Impact of Monetary Policy on the Bank Lending Channel in Old EMU and New EU Countries: Evidence from Period 1999-2012

Tomáš Heryán
Silesian University in Opava
School of Business Administration in Karviná, Department of Finance and Accounting
Univerzitní náměstí 1934/3
Karviná, 733 40
Czech Republic
e-mail: heryan@opf.slu.cz

Roman Matousek
University of Kent
Kent Business School
Canterbury, Kent CT2 7NZ
United Kingdom
e-mail: R.Matousek@kent.ac.uk

Abstract
This study focuses on the bank lending channels and transmission mechanisms of monetary policy in EU countries. Following previous empirical studies, we also deploy the generalized method of moments (GMM) with pooled annual data. We examine the period from 1999 to 2012. We extend the current research on the transmission mechanisms of monetary policy in the following ways: first, we compare the differences between the old and new EU countries. Second, we examine the interaction terms between bank characteristics and both monetary policy indicators. In particular, we look at the impact of short-term interest rates and monetary aggregate M2 on bank behavior. We argue that in the group of 'old' EMU countries, the monetary policy through the lending channel affects smaller banks that are less liquid or are strongly capitalized. For 'new' EU countries, we find similar results, i.e., the lending channel affects smaller banks. However, in terms of liquidity and capital adequacy, we find an opposite result, that is, monetary policy affects smaller banks with higher levels of liquidity and lower bank capital. We also describe how transmission mechanisms changed in the crises period.

Keywords: lending channel, transmission mechanism, crisis times, old EMU and new EU countries
JEL codes: C58, G01, G21, G28

1. Introduction

The recent global financial crisis (GFC) has changed banks' behavior and affected the monetary policies of central banks in Europe, the USA and also in other regions. As a reaction to the GFC, the central banks have adopted unconventional monetary policy measures such as supplying an unlimited amount of capital to the market to support the liquidity of commercial banks and foreign exchange interventions through competitive devaluations of other currencies against the euro. These systemic changes have undoubtedly had an impact on banking systems and have affected bank lending channels of monetary transmission in 'old' European Monetary Union (EMU) and 'new' European Union (EU) countries.

This paper attempts to contribute to the extensive research on monetary transmission mechanisms in general, and lending channels in particular. In the existing literature on monetary transmission mechanisms, three major bank characteristics are found to affect the responses of bank loans to shifts in monetary policy—asset size, bank capitalization and bank liquidity—as discussed in seminal papers by Kashyap and Stein, 2000; Kishan and Opiela, 2000 and further tested in different markets; see, for example, Gambacorta, 2005; Matousek and Sarantis, 2009; Fungáčová et al., 2014; and Heryán et al., 2015 among others.

Only a handful of studies have focused on comparing the development of short-term interest rates and changes in monetary aggregates and their impacts on lending channels in the context of the

distributional effects of monetary policies during the financial crisis period (see Heryán et al., 2015). However, there is no evidence of differences between old European economies that accept the euro as the common currency and new European Union (EU) economies in this field.

The study contributes to ongoing research by providing evidence for both the pre-crisis and the crisis periods using pooled data from 1999 to 2012 that were published by Bank Scope and using generalized method of moments (GMM) panel regression. From the methodological point of view, there are four major studies within the area of monetary policy on the bank lending channel among European countries, all of which use methodologies similar to the GMM with pooled data: Gambacorta (2005) estimated relationships within the Italian credit market; Matousek and Sarantis (2009) investigated the lending channels of each country in the Visegrad group and compared them with the channels in the Baltic states; Akinci et al. (2013) estimated the credit market in Turkey; and Heryán et al. (2015) investigated differences between the EMU and EU countries with their own currencies.

This paper extends the previous studies on the lending channel in the following ways: first, we use short-term interest rates as well as the monetary aggregate M2 to examine which variables most affected the lending channels. Second, the paper uses two periods within the entire period of 1999 to 2012, that is, the pre-crisis period and the crisis period from 2007 to 2012, to show the differences in how banks' behaviors changed. Finally, we compare the results for old EMU countries with the results for new EU countries that joined after 2004 (the UK, Sweden and Denmark are therefore excluded from the analysis).

The results indicate the differences between the old EMU lending channel, in which the transmission mechanism was more obvious in terms of short-term interest rates before the financial crisis, whereas during the crisis period, there were changes in the monetary aggregate M2 that affected the channel more. In contrast, in the new EU lending channel, it was found that the transmission mechanism worked more effectively with the M2 before the crisis, whereas during the crisis period, it was the changing interest rates that affected the channel more.

Throughout the paper, we also show the following: first, smaller banks react more to changes in the M2 than in interest rates, but only in old EMU countries; this is consistent with the recent monetary behavior of the ECB. Otherwise, the old EMU lending channel is affected more by larger banks, in contrast to the existing literature. Even among new EU countries, no evidence supports the idea that bank size affects the lending channel. Second, bank liquidity mattered among both the old EMU and new EU countries during the crisis, but only the old EMU lending channel was affected throughout the entire crisis period. Third, strongly capitalized banks reacted more to monetary policy changes in the old EMU countries, which is consistent with the existing literature. In the case of the new EU countries, only the strongly capitalized banks reacted for the entire period, but the reactions of the undercapitalized banks were much more evident during both periods. Finally, last year's development of loans granted was significant in all GMM models. This result contrasts with the findings published by Fungáčová et al. (2014).

This study is structured as follows: Section 2 describes the estimation methodology used in the papers from the previous paragraph and the data, Section 3 discusses the empirical results, and the last section summarizes the main conclusions.

2. Data and Methodology

Data on banks were obtained from Bankscope, the main statistical banking database in Europe. The analysis encompasses 25 countries from the European Union (excluding the United Kingdom, Sweden and Denmark). Annual data on all commercial banks from the EU countries that were listed in Bankscope are included in our empirical investigation. The total number of banks was 933, with annual frequency data from the period 1997 to 2012. Selected macroeconomic data were also obtained from the World Bank statistical database. We used nominal GDP in current prices, inflation, and monetary aggregate as percentages of GDP for all European countries. Short-term interest rates were obtained from Eurostat for each country. Even for EMU countries that did not have their own monetary aggregates because they do not have their own currencies, we could run the tests with the M2 of each country using data published by the World Bank. Although using short-term interest rates is typical in previous studies, using the M2 could discover strong benefits or weaknesses in using euro currency. With its comparison of the results among old and new EU countries, the current study also contributes in that area.

The empirical specification (based on Gambacorta, 2005; Matousek and Sarantis, 2009; Akinci et al., 2013; Heryán et al., 2015) is designed to test whether banks react differently to monetary policy shocks. The current study contributes by employing two types of variables in the models to compare the relationships between the development of the credit market and the both, the short-term interest rates and the monetary aggregate M2. The model is given by the following equation (1), which includes interaction terms that are the product of the monetary policy indicator and a bank-specific characteristics

$$\Delta \log(L_{it}) = \alpha_{it} + \sum_{j=0}^{1} \beta \Delta \log(L_{i(t-1)}) + \sum_{j=0}^{1} \vartheta \Delta C_{t-j} \sum_{j=0}^{1} \delta \Delta \log(GDP_{t-j}) + \sum_{j=0}^{1} \gamma \Delta CPI_{t-j} + \sum_{k=1}^{3} \varphi Z_{kit-1} + \sum_{k=1}^{3} \sum_{j=0}^{1} \omega Z_{kit-1} \Delta C_{t-j} + \sum_{k=1}^{2} \sum_{h=k+1}^{3} \sum_{j=0}^{1} \xi Z_{kit-1} Z_{hit-1} \Delta C_{t-j} + \varepsilon_{it}, \quad (1)$$

where L_{it} represents the gross loans of $i = \{1,\ldots,N\}$ number of EU banks in time $t = \{1,\ldots, T\}$. Exogenous variable ΔC_{t-j} is either growth in the short-term interest rates in the first case or growth in the monetary aggregate M2. The next regressors are GDP_{t-j} and CPI_{t-j}, which refers to GDP and inflation in selected EU countries. The last three exogenous variables represent the combination of Z_k denotes $k=1,2,3$ bank-specific characteristic variables (see below) and ΔC_{t-j}. Constant and residuals means variable α_{it} and ε_{it}. We estimate two types of models, for both old EMU and new EU countries.

To follow Kashyap and Stein (2000), Gambacorta (2005), Matousek and Sarantis (2009), Akinci et al. (2013), and Heryán et al. (2015), the following bank characteristics, size S_{it}, liquidity Liq_{it} and capitalisation Cap_{it}, are applied to test the presence of the distributional effects of monetary policy on banks

$$S_{it} = \log(A_{it}) - \frac{\sum \log(A_{it})}{N_t}, \quad (2)$$

$$Liq_{it} = \frac{LA_{it}}{A_{it}} - \frac{1}{T} \sum_t \left(\frac{1}{N_t} \sum_i \frac{LA_{it}}{A_{it}} \right), \quad (3)$$

$$Cap_{it} = \frac{EQ_{it}}{A_{it}} - \frac{1}{T} \sum_t \left(\frac{1}{N_t} \sum_i \frac{EQ_{it}}{A_{it}} \right), \quad (4)$$

where A_{it} represents the assets of all estimated N_t banks, LA_{it} is liquid assets only (i.e., cash, interbank lending and securities), and EQ_{it} is bank capital and reserves (total equity).

Loan growth is regressed on changes in the interest rate controlled by the monetary authority, and on its interaction with three bank-specific characteristics (size, liquidity and capitalization). Regression (1) also includes inflation and GDP growth to control for demand effects. The introduction of these two variables allows us to capture cyclical movements and serves to isolate the monetary policy component of interest rate changes. This will allow us to gain further insight into the interbank lending channel by reporting the effects of changes in the interest rates on these other items on banks' balance sheets (Gambacorta, 2005). Moreover, we employ the growth of monetary aggregate M2 to compare which will have a greater impact on the development of credit markets, short-term interest rates or M2.

To avoid multicollinearity problems, we apply a pseudo-general-to-specific model reduction method in our application of the GMM estimator following Akinci et al. (2013). The pseudo-general model includes the current and first lagged values of the variables C_{t-j}, GDP_{t-j}, CPI_{t-j} as well as the first lag of each bank characteristic $S_{i(t-1)}$, $Liq_{i(t-1)}$ and $Cap_{i(t-1)}$. Therefore, the whole estimated period begins in 1999. Arellano and Bond tests show that the first-order statistic is statistically significant, whereas the second-order statistic is not, which is what we would expect if the model error

terms are serially uncorrelated on different levels. Thus, we reject the presence of significant serial correlations in all countries, thus implying that GMM estimators are consistent. In the case of bank characteristics, we estimated the model with each characteristic separately, then with all possible pairs of characteristics, and finally with all three characteristics together (Matousek and Sarantis, 2009). The results presented in Tables 1–8 were produced using EViews 9.0. The model does not allow for random effects. Nevertheless, all of the major studies that used GMM allowed for period effects. We had to constantly maintain the GMM weights to test Arellano-Bond serial correlation and Sargan tests, too.

3. Discussion of Empirical Results

This section mainly describes the significant relationships that were estimated by the GMM models. From these relationships, we established particular economic statements in the last section. We investigated the lending channel and the impacts of monetary policy among both old EMU and new EU countries, including the differences between the impacts of short-term interest rates and monetary aggregate M2. To show the differences that could have been caused by both the global financial crisis and the sovereign debt crisis in the EMU, the separate crisis periods were also estimated in this section.

Table 1: OLD EMU Countries with Short-Term Interest Rates

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.5694 [a]	0.6240 [a]	0.3168 [a]	0.6081 [a]	0.5445 [a]	0.7049 [a]	0.6656 [a]
Rate	0.0407	0.0330	0.0690 [b]	-0.0423	0.0254	0.0238	-0.0141
Rate(1)	-0.1336	-0.0358	-0.0656 [c]	-0.0284	-0.0836	-0.0274	-0.0290
GDP	0.9866	0.4963	0.8090 [b]	0.1340	1.0246	0.2505	0.1964
GDP(1)	-2.2433 [a]	0.3997	0.0453	-1.5102 [b]	-2.0787 [b]	0.8655	-1.5700 [b]
CPI	-0.0119	0.0157	0.0009	0.0004	-0.0114	0.0197 [c]	0.0009
CPI(1)	0.0252 [a]	0.0190 [a]	0.0152 [a]	0.0263 [a]	0.0243 [a]	0.0195 [a]	0.0278 [a]
Size(1)	-0.8795 [a]			-1.1232 [a]	-0.7493 [a]		-1.0673 [a]
Size(1) * Rate	-0.0013			0.0171 [a]	-0.0105		0.0102
Size(1) * Rate(1)	0.0189 [a]			0.0124 [c]	0.0155 [b]		0.0083
Liq(1)		-2.6625 [a]		-3.0791 [a]		-3.3072 [a]	-3.2803 [a]
Liq(1) * Rate		0.0978 [a]		0.0535		0.1200 [a]	0.1198 [a]
Liq(1) * Rate(1)		0.0191		0.1022 [b]		0.0480	0.0485 [c]
Capital(1)			1.6004 [a]		0.7865 [b]	3.0620 [a]	1.1537 [a]
Capital(1) * Rate			-0.1041		0.0497	-0.1013	-0.0696
Capital(1) * Rate(1)			-0.1158 [c]		-0.1260	-0.1109	-0.0701
Size(1) * Liq(1) * Rate				0.0399 [c]			
Size(1) * Liq(1) * Rate(1)				-0.0335			
Size(1) * Capital(1) * Rate					-0.1492 [a]		
Size(1) * Capital(1) * Rate(1)					0.0954 [b]		
Liq(1) * Capital(1) * Rate						-0.0364	
Liq(1) * Capital(1) * Rate(1)						0.1761	
No. of observations	4628	4628	4628	4628	4628	4628	4628
Sargan test (p-values)	0.1539	0.2956	0.0814	0.1043	0.1455	0.3819	0.1139
Arellano Bond (p-AR1)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Arellano Bond (p-AR2)	0.0786	0.1854	0.2437	0.1436	0.0924	0.1366	0.1176

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: authors' calculation

For the whole sample estimation (Tables 1–4), our lagged endogenous variables were statistically significant within independent regressors at the 1% level in all GMM estimations. Fungáčová et al. (2014) argued that in their case, the results indicate that the lagged value of loan growth is not significant, which casts serious doubt on the benefits of using the differences or the system GMM due to the differences. In contrast, GMM models with annual data were deployed not only in the current study but also in Matousek and Sarantis (2009), and Heryán et al. (2015).

Table 2: OLD EMU Countries with Monetary Aggregate M2

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.4357 [a]	0.6348 [a]	0.5954 [a]	0.3218 [a]	0.5112 [a]	0.7616 [a]	0.6930 [a]
M2	-0.5943 [b]	-0.1555	-0.2196	-0.5463 [b]	-0.5914 [b]	-0.1010	-0.6632 [a]
M2(1)	0.7721 [a]	0.0908	0.3680 [c]	0.6743 [a]	0.6782 [b]	0.0792	0.5200 [c]
GDP	1.0024	-0.3395	0.9482	0.0130	1.3365	-0.9073	0.3671
GDP(1)	-1.4299	1.7947 [b]	0.2001	0.5386	-1.7686 [c]	2.2266 [b]	-1.2780
CPI	-0.0036	0.0178 [c]	0.0039	0.0090	-0.0117	0.0177	-0.0079
CPI(1)	0.0225 [a]	0.0105 [c]	0.0081	0.0210 [a]	0.0192 [a]	0.0100	0.0250 [a]
Size(1)	0.2515			0.5520	-0.5707		-1.4205 [b]
Size(1) * M2	0.0627			0.1046	0.0605		0.0847
Size(1) * M2(1)	-0.0986			-0.1440 [b]	-0.0659		-0.0733
Liq(1)		5.7052 [b]		4.1057		7.7597 [b]	9.3008 [a]
Liq(1) * M2		0.4784		1.6806 [a]		0.6968 [c]	0.1291
Liq(1) * M2(1)		-0.7662 [c]		-1.9040 [a]		-1.0854 [a]	-0.5655
Capital(1)			-10.8927 [c]		-12.2582 [b]	-4.8236	-11.2294 [b]
Capital(1) * M2			-0.9633		-0.6014	-1.8205 [b]	-1.7293 [c]
Capital(1) * M2(1)			1.4165		1.0631	2.0844 [b]	2.1650 [b]
Size(1) * Liq(1) * M2				-0.7094 [a]			
Size(1) * Liq(1) * M2(1)				0.7169 [a]			
Size(1) * Capital(1) * M2					0.0349		
Size(1) * Capital(1) * M2(1)					-0.0438		
Liq(1) * Capital(1) * M2						3.0613	
Liq(1) * Capital(1) * M2(1)						-3.0021	
No. of observations	4251	4251	4251	4251	4251	4251	4251
Sargan test (p-values)	**0.0242**	0.1608	0.1648	**0.0024**	0.0508	0.2501	**0.0166**
Arellano Bond (p-AR1)	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
Arellano Bond (p-AR2)	0.0585	0.1281	0.0628	0.3950	0.0861	0.0744	0.0888

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: authors' calculation

However, we found the lagged value of loans' growth to be significant in all estimations, which could have been caused by cyclical development in the loans that were granted. This is also supported by the significant positive impact of GDP development on the lending channel, which is often obvious in the estimations (except Tables 1, 2, 5). We found positive impacts of the lagged inflation's development on the lending channel only among old EMU countries. In new EU countries only, we found a strong positive impact of changes in monetary aggregate M2 and a negative impact of changes in short-term interest rates. From the output of the GMM models with pooled data for both old EMU and new EU countries, it is evident that on average, only smaller banks were affected by lending channel changes throughout the entire estimation period. In the old EMU economies, their lending channels were affected by smaller banks, which are simultaneously less liquid and more strongly capitalized (for short-

term interest rates) or by banks that are more liquid and less capitalized (for monetary aggregate M2). In new EU economies, their lending channels are affected by smaller banks that are also simultaneously more liquid on average.

In contrast, in new EU economies, their lending channels are affected by smaller banks with lower levels of bank capital (for interest rates and M2). The argument that smaller banks affect lending channels supports results by Matousek and Sarantis (2009), who found the same result among banking sectors in Hungary and Poland. The authors argued that it was surprising to not find significant responsiveness in the increase in bank loans to monetary policy stances that are measured by the short-term interest rate (apart from Slovenia). However, the picture also changes in the current study when we take into account the bank characteristics.

Table 3: NEW EU Countries with Short-Term Interest Rates

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.5412 [a]	0.6842 [a]	0.6680 [a]	0.5168 [a]	0.4894 [a]	0.6930 [a]	0.4489 [a]
Rate	-0.0394 [a]	-0.0053 [b]	-0.0067 [a]	-0.0376 [a]	-0.0347 [a]	0.0005	-0.0434 [a]
Rate(1)	0.0080 [c]	-0.0059 [a]	0.0011	0.0008	0.0027	-0.0107 [a]	-0.0058
GDP	0.5639 [a]	0.5190 [a]	0.4325 [a]	0.5234 [a]	0.5259 [a]	0.5032 [a]	0.6286 [a]
GDP(1)	0.2609 [a]	0.0966	0.1540 [c]	0.3416 [a]	0.3423 [a]	0.1309 [c]	0.3481 [a]
CPI	-0.0002	0.0018	0.0015	0.0004	0.0001	0.0006	-0.0010
CPI(1)	0.0002	-0.0028 [b]	-0.0019	-0.0014	-0.0007	-0.0020	-0.0002
Size(1)	-0.2349 [a]			-0.1969 [a]	-0.1893 [a]		-0.1378 [b]
Size(1) * Rate	0.0084 [a]			0.0100 [a]	0.0088 [a]		0.0124 [a]
Size(1) * Rate(1)	-0.0017			-0.0014	-0.0011		-0.0028 [c]
Liq(1)		0.6330 [a]		0.3984 [a]		0.6898 [a]	0.3525 [a]
Liq(1) * Rate		-0.1136 [a]		-0.1151 [a]		-0.0670 [a]	-0.0978 [a]
Liq(1) * Rate(1)		0.1058 [a]		0.1985 [a]		0.0627 [a]	0.0978 [a]
Capital(1)			0.3216		-0.4311 [b]	0.1482	-0.5893 [a]
Capital(1) * Rate			-0.1353 [a]		-0.1113 [b]	-0.0646 [a]	-0.0798 [a]
Capital(1) * Rate(1)			0.1089 [a]		0.1457 [a]	0.0987 [a]	0.1250 [a]
Size(1) * Liq(1) * Rate				0.0055			
Size(1) * Liq(1) * Rate(1)				-0.0380 [a]			
Size(1) * Capital(1) * Rate					-0.0080		
Size(1) * Capital(1) * Rate(1)					-0.0124		
Liq(1) * Capital(1) * Rate						-0.9199 [a]	
Liq(1) * Capital(1) * Rate(1)						0.8143 [a]	
No. of observations	1542	1542	1542	1542	1542	1542	1542
Sargan test (p-values)	0.3275	0.3775	0.3945	0.5031	0.4624	0.3220	0.4077
Arellano Bond (p-AR1)	0.0040	0.0007	0.0023	0.0021	0.0050	0.0025	0.0051
Arellano Bond (p-AR2)	0.0872	**0.0187**	0.0780	0.0801	0.1702	**0.0182**	0.1318

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: authors' calculation

To assess the distributional effects of monetary policy, we also need to examine the coefficients of the interaction terms between the bank characteristics and the monetary policy indicator (see Matousek and Sarantis, 2009). As above, we estimated the negative effects of monetary policy in the case with short-term interest rates and positive effects of monetary policy in the case with monetary aggregate M2 only within new EU countries. In the first case with interest rates, larger banks react more to changes within the old EMU countries versus the new EU countries, where smaller banks react more to the changes. The reactions were investigated with and without one year's lag in the interest rate

development. It was clear that larger banks react without any lag within old EMU economies but that we saw a statistically significant reaction of smaller banks within new EU economies with only the lagged development. As Matousek and Sarantis (2009) concluded, we could also conclude that small banks that started their activities almost from scratch have more dynamic lending activities compared with large, established banks, but only in the case of new EU countries.

Table 4: NEW EU Countries with Monetary Aggregate M2

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.5195 [a]	0.6163 [a]	0.5504 [a]	0.6189 [a]	0.5052 [a]	0.6037 [a]	0.5981 [a]
M2	0.3100 [a]	0.1987 [a]	0.2953 [a]	0.1136	0.2281 [b]	0.2151 [a]	0.1354
M2(1)	0.3132 [a]	0.3917 [a]	0.3084 [a]	0.4303 [a]	0.4060 [a]	0.3698 [a]	0.4054 [a]
GDP	0.4071 [a]	0.4291 [a]	0.3390 [a]	0.3667 [a]	0.3617 [a]	0.4192 [a]	0.3993 [a]
GDP(1)	-0.2612 [b]	-0.4518 [a]	-0.1955 [c]	-0.3803 [a]	-0.2067 [c]	-0.3544 [a]	-0.3393 [a]
CPI	-0.0072 [a]	-0.0115 [a]	-0.0073 [a]	-0.0101 [a]	-0.0071 [a]	-0.0113 [a]	-0.0097 [a]
CPI(1)	0.0000	-0.0001	0.0001	0.0002	0.0001	0.0001	0.0000
Size(1)	0.3668			0.1773	0.3393		0.0918
Size(1) * M2	-0.0163			0.0232	0.0188		0.0183
Size(1) * M2(1)	-0.0069			-0.0438	-0.0400		-0.0356
Liq(1)		-2.7112 [c]		-0.0424		-3.0814 [c]	-1.4731
Liq(1) * M2		0.0429		-1.7090 [a]		-0.0407	-0.0269
Liq(1) * M2(1)		0.0993		1.7822 [a]		0.1974	0.1174
Capital(1)			-7.1429 [b]		-4.1931	-6.1875 [c]	-8.5022 [b]
Capital(1) * M2			1.6306 [a]		1.2073	1.3916 [a]	1.8543 [a]
Capital(1) * M2(1)			-1.3248 [a]		-1.0188	-1.1224 [a]	-1.5007 [a]
Size(1) * Liq(1) * M2				0.8384 [a]			
Size(1) * Liq(1) * M2(1)				-0.8564 [a]			
Size(1) * Capital(1) * M2					0.1073		
Size(1) * Capital(1) * M2(1)					-0.1157		
Liq(1) * Capital(1) * M2						0.1379	
Liq(1) * Capital(1) * M2(1)						-0.0508	
No. of observations	1596	1596	1596	1596	1596	1596	1596
Sargan test (p-values)	0.0821	0.0997	0.2177	0.0961	0.1484	0.1626	0.1790
Arellano Bond (p-AR1)	0.0041	0.0027	0.0026	0.0032	0.0040	0.0032	0.0037
Arellano Bond (p-AR2)	0.0842	**0.0355**	**0.0470**	0.0551	0.0690	**0.0342**	**0.0484**

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: authors' calculation

In the second case, with monetary aggregate M2, in the new EU countries, the banks that reacted were strongly capitalized or had less capital on average. In contrast, banks with stronger capitalization reacted to the one-year lagged development of M2, whereas among banks with less capital, we found the interaction without any lags. Gambacorta (2005) argued that the widely used capital-to-asset ratio might be a poor approximation of the capital constraints that banks face under the Basel standards. Following Gambacorta (2005) and Matousek and Sarantis (2009), we also defined capitalization as the amount of capital that banks hold in excess of the minimum required to meet the prudential regulation standards in their respective countries and then re-estimated all country equations using this alternative measure of capitalization. The overall pattern of results for new EU countries, in terms of the sign and significance of the coefficients on the interaction of interest rate changes with capitalization, remained similar to the reports that have been reported (see tables 3 and 4). Hence the result for capitalization seems to be related to the measure of capitalization that we employed. In the period that was affected

by the financial crises (Tables 5–8), we see large differences among old EMU and new EU lending channels. We argue that in old EMU countries, the transmission mechanism of monetary policy works more in the cases with short-term interest rates throughout the whole period, whereas in the crisis period, the results were the exact opposite, and the mechanism was more obvious in the cases with monetary aggregate M2. The same changes are estimated among new EU countries, when we argue that the mechanism works more in the cases with M2 in the whole period, whereas in the crisis period, it is more obvious in the cases with short-term interest rates. This major change does not definitely cause minor changes.

Table 5: OLD EMU Countries with Short-Term Interest Rates in the CRISIS

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.4998 [a]	0.5081 [a]	0.2355 [a]	0.5438 [a]	0.5027 [a]	0.6006 [a]	0.5746 [a]
Rate	-0.0336	-0.0518	-0.0005	-0.3455	-0.0065	-0.2042	-0.2909
Rate(1)	0.3578	0.1980	-0.1043	0.7544 [b]	0.3496	0.3846	0.6896 [b]
GDP	0.6711	1.5306 [c]	1.0602	0.9068	0.8413	0.9258	0.9402
GDP(1)	-0.2258	0.0197	0.1107	0.3534	-0.3207	0.1533	0.3498
CPI	-0.0052	0.0103	0.0003	0.0100	-0.0093	0.0174	0.0094
CPI(1)	0.0169 [b]	0.0100	0.0149 [c]	0.0129	0.0129	0.0147 [c]	0.0116
Size(1)	-1.0994 [a]			-1.4923 [a]	-1.1845 [a]		-1.5240 [a]
Size(1) * Rate	0.0162 [b]			0.0362 [a]	-0.0107		0.0223 [b]
Size(1) * Rate(1)	0.0105			0.0117	0.0321 [a]		0.0095
Liq(1)		-2.1040 [a]		-3.0445 [a]		-2.8777 [a]	-3.1951 [a]
Liq(1) * Rate		0.1475 [a]		0.1579 [b]		0.1828 [a]	0.2252 [a]
Liq(1) * Rate(1)		0.0159		0.0580		0.0482	0.0767 [b]
Capital(1)			1.9593 [a]		0.2940	3.0593 [a]	0.4188
Capital(1) * Rate			-0.2150 [a]		-0.2084 [b]	-0.1782 [b]	-0.2047 [b]
Capital(1) * Rate(1)			-0.0901		0.0435	-0.0721	-0.0242
Size(1) * Liq(1) * Rate				0.0436			
Size(1) * Liq(1) * Rate(1)				0.0131			
Size(1) * Capital(1) * Rate					-0.1509		
Size(1) * Capital(1) * Rate(1)					0.2127 [b]		
Liq(1) * Capital(1) * Rate						0.1844	
Liq(1) * Capital(1) * Rate(1)						0.0037	
No. of observations	2761	2761	2761	2761	2761	2761	2761
Sargan test (p-values)	0.1554	0.3345	0.3694	0.0970	0.1452	0.3408	0.0841
Arellano Bond (p-AR1)	0.0000	0.0000	0.0002	0.0018	0.0000	0.0001	0.0009
Arellano Bond (p-AR2)	0.2036	0.2386	0.5243	0.1551	0.1327	0.1355	0.1157

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: authors' calculation

Whether we finally focus only on the output where the transmission mechanism is more obvious within the crises, we see differences among the coefficients of the interaction terms between the bank characteristics and the monetary policy indicators in the crisis period. In old EMU economies, the lending channels were more affected by larger banks in average, but smaller banks reacted to the changes in monetary aggregate M2 without any lags. The lending channels are more affected by more liquid banks, but less liquid banks react to the changes without any lags. With the changes in M2, strongly capitalized banks reacted more on average (see Table 6). In new EU economies, the lending channels were more affected by smaller banks, but we cannot clearly argue whether banks react to the changes in

short-term interest rates with or without any lags. The lending channels are also more affected by more liquid banks, and more liquid banks react to the changes without any lags. With the changes in interest rates, strongly capitalized banks reacted more on average (see Table 7).

Table 6: OLD EMU Countries with Monetary Aggregate M2 in the CRISIS

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.2091 [a]	0.5454 [a]	0.5449 [a]	0.5663 [a]	0.4080 [a]	0.7214 [a]	0.6640 [a]
M2	-0.6586 [b]	-0.4744	-0.5428 [c]	-1.0666 [a]	-0.5122 [c]	-0.6043 [c]	-0.8603 [a]
M2(1)	1.0837 [a]	0.4482 [c]	0.6568 [b]	1.4279 [a]	0.8513 [a]	0.5720 [b]	1.2148 [a]
GDP	2.2289 [b]	2.0446 [c]	2.3148 [b]	3.2095 [a]	2.4245 [b]	2.0114 [c]	2.8399 [b]
GDP(1)	-1.2597	-0.3602	-1.9002	-2.5230 [c]	-1.5248	-1.0683	-1.6930
CPI	-0.0083	-0.0002	-0.0097	-0.0261 [c]	-0.0142	-0.0057	-0.0213
CPI(1)	0.0206 [b]	0.0095	0.0153 [c]	0.0169 [c]	0.0147	0.0136	0.0126
Size(1)	5.5433 [a]			3.7120 [b]	3.2773 [b]		3.0886 [c]
Size(1) * M2	0.0923			0.2325 [b]	-0.0240		0.1129
Size(1) * M2(1)	-0.3056 [a]			-0.4138 [a]	-0.1185		-0.2796 [b]
Liq(1)		11.6562 [a]		7.8456 [b]		16.8670 [a]	9.8209 [a]
Liq(1) * M2		1.0151 [b]		0.6308		0.8502	0.8824 [c]
Liq(1) * M2(1)		-1.4950 [a]		-0.9886		-1.5506 [a]	-1.3319 [a]
Capital(1)			-12.9145		-2.5257	-11.7796	-2.8486
Capital(1) * M2			-2.2493 [c]		-2.4170 [b]	-2.4345 [b]	-2.8202 [b]
Capital(1) * M2(1)			2.7821 [b]		2.5159 [b]	2.9435 [b]	2.9309 [b]
Size(1) * Liq(1) * M2				-0.0930			
Size(1) * Liq(1) * M2(1)				0.0880			
Size(1) * Capital(1) * M2					-0.2603		
Size(1) * Capital(1) * M2(1)					0.2441		
Liq(1) * Capital(1) * M2						6.0665	
Liq(1) * Capital(1) * M2(1)						-5.9825	
No. of observations	2761	2761	2761	2761	2761	2761	2761
Sargan test (p-values)	0.1002	0.4097	0.5954	0.1013	0.2240	0.5839	0.0906
Arellano Bond (p-AR1)	0.0004	0.0000	0.0000	0.0015	0.0001	0.0001	0.0011
Arellano Bond (p-AR2)	0.6481	0.2342	0.1405	0.2506	0.2549	0.1394	0.1652

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: authors' calculation

Finally, to compare the results for the crisis period and the whole period, we argue that the crisis period differs from the whole due to more obvious transmission mechanisms in these relationships. From the point of view of the lending channels: (i) in the case of old EMU countries, the channels are affected by bigger banks, whereas during the whole period, smaller banks are more affected. In the case of new EU countries, lending channels are affected by smaller banks during the crisis as well as during the full estimated period. (ii) In old EMU economies, the lending channels are affected by more liquid banks, whereas within the whole period, the less liquid banks reacted more. In new EU economies, more liquid banks were affected during both the crisis period and the whole period. (iii) The old EMU lending channels are affected by strongly capitalized banks for the whole period, but we cannot argue any changes during the crisis period due to missing significant results. The new EU lending channels are affected during both periods by more undercapitalized banks.

Table 7: NEW EU countries with short-term interest rates in the CRISIS

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.5373 [a]	0.6020 [a]	0.5454 [a]	0.5876 [a]	0.5114 [a]	0.6359 [a]	0.4883 [a]
Rate	-0.0148 [a]	-0.0175 [a]	-0.0192 [a]	-0.0049	-0.0176 [a]	-0.0213 [a]	-0.0189 [a]
Rate(1)	-0.0108 [c]	-0.0109 [a]	-0.0149 [a]	0.0012	-0.0194 [a]	-0.0132 [a]	-0.0194 [a]
GDP	0.4008 [a]	0.2256 [b]	0.2909 [a]	0.2411 [c]	0.3864 [a]	0.1786	0.4064 [a]
GDP(1)	0.3756 [a]	0.3723 [a]	0.3698 [a]	0.3239 [a]	0.3999 [a]	0.4521 [a]	0.4650 [a]
CPI	0.0044 [b]	0.0037 [c]	0.0038 [b]	0.0057 [a]	0.0045 [b]	0.0046 [b]	0.0045 [b]
CPI(1)	0.0030	0.0010	0.0022	0.0025	0.0032 [c]	0.0008	0.0011
Size(1)	-0.4540 [a]			-0.5263 [a]	-0.4274 [a]		-0.4052 [a]
Size(1) * Rate	0.0002			-0.0027	-0.0001		0.0011
Size(1) * Rate(1)	-0.0015			-0.0038 [c]	0.0017		0.0014
Liq(1)		0.1864		0.3818 [a]		0.3261 [a]	0.3812 [a]
Liq(1) * Rate		-0.0215		-0.0010		-0.0396 [a]	-0.0374 [a]
Liq(1) * Rate(1)		0.0871 [a]		0.1410 [a]		0.0699 [a]	0.0507 [a]
Capital(1)			-0.0543		-0.6334 [a]	0.2956	-0.2887
Capital(1) * Rate			-0.0451		0.0201	-0.0768 [b]	-0.0572
Capital(1) * Rate(1)			0.1340 [a]		0.1359 [a]	0.1803 [a]	0.1276 [a]
Size(1) * Liq(1) * Rate				-0.0192			
Size(1) * Liq(1) * Rate(1)				-0.0414 [a]			
Size(1) * Capital(1) * Rate					-0.0388		
Size(1) * Capital(1) * Rate(1)					-0.0030		
Liq(1) * Capital(1) * Rate						0.0211	
Liq(1) * Capital(1) * Rate(1)						0.3609 [c]	
No. of observations	1007	1007	1007	1007	1007	1007	1007
Sargan test (p-values)	0.5921	0.3676	0.4300	0.7832	0.5955	0.6745	0.7339
Arellano Bond (p-AR1)	0.0229	0.0132	0.0205	0.0068	0.0253	0.0168	0.0206
Arellano Bond (p-AR2)	0.4578	0.1260	0.4139	0.2576	0.6566	0.2721	0.3620

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: Authors' calculation

The last paragraph describes the minor changes connected with the transmission mechanisms. From the view of the transmission mechanisms of monetary policy, the crisis period differs from the whole period in these relationships: (iv) In the case of old EMU countries, smaller banks react more to changes in monetary aggregate M2 during the crisis, whereas larger banks react more to changing short-term interest rates during the whole period. In the case of new EU countries, we cannot argue that bank size affects transmission mechanisms. (v) In old EMU economies, only more liquid banks reacted more to the changing M2 during the crisis period as well as the changing interest rates throughout the whole period. In new EU economies, the same findings held only during the crisis period in the case with short-term interest rates. (vi) In the old EMU countries, strongly capitalized banks reacted more to changing M2 during the crisis and to changing interest rates throughout the whole period. Undercapitalized new EU banks react more to changes in monetary aggregate M2 in both periods, whereas the strongly capitalized banks reacted to changing M2 only in the full period.

Table 8: NEW EU countries with monetary aggregate M2 in the CRISIS

	Size	Liq	Capital	Size Liq	Size Capital	Liq Capital	Size Liq Capital
Loans(1)	0.4402 [a]	0.5032 [a]	0.4824 [a]	0.4896 [a]	0.4385 [a]	0.5493 [a]	0.5646 [a]
M2	0.2824 [a]	0.1758	0.3638 [a]	-0.0453	0.3488 [a]	0.2218 [b]	0.1365
M2(1)	0.0300	0.2587 [a]	0.1705 [b]	0.2009	0.0049	0.2610 [a]	0.0060
GDP	0.3418 [a]	0.1180	0.1625	0.3138 [b]	0.2794 [b]	0.0489	0.1973
GDP(1)	0.5147 [a]	0.2967 [b]	0.4060 [a]	0.5194 [a]	0.5210 [a]	0.3957 [a]	0.5274 [a]
CPI	0.0039 [c]	0.0018	0.0031	0.0016	0.0043 [c]	0.0022	0.0036
CPI(1)	-0.0020	-0.0006	-0.0035 [b]	-0.0019	-0.0027 [c]	-0.0020	-0.0016
Size(1)	-0.4029			-0.8953 [a]	-0.4884 [c]		-0.9956 [a]
Size(1) * M2	-0.0316			0.0731	-0.0328		-0.0563
Size(1) * M2(1)	0.0354			-0.0545	0.0413		0.0771 [a]
Liq(1)		-0.4773		2.3642		0.6499	1.5426
Liq(1) * M2		-0.7194 [a]		-2.0006 [a]		-0.9909 [a]	-0.7452 [a]
Liq(1) * M2(1)		0.7661 [a]		1.9523 [a]		0.9921 [b]	0.7127 [a]
Capital(1)			-13.3392 [a]		-13.2238 [a]	-7.7950 [b]	-14.1613 [a]
Capital(1) * M2			1.3200 [a]		0.4524	-0.9901	0.5044
Capital(1) * M2(1)			-0.7486		0.0969	1.3670	0.1004
Size(1) * Liq(1) * M2				0.8470 [b]			
Size(1) * Liq(1) * M2(1)				-0.8597 [b]			
Size(1) * Capital(1) * M2					0.3030		
Size(1) * Capital(1) * M2(1)					-0.3033		
Liq(1) * Capital(1) * M2						-17.9364 [a]	
Liq(1) * Capital(1) * M2(1)						18.1296 [a]	
No. of observations	987	987	987	987	987	987	987
Sargan test (p-values)	0.3376	0.1137	0.1472	0.2810	0.4228	0.1757	0.7137
Arellano Bond (p-AR1)	0.0379	0.0245	0.0331	0.0268	0.0389	0.0281	0.0330
Arellano Bond (p-AR2)	0.5172	0.2103	0.5308	0.3657	0.6214	0.3572	0.3899

Note: Symbol [a]. [b] or [c] indicates significance at 1%. 5% or 10%.
Source: Authors' calculation

4. Concluding Remarks

This paper provides new evidence of the bank lending channels in the EU member states during the GFC. Our study confirms that the lending channels were affected by changes in short-term interest rates as well as in the monetary aggregate M2. The results further indicate that commercial banks react to monetary policy shocks differently compared with the pre-crisis period. In fact, the bank lending channels in old EMU countries became more sensitive to changes in M2 than in short-term interest rates during the GFC. In contrast, our results show that the bank lending channels in new EU countries were more sensitive to short-term market interest rates.

We argue that the monetary transmission mechanisms in the old EMU countries could have changed due to the unprecedented liquidity injection by the ECB (see also Drehmann and Nikolaou, 2013; Beaupain and Durré, 2013). Reichlin (2014) argues that the key non-standard monetary policy measures taken by the ECB were liquidity operations. Moreover, as Akinci et al. (2013) argue, new empirical studies on the bank lending channels during the GFC indicate that bank behavior has also changed. Banks that face financial distress go through restructuring processes and operate in unstable economic environments. Mutual distrust between commercial banks in the EU has resulted in the problem with market liquidity. Otherwise, due to changes in monetary policy, higher levels of liquidity are inevitable among EMU countries. Banks therefore do react to the added liquidity in the crisis periods.

The transmission mechanisms among new EU countries are more obvious for the whole period of our analysis in the cases with M2. This finding could have been caused by the fact that some of our selected new EU economies were not members of the EMU. Due to that, those countries' central banks still control the monetary base, which affects the entire lending channel. The ECB indirectly controls the monetary base. However, the ECB's interventions affects the entire EMU. Whether there is no argument for these interventions in the entire market, the ECB leaves it to the interbank market and its demand and supply. Nonetheless, because of the financial crises, new EU countries are less liquid than old EMU countries. The central banks out of the EMU do not add liquidity to the markets in the same way as the ECB. Therefore, the lending channels in new EU economies were more sensitive to changes in interest rates during the crisis, period and the transmission mechanisms are becoming more effective.

Further, we analyze the interaction terms between the bank characteristics and the monetary policy indicators. Recent empirical studies, e.g., Matousek and Sarantis (2009), Fungáčová et al. (2014), and Heryán et al. (2015), among others, find that liquidity plays the prominent role in the lending channel as well. Although we find that bank size is an important factor that has affected the new EU lending channel. In contrast to the previous research studies, we could not confirm that bank size did not have the same effect for the group of old EMU countries. Although in the whole period, new EU undercapitalized banks reacted more to monetary shocks in the case with M2, and more strongly capitalized banks in the new EU countries reacted more in the case with short-term interest rates. We do not, however, find that bank capital is important among old EMU countries.

Acknowledgement

This paper is supported by the Czech Science Foundation within the project GACR 13-03783S "Banking Sector and Monetary Policy: Lessons from New EU Countries after Ten Years of Membership".

References

AKINCI, D.A., MATOUSEK, R., RADIĆ, N., STEWART, C. (2013). Monetary policy and the banking sector in Turkey. *Journal of International Financial Markets, Institutions and Money*, vol. 27, pp. 269–285.

BEAUPAIN, R., DURRÉ, A. (2013). Central bank reserves and interbank market liquidity in the euro area. *Journal of Financial Intermediation*, vol. 22, no. 2, pp. 259–284.

DREHMANN, M., NIKOLAOU, K. (2013). Funding liquidity risk: Definition and measurement. *Journal of Banking & Finance*, vol. 37, no. 7, pp. 2173–2182.

FUNGÁČOVÁ, Z., SOLANKO, L., WEILL, L. (2014). Does competition influence the bank lending channel in the euro area? *Journal of Banking and Finance*, vol. 49, pp. 356−366.

GAMBACORTA, L. (2005). Inside the bank lending channel. *European Economic Review*, vol. 49, no. 7, pp. 1737–1759.

HERYÁN, T., PALEČKOVÁ, I., RADIĆ, N. (2015). *Comparison of monetary policy effects on lending channel in EMU and non-EMU countries: Evidence from period 1999-2012*. Working Paper in Interdisciplinary Economics and Business Research, No. 3. Karviná: Silesian University, School of Business Administration.

KASHYAP, A.K., STEIN, J.C. (2000). What do a million observations on banks say about the transmission of monetary policy. *American Economic Review*, vol. 90, no. 3, pp. 407–428.

KISHAN, R.P., OPIELA, T.P. (2000). Bank size, bank capital, and the bank lending channel. *Journal of Money Credit and Banking*, vol. 32, pp. 121–141.

MATOUSEK, R., SARANTIS, N. (2009). The bank lending channel and monetary transmission in Central and Eastern European countries. *Journal of Comparative Economics*, vol. 37, no. 2, pp. 321–334.

REICHLIN, L. (2014). Monetary Policy and Banks in the Euro Area: The Tale of Two Crises. *Journal of Macroeconomics*, vol. 39, pp. 387–400.