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DID QUANTITATIVE EASING BOOST BANK LENDING?

THE SLOVAK EXPERIENCE.

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Did quantitative easing boost bank lending? The Slovak experience.[1]

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Abstract

We find evidence that households in Slovakia do benefit from the ECB asset purchase programme. On the individual bank-level data of 26 financial institutions (full representation of the banking sector) we establish and confirm a traditional relationship between bank lending and changes to deposit ratio. We find the long-run relationship to be twice as strong in the household sector as in the sector of non-financial corporations. Controlling for interest rate changes and other factors, we also introduce asset purchases into the model. We document some, although limited, evidence of the presence of the bank lending channel of asset purchases in the household sector.

JEL classification: E52, G21.
Keywords: Bank lending channel, quantitative easing, panel data.

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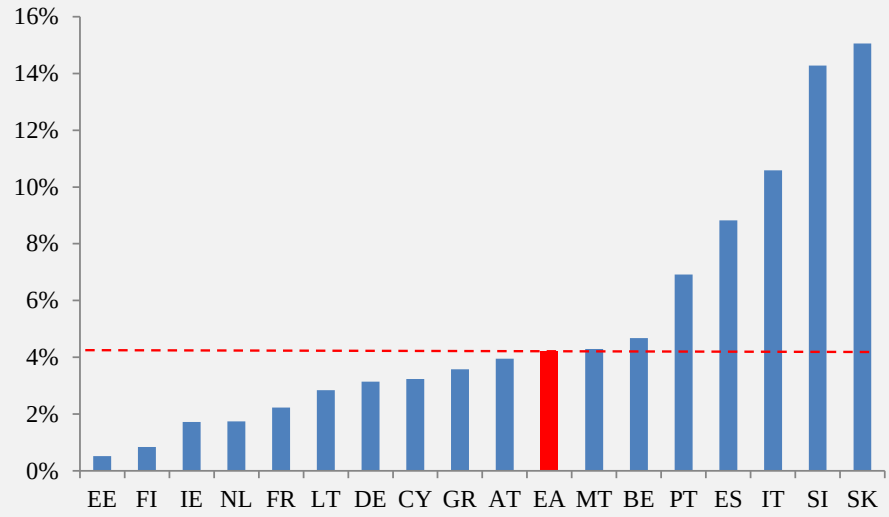
INTRODUCTION

In early 2015 the ECB joined several major central banks in implementing a programme of large scale asset (predominantly government bonds) purchases, commonly referred to as quantitative easing, or QE.[3] This programme is coordinated by the ECB, but conducted in a decentralised fashion whereby each national central bank focuses on its domestic market. In this respect Slovakia belongs to a group of countries where local banks have the highest holdings of domestic government bonds (see Figure 1). Since banks are expected to play a central role in the transmission of these purchases, in this paper we are looking for the presence of a lending channel of these purchases.

Figure 1. Banks' domestic government bond holdings



Note: Domestic government bond portfolio measured as percentage of total banks' assets. Average figures over the QE implementation period.

From the start of the programme in March 2015 until April 2017, the National Bank of Slovakia (NBS) and the ECB purchased €9.3 billion of Slovak government bonds, which compares to 7.7% of national GDP.[4] The vast majority of Slovak government debt is held by banks and a minority by insurance corporations and pension funds. In

[3] On 22 January 2015, the Governing Council of the ECB announced that it would implement the public sector purchase programme (PSPP) in order to address the risks of a too prolonged period of low inflation.
[4] The NBS has purchased public sector securities which amount to 27% of overall government debt.

theory, when the NBS purchases government securities either from a commercial bank or a non-bank, it leaves this institution with two options in terms of what to do with reserves obtained.[5] First, an institution may use reserves to purchase other assets and thus reallocate its portfolios, for example towards corporate bonds and/or equity. The literature refers to this as a portfolio rebalancing channel (PRC). Or, second, since excess reserves are currently remunerated with a negative rate of interest, a commercial bank may benefit from an expansion of lending to the real economy, and thus use the bank lending channel (BLC).

There is now a large and growing body of literature that discusses these transmission channels. For example, empirical evidence in support of the portfolio rebalancing channel has been found in studies for the euro area (e.g. Andrade et al., 2016), the United Kingdom (e.g. Joyce et al., 2014), for the United States (e.g. Carpenter et al., 2015), and for Japan (e.g. Hogen and Saito, 2014). The effects of large asset purchases on banks have received much less attention, partially owing to the view of policy makers that the main effects of QE have come through boosting asset prices, aggregate demand and inflation, but it is less clear whether these improve the flow of credit to the economy. The credit channel is discussed in e.g. Altavilla et al. (2016) for the euro area, and Joyce and Spaltro (2014) for the United Kingdom. Most of this literature focuses on the impact of QE in major economies, and to a lesser extent discusses the influence it might have on small countries participating in the programme. In the euro area the asset purchases are conducted on a decentralised basis, and thereby have a significant impact across various sectors of the economy. In a small open economy with a fully bank based system (i.e. with very limited capital markets), almost any domestic bond market transaction involves a bank as counterparty.[6] Therefore, in this paper we deal with two main questions.

[5] A commercial bank technically receives reserves instead of cash, which are then held at the central bank. For a non-bank, for instance a pension fund, the deposit account is credited in exchange for selling government securities to the central bank. For more details, see Butt et al. (2012).

[6] The Slovak capital market is rather small and fully dominated by government bond trading (almost 99.3%). Since corporate bonds and shares are traded in small amounts, there is rather limited room for portfolio rebalancing behaviour among Slovak banks. For more details, see A. Lojschová (2016).

First, we document the presence of the bank lending channel and second, we assess to what extent quantitative easing helped to boost this channel.

The traditional approaches to the bank lending channel examine how banks' lending supply responds to monetary shocks which affect the level of liabilities held at the commercial bank. Our analysis follows a methodology originally proposed by Kashyap and Stein (1994). Borrowing from this literature, we investigate the relationship between bank lending and deposit growth. We specify this relationship in a pooled mean group (PMG) setup developed by Pesaran et al. (1999). To do this, we use individual bank-level data of 26 financial institutions operating in the Slovak banking sector between January 2009 and mid-2016.

Our paper makes two main findings. First, we find a positive and significant long-run link between bank lending and changes in deposit ratio for the non-financial private sector. We show that the long-run effect for lending to households is almost twice as strong as for non-financial corporations. These results support the presence of the bank lending channel in Slovakia, and boost for household lending; however this could well be caused by the reduction of the policy rate during the period investigated. Even if we control for the policy rate cut, the long-run relationship still exists. Second, we find a significant long-run relationship between bank lending and deposit ratio if we include individual banks' sales of Slovak government bonds as a proxy for QE purchases. This relationship is strong only for the household sector, supporting evidence that the asset purchase programme provided an additional boost mainly to lending to Slovak households.

The rest of this paper is structured as follows. Section 2 provides more details on the type of bank lending channel we are examining in this paper. Section 3 outlines the empirical framework we adopt, while Section 4 discusses the econometric results. The final section concludes.

THE BANK LENDING CHANNEL

The possibility that monetary policy affects the real economy through credit channels has received considerable attention.[7] While the "money view" of monetary policy tends to be rather narrowly focused on interest rates, the "lending view" argues that monetary policy actions have a direct effect on bank lending.

For the purpose of clarity, it is useful to begin with defining what we mean by the bank lending channel. The central bank "creates" money when it buys government securities from a bank. From a balance sheet perspective, there is an increase in the monetary base, or reserves held by banks at the central bank plus currency in circulation, equal to the amount of central bank asset purchases. Banks require a certain amount of cash to meet daily requirements; however banks will not usually choose to hold excess reserves and will instead seek to make a return on it. Since reserves attract a low rate of interest (the deposit facility has been in negative territory since June 2014), banks could possibly benefit from an expansion of lending to the real economy, subject to their own capital constraints.

Even if the central bank buys assets from a non-bank financial institution (for instance, a pension fund or an insurance corporation) this can still indirectly affect bank lending. When a non-bank investor sells government bonds to the central bank, the reserves it receives become a deposit at its commercial bank. If they do not use these excess reserves to invest in an alternative asset, the deposits held by the commercial bank expand. The bank may choose to employ these new deposits by expanding its credit supply to the real economy.

Another indirect channel, which acts counter to the above, is the impact on bank lending through a reduction in long-term interest rates. This can lower banks' net interest margins, and, if they are capital constrained, reduce their ability to lend to

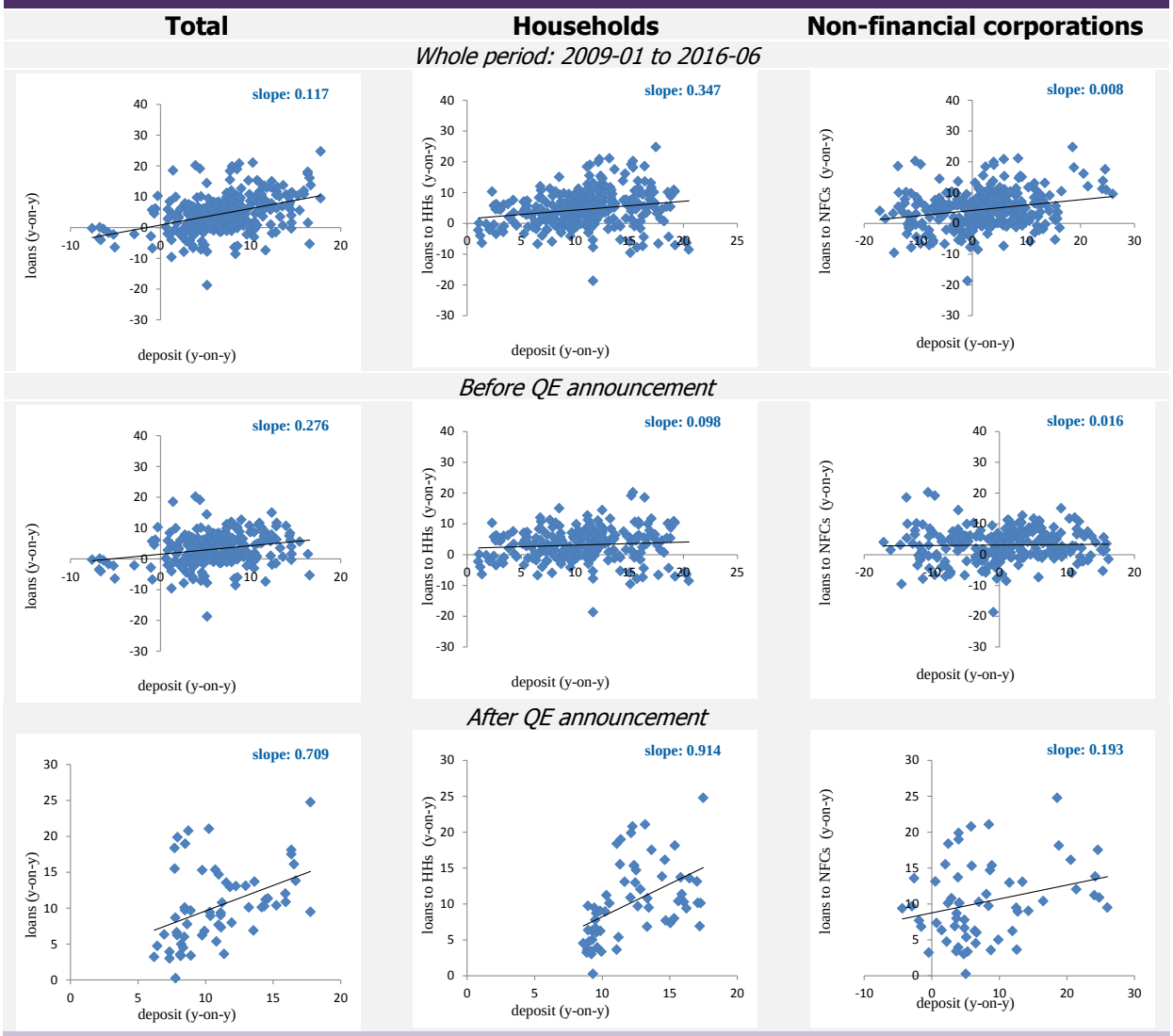
[7] These channels have been discussed by a number of authors, e.g. Bernanke and Gertler (1995), Mishkin (1996), Gambacorta and Marques-Ibanez (2011) and more recently by Di Maggio et al. (2016) or Ippolito et al. (2016).

the real economy. In terms of the impact of the bank lending channel in Slovakia, according to the ECB April 2016 Bank Lending Survey (BLS), some Slovak banks indicated they have used the funds arising from the expanded APP to support their credit supply to households and non-financial corporations.

In this paper we focus on the direct balance sheet effects, i.e. the reaction of bank lending following changes in the stock of deposits. In order to do this, we use individual bank-level data of 26 financial institutions operating in the Slovak lending market between January 2009 and mid-2016. Figure 2 shows that the relationship between bank lending and deposit growth was positive (first row) and changed after the QE announcement, especially for the household sector (second and third rows). A key challenge for our empirical work is to show that the causality runs from changes in deposits to changes in lending, rather than the other way around. For example Kumhof and Jakab (2015) argue that loans come before deposits, i.e. banks create deposits of new money through lending.[8] The endogenous variation in deposits, caused by the creation of deposits when a bank extends a loan, may therefore risk biasing the estimation results.

[8] More specifically, in the modern banking system, whenever a bank makes a new loan to a non-bank customer, it creates a new loan entry on the asset side of its balance sheet, and it simultaneously creates a new and equal sized deposit entry on the liability side of its balance sheet. The bank therefore creates its own funding, deposits, in the act of lending.

Figure 2. Relationship between loans and deposits for top 4 banks in Slovakia



Note: Top 4 banks cover almost 70% of the total banking sector in Slovakia.

EMPIRICAL APPROACH

Our analysis of the bank lending channel follows a methodology proposed by Kashyap and Stein (1994). They present a two period, partial equilibrium model where banks must make an asset choice between holding liquid securities and earning a spread on lending; and a liability choice in terms of how much external financing they use at an increasing premium. Monetary authority is assumed to affect banks' balance sheets through changes in reserves, which lead to a change in deposits, on the assumption that banks maintain a fixed ratio between reserves and deposits.[9]

Borrowing from this literature, we investigate the relationship between bank lending and deposit growth by employing the pooled mean group (PMG) estimator developed by Pesaran et al. (1999). The PMG estimator is a panel data version of an error-correction model which allows us to estimate both short and long-run dynamics.[10] This approach does not require prior specification of which variables are stationary I(0) or integrated of order I(1), and does not oblige all variables to be the same order unlike the traditional methods.[11] In addition, different variables can be assigned different lag lengths, i.e. this representation does not require symmetry of lag terms.[12]

The estimating equation is given by:

$$\Delta l_{i,t} = \alpha_i + \phi_i\left(l_{i,t-1} - \theta x_{i,t-1}\right) + \sum_{j=1}^{p-1} \gamma_{i,t}\, \Delta l_{i,t-j} + \sum_{j=0}^{q-1} \delta_{i,t}\, \Delta x_{i,t-j} + \varepsilon_{i,t} \qquad (1)$$

[9] The total reserve requirements for euro area banks stand at around 113 billion euro. Banks have to hold a minimum of 1% of certain liabilities, mainly customers' deposits, at their national central bank.
[10] PMG estimator constrains long-run coefficients to be the same and allows short-run coefficients and error variances to differ across cross-sectional units.
[11] Traditional methods of estimating co-integrating relationships, such as Engle-Granger or Johansen's method, or single equation methods such as OLS, or dynamic OLS either require all variables to be I(1), or require prior knowledge and specification of which variables are I(0) and which are I(1).
[12] Another benefit of this representation is the lag structure, which ensures a causal relationship being embedded directly into the specification, i.e. causality tests are not therefore necessary.

where $l_{i,t}$ is annual lending growth for bank *i* in period *t* and $x_{i,t}$ is a vector of individual bank variables that impact bank lending activity such as deposit growth, change in deposits ratio (i.e. deposits over total assets) and change in capital ratio (i.e. capital over risk-weighted assets). We include deposit ratio in our analysis because it helps us to capture large changes in deposits that may lead to increases in assets. For example, Joyce and Spaltro (2014) found that movements in the deposit ratio have a positive and significant effect on bank lending. Most studies investigate the relationship between bank lending and how well-capitalised banks are.[13] Joyce and Spaltro (2014) found that changes in capital have a significant, but negative, impact on lending growth in the first lag and long-run. As they argue, this does not necessarily contradict the fact that there is a positive long-run equilibrium relationship with the level of capital. Another possible explanatory variable, such as macroeconomic factors, did not prove significant for our analysis.[14]

Equation (1) originates in an autoregressive distributed lag ARDL model which allows us to estimate both short and long-run dynamics.[15] The second term in equation (1) represents the long-run relationship between bank lending and deposit growth and other explanatory variables. The PMG estimator incorporates the assumptions that the cross-sectional units (in our case individual banks) share the same long-run relationship, but differ in the short-term adjustment and dynamics around that long-run link. The long-term coefficient θ is thus restricted to being equal for all the banks included in the estimation. Parameter ϕ_i is the bank-specific error-correction coefficient. Panel estimates of this coefficient are obtained through the mean group procedure by averaging over the individual bank slope estimates. The existence of a long-run relationship can be tested on the t-statistic of the panel mean group estimate of ϕ. The third and fourth terms in equation (1) represent the bank-specific

[13] For example, Marques-Ibanez (2011) shows that the health of banks' balance sheets, and in particular the amount of capital they hold, is important in determining the effectiveness of the bank lending channel.
[14] We have tested GDP growth, unemployment rate, and HICP inflation.
[15] In fact equation (1) is obtained by transforming an ARDL model of order *p* and *q* into first differences.

short-term dynamics, which are captured by the coefficients of the individual time lags $\gamma_{i,t}$ and $\delta_{i,t}$. Panel estimates of these coefficients are also obtained through the mean group procedure.

We estimate equation (1) using Pooled Mean Group (PMG) estimator. There are, for instance, different possibilities regarding how to evaluate this relationship. Some authors (e.g. Bond, 2002, Alessandri and Nelson, 2012) deal with this problem by using a GMM estimator. However, the asymptotic properties of GMM estimators are derived for large N and small T datasets and may not be applicable to our case. In order to assess the robustness of our results, we employ in our analysis the Fixed Effect (FE) estimators.[16] Since they are similar in magnitude and significance, we present only the Pooled Mean Group (PMG) estimation results.

[16] See Annex 2 on Robustness Analysis.

RESULTS

In our analysis we use a unique data set which includes 13 Slovak banks and 13 branches of foreign banks located in Slovakia.[17] The balance sheet size of these 26 banks amounts to over €70 billion, with deposits accounting for more than 70% of total liabilities and loans for around 65% of total assets.

We start by exploring the relationship between bank lending and deposit growth using the whole sample of 2340 observations. We use changes in deposit ratio (i.e., deposits over total assets) as an explanatory variable because by construction this variable captures well changes in other non-deposit liabilities. As Joyce and Spaltro (2014) argue, by looking at this ratio, we are more likely to capture large changes in deposits that drive increases in assets and it is therefore closer to QE-induced expansion of banks' deposits. Table 1 shows the Pooled Mean Group (PMG) estimation of equation (1) and confirms that there is a positive and significant long-run link between bank lending and changes in deposit ratio for the non-financial private sector.[18] When comparing across sectors, the long-run effect is almost twice as strong for the household sector as for non-financial corporations. Lending to insurance corporations and pension funds is rather volatile and introduces too much noise to be able to model it in any form.[19]

[17] We have included financial entities on a consolidated level, as we assume that lending decisions are taken on a group-level basis. For more information, see Annex 1 on data set.
[18] We find a positive and significant long-run link between bank lending and deposit growth, but as argued earlier we report results only for deposit ratio.
[19] The insurance corporations and pension funds (ICPFs) sector constitutes on average around 6% of total lending to economy.

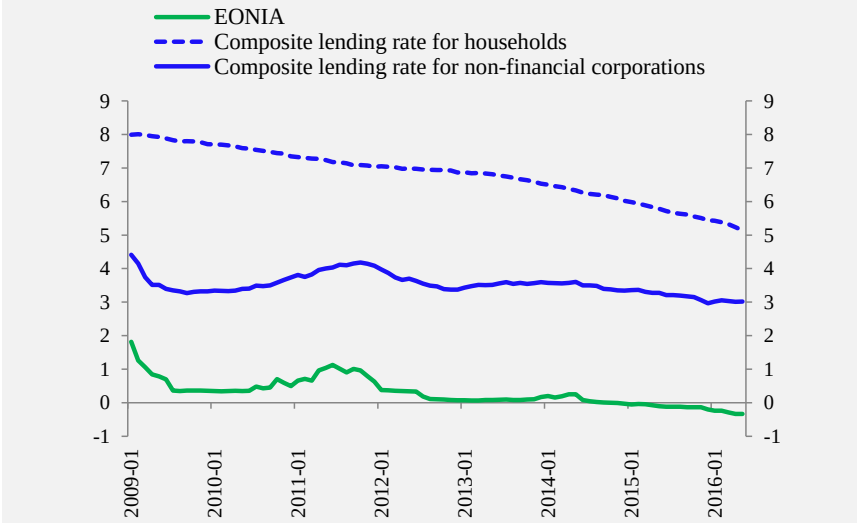
Table 1. Lending growth estimation results for full sample

Sectoral break-down	**Lending growth**			
	to households (HHs)	**to non-financial corporations (NFCs)**	**to insurance corporation and pension funds (ICPFs)**	**total**
Long run				
Change in Deposit ratio (DR)	0,48***	0,209**	-0,221	0,25**
	(0,096)	(0,087)	(0,253)	(0,115)
Error correction	-0,093***	-0,18***	-0,251***	-0,119***
	(0,021)	(0,051)	(0,039)	(0,038)
Short-term dynamics				
Δ L1	0,305***		0,161**	0,093**
	(0,074)		(0,075)	(0,041)
Δ L2	0,127**		-0,029	0,001
	(0,060)		(0,108)	(0,067)
Δ DR0	-0,047*	-0,044	-0,595***	-0,125*
	(0,026)	(0,098)	(0,200)	(0,064)
Δ DR1	0,061			
	(0,064)			
Constant	0,01	-0,007	0,044	0
	(0,008)	(0,007)	(0,062)	(0,004)
Number of Obs.	2340	2340	1668	2340
Number of Banks	26	26	26	26
Model selection	ARDL (3,2)	ARDL (1,1)	ARDL (3,1)	ARDL (3,1)
RMSE	0,316	0,295	0,493	0,242

*Notes: This table reports the Pooled Mean Group (PMG) estimation of equation (1). DR stands for change in deposit ratio (measured as deposit over total assets), L for lending growth, number behind DR or L indicates to current or lagged changes. RMSE is the root mean squared error. Standard errors are shown in parentheses and ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.*

These results might support the existence of a bank lending channel, and a boost for household lending; however this could well be caused by the reduction of policy rate during the period investigated. Thus we re-estimate equation (1) and include the short-term interest rates to capture this effect. Data on individual banks' lending rates suggest that successive declines in EONIA rate have been passed through to lending rates to a different extent across sectors (a larger decline for households than for corporations – see Figure 3); therefore we include the composite lending rate in our analysis.

Figure 3. Developments in policy rate and composite lending rate



Note: Composite lending rate for households and non-financial corporations is calculated as a weighted average of individual banks' interest rates included in the sample.

In addition, we include two dummy variables in our estimation. First, since we investigate the relationship between bank lending and deposit ratio during the QE implementation phase, we include a dummy for the post March 2015 period. Second, we use an additional dummy to account for changes in legislation that allowed for significant reduction of a fee for early repayment of mortgage loans since March 2016, which have led to an additional boost in lending for house purchases.[20]

[20] For more information, see https://www.etrend.sk/trend-archiv/rok-2016/cislo-23/koho-netesia-lacne-hypoteky.html.

Table 2 reports the estimation results and shows that there is a long-run relationship between bank lending growth and changes in deposit ratio if we control for policy rate cuts and include the two dummy variables. The magnitude of the long run link stays robust, suggesting that bank lending activity remains ample in the period where the short-term policy rate was constrained at its effective lower bound. When comparing across sectors, the long-run effect is more than twice as strong for the household sector than for non-financial corporations. The coefficient on composite lending rate is negative and significant for households and insignificant for the remaining sectors.[21] These results further support the existence of the bank lending channel, and in particular a boost for household lending.

[21] Even if we include EONIA rate instead of the composite lending rate the coefficient remains insignificant.

Table 2. Lending growth estimation results if we control for policy rate cut

Sectoral break-down	Lending growth			
	to households (HHs)	**to non-financial corporations (NFCs)**	**to insurance corporation and pension funds (ICPFs)**	**total**
Long run				
Change in Deposit ratio (DR)	0,556***	0,214*	-0,216	0,229**
	(0,093)	(0,095)	(0,251)	(0,098)
Error correction	-0,089***	-0,173***	-0,264***	-0,111***
	(0,025)	(0,048)	(0,037)	(0,038)
Short-term dynamics				
Δ L1	0,264***		0,158**	0,088**
	(0,070)		(0,076)	(0,039)
Δ L2	0,123**		-0,018	0,012
	(0,062)		(0,103)	(0,071)
Δ DR0	-0,043	0,022	-0,593***	-0,113*
	(0,034)	(0,143)	(0,204)	(0,068)
Δ DR1	0,038			
	(0,064)			
Δ DR2	-0,007***			
	(0,041)			
Δ Composite lending rate	-0,099***	0,033	-0,017	-0,106***
	(0,024)	(0,107)	(0,064)	(0,017)
Constant	0,004	-0,007	0,045	-0,001
	(0,009)	(0,007)	(0,063)	(0,003)
Number of Obs.	2340	2340	1668	2340
Number of Banks	26	26	26	26
Model selection	ARDL (3,3)	ARDL (1,1)	ARDL (3,1)	ARDL (3,1)
RMSE	0,351	0,725	0,496	0,240

Notes: This table reports the Pooled Mean Group (PMG) estimation of equation (1). DR stands for change in deposit ratio (measured as deposit over total assets), L for lending growth, number behind DR or L

*indicates to current or lagged changes. RMSE is the root mean squared error. Standard errors are shown in parentheses and ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. There are two dummy variables included in the estimation (i) QE dummy which has 0 before the QE implementation phase and 1 after, and (ii) a legislation dummy which has value 0 before March 2016 and 1 till the end of sample.*

As suggested in the previous section, we also include some micro-prudential bank variables, such as capital ratio (i.e. capital over risk weighted assets). As risk weighted assets, Tier 1 and 2 capital data were mostly available for Slovak banks and just a very few foreign branches; we report our results only for Slovak banks. Table 3 shows that a new explanatory variable – changes in capital ratio – has a statistically significant and negative impact on lending growth. As argued by Joyce and Spaltro (2014), this does not necessarily contradict the fact that there is a positive long-run equilibrium relationship with the level of capital. In fact, we find a positive long-run link between bank lending and capital if we use them in levels.

Table 3. Lending growth estimation results if we include micro-prudential variable

Sectoral break-down	**Lending growth**			
	to households (HHs)	**to non-financial corporations (NFCs)**	**to insurance corporation and pension funds (ICPFs)**	**total**
Long run				
Change in Deposit ratio (DR)	0,508***	0,125	-0,072	0,157*
	(0,127)	(0,086)	(0,246)	(0,082)
Change in Capital ratio (CR)	-0,141***	0,182	-0,183*	-0,159***
	(0,026)	(0,110)	(0,070)	(0,024)
Error correction	-0,081***	-0,131***	-0,303***	-0,18***
	(0,019)	(0,042)	(0,058)	(0,059)
Short-term dynamics				
Δ Composite lending rate	-0,104***	0,037	0,049	-0,095***
	(0,024)	(0,101)	(0,158)	(0,022)
Number of Obs.	1170	1170	834	1170
Number of Banks	13	13	13	13
Model selection	ARDL (3,1,1)	ARDL (3,3,3)	ARDL (3,1,1)	ARDL (4,4,4)
RMSE	0,252	0,294	0,498	0,260

*Notes: This table reports the Pooled Mean Group (PMG) estimation of equation (1). DR stands for change in deposit ratio (measured as deposit over total assets), CR for change in capital ratio (measured as Tier 1 and 2 capital over risk weighted assets). RMSE is the root mean squared error. Standard errors are shown in parentheses and ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. There are two dummy variables included in estimation (i) QE dummy which has 0 before the QE implementation phase and 1 after, and (ii) legislation dummy which has value 0 before March 2016 and 1 till the end of sample.*
To save space, we do not report all short-term coefficients.

Our results suggest that there is a positive and significant link between bank lending and deposit ratio if we control for policy rate cut and include micro-prudential variables. Using our proxy series for QE participation (sovereign bond transactions), we test whether such long-run link holds also for QE-induced deposits. Table 4 reports these findings.

Table 4. Lending growth estimation results if we include proxy for QE purchases

Sectoral break-down	**Lending growth**			
	to households (HHs)	**to non-financial corporations (NFCs)**	**to insurance corporation and pension funds (ICPFs)**	**total**
Long run				
Change in Deposit ratio (DR)	0,446***	0,042***	0,022***	0,046***
	(0,065)	(0,013)	(0,032)	(0,005)
Change in Capital ratio (CR)	0,144***	-0,202***	-0,553***	0,026**
	(0,012)	(0,049)	(0,104)	(0,011)
Change in SK govies	0,031***	-0,011	0,084	0,002
	(0,007)	(0,008)	(0,053)	(0,001)
Error correction	-0,151*	-0,262***	0,266***	-0,129
	(0,079)	(0,097)	(0,080)	(0,092)
Short-term dynamics				
Δ Composite lending rate	-0,005	-0,061	0,048	-0,211**
	(0,092)	(0,162)	(0,048)	(0,080)
Number of Obs.	858	858	704	858
Number of Banks	13	13	13	13
Model selection	ARDL (2,1,1,1)	ARDL (2,2,2,2)	ARDL (3,1,1,1)	ARDL (2,2,2,2)
RMSE	0,160	0,165	0,559	0,140

*Notes: This table reports the Pooled Mean Group (PMG) estimation of equation (1). DR stands for change in deposit ratio (measured as deposit over total assets), CR for change in capital ratio (measured as Tier 1 and 2 capital over risk weighted assets). RMSE is the root mean squared error. Standard errors are shown in parentheses and ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. There are two dummy variables included in estimation (i) QE dummy which has 0 before the QE implementation phase and 1 after, and (ii) legislation dummy which has value 0 before March 2016 and 1 till the end of sample.*
To save space, we do not report all short-term coefficients.

These results suggest that after backing out all other eventual effects from the lending channel, we are still left with a significant positive effect of quantitative easing on lending to the household sector in Slovakia. Indeed, the self-reported evidence from the ECB Bank Lending Survey (BLS) confirms this view.[22] In particular, some Slovak banks indicated that they have used the funds arising from the expanded APP to support their credit supply to households and non-financial corporations. While Slovak banks and foreign branches have provided more new loans to the household sector, lending to corporates was on a declining trend from mid-2015, although experiencing some recovery in recent months. New lending to households has held more robustly, and has indeed increased since the QE announcement.

[22] The bank lending survey (BLS) for the euro area was launched in 2003 and the sample group comprises around 140 banks from all euro area countries (5 banks from Slovakia). Since October 2015, the BLS includes ad hoc questions related to the impact of the ECB's expanded asset purchase programme (APP).

CONCLUSION

The effects of large asset purchases on banks have received much less attention, partially owing to the view of policy makers that the main effects of QE have come through boosting asset prices, aggregate demand and inflation, but it is less clear whether it improves the flow of credit to the economy. The bank lending channel can be understood as a supplementary channel of monetary policy which leads banks to increase their supply of lending. In a small country with less effective capital markets – such as Slovakia – the bank lending channel may in fact be the primary transmission channel of QE.

In this paper we examine whether and to what extent the ECB asset purchases gave rise to a bank lending channel in Slovakia. We use individual bank-level data on 26 financial institutions operating in the Slovak banking sector between January 2009 and June 2016. We see the value added of this paper in two main areas. First, we found a positive and significant long-run link between bank lending and changes in deposit ratio for the non-financial private sector. We show that the long-run effect for lending to households is almost twice as strong as for non-financial corporations. These results support the presence of the bank lending channel in Slovakia, and a boost for household lending, also when controlling for dynamics in retail interest rates and other possible factors. Second, we found a significant long-run relationship between deposit ratio and bank lending if we include individual banks' sales of Slovak government bonds as a proxy for QE purchases. This relationship is positive only for the household sector, supporting evidence of an additional boost from the asset purchase programme to lending to Slovak households.

Since the purchases under the PSPP programme are expected to run until the end of 2017 or in any case until inflation returns to a path consistent with the ECB's objective, this paper provides an early assessment of the local impact of the programme.

ANNEX 1: THE DATA SET

In our analysis we make use of a unique bank-level data set which covers balance sheet and interest rate data for all credit institutions located in Slovakia. We have included financial entities at a consolidated level, as we assume that lending decisions are taken on a group-level basis. This sample includes 13 Slovak banks (predominantly foreign-owned) and 13 branches of foreign banks located in Slovakia (see Table 5) and is therefore highly representative of aggregate and of cross-sectional patterns. For comparison, most of the empirical studies for the euro area include only the three biggest significant institutions from Slovakia and thus do not have full representation of the Slovak banking sector.

Table 5. List of financial institutions

Slovak banks	**Branches of foreign banks located in Slovakia**
Všeobecná úverová banka, a.s.	UniCredit Bank Czech Republic and Slovakia, a.s.
Slovenská sporiteľňa, a.s.	Komerční banka, a.s.
Tatra banka, a.s.	Citibank Europe plc
Slovenská záručná a rozvojová banka, a.s.	ING Bank N.V.
Sberbank Slovensko, a.s.	COMMERZBANK Aktiengesellschaft
OTP Banka Slovensko, a.s.	Banco Banif Mais, S.A.
Prima banka Slovensko, a.s.	J&T BANKA, a.s.
Prvá stavebná sporiteľna, a.s.	Fio banka, a.s.
Poštová banka, a.s.	mBank S.A.
Wüstenrot stavebná sporiteľňa, a.s.	Oberbank AG
Privatbanka, a.s.	ZUNO BANK AG
ČSOB stavebná sporiteľňa, a.s.	BKS Bank AG
Československá obch. banka, a.s.	KDB Bank Europe Ltd.

From the data set called Individual Balance Sheet Indicators, or IBSI, reporting the main asset and liability items of 26 banks resident in Slovakia from January 2009 to mid-2016, we obtain data on the amount of outstanding loans, deposits (with further sectoral breakdown into households, non-financial corporations, insurance corporations and pension funds) and the exposures to sovereign debt (with detailed information on issuer, maturity, ISIN code and type of portfolio such as held to maturity (HTM), available for sale (AFS), and held for trade (HFT).[23] We construct a series where the decline/increase in stock of domestic sovereign bond holdings would serve as a proxy of purchase/sale of assets related to QE. Since a decline/increase in stock may as well refer to maturing debt/new emission, this effect is backed out from the series.[24]

The second data set, called Individual Monetary and Financial Institution Interest Rates or IMIR, contains information on individual deposits and lending rates charged by banks for different maturities and for different loan sizes. In addition, we incorporate in our analysis the micro-prudential bank variables coming from FINREP/COREP data set. Since the variables for capital adequacy (Tier 1 and 2), risk weighted assets (RWAs), non-performing loans (NPL) and return on assets (RoA) were only available for Slovak banks and just a very few foreign branches, we report our results only for Slovak banks.

[23] Monthly report V86 contains data on issuer, maturity, ISIN code, type of portfolio (HTM, AFS, HFT) etc. These data have been available since January 2012.
[24] For example in February 2016, two major Slovak banks recorded a steep decline in domestic sovereign bond holdings which was associated with maturing of Slovak 6-year government bonds.

ANNEX 2: ROBUSTNESS ANALYSIS

In order to assess the robustness of our results, we report the Fixed Effect (FE) estimations of the relationship between bank lending and changes to deposit ratio. Table 6 shows estimation results of the short and long-term dynamics across different specifications for the non-financial private sector. [25,26]

The FE estimation results confirm the main findings of our paper, and in particular that we find a positive and significant long-run link between bank lending and changes in deposit ratio for the non-financial private sector. The magnitude and significance of the short- and long-term coefficients are comparable with PMG estimations results reported in Tables 2-4. It still holds that the long-run effect for lending to households is almost twice as strong as for non-financial corporations. If we include individual banks' sales of Slovak government bonds as a proxy for QE purchases, we find a significant long-run relationship only for the household sector, documenting some, although limited, evidence of the presence of the bank lending channel of asset purchases for the household sector. Changes in capital ratio have a statistically significant and negative impact only for the household sector, and are insignificant for the non-financial sector. The composite lending rate is negative and significant for all three household sector specifications as for the PMG estimations. All in all, the FE results support the conclusions of our preliminary assessment of large scale asset purchases on bank lending activity in Slovakia.

[25] The short-run effect is captured by the coefficients of the individual time lags, while the cumulative long-run effect is defined by the sum of the lagged coefficients divided by one minus the sum of the lagged lending coefficients.

[26] As lending to insurance corporations and pension funds is somewhat volatile and introduces too much noise into our estimations, we present results only for lending to households and non-financial corporations.

Table 6. Fixed Effect estimators results

Sectoral break-down	**Lending growth**					
	to households (HHs)			**to non-financial corporations (NFCs)**		
Specification	Table 2	Table 3	Table 4	Table 2	Table 3	Table 4
Long-run						
Change in Deposit ratio (DR)	0,549**	0,51**	0,361*	0,236**	0,169	0,535
	(0,045)	(0,257)	(0,381)	(0,032)	(0,239)	(0,672)
Change in Capital ratio (CR)	-	-0,028*	-0,041	-	-0,018	-0,005
		(0,016)	(0,029)		(0,017)	(0,023)
Change in SK govies	-	-	0,014*	-	-	0,047
			(0,798)			(0,057)
Short-term dynamics						
Δ Composite lending rate	-0,182***	-0,188***	-0,314***	-0,001	-0,001	-0,007
	(0,024)	(0,023)	(0,041)	(0,003)	(0,003)	(0,026)
Number of Obs.	2340	1170	858	2340	1170	858
Number of Banks	26	13	13	26	13	13
RMSE	0,206	0,206	0,224	0,207	0,208	0,201

*Notes: This table reports the Fixed Effect (FE) estimation of equation (1). RMSE is the root mean squared error. Standard errors are shown in parentheses and ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. There are two dummy variables included in estimation (i) QE dummy which has 0 before the QE implementation phase and 1 after, and (ii) legislation dummy which has value 0 before March 2016 and 1 till the end of sample. For space reason, we do not report all short-term coefficients.*

REFERENCES

Alessandri, P. and Nelson, B. (2012), "Simple banking: profitability and the yield curve", Bank of England Working Paper, No. 452.

Altavilla, C., Pagano, M. and Simonelli, S. (2016), "Unconventional Monetary Policies, Bank Lending and Sovereign Debt Holdings", Conference on Monetary policy pass-through and credit markets, ECB, 27 October 2016.

Andrade, P., Breckenfelder, J., De Fiore, F., Karadi, P. and Tristani, O. (2016), "The ECB's asset purchase programme: an early assessment", ECB Working Paper Series.

Bauer, M. D. and Rudebusch, G. D. (2013), "The Signalling Channel for Federal Reserve Bond Purchases," Federal Reserve Bank of San Francisco Working Paper Series.

Bernanke, B. S. and Gertler, M. (1995), "Inside the black box: the credit channel of monetary policy transmission," Journal of Economic Perspectives, 9. 27-48.

Bond, S. (2002), "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice", CEMMAP Working Paper, CWP09/02.

Butt, N., Domit, S., McLeay, M., Thomas, R. and Kirkham, L. (2012). "What can the money data tell us about the impact of QE?" Bank of England Quarterly Bulletin, Bank of England, Vol. 52, No.4, pp. 321-331.

Butt, N., Churm, R., McMahon, M., Morotz, A., and Schanz, J. (2014), "QE and the bank lending channel in the United Kingdom", Bank of England working papers 511, Bank of England.

Di Maggio, M., Kermani, A., and Palmer, Ch. (2016), "Unconventional Monetary Policy and the Allocation of Credit", ECB Conference Monetary policy pass-through and credit markets.

Gambacorta, L., and Marques-Ibanez, D. (2011), "The bank lending channel: lessons from the crisis," Economic Policy, 26, 135-182.

ECB, (2015a), "ECB announces expanded asset purchase programme," ECB Press Release, 22 January 2015.

ECB, (2015b), "Asset purchase programmes"
https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html

ECB, (2015c), "The transmission of the ECB's recent non-standard monetary policy measures". ECB Economic Bulletin, Issue 7 / 2015 – Articles.

Carpenter, S., Demiralp S., Ihrig, J. and Klee, E. (2015), "Analyzing Federal Reserve asset purchases: From whom does the Fed buy?" Journal of Banking & Finance, Vol. 52, pp. 230–244.

Hogen, Y. and Saito, M. (2014), "Portfolio Rebalancing Following the Bank of Japan's Government Bond Purchases: Empirical Analysis Using Data on Bank Loans and Investment Flows," Bank of Japan Research Papers 14-06-19, Bank of Japan.

Ippolito, F., Ozdagliy, A.K., and Perez-Orive, A. (2016), "The Transmission of Monetary Policy through Bank Lending: The Floating Rate Channel", ECB Conference Monetary policy pass-through and credit markets.

Jakab, Z., and Kumhof, M. (2015), "Banks are not intermediaries of loanable funds – and why this matters", Bank of England working papers 529, Bank of England.

Joyce, M., and M. Spaltro (2014), "Quantitative easing and bank lending: a panel data approach," Bank of England working papers 504, Bank of England.

Joyce, M., Liu, Z. and Tonks, I. (2014), "Institutional investor portfolio allocation, quantitative easing and the global financial crisis," Bank of England working papers 510, Bank of England.

Kashyap, A.K., and Stein, J.C. (1994), "The Impact of Monetary Policy on Bank Balance Sheets", National Bureau of Economic Research, Working Paper No. 4821.

Kaihatsu, S. and Nakajima J. (2015), "Has Trend Inflation Shifted?: An Empirical Analysis With a Regime-Switching Model," Bank of Japan Working Paper Series, No. 15-E-3.

Lojschová, A. (2016), "Kapitálový trh na Slovensku", Biatec vol. 24 (2), 14-17.

Mishkin, F. (1996), "The Channels of Monetary Transmission: Lessons for Monetary Policy," NBER Working Paper Series No. 5464.

Pesaran, M. H., Shin, Y. and R. P. Smith (1999), "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels", Journal of the American Statistical Association, Vol. 94, No. 446, pp. 621-634.