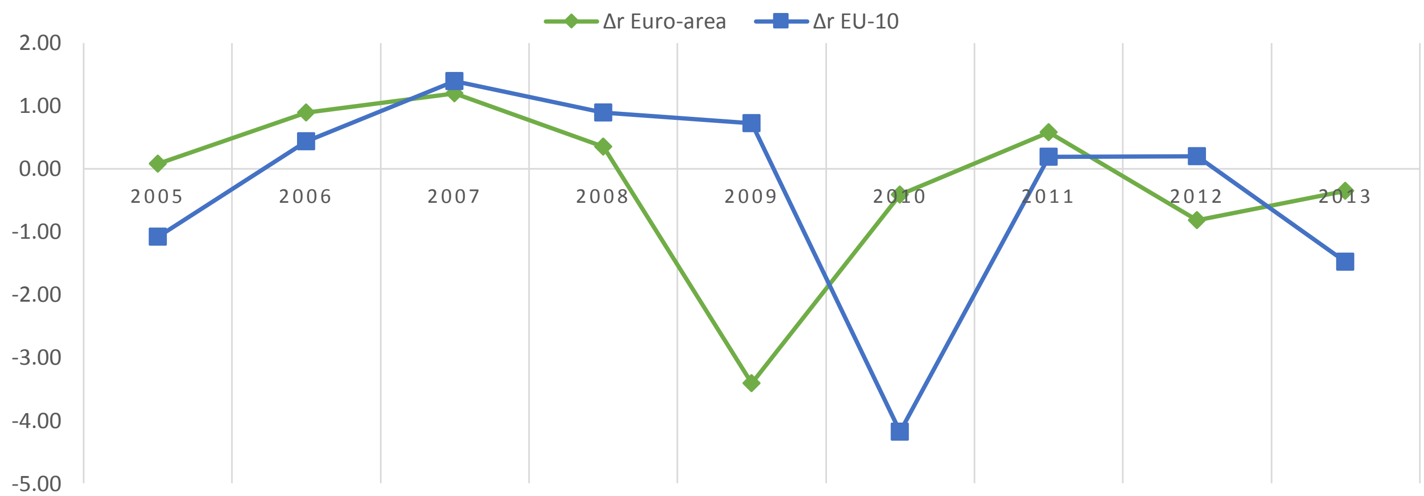
Before crisis (2004-07)	Obs.	Mean	Std.Dev.	Min.	Max.
Δln (Loans)	339	0.2714	0.318	-1.674	3.183
Size	339	13.993	1.679	8.958	17.371
Capitalisation	339	0.110	0.093	0	0.928
Liquidity	339	0.271	0.184	0	1
Risk factor	339	21.928	25.574	0.172	174
GDP (growth rate)	339	3.75	7.267	-5.50	13.9
ΔR	339	0.247	1.018	-1.084	1.392

During crisis (2008-10)	Obs.	Mean	Std.Dev.	Min.	Max.
Δln (Loans)	273	.0771	0.99	-3.907	2.927
Size	273	14.145	1.778	6.331	17.577
Capitalisation	273	0.111	0.110	0	0.987
Liquidity	273	0.204	0.164	0	0.978
Risk factor	273	20.093	22.675	-4.493	151.66
GDP (growth rate)	273	9.67	5.458	4.9	17.3
ΔR	273	-0.853	2.354	-4.178	0.8938

Post crisis (2011-13)	Obs.	Mean	Std.Dev.	Min.	Max.
Δln (Loans)	220	0.043	0.280	-1.307	1.762
Size	220	14.280	1.7645	7.198	17.687
Capitalisation	220	0.110	0.107	0	0.933
Liquidity	220	0.210	0.194	0	1
Risk factor	220	21.450	25.034	-7.860	157.408
GDP (growth rate)	220	14.20	1.595	12.3	16.2
ΔR	220	-0.364	0.791	-1.482	0.2

Fig. 2

Money market interest rates, deposit liabilities, 3 months (80-100 days maturity) annual frequency:



Source: (ECB, Eurostat, OECD and Central Banks)

Table: 13

Variable	Expected sing	Hypothetical Outlook [22]	Regression results based on **Model.1**
$Size_{it-1}$	+/-	Large banks may be less vulnerable to dramatic changes in monetary policy (+). Smaller banks could have more variable lending activity if newly founded, relative to the larger banks. Additionally, a healthy lending relationship between small banks and firms could be a possibility (-)	
$Size_{it-1}*C$	+/-	Too big to fail (+) / Too big to be bailed out (-)	--
CAP_{it-1}	+	Banks that are well-capitalised banks tend to increase the loan supply	
$CAP_{it-1}*C$	+	Especially during the period of the financial crisis	
LIQ_{it-1}	+	Banks with higher liquidity are expected to increase their loan supply	++
$LIQ_{it-1}*C$	+	Especially during the period of the financial crisis	+++
$Risk_{it-1}$	+/-	Bank loan portfolios that are low risk are not as vulnerable if mandated by regulation from capital markets (+) Banks with higher risk could increase their lending activity (-)	
$Risk_{it-1}*C$	+	During the period of the financial crisis, banks with less risk are not particularly disposed to decrease their lending activity relative to the opposite side of the spectrum	++
ΔR_t	-	Tight monetary policy results in decreased lending activity (-)	
ΔR_t*C	+/-	During the period of the financial crisis a "*pushing on a string effect*" could occur (+); this effect could be augmented (-)	
$GGDP_t$	+	Favourable economic conditions are conducive to expanded loan supply by banks	+
$GGDP_t*C$	+	Especially during the period of the financial crisis	
CPI_t	+/-	Inflation levels could have a favourable impact on the growth of nominal loans (+). Inflation rates could have the opposite effect on these loans (-)	---
<u>The bank lending channel (BLC) postulation:</u> The 2-way and 3-way interaction between bank characteristics and the monetary policy measurement			
$Size_{it-1}*\Delta Rt$ $Size_{it-1}*\Delta Rt*C$	+ +	Larger banks are predicted to resist the changes in monetary policy Especially during the period of the financial crisis	
$CAP_{it-1}*\Delta Rt$ $CAP_{it-1}*\Delta Rt*C$	+ +	Well-capitalised banks are predicted to resist the changes in monetary policy Especially during the period of the financial crisis	
$LIQ_{it-1}*\Delta Rt$ $LIQ_{it-1}*\Delta Rt*C$	+ +	Highly liquid banks are predicted to resist the changes in monetary policy Especially during the period of the financial crisis	--
$Risk_{it-1}*\Delta Rt$ $Risk_{it-1}*\Delta Rt*C$	+ +	low risk banks are less sensitive to monetary policy changes Especially during the period of the financial crisis	---
$Size_{it-1}*CAP_{it-1}*\Delta Rt$ $Size_{it-1}*CAP_{it-1}*\Delta Rt*C$	+ +	Large banks that are well-capitalised are predicted to resist the changes in monetary policy Especially during the period of the financial crisis	
$Size_{it-1}*LIQ_{it-1}*\Delta Rt$ $Size_{it-1}*LIQ_{it-1}*\Delta Rt*C$	+ +	Large banks with high liquidity are predicted to resist the changes in monetary policy Especially during the period of the financial crisis	-
$Size_{it-1}*Risk_{it-1}*\Delta Rt$ $Size_{it-1}*Risk_{it-1}*\Delta Rt*C$	+ +	Large banks with low risk are less sensitive to monetary policy changes Especially during the period of the financial crisis	
$CAP_{it-1}*LIQ_{it-1}*\Delta Rt$ $CAP_{it-1}*LIQ_{it-1}*\Delta Rt*C$	+ +	Banks with high liquidity that are well-capitalised are predicted to resist the changes in monetary policy Especially during the period of the financial crisis	
$CAP_{it-1}*RISK_{it-1}*\Delta Rt$ $CAP_{it-1}*RISK_{it-1}*\Delta Rt*C$	+ +	Well capitalised and low risk banks are less sensitive to monetary policy changes Especially during the period of the financial crisis	
$LIQ_{it-1}*RISK_{it-1}*\Delta Rt$ $LIQ_{it-1}*RISK_{it-1}*\Delta Rt*C$	+ +	Liquid and low risk banks are less sensitive to monetary policy changes Especially during the period of the financial crisis	
Notes: The sample for this study spans from 2004 to 2013. The signs + (-), ++ (--), +++ (---) indicate significance of a statistic at the 10 percent, 5 percent and 1 percent level, correspondingly. C denotes the period of financial crisis.			

[22] The hypothetical foundation of the assertion stated in this segment is sourced from empirically supported research (Gambacorta, 2005; Matousek & Sarantis, 2009; Altunbas, *et al*. 2010; Gambacorta and Marques-Ibanez, 2011 and Akinci *et al*. 2013, among others).

Appendix. II: Robustness check (Estimates of Model.1 using bank data):

Table 14A (Estimates of Model.1 using bank data. Czech Republic).

	Size	Liq	Cap	Risk	Size Liq	Size Cap	Size Risk	Liq Cap	Liq Risk	Cap Risk
Specification	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ΔR_{t-1}	-0.043	-0.016	0.014	-0.012	-0.081	-0.081	-0.058	-0.031	-0.027	0.024
	(0.78)	(0.21)	(0.18)	(0.16)	(1.31)	(1.49)	(1.10)	(0.39)	(0.36)	(0.31)
$GGDP_{t-1}$	0.022	0.001	-0.015	-0.009	0.032	0.026	0.022	-0.002	0.001	-0.011
	(1.51)	(0.06)	(0.74)	(0.46)	(2.09)*	(1.85)	(1.60)	(0.08)	(0.03)	(0.56)
CPI_{t-1}	-0.021	-0.017	-0.003	-0.005	-0.028	-0.021	-0.018	-0.013	-0.013	-0.002
	(1.87)	(1.05)	(0.21)	(0.31)	(2.45)*	(1.96)	(1.74)	(0.77)	(0.80)	(0.10)
$Size_{it-1}$	-0.945				-0.933	-0.975	-0.879			
	(10.38)***				(10.00)***	(11.31)***	(10.05)***			
$Liquidity_{it-1}$		0.249			0.141			0.209	0.151	
		(2.73)**			(2.12)*			(2.18)*	(1.60)	
$Capitalisation_{it-1}$			-0.221			-0.763		-0.483		0.301
			(0.98)			(3.82)***		(1.48)		(1.19)
$Risk_{it-1}$				-0.514			-0.393		-0.423	-0.686
				(3.79)***			(4.10)***		(2.82)**	(4.14)***
$Size_{it-1} \times \Delta R_{t-1}$	0.069				0.071	0.119	0.095			
	(1.46)				(1.32)	(2.31)*	(1.97)			
$Liq_{it-1} \times \Delta R_{t-1}$		-0.118			-0.043			-0.143	-0.104	
		(1.70)			(0.70)			(1.90)	(1.40)	
$Cap_{it-1} \times \Delta R_{t-1}$			-0.122			0.040		-0.001		0.0508
			(1.13)			(0.41)		(0.08)		(0.39)
$Risk_{it-1} \times \Delta R_{t-1}$				0.0420			0.002		0.053	0.026
				(0.64)			(0.04)		(0.62)	(0.34)
$Size_{it-1} \times Liq_{it-1} \times \Delta R_{t-1}$					-0.053					
					(0.96)					
$Size_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$						0.112				
						(2.46)*				
$Size_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$							-0.04			
							(0.69)			
$Liq_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$								-0.110		
								(1.28)		
$Liq_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$									0.069	
									(0.76)	
$Cap_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$										-0.06
										(0.33)
Constant	-0.0143	1.816	2.173	1.644	-0.242	-0.494	-0.298	1.641	1.436	1.545
	(0.02)	(1.61)	(1.86)	(1.48)	(0.29)	(0.62)	(0.38)	(1.44)	(1.31)	(1.40)
R-squared	0.540	0.123	0.048	0.161	0.564	0.605	0.608	0.143	0.210	0.199
Observations	130	130	130	130	130	130	130	130	130	130

* Indicates significance at 10%.

** Idem, 5%.

*** Idem, 1%.

Table 14B (Estimates of Model.1 using bank data. Poland).

	Size	Liq	Cap	Risk	Size Liq	Size Cap	Size Risk	Liq Cap	Liq Risk	Cap Risk
Specification	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ΔR_{t-1}	-0.032	-0.006	-0.004	-0.005	-0.032	-0.032	-0.034	-0.004	-0.006	-0.004
	(1.50)	(0.29)	(0.18)	(0.22)	(1.49)	(1.33)	(1.57)	(0.18)	(0.27)	(0.16)
$GGDP_{t-1}$	-0.006	-0.004	-0.004	-0.004	-0.005	-0.007	-0.007	0.000	-0.003	-0.004
	(0.69)	(0.38)	(0.40)	(0.40)	(0.53)	(0.75)	(0.78)	(0.03)	(0.25)	(0.38)
CPI_{t-1}	0.006	-0.002	-0.004	-0.003	0.006	0.008	0.008	-0.007	-0.003	-0.004
	(0.50)	(0.14)	(0.27)	(0.24)	(0.45)	(0.58)	(0.62)	(0.55)	(0.26)	(0.28)
$Size_{it-1}$	-0.552				-0.552	-0.576	-0.571			
	(4.56)***				(4.53)***	(4.35)***	(4.40)***			
$Liquidity_{it-1}$		0.044			0.044			0.045	0.061	
		(0.91)			(0.97)			(0.91)	(1.22)	
$Capitalisation_{it-1}$			0.108			-0.0543		0.109		0.090
			(1.06)			(0.52)		(1.05)		(0.61)
$Risk_{it-1}$				0.099			-0.0825		0.148	0.023
				(0.85)			(0.70)		(1.22)	(0.14)
$Size_{it-1} \times \Delta R_{t-1}$	0.030				0.032	0.030	0.033			
	(1.63)				(1.65)	(1.55)	(1.79)			
$Liq_{it-1} \times \Delta R_{t-1}$		0.005			0.006			0.007	0.009	
		(0.24)			(0.28)			(0.34)	(0.42)	
$Cap_{it-1} \times \Delta R_{t-1}$			-0.001			-0.002		0.006		-0.009
			(0.05)			(0.04)		(0.19)		(0.26)
$Risk_{it-1} \times \Delta R_{t-1}$				0.012			-0.008		0.006	0.014
				(0.64)			(0.36)		(0.28)	(0.61)
$Size_{it-1} \times Liq_{it-1} \times \Delta R_{t-1}$					0.007					
					(0.19)					
$Size_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$						0.017				
						(0.51)				
$Size_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$							-0.019			
							(0.91)			
$Liq_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$								0.042		
								(1.01)		
$Liq_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$									-0.021	
									(0.99)	
$Cap_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$										-0.001
										(0.01)
Constant	0.220	0.796	1.010	0.953	0.122	0.133	0.140	0.933	0.826	1.012
	(0.56)	(2.00)*	(2.53)*	(2.45)*	(0.30)	(0.30)	(0.34)	(2.27)*	(2.06)*	(2.50)*
R-squared	0.170	0.063	0.065	0.064	0.174	0.173	0.176	0.078	0.078	0.068
Observations	210	210	210	210	210	210	210	210	210	210

* Indicates significance at 10%.

** Idem, 5%.

*** Idem, 1%.

Table 14C (Estimates of Model.1 using bank data. Hungary).

Specification	Size **1**	Liq **2**	Cap **3**	Risk **4**	Size Liq **5**	Size Cap **6**	Size Risk **7**	Liq Cap **8**	Liq Risk **9**	Cap Risk **10**
ΔR_{t-1}	0.019	0.024	0.017	0.024	0.041	0.014	0.025	0.024	0.027	0.034
	(0.53)	(0.78)	(0.45)	(0.65)	(1.32)	(0.34)	(0.69)	(0.79)	(0.91)	(0.90)
$GGDP_{t-1}$	-0.030	-0.021	-0.009	-0.015	-0.033	-0.029	-0.032	-0.021	-0.026	-0.017
	(0.98)	(0.81)	(0.28)	(0.46)	(1.28)	(0.94)	(1.04)	(0.78)	(0.99)	(0.54)
CPI_{t-1}	-0.005	-0.003	-0.009	-0.008	-0.003	-0.004	-0.004	-0.003	-0.005	-0.007
	(0.82)	(0.51)	(1.42)	(1.22)	(0.50)	(0.67)	(0.66)	(0.58)	(0.86)	(1.14)
$Size_{it-1}$	-1.392				-0.726	-1.442	-1.259			
	(4.13)***				(2.37)*	(3.90)***	(3.55)***			
$Liquidity_{it-1}$		0.825			0.731			0.866	0.716	
		(7.30)***			(6.20)***			(6.99)***	(5.66)***	
$Capitalisation_{it-1}$			0.233			0.056		-0.056		-0.215
			(1.70)			(0.40)		(0.47)		(0.88)
$Risk_{it-1}$				0.875			0.518		-0.024	1.289
				(2.66)**			(1.57)		(0.08)	(2.20)*
$Size_{it-1} \times \Delta R_{t-1}$	-0.003				0.012	0.021	0.006			
	(0.14)				(0.51)	(0.64)	(0.23)			
$Liq_{it-1} \times \Delta R_{t-1}$		0.0204			0.044			0.023	0.079	
		(0.97)			(1.45)			(1.05)	(2.14)*	
$Cap_{it-1} \times \Delta R_{t-1}$			0.0193			0.042		-0.009		-0.031
			(0.67)			(0.64)		(0.37)		(0.64)
$Risk_{it-1} \times \Delta R_{t-1}$				0.0239			0.0392		0.004	0.089
				(1.07)			(0.81)		(0.24)	(1.43)
$Size_{it-1} \times Liq_{it-1} \times \Delta R_{t-1}$					0.048					
					(1.57)					
$Size_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$						-0.003				
						(0.07)				
$Size_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$							0.007			
							(0.23)			
$Liq_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$								-0.028		
								(1.00)		
$Liq_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$									0.166	
									(2.05)*	
$Cap_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$										-0.014
										(0.83)
Constant	3.781	2.580	2.104	2.493	3.821	3.588	3.844	2.592	3.276	2.741
	(1.05)	(0.83)	(0.55)	(0.66)	(1.25)	(0.99)	(1.07)	(0.83)	(1.06)	(0.72)
R-squared	0.18	0.39	0.067	0.11	0.44	0.20	0.22	0.40	0.42	0.12
Observations	121	121	121	121	121	121	121	121	121	121

* Indicates significance at 10%.

** Idem, 5%.

*** Idem, 1%.

Table 14D (Estimates of Model.1 using bank data. Baltic States).

	Size	Liq	Cap	Risk	Size Liq	Size Cap	Size Risk	Liq Cap	Liq Risk	Cap Risk
Specification	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ΔR_{t-1}	0.004	0.004	-0.020	0.001	0.016	-0.014	0.003	0.005	0.006	-0.020
	(0.40)	(0.29)	(1.44)	(0.09)	(1.16)	(0.96)	(0.27)	(0.22)	(0.41)	(1.43)
$GGDP_{t-1}$	-0.006	-0.003	-0.003	-0.004	-0.006	-0.005	-0.005	-0.002	-0.003	-0.002
	(1.86)	(1.16)	(0.93)	(1.31)	(2.06)*	(1.63)	(1.80)	(0.80)	(1.16)	(0.82)
CPI_{t-1}	-0.013	-0.014	-0.014	-0.014	-0.011	-0.013	-0.012	-0.014	-0.014	-0.015
	(7.85)***	(9.86)***	(9.86)***	(9.54)***	(6.75)***	(7.97)***	(7.71)***	(9.61)***	(9.25)***	(9.70)***
$Size_{it-1}$	-0.282				-0.416	-0.250	-0.271			
	(3.20)**				(4.59)***	(2.81)**	(3.00)**			
$Liquidity_{it-1}$		0.099			0.161			0.094	0.099	
		(2.54)*			(4.08)***			(2.48)*	(2.53)*	
$Capitalisation_{it-1}$			0.084			0.046		0.084		0.082
			(2.39)*			(1.21)		(2.41)*		(1.95)
$Risk_{it-1}$				0.060			0.026		0.063	-0.010
				(1.24)			(0.53)		(1.30)	(0.19)
$Size_{it-1}\times\Delta R_{t-1}$	-0.002				-0.003	0.030	0.001		-0.007	
	(0.20)				(0.19)	(1.57)	(0.74)		(0.28)	
$Liq_{it-1}\times\Delta R_{t-1}$		-0.001			-0.007			-0.020	-0.002	
		(0.00)			(0.79)			(1.20)	(0.19)	
$Cap_{it-1}\times\Delta R_{t-1}$			0.022			0.012		0.003		0.024
			(1.98)*			(0.86)		(0.16)		(1.84)
$Risk_{it-1}\times\Delta R_{t-1}$				0.003			-0.018			-0.017
				(0.28)			(1.00)			(1.06)
$Size_{it-1}\times Liq_{it-1}\times\Delta R_{t-1}$					0.001					
					(0.04)					
$Size_{it-1}\times Cap_{it-1}\times\Delta R_{t-1}$						-0.020				
						(1.43)				
$Size_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$							-0.028			
							(1.50)			
$Liq_{it-1}\times Cap_{it-1}\times\Delta R_{t-1}$								0.015		
								(1.06)		
$Liq_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$									0.004	
									(0.32)	
$Cap_{it-1}\times Risk_{it-1}\times\Delta R_{t-1}$										0.007
										(0.66)
Constant	2.326	2.196	2.148	2.333	1.953	2.199	2.278	1.935	2.108	2.131
	(6.73)***	(6.13)***	(5.99)***	(6.51)***	(5.67)***	(6.19)***	(6.51)***	(5.33)***	(5.76)***	(5.91)***
R-squared	0.42	0.40	0.42	0.39	0.47	0.45	0.43	0.45	0.41	0.43
Observations	214	214	214	214	214	214	214	214	214	214

* Indicates significance at 10%.

** Idem, 5%.

*** Idem, 1%.

Table 14E (estimates of Model.1 using bank data. Slovenia & Slovakia, Cyprus & Malta).

	Slovenia & Slovakia				Cyprus & Malta			
	Size	Liq	Cap	Risk	Size	Liq	Cap	Risk
Specification	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
ΔR_{t-1}	0.112	0.078	0.132	0.177	-1.093	-0.069	-0.132	-0.012
	(1.42)	(0.99)	(1.54)	(2.89)*	(2.74)*	(0.17)	(0.35)	(0.03)
$GGDP_{t-1}$	-0.010	-0.007	-0.010	-0.005				
	(1.35)	(0.92)	(1.32)	(0.91)				
$Size_{it-1}$	-0.677				-1.192			
	(1.42)				(3.66)**			
$Liquidity_{it-1}$		0.299				-0.109		
		(2.16)*				(0.52)		
$Capitalisation_{it-1}$			0.440				-0.027	
			(1.15)				(0.08)	
$Risk_{it-1}$				1.233				0.112
				(3.88)**				(0.21)
$Size_{it-1} \times \Delta R_{t-1}$	-0.006				0.564			
	(0.11)				(1.80)			
$Liq_{it-1} \times \Delta R_{t-1}$		0.044				0.045		
		(0.62)				(0.10)		
$Cap_{it-1} \times \Delta R_{t-1}$			-0.057				-0.836	
			(0.29)				(1.57)	
$Risk_{it-1} \times \Delta R_{t-1}$				0.161				0.258
				(2.34)*				(0.44)
$Size_{it-1} \times Liq_{it-1} \times \Delta R_{t-1}$								
$Size_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$								
$Size_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$								
$Liq_{it-1} \times Cap_{it-1} \times \Delta R_{t-1}$								
$Liq_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$								
$Cap_{it-1} \times Risk_{it-1} \times \Delta R_{t-1}$								
Constant	1.292	0.922	1.328	0.849	0.488	0.104	0.099	0.091
	(1.62)	(1.18)	(1.64)	(1.37)	(3.54)**	(0.83)	(0.76)	(0.63)
R-squared	0.24	0.34	0.22	0.56	0.53	0.05	0.18	0.04
Observations	45	45	45	31	31	31	31	31

* Indicates significance at 10%.

** Idem, 5%.

*** Idem, 1%.

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