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Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

The Interest Rate Pass Through during the Crisis: Evidence from Slovakia

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 14, 2015

Signature

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Abstract

The effectiveness of interest rate pass-through is crucial when shaping monetary policy. In this paper we use error correction framework in order to estimate the speed and the completeness of pass through in Slovakia. Our thesis brings a unique research on how the financial crisis and Euro adoption affect the pass-through. In Slovakia those events occur at the same time; we attempt to distinguish between what phenomenon has greater impact. We also distinguish between what bank characteristics have impact on individual bank's spread during financial crisis.

Our results suggest that the interest rate pass-through completeness increases in long term. We however found evidence of decreasing pass-through in case of deposit rates during crisis. Banks are unwiling to lower them and hence harm their competitve position.

The pass-through in Slovakia is found to be relatively fast and consistent throughout periods. With the crisis, the speed for mortgages rates however decreases. We conclude that the impact of financial crisis outweights the impact of Euro adoption.

Concerning the banks' characteristics, we conclude that higher portion of loans on assets, higher costs over income and better liquidity position decrease the spread. This is explained by the size of Slovakian banking market; banks lower their spread to remain competitive. We further conclude that less capitalized banks increase their risk premium. Banks' size is not found to have any effect on the spread.

JEL Classification	E43, E58, G21
Keywords	interest rate, pass-through, Slovakia, crisis, Euro, error correction

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Abstrakt

Efektivita prenosu úrokových sadzieb je zásadná pri tvorbe monetárnej politiky. V tejto práci používame model korekcie chýb na odhadovanie rýchlosti a úplnosti prenosu na Slovensku. Táto práca prináša jedinečný pohľad na to, ako finančná kríza a prijatie Eura ovplyvňujú tento prenos. Na Slovensku sa tieto dve udalosti odohrali v rovnakom čase; zisťujeme preto ktorá z nich mala na prenos väčší dopad. Taktiež skúmame ktoré charakteristiky bánk ovplyvňujú individuálny „spread“ počas finančnej krízy.

Naše výsledky naznačujú že úplnosť prenosu sa zvyšuje v dlhodobom horizonte. Našli sme ale taktiež dôkazy o klesajúcej úplnosti prenosu v prípade depozitných sadzieb počas krízy. Banky nie sú ochotné tieto sadzby znižovať a tak znižovať svoju konkurencieschopnosť.

Prenos úrokových sadzieb je na Slovensku pomerne rýchly a konzistentný medzi skúmanými obdobiami. S krízou sa však znižuje rýchlosť pri sadzbách hypoték. Dochádzame teda k záveru, že kríza má na prenos väčší vplyv ako prijatie spoločnej meny.

Ak vezmeme do úvahy charackeristiky bánk, dochádzame k záveru, že vyšší podiel úverov na aktívach, vyššie náklady v porovnaní so ziskom a lepsia likvidita znižujú „spread“. Tento efekt je vysvetlený veľkosťou slovenského bankového trhu; banky znižujú svoj „spread“ aby boli konkurencieschopné. Ďalej dochádzame k záveru že menej kapitalizované banky zvyšujú svoju rizikovú prirážku. Veľkosť bánk na „spread“ nemá efekt.

JEL Klasifikácia	E43, E58, G21
Kľúčové slová	úrok, prenos, Slovensko, kríza, Euro, korekcia chýb

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Contents

List of Tables

List of Figures

Acronyms

EMU	European Economic and Monetary Union
EU	European Union
NBS	National Bank of Slovakia
OLS	Ordinary Least Squares
BRIBOR	Bratislava Interbank Offered Rate
EURIBOR	Euro Interbank Offered Rate
EONIA	Euro Over-Night Index Average
CEE-5	Five Central and Eastern European countries – the Czech Republic, Slovakia, Hungary, Poland, Slovenia
ECB	European Central Bank
ESCB	European System of Central Banks

Master Thesis Proposal

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Proposed Topic:

The Interest Rate Pass-Through during the Crisis: Evidence from Slovakia

Motivation:

The interest rate pass-through reflects the effectiveness of monetary policy transmission. It is very important to examine this phenomenon. The monetary policy performance turns out to be essential especially in times of crisis, because individuals, firms and financial entities shape their investment, savings and consumption decisions with respect to deposit and lending rates. It is of great importance to know how fast and at what degree retail rates adjust to policy rates.

Surely, the research on the pass-through is more important in countries which use interest rate channel as monetary policy instrument. Euro-area is a very good example of such conditions. Since the individual countries lost one of the instruments of monetary policy – foreign exchange rate, interest rates became the principal tool for central bankers. The interest rate pass-through in Euro-area is examined for example by Gabe J. De Bondt (2002). In line with previous studies, he finds out that the pass-through is incomplete in short term, but increases in long term, especially for lending rates. Secondly, the results suggest a quicker pass-through process since the introduction of the euro.

As for the pass-through since the financial crisis, Illes and Lombardi (2013) conclude that the policies of near-zero interest rates maintained by central banks of major advanced economies have lowered lending rates to non-financial firms only to a limited extent. Furthermore, results for euro area countries are very diverse. Firms in Italy and Spain continued to face high bank financing costs. At the same time, lending rates in Germany and France were trending downwards over the last few years.

The example of Slovakia may be very interesting for the research of the Interest Rate Pass-Through. Since the country introduced a common currency at the beginning of 2009 and the financial crisis hit Euro-zone in 2008, Slovakia becomes a unique example of the two events occurring at the same time. No previous study examines such a situation and this research therefore becomes highly desirable.

As for Slovakia itself, a similar study was done for a crisis period (Beka, NBS, 2014).This study however does not differentiate between commercial banks. The added value of my research therefore also lies in taking into consideration various characteristics of different commercial banks.

Hypotheses:

1. Hypothesis #1: The pass-through is incomplete in short term, but increases in long term.
2. Hypothesis #2: The pass-through is quicker since the introduction of the euro, despite the crisis.
3. Hypothesis #3: The pass-through differs among banks in short-term, but becomes homogenous in long term. Higher credit risk increases vulnerability of banks to

money market shocks. A similar result applies for lower liquidity and smaller size.

Methodology:

The first step is the collection of data. The information on banks are collected by the National Bank of Slovakia (NBS). I will also use the Bankscope database for bank specific financial information. Then, I will apply the approach of Horváth and Podpiera (2009) on this data. They use the error correction model, given the non-stationarity of bank-level interest rate panels, which I will try to apply myself. The error correction model is very useful in situations when we are interested in both short term and long term relationship between multiple time series and also in the speed at which the explained variable returns to equilibrium after a deviation has occurred.

As for the link between money market rates and bank interest rates I will use respectively: BRIBOR and EURIBOR rates available at NBS website and the weighted average of bank interest rates available at NBS website (usage of median would be in line with Horváth and Podpiera, however the majority of papers uses weighted average).

Concerning the differentiation among banks; I would like to use liquidity, capital adequacy, size, deposits, efficiency and credit risk ratio (in line with Horváth and Podpiera). As for the data, I will collect them from the Bankscope database. NBS collects these data but do not share them publically.

In line with Horváth and Podpiera, I will apply the mean-group estimator of Pesaran and Smith, the pooled mean-group estimator of Pesaran, Shin, and Smith, the Stock-Watson Dynamic OLS and Swamy's random coefficient.

Expected Contribution:

Slovakia is a unique example in the research on interest rate pass-through because the moment of adoption of common currency and the beginning of financial crisis occur practically in the same time. The research can be therefore very useful when shaping future monetary policies for similar situations, in other transitive economies or in countries in periphery of European Union which will adopt the Euro in the future.
Also, there is no similar study on Slovakia which covers the crisis period and also differentiates among banks. The results can therefore be very useful for policy makers in Slovakia, so they can shape their policies by taking into consideration the characteristics of banking market.

Outline:

1. Introduction – motivation of this research; Slovakia is a unique example in the research on interest rate pass-through. I will state my hypotheses.

2. Literature review with emphasis on the similar studies conducted in central Europe, Euro-area and during crisis.

3. Brief description of the interest rate pass-through process.

4. Data: I will explain what methodology was applied during data collection.

5. Methodology: I will explain the applied models and the tests used

6. Results: I will discuss the results and their implications.

7. Conclusion: I will summarize my results, respond to the questions posed in the beginning and provide further implications.

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Author **Supervisor**

1. Introduction

The effectiveness of monetary policy transmission is crucial when shaping those policies and implementing them. Since individuals, firms and financial entities adjust their decisions with respect to deposit and lending rates, the monetary policy performance is important especially during crisees. It is of great importance to know how fast and at what degree bank retail rates adjust to policy rates.

In this paper we examine how bank retail rates are affected by money market rate. The money market rate driven by policymakers, usually central banks, is one of key monetary policy instruments. We attempt to look into how fast and how complete is the pass-through of money market rate into bank retail rates.

Slovakia, being part of Euro-area as of 1 January 2009, is one of countries which use interest rates as their principal monetary policy instrument. Various studies have been previously written on the subject of pass-through development in case of common currency adoption or during financial crisis.

Slovakia however is a unique example of the two events occuring at the same time. No previous study examines such situation. This research may be therefore useful when shaping monetary policies in similar situations in other transitive economies or in countries on periphery of European Union which will adopt the common currency in the future. According to previous researches, the pass-through differentiates significantly among European Union countries; our results may be therefore useful for economies similar to Slovakia.

Another aspect of this thesis which is rather rare is the differentiation among banks. We attempt not only to examine the pass-through for the banking sector as a whole, but also to examine how the individual bank characteristics affect the spread of the individual commercial bank. Our results may be very useful for policymakers in Slovakia whom could therefore take into consideration the characterisitcs of banks when shaping their monetary policies.

Based on previous studies we presume that the pass-through is incomplete in short term but increases in long term. That means that any change to the money market rate should be reflected in the retail bank rate, but it takes time for the shock to be reflected to greater extent.

Secondly, we suppose that the speed of interest rate adjustment increases with the adoption of common currency, despite the financial crisis. Previous studies conclude adverse effects of these phenomenos; we therefore attempt to shed light on the issue.

Thirdly, concerning the differentiation among banks, we hypothesize that the pass-through becomes homogenous across banks only in long term. Further we presume

that higher credit risk, lower liquidity and smaller size increase the bank's vulnerability to money market shocks and therefore increase the bank's individual risk premium – spread above the money market rate.

In order to confirm our hypothesis, we apply error-correction framework. Error-correction models are very useful in situations when we are interested in both short term and long term relationship between multiple time series and also in the speed at which the explained variable returns to equilibrium after a deviation has occurred.

We also use pooled ordinary least squares, fixed effects and random effects panel estimators. The latter are used to differentiate among individual bank characterstics' impact on spread.

The methodology outlined above is applied on data collected by the National Bank of Slovakia but also on new datasets created for the purpose of this thesis by the author. For various reasons, we divide our study into two time periods; 2004 to 2008 and 2009 to 2013. This allows us to compare the pass-through process prior and after the adoption of Euro as well as prior and after the crisis hit Slovakia.

The paper is structured as follows. In section 2 we review the existing literature concerning the interest rate pass-through and we outline our contribution. In section 3 we provide a short overview of monetary policy transmission mechanism and Slovakian banking sector in order to provide context for our research. The fourth section describes the data and the process of its collection. In section 5 we explain in detail our methodology. The results are presented in the section 6. Finally, the section 7 concludes our findings. We also propose directions for future research in this section.

2. Literature review

The question of how monetary policy reflects itself into economy is a very important one and is a basis of many papers. Concerning the interest rate channel, the work of Cottarelli and Kourelis (1994) is one of the influential ones. They attempted to provide a measure of lending rate stickiness to money market rates. They have first shown that the stickiness vary across countries and particularly in short run. They have also pioneered the idea of the heterogeneity being connected with the structure of financial system and provided important implications for future monetary policies.

Another cross-country study was performed by Borio and Fritz (1995). Their paper compares the responses of short-term bank lending rates to policy rates in a sample of 12 industrialised countries and seeks to relate them to characteristics of the financial system and of the policy environment. They conclude that the stickiness is dependent on monopoly power of banks, which is in line with later studies. They however rejected the hypothesis of asymmetry in loan rates responses to shocks in money market rates. The phenomenon was later on proven to exist in some individual country level studies.

A very interesting study of pre-crisis interest rate pass-through was performed by Bredin, Fitzpatrick and O Reilly (2001) on an example of Ireland. In line with previous papers, they conclude that the pass-through process is incomplete in short run and the speed varies across different types of lending rates. The most important of their findings however seems to be the fact that the pass-through changed several times during their sample period. They conclude the changes occurred at the same time as significant structural changes of Irish financial system. This finding confirms the ideas of above mentioned Cottarelli and Kourelis (1994).

Angeloni and Ehrmann (2003) observe a structural change in European countries pass-through process related with the transition towards EMU. The authors follow two main questions; has it changed after and because of EMU and, if so, is it becoming homogeneous across countries. The authors concentrate on three blocks of transmission: the banking, interest-rate and asset-market channels. They conclude that the process, before very heterogeneous across countries, became somehow similar in speed and completeness, although not uniform.

As for the region of central Europe, an interesting research was performed by Égert, Crespo-Cuaresma and Reininger (2006). They have studied the interest rate pass-through in five Central and Eastern European countries; the Czech Republic, Hungary, Slovakia, Poland and Slovenia – the CEE-5. Their results are somehow in contrast with previous literature as they do not find cointegration between policy

rates and long term or short term retail rates. They further conclude that the pass-through is decreasing in this region and that it is likely to continue in decreasing. Finally, the authors conclude that the pass-through in CEE-5 is higher than in former Euro-area countries and therefore that adoption of common currency by those five countries would not aggravate the heterogeneity of pass-through within Euro-area. The authors however stress out the limitations of their studies, rightfully so, since they are later found to be imprecise for example by Horvath and Podpiera (2009).

There were a considerable number of studies of the interest rate pass through in the recent years, since the monetary policy performance turns out to be essential especially in times of crisis. Individuals, firms and financial entities shape their investment, savings and consumption decisions with respect to deposit and lending rates. It is of great importance to know how fast and at what degree retail rates adjust to policy rates.

Illes and Lombardi (2013) are examining the pass-through since and during the financial crisis on a panel of interest rates from five Euro-area developed economies and USA. The examined period covers both pre-crisis and post-crisis pass-through. Illes and Lombardi use cointegration framework to find out that the policy of near zero policy rates reflects itself into retail interest rates, but only to limited extent. As an explanation, they propose the fact that financial intermediaries require a higher premium for risk during crisis. They also find out significant heterogeneity in Euro-area. Apparently, countries at the periphery face higher retail interest rates although the policy rates are common for every member of the Euro-area. This is a true challenge for common monetary policy.

With regard on the focus of this study, we should certainly mention Gabe De Bondt (2005), who also examines the interest rate pass-through process in Euro-area. In addition, he distinguishes between short-term and long-term responses of retail bank rates to shocks in money markets. First time, the pass-through is being examined by more than one empirical method. De Bondt uses the error-correction framework. As of, this work becomes a basis of our hypotheses. De Bondt finds out that the interest rate pass-through is higher in long term and fuller for lending rates than for deposit rates. The immediate pass-through is found out to be, at highest, around 50%. In long term, the pass-through completion, especially for lending rates, approaches 100%. De Bondt also concludes that the pass-through process becomes quicker after the adoption of common currency. He proposes three explanations to this phenomenon; increase in competition between commercial banks, more elastic demand for bank products or decrease in switching and asymmetric information costs after the completion of common currency adoption.

Sørensen and Werner (2006) further confirm the conclusions of DeBondt on the Euro-area level but find a significant heterogeneity in pass-through speed and completion across Euro-area countries. Their conclusions encourage our objective to examine the pass-through on an individual country level. Sørensen and Werner provide different levels of competition as an explanation to the heterogeneity. Since the European banking market is not being integrated yet, this seems like a plausible hypothesis.

As the heterogeneity between countries is significant, researchers turned their focus on individual country level pass-through. Mier-y-Teran (2012) comes to the similar conclusion as Sørensen and Werner when examining the pass-through process in Mexico. He further discovered an asymmetry in the interest rate pass-through; lending rates adjust less in case of monetary policy easing and more in case of tightening. This work continues the research of Cas, Carrión-Menéndez and Frantischek (2011) who attempted to examine the pass-through in Central American countries and concluded that bank concentration is negatively correlated with pass-through completion.

The closest to our objective is the work of Horvath and Podpiera (2009) who attempt to address the bank heterogeneity based on micro level data from the Czech Republic. They use a panel of individual bank level interest rates and financial information about the banks to examine the differences in pass-through between individual banks. In contrast to other papers in this stream of literature, Horvath and Podpiera not only introduce bank heterogeneity via a bank dummy, but they use so-called heterogeneous panel data estimators. Based on their results, they conclude that the pass-through is heterogeneous between banks in short-term but becomes homogenous in long term. Retail interest rates are also found to adapt rather fast to money market rates, but often not fully, even in long run. They further found out that large banks do not benefit from their competitive position in pricing their products. From the point of view of bank characteristics, it is credit risk and stability of deposits pool which influence the pass-through the most. The banks more dependent on deposits smooth their interest rates and tend to require a higher spread for it.

In relation to the crisis, Horvath and Podpiera found out that the speed of pass-through decreased and the heterogeneity between banks increased as the crisis hit Euro-area in 2008-2009.

We attempt to apply the similar approach for Slovakia. The contribution therefore lays in the fact that in case of Slovakia, the adoption of common currency and the financial crisis occur at the same time. De Bondt found out that the pass through-becomes quicker with the adoption of common-currency, while Horvath and Podpiera

conclude that the crisis had an adverse effect. It would be interesting to see which phenomenon has greater impact on the pass-through process. The uniqueness of this situation therefore differentiates this study from others. In case of Slovakia, we have a chance to shed ligh on whether it is the crisis or Euro adoption which has a greater impact on pass-through.

As for Slovakia itself, a brief study was done for a crisis period by Beka (2014). This study however does not differentiate between commercial banks. Beka, who also uses the error-correction framework, concludes that the pass through is fast and almost fully complete.

The expected contribution of our research lies in a uniqueness of Slovakia example; the moment of adoption of unique currency and the beginning of financial crisis occur practically at the same time. The research can be therefore very useful when shaping future monetary policies for similar situations, in other transitive economies or in countries on periphery of European Union which will adopt the Euro in the future.

Also, there is no similar study on Slovakia which covers the crisis period and also differentiates among banks. The results can therefore be very useful for policy makers in Slovakia, so they can shape their policies by taking into consideration the characteristics of banking market.

Of course Slovakia is not the only country adopting Euro close to the crisis period. For example Slovenia did so at the beginning of 2007. Slovenian economy may also be considered comparable to the Slovakian one. Unfortunately there is no study referring to the phenomenon of common currency adoption and its impact on interest rate pass-through. A brief study of Slovenian, Bulgarian and Greek pass-through was performed by Kariagiannis, Panagopoulos and Vlamis (2010). Their results vary across those countries; they therefore conclude there is an asymmetry in monetary transmission process. They interpret this assymetric behavior as a result of different levels of competition, development and liberalization of banking markets. In case of Slovenia, they introduce a very interesting hypothesis of consumer sophistication. According to this theory, the more sophisticated depositors and borrowers are, the more reluctant banks will be to exercise market power to their own benefit. In case of decreasing market rate, this may be also related to the stickiness idea mentioned above – deposit rates are rigid downwards and lending rates are rigid upwards. Since Kariagiannis, Panagopoulos and Vlamis found an assymetric adjustment to money market rate in Slovenia, they conclude that competition and hence sophistication are higher here.

3. Transmission mechanism of monetary policy

The transmission mechanism of monetary policy is a process through which the policymakers' decisions affect the economy. The process is characterized by time lags of uncertain length; it is therefore rather difficult to predict when and how will the decisions affect the economy.

There are however some general patterns applicable in the process based on which we were able to identify the basic channels the mechanism is composed of.

3.1 Interest rate channel

The traditional Keynesian view on the transmission mechanism of monetary policy can be characterized by the following equation:

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

where $M \uparrow$ denotes the expansion monetary policy leading to a decrease in real interest rates $i \downarrow$. The cost of capital decreases and so the investment expenditures increase ($I \uparrow$). This leads to an increase in output $Y \uparrow$.

The scheme applies not only on business investment decisions, but also on households' decisions about their consumption. In that case, I represents housing and consumer durable expenditures.

An important feature of the interest rate channel is that it works with real interest rates, not nominal ones. The fact is important to understand how the channel works if nominal rates are near zero. In the deflationary times, the expansion in monetary policy $M \uparrow$ raises the expected price level $P^e \uparrow$ and therefore the expected inflation $\pi^e \uparrow$. Thereby, the real interest rate decreases ($i \downarrow$), even in the nominal rates are near zero.

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

There is, however, a key objection to the Keynesian view on monetary policy transmission; that the ISLM model takes into account only one asset price – the interest rate. With the growing international markets, there are two other channels that require attention – exchange rate channel and equity channel.

3.2 Exchange rate channel

The exchange rate is the relative price of domestic and foreign money, so it depends on both domestic and foreign monetary conditions. The precise impact on exchange rates of an official rate change is uncertain, as it will depend on expectations about domestic and foreign interest rates and inflation, which may themselves be affected by a policy change. However, other things being equal, an unexpected rise in the official rate will probably lead to an immediate appreciation of the domestic currency in foreign exchange markets, and vice versa for a similar rate fall. (Bank of England, 1999)

This channel also involves interest rate effects because when domestic real interest rates fall, domestic currency deposits become less attractive relative to deposits denominated in foreign currencies, leading to a fall in value of domestic currency deposits relative to other currencies deposits, that is, a depreciation of domestic currency ($E \downarrow$). The depreciation then causes a rise in net exports ($NX \uparrow$) and hence a rise in output.

$$M \uparrow \Rightarrow i \downarrow \Rightarrow E \downarrow \Rightarrow NX \uparrow \Rightarrow Y \uparrow$$

3.3 Equity price channels

There are two channels involving equity prices which need to be stated – Tobin's q theory on investments (Tobin, 1969) and wealth effect on consumption.

Tobin introduces a q variable which equals to the market value of a company divided by the costs necessary to replace capital. If q is high, new equipment and plant is cheap relative to the market value of a company. The investment will therefore increase – firms are able to invest with only a small number of shares issued. Contrarily, if the q is low, the market value of a company is small relative to the cost of replacement of capital. The investment is then also low.

The bottom line is that there is a link between q and the investment spending. The Keynesians then come with a conclusion that a fall in interest rates makes bonds less attractive than equity and therefore increases shares prices. Combining these two effect gives:

$$M \uparrow \Rightarrow P_E \uparrow \Rightarrow q \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow$$

An alternative to the Tobin's theory is in wealth effect on consumption (Modigliani, 1971). According to the theory, consumption is determined by the life wealth of an individual. One of the components of the lifetime wealth is also the financial wealth.

When equity prices increase, the wealth also increases. That leads to an increase in consumption and to the higher aggregate output.

$$M \uparrow \Rightarrow P_E \uparrow \Rightarrow wealth \uparrow \Rightarrow consumption \uparrow \Rightarrow Y \uparrow$$

3.4 Credit channels

Dissatisfaction with the fact that the traditional channels ignore the asymmetry of information distribution, two new major channels have arisen.

The bank lending channel, which we examine in this thesis, assumes a special role of bank as an institution providing access to credit markets to those borrowers, whom could not borrow elsewhere. That means there is no perfect sustainability of bank deposits with other sources of funds. In this case, the channel works as follows:

$$M \uparrow \Rightarrow bank\ deposits \uparrow \Rightarrow bank\ loans \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow$$

Expansionary monetary policy leads to an increase in deposits, and therefore to an increase in loans. Firms (especially small ones) and households, otherwise unable to invest, get a source of funding for their investments. The investments lead to higher output.

There is, however, another point of view on lending. The balance sheet channel assumes that the lower the net worth of a firm, the higher is the adverse selection and the moral hazard in lending to this firm. Lower net worth means less collateral and higher risk of lending to this firm, and vice versa. Formally, the channel works as described below:

$$M \uparrow \Rightarrow P_E \Rightarrow adverse\ selection\ \&\ moral\ hazard \downarrow \Rightarrow lending \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow$$

This channel is especially important in countries where it is more common to invest on the financial markets even for smaller subjects (i.e. USA).

3.5 Monetary policy administration

It is usually the central bank which controls the monetary base; its liabilities include both currency and bank reserves. Hence, the monetary policy administration usually begins when the central bank changes the monetary base through an open market operation, purchasing other securities—most frequently, government bonds—to increase the monetary base or selling securities to decrease the monetary base.

The key assumption for these actions to have any effect on the economy is that there is no other entity that has the ability to offset them exactly by changing the quantity or the composition of its own liabilities. This assumption holds if, for example, no

other agent has right to issue debt with characteristics similar to those of central bank's liabilities. (Ireland, 2005)

A central bank has usually a variety of tools available in order to administrate the monetary policy:

Reserves requirement – the central bank may require commercial banks to hold a fraction of their liabilities, usually clients' deposits. These reserves limit the amount of loans commercial banks are able to offer to the domestic economy and therefore limit the supply of money. This of course works only under an assumption that commercial banks hold a stable relationship between collected deposits and offered loans.

Open market operations – the central bank purchases and sells securities to both financial and non-financial entities. This may include a wide variety of securities – treasury bills, selling bonds on behalf of state, etc. When the bank sells securities it increases money supply and when it purchases them back, the money supply decreases.

Lending – the central bank may provide lending to commercial banks and hence affect the monetary base.

Interest rates – the central bank usually announces a set of base interest rates. These are the rates at which for example a loan is offered to commercial banks. Then it is also a rate at which the central bank will hold minimum required reserves. These interest rates also reflect the actual development of economy.

Supervision over banking sector – the central bank supervises the local banking sector. It may set requirements, regulations and guidelines for commercial banks to follow. In this way, the central bank affects the banking environment and hence the economy.

Exchange rate – in case the country has its own currency and trades with other countries with different currencies, exchange rate may be a very powerful tool available to affect the economy. The central bank affects the money supply by either purchasing or selling foreign currency – expanding or tightening its foreign currency reserves.

3.6 Slovakian banking sector and the crisis

The recent global crisis has its origins on financial markets, mainly in USA. Factors causing it were mostly moral hazard during lending, tendency of households to indebt themselves, speculation, overly complicated financial derivatives and missing regulation. Globally, banking sector was therefore the first one to be hit.

The financial crisis however did not remain isolated in the banking sector. Through negative expectations and therefore smaller consumer demand it spreaded into the real economy. This economic crisis then affected the majority of countries lowering economic activity, increasing unemployment and rising insolvency of both households and firms. Increasing credit risk furthermore deepened the problems of banking sector.

The magnitude of the first hit by financial crisis is highly correlated with bank's involvement in trading with toxic securities. Slovakian banking sector, not being involved in such trading, was hit only marginally. This can be observed on various indicatiors: high and stable profits, increasing volume of loans and deposits.

Table 1: Profitability of banking sector before crisis

in billions of EUR	**2004**	**2005**	**2006**	**2007**	**2008**
Yearly profit of banking sector	0,41	0,46	0,59	0,58	0,55
Volume of loans	11,60	14,10	17,50	21,00	24,80
Volume of deposits	24,90	23,50	26,40	30,00	35,20

Source: National Bank of Slovakia

The positive development on the Slovakian banking sector was caused by various factors such as the strong growth of local economy, historically prudential lending policy of Slovakian banks or low international integration. These factors led to lower exposition to risks from toxic securities.

The stability of Slovakian banking sector was also reflected in consistent liquidity position of retail banks. The National Bank of Slovakia did not need to exercise any refinancing repo operations (central bank purchases a security from a retail bank and then sells it back to the bank – this operation is udes to boost liquidity). Retail banks could use both the refinancing repo operations and treasury bills, but there was no need for any of them (Institute for Financial Policy, 2009).

The Slovakian banks, however, could not avoid being affected by the consequences of financial crisis – the economic crisis. The growth rate of Slovakian economy decreased as well as borrowers' ability to repay their obligations.

Both of these phenomenos reflected themselves in an increased volume of non-performing loans, provisons of these loans and hence in decreased profits.

Net provisons on non-performing loans amounted for 236 million Euros for the first seven moths of 2009. Comparing to 89 million for the same amount of time in 2008 and 41 million in 2007, the sharp increase in non-performing loans is rather evident (Institute for Financial Policy, 2009). The need of provisions creation directly reflects the deteriorating economic situation in Slovakia. The increase of provision is the main cause of decreasing net profits in banking sector. Overall, it decreased by approximately 50% in 2009 when compared to the previous year.

Also the relative portion of non-performing loans on total volume of loans increased. While in 2008, and also in previous years, the portion of such loans was oscilating around 2,9%, in 2009 it was already 4%. This naturally led to further increase in banks' prudence when providing loans.

In case of Slovakia, it did not mean that banks were borrowing less. The growth in loans provision however stopped and the banks were only lending as much as the existing borrowers were repaying. The measure was aimed to fix and stabilize the portion of non-performing loans (Institute for Financial Policy, 2009).

The abortion of loans provision volume growth was not however caused solely by banks' prudence. The uncertainity about future economic performance also reflected itself in firms' willingness to invest and hence to borrow money. On the other hand households, uncertain about employment, reconsidered their consumption and property purchases.

Despite the decrease in demand for loans and the increase in banks' prudence, Slovakian banking sector remained stable throughout the crisis. Unlike in many other European countries, Slovakian banks did not require sanitation from state.

On the other hand, Slovakian government decided to encourage households' consumption and also to support lending to small and medium companies. Therefore Slovakia fought the economic crisis rather than the financial one.

The most important measures taken by the government was for example a capital increase of Slovak guarantee and development bank allowing the bank to provide lending to small and medium firms. Then the government attempted to lower administration costs of such firms, facilitate a start of a new company or encourage the export of local goods and services.

On the households' consumption site, the main measure taken were the allowances for buying a new car – since automotive is the main industry in Slovakia.

3.7 Monetary policy and the Euro adoption

As of 1 January 2009, NBS is a part of Eurosystem. The Eurosystem comprises the European Central Bank and the national central banks of countries that have adopted the Euro.

On the other hand, the European System of Central Banks (ESCB) comprises the ECB and national central banks of all EU Member States irrespective of whether or not they have adopted euro. Besides the euro area countries, the ESCB includes also the national central banks of countries with special opt-outs from euro area membership (Denmark and United Kingdom) and countries with derogation from euro area membership (Bulgaria, Czech Republic, Croatia, Hungary, Poland, Romania and Sweden). EU countries with special opt-outs or a derogation from euro area membership still have their own national currency, conduct their own monetary policy and their central banks have so far retained independence in monetary policy matters.

The legal basis for the single monetary policy of the euro area is the Treaty establishing the European Union and the Statute of the European System of Central Banks and of the European Central Bank. The primary objective of the ECB's monetary policy is to maintain price stability. The ECB aims at inflation rates of below, but close to, 2% over the medium term.

The ECB is responsible for prudential supervision of credit institutions located in the Euro-area and participating non-euro area member states, within the single supervisory mechanism, which also comprises the national competent authorities. It contributes to the safety of the banking system and the stability of the financial system within the EU and each participating member state.

The main decision making body of ECB is the Governing council. It consists of six members of the Executive board and of the governors of national central banks. The Executive board consists of the president of ECB, the vice-president and four other members.

While the decision making about monetary policy, including decisions about key interest rates, was left on the ECB, national central banks have other tasks. First it is the execution of monetary policy and hence the management of foreign reserves and minimum reserves from retail banks.

The responsabilities of national central banks then also comprise the oversight of financial market infrastructures and payment instruments. Also the NBS oversees the

Slovakian banking and financial sector. Central banks often also need to operate local payment systems.

National central banks then supervise over management and operations with cash. They cooperate with ECB in terms of new coins and new banknotes issuance.

Least but not last, the national central banks collect, evaluate and report all kinds of statistics to the ECB. It is somehow complicated to cooperate in such a heterogenous and large one-currency area, therefore data collection and reporting is left on local central banks.

It is important mentioning that the Slovakian monetary policy, performed before 2009 by the National Bank of Slovakia, aimed to converge towards the common Euro-area policy long before the actual common currency adoption. This fact naturally reflected itself into interest rates administration.

The set of criteria required to fulfill prior to the adoption of Euro is known as Maastrich criteria. Complience to these requirements aims to faciliate convergence of the national economy towards the conditions of Euro-area.

First, the objective of sustainable low inflation has to be incorporated into the inflation target of central bank. Maastricht criteria require inflation of no more than 1,5 percentage points above the average rate of the three EU member states with the lowest inflation over the previous year. The NBS approached this requirement by setting explicit inflation targets. These targets were announced explicitly in order to navigate the economy towards the set values.

In May 2004, the inflation in Slovakia amounted to 8,9 %. The Maastricht criteria required Slovakia to push the inflation below 3,2 % by 2008. The actual value amounted to 2,2 % in May 2008. The NBS managed to administrate the inflation close or below to the convergence criterium for 20 months before the adoption of Euro.

Secondly, the national budged deficit needs to be at or below 3 % of gross domestic product. Although many Euro-area countries do not actually fulfill the criteria themselves, new entrants are required to reduce in a sustainable and credible way the general government deficit.

Slovakian govenemnt and public bodies managed their budget with a deficit of 3,5 % in 2004. At the end of 2007, it did not seem Slovakia will be able to fulfill this criterium since the deficit amounted to 3,7 %. But the government managed to push it on 2,2 % by May 2008 and this criterium was also fulfilled.

The third requirement is about national public debt not exceeding 60 percent of gross domestic product. A country with a higher level of debt can still adopt the euro provided its debt level is falling steadily. This requirement seems crucial especially after the common realization of how important the public debt was for European countries during economic crisis. A great number of European economies did not maintain their debt on a sustainable level which led the region into a new debt crisis.

By May 2004, Slovakian public debt amounted to 42,8 % of GDP. Although well below the required value of 60 %, the government continued in lowering it to the amount of 29,4 % in May 2008.

The fourth criterium requires long-term interest rates to be no more than two percentage points above the rate in the three EU countries with the lowest inflation over the previous year. This requirement is especially important in context of this thesis. Slovakia was fulfilling the criterium continuously in period of 2004 to 2009.

Finally, the national currency – Slovenska koruna was required to enter the ERM 2 exchange rate mechanism two years prior to entry. In ERM 2, the exchange rate of a non-Euro-area member state is fixed against the Euro and is only allowed to fluctuate within set limits. A central exchange rate between the euro and the country's currency is agreed. The currency is then allowed to fluctuate by up to 15 % above or below this central rate. In Euro-area, instead of currency appreciation or depreciation, countries need to use budgetary and structural policies to manage their economies prudently. ERM 2 mimics these conditions thereby helping non-Euro-area states to prepare for them.

Slovenska koruna joined ERM 2 on 28 November 2005 and observed a central rate of 38.4550 to the euro until 19 March 2007 when it was revalued to 35.4424. On 29 May 2008, it was again revalued to 30.1260. The koruna left ERM 2 when the country adopted the Euro on 1 January 2009.

We included the list of Maastrich criteria here in order to underline what were the consequences of Euro adoption and crisis hitting Slovakia at the same time. The country’s economy was somehow in great condition because it was required by Maastricht criteria. We may only hypothesize how much it helped with the arrival of economic crisis. But low public indebtness, low deficit and low inflation are certainly desirable in difficult economic times.

4. Data

We have decided to perform the analysis of pass-through of money markets rates to retail rates over the period which starts in January 2004 and ends in December 2013. This period covers the two events important for our research – financial crisis and the adoption of Euro. Slovakia adopted the common currency as of 1st January 2009, which is in the middle of our sample period. This allows us to compare the pass-through prior and after the adoption of Euro.

The source of our data is mostly the database of the National Bank of Slovakia (NBS), which provides time series of monthly weighted averages of interest rates on loans and deposits, and also time series of monthly averages of BRIBOR and EURIBOR rates. In case of loans and deposits, the weights are the volumes of money lent or deposited with a specific interest rate.

In order to follow in detail the methodology applied by Horvath and Podpiera, we should use the median of bank interest rates instead of their weighted average. Since we do not have access to the individual bank level data, this is impossible for us. Our approach is however in line with the majority of previous interest rate pass-through related papers. Horvath and Podpiera are in fact the first to use median.

Table 2 : Number of banks in Slovakia

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Central bank	1	1	1	1	1	1	1	1	1	1
Commercial banks without foreign capital	2	2	2	1	2	2	2	2	2	2
Commercial banks with foreign capital	16	16	15	15	15	13	13	12	12	11
Branches of foreign banks	3	5	7	10	9	11	14	17	14	15
Total (including central bank)	22	24	25	27	27	27	30	32	29	29

Source: National Bank of Slovakia

Over the sample period, the number of commercial banks providing their services in Slovakia changed several times. The number has, however, an upward trend. It increases from 21 at the beginning of 2004 to 28 at the end of 2013. For the detailed evolution in banks number in Slovakia, please see the table 2.

As for retail rates, we have decided to analyze new mortgages to households and new loans to non-financial entities (in line with Horvath and Podpiera, 2009). From the

deposits point of view, we analyze new deposits of households and new deposits of non-financial entities.

The National Bank of Slovakia, following an EU regulation, distinguishes between various maturities and amounts in its database. We have decided to follow this distinction and therefore to run our regressions separately for these categories:

Loans:

- New mortgages to households, fixation of interest rate 1Y – 5Y
- New mortgages to households, fixation of interest rate 5Y – 10Y
- New mortgages to households, fixation of interest rate >10Y
- New loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y
- New loans to non-financial entities, amount <1M EUR, fixation of interest rate >5Y
- New loans to non-financial entities, amount >1M EUR, fixation of interest rate 1Y – 5Y
- New loans to non-financial entities, amount >1M EUR, fixation of interest rate >5Y

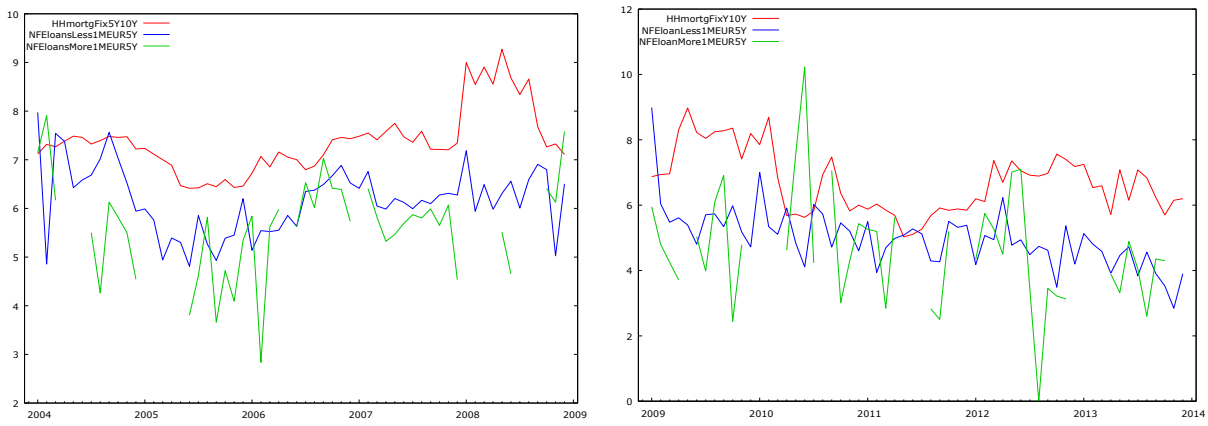
Deposits:

- New deposits of households, due immediately
- New deposits of households, maturity <1Y
- New deposits of households, maturity 1Y – 2Y
- New deposits of households, maturity >2Y
- New deposits of non-financial entities, due immediately
- New deposits of non-financial entities, maturity <1Y
- New deposits of non-financial entities, maturity 1Y – 2Y
- New deposits of non-financial entities, maturity >2Y

For various reasons, we have decided to run the regressions separately for 2004 – 2008 and 2009 – 2013 periods. Firstly, the NBS database is also divided into these two periods. Secondly, we will be able to compare our results prior, and after the

adoption of Euro. Thirdly, with the adoption of common currency, we have to switch from BRIBOR (Bratislava Interbank Offered Rate) to EURIBOR (Euro Interbank Offered Rate) as the money market variable.

Figure 1: Plot of selected interest rates

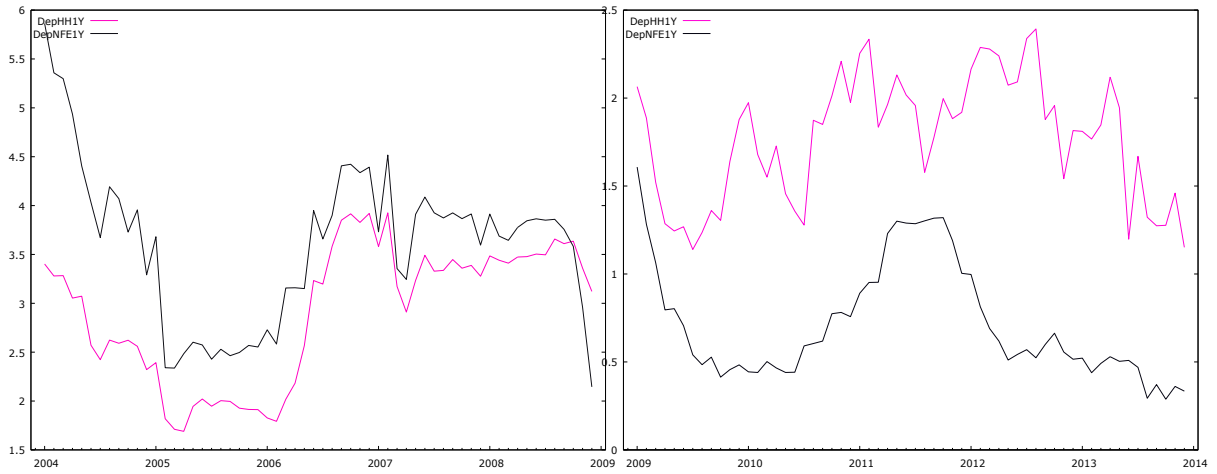


Source: Author's estimation

For illustration of loans interest rates, we provide a plot of selected interest rates in the figure 1. The red line represents new mortgages to households with fixation of interest rate from 5 years to 10 years, the blue line visualizes new loans to non-financial entities of amount inferior to 1 million EUR with fixation of interest rate more than 5 years and the green line represents new loans to non-financial entities of amount superior to 1 million EUR with fixation of interest rate more than 5 years. Interest rates for mortgages to households seem to be higher than interest rates to non-financial entities. This is in line with an assumption where loans to households are in average more risky than the loans to firms. We can also examine the fact that the interest rates to firms differ when taking into account the volume of the loan. Bigger loans have also lower interest rates – this may be because bigger loans are only accorded to reliable clients or because there is a smaller demand for these loans and the banks have to decrease their spread in order to remain competitive on the market.

The deposits, illustrated in fugure 2, show a very interesting behavior.

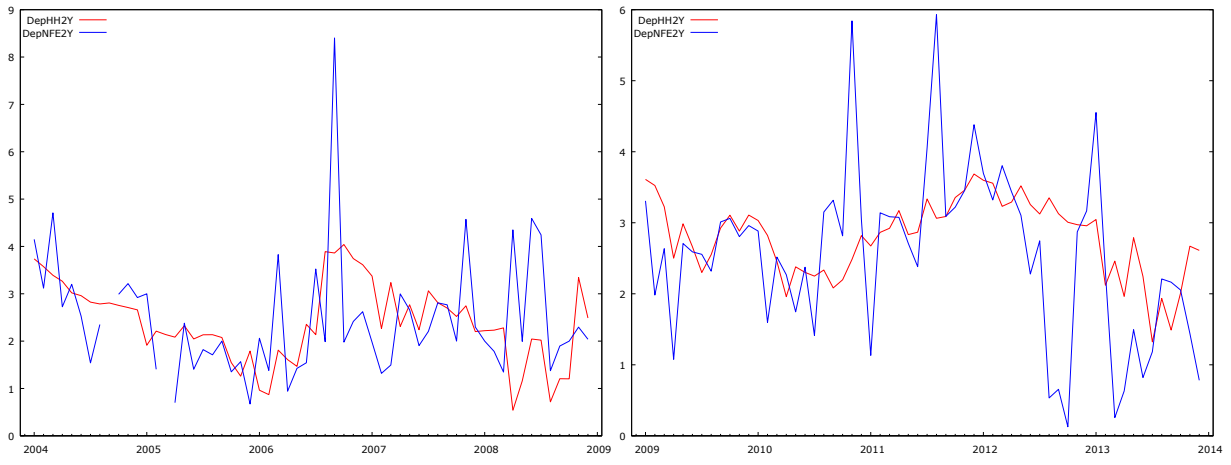
Figure 2 : Deposits to households and non-financial entities with maturity <1Y



Source: Author's estimation

The violet line represents new deposits of households with maturity shorter than one year and the black line visualizes new deposits of non-financial entities with maturity shorter than one year. In the period 2004-2008, firms benefit from higher interest rates on their deposits than households. At the end of 2008, the situation however turns and in the period 2009 – 2013, households deposit their resources with higher interest rates than non-financial entities. When thinking about explanation, we have to keep in mind the maturity of the deposits. Before 2009, the volume of deposits due immediately was significantly higher than the volume of deposits with maturity. In order to lower the risk, it is preferable for banks to have higher portion of clients' funds deposited with fixed maturity. They therefore try to keep the interest rate interesting enough for entities to deposit their resources for longer term. This specific

Figure 3 : Deposits to households and non-financial entities with maturity >2Y



Source: Author's estimation

maturity (less than 1 year) is in the first place intended for households. We may plot the deposits with longer maturity to see if the effect persists. See figure 3 for for the plot.

The red line represents here new deposits of households with maturity longer than 2 years and the blue line shows new deposits of non-financial entities with maturity longer than 2 years. We can see that interest rates to households are much smoother than to firms, we however cannot say that households benefit from higher rates than firms.

As for the money market rate, we always choose the one with the highest correlation with the given retail interest rate time series (in line with de Bondt, 2005). We tested the correlation of the money market rates listed below (W stands for week, M for month and Y for year):

BRIBOR: O/N, 1W, 2W, 1M, 2M, 3M, 6M, 9M, 1Y

EURIBOR: 1W, 2W, 3W, 1M, 2M, 3M, 4M, 5M, 6M, 7M, 8M, 9M, 10M, 11M, 1Y

Please find the correlation analysis in the appendix.

What differentiate the above mentioned rates are the maturities they indicate and the spread lending rates have above them. The fact that lending spreads increase or decrease does not indicate that interest rate pass-through as such changed. Illes and Lombardi (2013) attempt to decompose the lending spread into three components in order to assess factors affecting the transmission mechanism.

Each of these components represents a different aspect of risk.

$$r_l - r_p = (r_l - r_g) + (r_g - r_b) + (r_b - r_p)$$

In the equation above r_l respresent the lending and r_p represents the policy rate. Moving from the right, the brackets then indicate the three components of the lending spread.

First is the spread between policy rate and the overnight interbank rate. The interbank money market is believed to be the primary channel for the implementation of monetary policy. Therefore the two rates should be very close to each other. Any spread indicates the presence and aslo the magnitude of credit or liquidity risk linked with lending to banks.

The second component is a spread between one year government bond and the overnight interbank rate. Since the maturity mismatch is present, this component includes a term premium as well as a measure of credit risk linked to lending to government. This component could be negative in case lending to government is considered free of credit risk and in case the term premium is very low.

Finally, the third component captures the spread between one year government bond interest rate and the lending rate. The component captures the credit risk on entrepreneurial activities and the willingness of the bank to take on this risk. This component can be modified by individual financial intermediaries – mostly commercial banks.

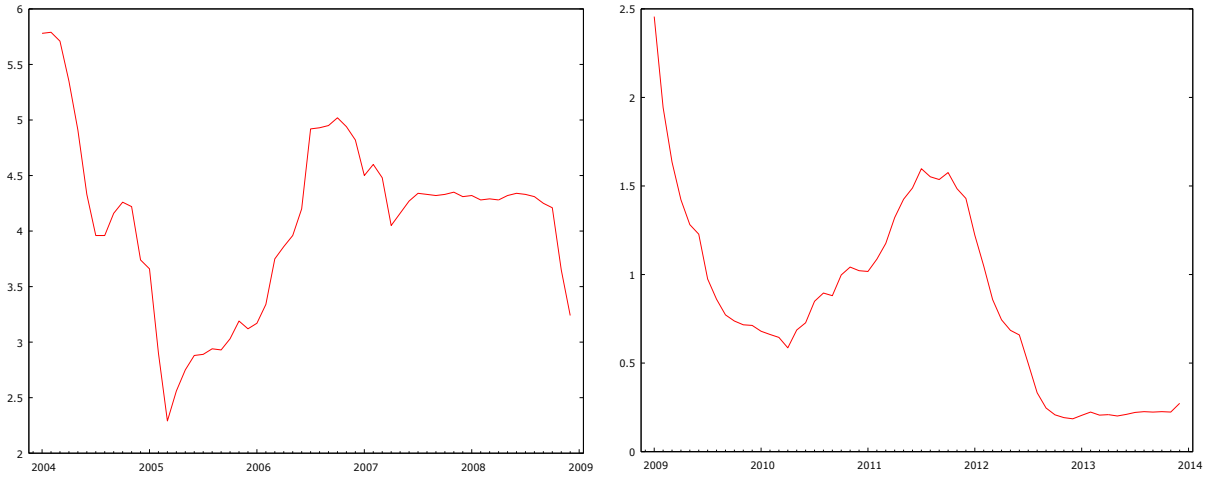
Illes and Lombardi (2013) provide a very interesting decomposition of these components. They conclude that in times of economic downturn, financial intermediaries tend to increase their respective component. Since credit risk increases, banks also need to increase their risk premium. On the other hand, banks need to remain competitive also in times of economic crisis. The decision making about spread is therefore also linked to the local market concentration.

An interesting relationship was discovered concerning government bond component. During financial and economic crisis, this component increased in case of Spain or Italy; countries with high public debt. On the other hands, components of safe heavens such as USA or Germany experienced downward pressure. This was reflected in a negative contribution to the lending spread.

We leave the decomposition of the spread in Slovakia for further research. We should however recall that Slovakia was obliged to fulfill Maastrich criteria for Euro adoption just before the economic crisis hit Euro-area. This means that inflation, public debt and public budged deficit were low. This may indicate that the government bond component did follow rather the path of Germany, not the one of Spain or Italy.

We plot below the 3 month BRIBOR in period 2004 - 2008 and the 3M EURIBOR in period 2009 – 2013 to demonstrate how the interest rates were administrated to decrease since the financial crisis hit Euro-area.

Figure 4 : 3M BRIBOR and 3M EURIBOR



Source: Author's estimation

We cannot interpret this figure equally for the BRIBOR and for the EURIBOR. The Bratislava rate contains a country specific spread which makes it higher than the EURIBOR. However, the trend is very well visible in both periods. After 2008, there is a sharp decline in rates. Although the EURIBOR rises back by approximately 0.5% in 2011 – 2012 period, this growth is again followed by a rather sharp decline to near-zero values.

Concerning the differentiation among banks, the data collection was rather challenging. The National Bank of Slovakia, as a supervisor over commercial banks, collects detailed financial information about banks, but does not share them publically (in line with EU regulations). Although we tried to find a way to work with the data with the representatives of the NBS; via anonymization of data or via cooperation with the central bank, we were unable to find a compromise.

We also addressed the Slovakian assiociation of Banks and all of the commercial banks in Slovakia individually, but a great majority of them refused to provide any historical financial information.

Then, we tried to collect the data from the annual reports of the banks. The data provided here however covers only a small period of time and banks are heterogeneous in methodology of data reporting.

We have therefore decided to use Bankscope database as a source of financial information. With regard on homogeneity of data reporting, it seems like the most suitable solution. As for the bank specific interest rates, we collected them from banks' websites. Since not all of the banks provide an archive of their interest rates, the data set is rather limited.

In line with Horvath and Podpiera (2009), we focus on liquidity, capital adequacy, size, deposits, efficiency and credit risk ratios.

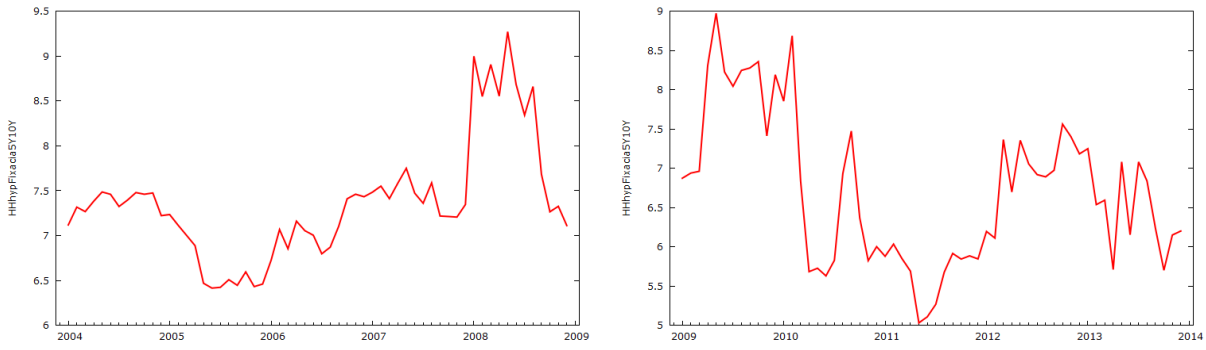
The data collection was challenging especially for deposits interest rates. The banks use a wide variety of deposits products. We were not able to identify volumes of deposits under each of them and it is therefore impossible to come with a single weighted interest rate based solely on data available on banks' websites. We have therefore decided to differentiate among banks only in terms of loans. We have used banks' basis interest rates for mortgages with a five year fixation of interest rate, as this type of mortgage was most frequently available. In order to come with a bank specific spread, we first searched for a money-market rate the most correlated with this type of bank product (see correlation matrix in the appendix) and then sustracted its value for the given month from the bank-specific interest rate value.

Due to the low availability of bank specific interest rates, our dataset is limited on four banks and period of June 2009 to December 2013. Also, the resulting panel dataset is considerably unbalanced and we therefore have to treat them as such further in our testing.

4.1 Non-stationarity and cointegration of data

In order to be able to use the error correction model, we first have to make sure our time series truly are non-stationary. For us to be able to choose correct characteristics for our test, we first plot the time series of interest rates. In the figure 5 is the plot of new mortgages to households with fixation of interest rate from 5 to 10 years.

Figure 5 : New mortgages to households with fixation of interest rate 5Y – 10Y



Source: Author's estimation

We use the Augmented Dickey-Fuller test to verify if the data is truly non-stationary. The test sets non-stationarity as its null hypothesis. Since it seems like the interest rate has an upward trend in 2004 – 2009 period and then a downward trend in 2009 – 2014 period, we test for both *constant* and *constant and trend* being present in our time series to make sure our results are not biased. If the p-value is greater than our chosen level of significance, the data is non-stationary. Please find the p-values of the test for all of the included variables in the appendix. The results suggest that the assumption about non-stationarity is safe to be made.

We also ran the KPSS test for selected variables to confirm our results. The test sets stationarity as its null hypothesis. We reject it if the critical value is greater than the test statistic. Please find the results in the appendix as well. Although the KPSS does not give such convincing results as the Augmented Dickey-Fuller test, in majority of cases, it refuses the null hypothesis of stationarity at 99% confidence level.

The other important future of the time series is their cointegration. In order to be able to use the error correction model, we test for it using two-step Engle-Granger test for cointegration. The first part of the test was already described above – we made sure that the null hypothesis of the Augmented Dickey-Fuller test for the individual time series is not rejected, they are therefore non-stationary. The second step is to run an OLS on the variables, save residuals of this regression and then run the Augmented Dickey-Fuller test on these residuals. In order to be able to conclude that the variables

are cointegrated, the residuals should be stationary – we need to reject the null hypothesis. We ran the ordinary least squares eight times; every time we chose one combination of loans to or deposits of households or non-financial firms and the money market rate with the highest correlation. Then, we saved the residuals, made sure they do not content constant or trend, and ran the Augmented Dickey-Fuller test. The results can be found in the appendix. These results of Engle-Granger test suggest our assumption about time series cointegration is right. We might therefore proceed and use the error correction model.

As a robustness check, we also run Johansen test for cointegration. The principle of this test is in eigenvalues. If all the eigenvalues are significantly different from zero, then all the processes are stationary. If, on the contrary, there is at least one zero eigenvalue, then the processes are integrated. On the other hand, if all eigenvalues are zero, no cointegration occurs either. We ran the test for the same pairs of variables as for the Engle-Granger test. The results can also be found in the appendix. Johanson test also sugests that the time series are coointegrated.

5. Methodology

The empirical link between retail interest rates and money market rate is rather straightforward – banks do not only use collected deposits for further lending, but they also borrow on money market for a money market rate to secure their lending. Then they provide loans for their bank lending rate. The difference under those two rates (bank lending rate being higher) is a spread required by the individual commercial bank. The relationship was described by Freixas and Rochet (2008) as follows:

$$br = mr + \mu$$

Where br denotes the bank rate, mr denotes the money market rate and μ denotes the spread. The size of the spread depends on more factors; competition, risk, etc. The money market rate – either the rate at which the bank borrows money on money market or the rate it offers to collect deposits, is a marginal cost for the bank. The very same relationship as described above is presented in the marginal cost pricing model by Rausseas (1985). His idea is that money market rates are the best representing marginal cost prices, because they are accurately reflecting the marginal costs of banks.

In this paper, we are examining whether and how the commercial bank lending or deposit rates are following moves of money market rates. The speed of adjustment and the level of its completeness are the key indicators which help to shape monetary policies. The pass-through may depend on numerous factors, already described in the related literature. The elasticity of demand with respect to interest rates, level of competition and the possibility to invest funds elsewhere then to banks seem to be the key factors influencing both lenders and customers. If the client may choose between numerous banks and financial securities, the pass-through will most certainly be different than if the client has only one institution to put his funds into or to borrow from.

Error correction models are useful for estimating both short term and long term effects of one time series on another. They also directly estimate the speed at which a dependent variable returns to its equilibrium after a shock has occurred in an independent variable. Furthermore, the error correction framework is rather easy to implement since the model can be estimated using ordinary least squares.

Cointegrated time series share a stochastic component and a long term equilibrium relationship. Deviations from this equilibrium relationship as a result of shocks will be corrected over time. We can think of dependent variable as responding to shocks

to explanatory variable over the short and long term. Engle and Granger (1987) suggested an appropriate model for dependent variable, based on two or more time series that are cointegrated. Given a dependent variable Y and and independent variable X; we first obtain an estimate of Z by regressing Y on X. Secondly, we can regress ΔY_t on Z_{t-1} and any relevant short term effects (Best, 2008).

Since we intend to explain both short term and long term effect of money market rates on bank retail rates, we have decided to implement a modified Engle and Granger two-step error correction model originally introduced by Horvath and Podpiera (2009);

$$\Delta br_t = \gamma + \beta_0 \Delta mr_t - \beta_1 (br_{t-1} - \alpha - \beta_2 mr_{t-1}) + \varepsilon_t \qquad (1)$$

The equation (1) captures both short term and long term dynamics of interest rate pass-through; the long term pass-through is captured by coefficient β_2, short term dynamics is captured by coefficient β_0 and β_1 stands for the speed of adjustment.

β_2 estimates the long term effect that a one unit increase in market rate has on a bank rate. This long term effect will be distributed over future time periods according to the rate of error correction β_1 (Best, 2008).

The process of estimation therefore goes as follows. First we run a regression of bank rates on market rates.

$$br_t = \alpha + \beta_2 mr_t + R_t \qquad (2)$$

Then we save the residuals R and add the first lag of it.

Finally we include this first lag of R into a second step of our estimation.

$$\Delta br_t = \alpha + \beta_0 \Delta mr_t - \beta_1 R_{t-1} + \varepsilon_t \qquad (3)$$

As we already mentioned previously, we run the regression always for a couple of one money market rate and one retail bank rate with the highest correlation to it. We do this always for both deposits and loans, both households and firms and for both of testing periods. This leads us to eight estimations of model (1).

For the time span January 2004 – December 2008, as robustness check, we run four additional estimations while replacing BRIBOR with EURIBOR. Since the majority of commercial banks operating in Slovakia is financed by foreign capital or is a branch of a foreign bank (see table 2), estimated relationships should hold also when switching to EURIBOR.

Since the majority of banks operating in Slovakia is financed by foreign capital or is a branch of a foreign bank, it is possible that they might have an option of receiving short-term intercompany loans from their mother or sister companies within Euro-area. Therefore, for the time span January 2004 – December 2008, we include Euro Over-Night Index Average rate (EONIA) into the initial correlation analysis.

In order to be able to differentiate between the amounts of loans to firms, we will also run a separate estimation for loans below and above one million Euros.

In order to compare the speed of adjustment of bank rates to market rates, we employ the mean adjustment lag, originally introduced by Hendry (1995). The mean adjustment lag, calculated as $(\beta_2 - \beta_0)/ -\beta_1$ indicates when the market rate is fully passed through to the bank rate. We employ the methodology in order to effectively compare the speed of adjustment.

A rather challenging approach is employed in order to explain the bank-specific differences of spread above money-market rate. In order to respond to our original question about what bank-specific characteristics influence the spread, we build a new dataset of bank-specific interest rates for mortgage with five year fixation of interest rate. Given the difficulties further described in other parts of this thesis, the dataset is very limited. We were able to build an unbalanced panel-dataset of four banks and time period of 2009 – 2013. The bank specific spread is given on monthly basis.

We employ three different approaches in order to assess the effects of bank characteristics on the spread. First, since the dataset is an unbalanced panel, we estimate it using both random effects and fixed effects. In the random effects approach, the bank-specific effect is a random variable that is uncorrelated with the explanatory variable. This assumption is rather strong one to be made; therefore we also test for fixed effects, where the bank-specific effect is allowed to be correlated with explanatory variables.

Finally, given the small size of the sample, pooled OLS might be a feasible option. We have therefore decided to ignore the panel structure of the data and simply estimate the coefficients using ordinary least squares.

We however do not attempt to make strong conclusions based on any of the above mentioned methods. They should simply help us to assess basic principles and relations between spread and bank characteristics. We put emphasis on pooled OLS and fixed effects when making our conclusions.

We use the three above mentioned methods to estimate the following relationship:

$$spread_{it} = \varphi + \theta_1 Tier_{it} + \theta_2 NetLoans_{it} + \theta_3 Liquid_{it} + \theta_4 Costs_{it} + \theta_5 Assets_{it} + \theta_6 Capital_{it} + \theta_7 Impaired_{it} \quad (4)$$

where $spread_{it}$ stands for the individual spread over money market rate of bank *i* at time *t*. The explanatory variables stand respectively for the Tier 1 ratio (a comparison between bank's equity and total risk-weighted assets), net loans to total assets ratio, ratio of liquid assets over deposits and short term funding of the bank, costs to income ratio, the volume of total assets, capital funds to net loans ratio and impaired loans over gross loans ratio.

The explanatory variables should cover all the bank characteristics we are interested in; capital adequacy, liquidity position, size of the bank, bank's ability to generate income and also financial health of bank's assets.

A positive link between *Tier1, Capital* and spread can be expected according to Ho and Saunders (1981). Their dealership model predicts a positive relationship, as net interest rate margins should increase the capital base as the exposure to risk increases. On the other hand, Brock and Franken (2003) claim that less capitalized banks have the motivation to accept more risk (associated with a higher spread) in order to receive higher returns. More capitalized banks could also invest more cautiously, as there is more capital at risk (Horvath and Podpiera, 2009).

The effect of the size of *Assets* is uncertain. On the one hand, larger banks may exercise market power and charge higher rates. Berger (1995) notes that banks with a large market share may price their products less competitively. On the other hand, the size of a bank may also reflect its efficiency and thus its ability to offer a smaller spread (Claeys and Vander Vennet, 2008).

We include *Costs* in order to assess banks' inefficiency. We examine the hypothesis that there is a positive relationship between costs-to-income ratio and the spread. That would mean that inefficient banks are trying to pass their inefficiency to customers.

As for banks' *Liquidity* and its effect on spread, we presume a negative relationship. A better liquidity position decreases liquidity risk and hence bank's overall risk exposure. This should reflect also in the risk premium bank is charging above money market rate.

Finally, the relationship between the ratio of *Impaired* loans on total loans and the spread is expected to be positive. Higher portion of impaired loans suggests higher exposure to credit risk; the bank is therefore motivated to reflect the exposure into its risk premium.

We should emphasize that in order to examine the determinants of spread in a cross-section of banks; we use values at the end of the years across period. As argued by De Graeve et al. (2007), this is possible because the bank characteristics considered, such as market position, are largely structural and typically do not change substantially over time.

6. Results

The estimated parameters from model (1) are provided below.

Table 3 : Estimation of model (1) for 2004 – 2008 period using BRIBOR

	Households rates	β_2	β_0	β_1
2004 to 2008	Mortgages	0,4746 *** (0,0934)	0,0764 (0,0698)	-0,1332 *** (0,0464)
	Deposits	0,7185 *** (0,0594)	0,3542 *** (0,0945)	-0,2012 *** (0,0706)
	Firms rates	β_2	β_0	β_1
	Loans	0,9123 *** (0,1277)	0,3313 (0,3786)	-0,8545 *** (0,1328)
	Deposits	0,9594 *** (0,0216)	0,9824 *** (0,0454)	-0,8898 *** (0,1284)

Source: Author's estimation

Table 4: Estimation of model (1) for 2009 – 2013 period using EURIBOR

	Households rates	β_2	β_0	β_1
2009 to 2013	Mortgages	0,7966 *** (0,1313)	0,0654 (0,1690)	-0,0619 * (0,0331)
	Deposits	0,5401 *** (0,0875)	0,2561 (0,2197)	-0,1344 ** (0,0645)
	Firms rates	β_2	β_0	β_1
	Loans	0,9034 *** (0,1458)	0,0470 (0,6985)	-0,6215 *** (0,1234)
	Deposits	0,6509 *** (0,0341)	0,5855 *** (0,0746)	-0,1854 ** (0,0786)

Source: Author's estimation

6.1 Completeness of interest rate pass-through

The completeness of interest rate pass-through was estimated using parameters β_0 and β_2. They stand for short term completeness and long term completeness respectively. The results provided in Table 3 and Table 4 suggest our original hypothesis about completeness being higher in long term was correct. The pass through completeness is higher in long term both for households and firms, both for loans and deposits. The phenomenon also persists across timeframes.

The only exception seems to be in deposit rates of firms in 2004 – 2008 period. In this case, the pass-through is already almost complete in short term. It then decreases a little in long term, but still the pass-through is almost fully complete. Both coefficiants are highly significant.

It is interesting to compare the estimates between periods. As for households, it seems that the long term completeness increases after the adoption of Euro (and with financial crisis hitting Euro-area) for borrowing rates, but decreases when looking on deposit rates. This phenomenon seems to be in line with stickiness idea originally introduced by Cottarelli and Kourelis (1994), later developed by Borio and Fritz (1995). With the arrival of financial crisis, banks are motivated to lower interest rates on both loans and deposits. They are however more reluctant to do so in case of deposits, since lowering these rates harms their competitive position.

The short term completeness stays at approximately same levels, the coefficients are however mostly insignificant.

As for non-finencial entities, the long term completeness of pass-through of borrowing rates stays rather high across periods. The pass-through is almost complete in long term, but incomplete in short term. The short term coefficients are again insignificant. The completeness of pass-through shows an interesting behavior when looking at deposit rates. The pass-through, almost complete in both short and long term in 2004 – 2008 period decreases in 2009 – 2013 period. All coefficients are significant. The completeness of pass-through increases only a little when comparing short term and long term coefficient in 2009 – 2013 time span. The phenomenon might be caused by the fact that with the adoption of common currency and with the financial crisis hitting Europe, the banks must be competitive when offering deposit rates. Firms suddenly get a much wider offer of institutions to deposit their resources into, as the domestic currency switched to Euro. Domestic banks, in order to protect these clients, therefore do not follow development of market rates. The development is also in line with the interest rate stickiness mentioned above.

In order to differentiate between the amounts of loans, we run a separate estimation of model (1) for loans to firms below and above one million Euros. We provide the summary of results in Table 5. The hypothesis about completeness being higher in long term again holds, with an exception of loans above one million Euros in 2009 – 2013 period. The short term completeness coefficient here is above 100%, insignificant and with high standard error. This may be caused by the fact that the volume of large loans is much smaller than of small loans. Given the size of Slovakian banking market and the frequency of our data, it is possible that the average monthly interest rate for loans above one million Euros is composed of a small number of loans. Also, the conditions and characteristics of large loans may be very specific.

However, we observe sound differences in pass-through for small and large loans.

Table 5: Estimation of model (1) for loans to firms below and above 1M EUR

	Firms rates	β_2	β_0	β_1
2004 to 2008	Loans below 1M EUR	0,5766 *** (0,0870)	0,3413 (0,2451)	-1,0890 *** (0,1352)
	Loans above 1M EUR	0,9123 *** (0,1277)	0,3313 (0,3786)	-0,8545 *** (0,1328)
	Firms rates	β_2	β_0	β_1
2009 to 2013	Loans below 1M EUR	0,9301 *** (0,1485)	0,1504 (0,6796)	-0,6249 *** (0,1239)
	Loans above 1M EUR	0,7954 ** (0,3372)	2,8349 (1,7620)	-0,7842 *** (0,1290)

Source: Author's estimation

In 2004 – 2008 period, the pass-through is not complete not even in long term for loans under one million Euros. On the other hand, the long term pass-through is almost fully complete for large loans. The situation however turns around for 2009 – 2013 period. Here, the long term pass-through of smaller loans is almost fully complete while the pass-through of large loans is not.

The increase of pass-through completeness on small loans might be related to the increases competitiveness on the market with the adoption of Euro and the arrival of financial crisis. The joint effect of these phenomenons forces commercial banks to lower interest rates and react to changing market environment.

On the other hand, the pass-through completeness of large loans decreased. This might also be explained by the increased competition. Since only a small number of such loans is available on the Slovakian market, commercial banks may offer specific

conditions to their customers, which are not in line with the market development, in order to attract such clients.

For the time span January 2004 – December 2008, as robustness check, we run four additional estimations while replacing BRIBOR with EURIBOR or EONIA, if applicable. Since the majority of commercial banks operating in Slovakia are financed by foreign capital or are a branch of a foreign bank (see Table 2), estimated relationships should hold also when switching to EURIBOR. Find the results of these estimations in the Table 6.

Table 6: Estimation of model (1) for 2004 – 2008 using EURIBOR / EONIA

	Households rates	β_2	β_0	β_1
2004 to 2008	Mortgages	0,6214 *** (0,0881)	0,3717 (0,4107)	-0,4281 *** (0,1099)
	Deposits	0,4449 *** (0,0570)	0,3173 ** (0,1501)	-0,1402 ** (0,0580)
	Firms rates	β_2	β_0	β_1
	Loans	0,5675 *** (0,1317)	0,9366 (0,5807)	-0,5991 *** (0,1162)
	Deposits	0,4590 *** (0,1076)	-0,5112 (0,5027)	-0,5127 *** (0,1107)

Source: Author's estimation

Generally the hypothesis about pass-through being higher in long term holds also if switching to EURIBOR. The exception however comes with loans to non-financial entities where the short term parameter, although insignificant, is higher than the long term beta. This might be caused by the fact that these kinds of loans reflect more the specifics of market and therefore switching to EURIBOR may not work for firms' variables. The fact that the short term parameter for deposits of firms is negative (even after correcting for standard error) may support this idea.

So if we are looking solely on households, the estimates for loans are in line with previous results. Comparing the long term pass-through during 2004 – 2008 and 2009 – 20013, this one slightly increases.

A difference can be found in deposits. While previously concluding that the pass-through declined with the adoption of Euro and the financial crisis, if we look on estimates obtained using EURIBOR, there is a slight increase in pass-through.

When looking at this development, a straightforward logical explanation appears; in 2004 – 2008 period, the commercial banks in Slovakia adjusted their interest rates

with respect to local market conditions. Given that the Slovakian economy is small, open and to a great extent influenced by the economy of Euro-area, the same was done by the National Bank of Slovakia. The interest rates published by NBS reflect EURIBOR and local influences. The pass-through of commercial interest rates is therefore higher when using BRIBOR.

Now if the idea mentioned above works, the same should apply for mortgages, when in fact, it does not. It is interesting to observe that commercial banks react more to local environment when deciding about deposit rates and more to regional environment when deciding about mortgages interest rates.

There might be a simple reason for it. The deposits of households are usually of much shorter maturity than mortgages. A mortgage with maturity in decades should therefore more reflect the regional conditions. Furthemore, in 2004 – 2008, Slovakian banks were already in preparation for the transition towards the common currency. They may therefore intentionally reflect Euro-area performance in their decision about interest rates.

6.2 Speed of adjustment

Coefficient β_1, representing the speed of adjustment, is negative and significant in all of our estimations. This shows there exists a mechanism that brings bank interest rates back to a long-term equilibrium after a shock occurs. Hendry (1995) introduced a mean adjustment lag, calculated as $(\beta_2 - \beta_0)/ -\beta_1$ which indicates when the market rate is fully passed-through to the bank rate. We employ the methodology in order to effectively compare the speed of adjustment.

Find the calculated mean adjustment lags rounded to months in the Table 7 for loans and Table 8 for deposits.

Table 7: Mean adjustment lags for loans

2004 to 2008	Mortgages to households	3 months
	Loans to firms	<1 month
2009 to 2013	Mortgages to households	12 months
	Loans to firms	1 month
2004 to 2008	Loans to firms < 1M EUR	<1 month
	Loans to firms > 1M EUR	<1 month
2009 to 2013	Loans to firms < 1M EUR	1 month
	Loans to firms >1M EUR	n/a

Source: Author's calculation

Table 8: Mean adjustment lags for deposits

2004 to 2008	Deposits of households	2 months
	Deposits of firms	<1 month
2009 to 2013	Deposits of households	2 months
	Deposits of firms	<1 month

Source: Author's calculation

From Table 8 we can see that the adjustment of deposit interest rates is relatively fast, especially for the deposits made by firms. There is no significant change between 2004 – 2008 and 2009 – 2013 periods.

The Table 7 however brings more interesting results. While the adjustment of borrowing rates to firms is fast and consistent throughout periods, the mean adjustment lag for mortgages to household increases from three months to one year. This is very interesting since De Bondt (2005) finds that the interest rate pass-through speeded up after the introduction of the Euro. On the other hand, Horvath and Podpiera (2009) conclude, in the very case of loans to households, that a lower speed of adjustment came with the financial crisis. In case of Slovakia, we have the unique

opportunity to compare the magnitude of these two effects. It seems that the impact of financial crisis was higher.

As an explanation of this phenomenon, we propose the idea of Horvath and Podpiera (2009); the banks are reluctant to follow money market rates in order to avoid too risky projects. This seems to be especially relevant in our case; we should keep in mind what bank product we are analyzing. Mortgages to households are not usually considered too risky since they are secured by property. With the financial crisis hitting Euro-zone and also Slovakia, the prices of real estate were however decreasing. The fact means that in case of a default mortgage, the bank could have had problems selling the property. Another factor we should consider is the rising unemployment increasing the credit risk of commercial banks. The joint effect of increasing credit risk and increasing difficulty of reselling the collateral seems to sufficiently explain banks' stickiness to higher interest rates.

6.3 Differentiation among banks

The last estimation to be made is the assessment of bank specific characteristics and their effect on the pass-through. Given the short time span and the fact that our dataset on banks' ratios is rather unbalanced, we are not able to estimate the pass-through homogeneity in short term or long term. We however employ three different approaches in order to explain the effects of capital adequacy, liquidity, costness, size of assets and loans' health to the size of bank specific spread over money-market rate. Please find the results in Table 9.

We also tried to include year dummies into our regressions in order to account for fluctuation unexplained by our explanatory variables. These were however omitted on all occasions.

Tier 1 ratio is a measure of bank's core equity capital over total-risk weighted assets. It is used by regulators in order to grade bank as well-capitalized or under-capitalized. The higher the ratio is, the better the bank is capitalized. From our results in Table 9 we may conclude that higher capitalization of a bank has an increasing effect on its spread.

If looking solely on the results of pooled OLS and Fixed Effects, this is in contrast with estimated parameters of Capital funds to Net Loans ratio. This ratio assesses how much capital the bank has to cover provided loans. The results suggest that the spread lowers with less capital to cover loans issued.

There is an explanation attributable to this phenomenon. Since the banks have less capital when compared to loans issued, they have to charge more for the loans. Their risk is higher as well as the risk premium they charge.

Next ratio to be evaluated is the portion of net loans on total assets. According to our results, the higher the portion of loans on assets, the lower the spread charged by commercial bank above money market rate is. This ratio may also be perceived as an exposure to the credit risk. Although we expected the relationship between credit risk and spread to be positive, we should again stress our dataset is composed from data of four large banks on small Slovakian market for a period of 2009 – 2013. It is possible that banks lower their spread in order to remain competitive.

The same competitiveness logic may be employed in case of negative liquidity ratio. The better the bank's liquidity position is, the more room for providing long-term loans it has. It may therefore afford to charge lower spread in order to attract new borrowers. Let's recall here that the spread is between banks' mortgage rate (long-term loan) and a money market rate. A better liquidity position also decreases bank's

exposure to liquidity risk. It is hence logical bank can afford to lower its risk premium.

Table 9: Effects of bank characteristics on its spread

	Pooled OLS	Fixed Effects	Random Effects
Tier 1 ratio	0,3655 *** (0,0962)	0,1851 ** (0,0869)	0,3652 ** (0,1454)
Net Loans to Total Assets	-0,6543 *** (0,1817)	-0,6515 ** (0,2795)	0,6515 ** (0,3042)
Liquid Assets to Deposits & Short Term Funding	-0,2702 ** (0,1088)	-0,0223 (0,1078)	0,2675 * (0,1819)
Costs to Income	-0,1481 ** (0,0619)	-0,4422 ** (0,1669)	0,1475 * (0,0975)
Total Assets	-1,52E-10 (1,19E-10)	6,83E-09 *** (2,10E-09)	1,55E-10 (2,21E-10)
Capital Funds to Net Loans	-0,5924 *** (0,1822)	-0,8112 *** (0,2985)	0,5896 ** (0,2625)
Impaired Loans to Gross Loans	omitted	omitted	omitted

Source: Author's estimation

Again, a negative effect of costs to income ratio may be attributed to the need of protecting a competitive position. Banks who are less efficient in generating income can not afford to lose clients, even though at the cost of lower spread.

The effect of bank size is estimated to be negligible. This may be caused by the fact that among the banks evaluated, there is not one considerably bigger than others. Although their sizes differ, is does not seem to bring an advantage or a disadvantage to any of them in terms of spread.

The impaired lonas over gross loans ratio was omitted at every occasion because of nearly complete collinearity with net loans over total assets ratio. That means that the percentage of impaired loans is constant across banks and does not change with the amount of loans provided.

7. Conclusion

In this thesis, we have attempted to examine the completeness and the speed of interest rate pass-through in Slovakia. We have studied the time period from 2004 to 2013 in order to cover two important events influencing the monetary policy transmission; adoption of common currency and financial crisis. Since Slovakia is a unique example of the two events occurring at the same time, our results may be very useful when shaping monetary policies in similar economies at the periphery of European Union.

We have used error-correction framework in order to distinguish between short term and long term completeness. Error-correction models are also capable of capturing the speed at which an explained variable returns to its equilibrium after a shock has occurred. We have used this feature to examine the speed of interest rate adjustment.

From the point of view of pass-through completeness, we have succeeded in confirming our hypothesis about the pass-through being more complete in long term. The phenomenon has been proved to be consistent for both firms and households, for loans as well as deposits and also across time periods.

When looking closely to the values of pass-through, we observe that it changes across periods. In case of households, the long term pass-through increases after the adoption of Euro (and with crisis) for loans, but decreases for deposits. This finding is consistent with the stickiness hypothesis introduced by Cottarelli and Kourelis (1994). During the crisis, banks are unwilling to lower deposit rates because that would harm their competitive position. No significant change in pass-through completeness is observed in short run.

The same behavior can be observed in case of non-financial entities. The pass-through completeness for deposit rates decreases with the arrival of financial crisis. Again, this behavior is consistent with the idea that banks are unwilling to follow market development in order to attract and protect clients.

In case of firms, we also differentiate for the amount borrowed when looking at loans. We conclude that for loans above one million Euros, the pass-through is affected by the size of Slovakian banking sector. Since the number of such loans is rather low, the banks are forced to compete for those clients and therefore offer customized conditions which may not be in line with the market. Therefore the pass-through is also lower for this type of loans. The effect becomes visible mainly after the adoption of Euro because of increased competition – firms are able to take a loan in their domestic currency anywhere in the Euro-area.

The situation is however adverse in case of loans below one million Euros. These are of course much more common and the pass-through completeness for these loans increases after the switch to the common currency. We explain this by the fact that prior to the adoption, Slovakian banks have not have to compete with other banks across Euro-area and they were therefore able not to follow the market and still

attract the clients. After 2008, with increased competition, banks were forced to follow decreasing money market rates in order to remain competitive.

As a robustness check, we run our estimations for 2004 – 2008 period using EURIBOR instead of BRIBOR. Since the majority of Slovakian banks are a daughter company or a branch of foreign banks, it seems like a plausible option. We conclude that our results remain mainly consistent. It is however interesting to observe that in case of mortgages to households, commercial banks were in greater extent following EURIBOR even before the adoption of common currency. We explain this by the fact that banks were preparing for the adoption of common currency and therefore following the Euro-area development for their long term assets – which mortgages are.

Secondly, we examined the speed of adjustment of bank interest rates to money market rates. In order to effectively compare the speed of adjustment we employ the mean adjustment lag developed by Hendry (1995). We conclude that in case of deposits, the pass through is rather fast, especially in case of firms' deposits. The speed of adjustment also remains consistent across time periods, despite the financial crisis.

As for borrowing rates, the speed of adjustment is again rather high for firms. The interest rates adjust usually in approximately one month. The speed also remains consistent across time periods.

In case of households' borrowing rates, an interesting behavior was observed. The speed of adjustment for mortgage rates being three months before the financial crisis and before the introduction of Euro, increased to nine moths after 2009. De Bondt (2005) found out that the pass-through speeded up with the adoption of common currency and Horvath and Podpiera (2009) concluded the financial crisis to have an opposite effect. We therefore conclude that when the speed of monetary policy transmission is concerned, the impact of financial crisis outweights the impact of common currency adoption in Slovakia.

We explain this stickiness to higher mortgage interest rates by the phenomenons the financial crisis brought; decreasing real estate prices and rising unemployment. The mortgages, secured by real estate, have become riskier since it is harder for the bank to resell collateral in case of default. Additionaly, rising unemployment rate also increases the bank's credit risk.

Finally, to differentiate between individual banks characteristics' effect on bank's spread above money market rate, we examined a panel of four banks in period of 2009 – 2013. We conclude that higher portion of loans on assets, higher costs to income ratio and better liquidity position decrease the spread bank is charging above money market rate. This may be explain by the fact that Slovakian banking market is

small and banks therefore need to lower their spread in order to remain competitive. Since our data is from the crisis period, this may be especially true. Despite higher costs and higher credit risk, banks simply cannot afford loosing clients and therefore they need to lower the spread.

In line with Horvath and Podpiera (2009) we do not find evidence of larger banks benefiting from their competitive position in terms of spread. The size is estimated to have a negligible effect on it.

We further conclude that lower capital backing up loans has an increasing effect on bank's spread. This is explained by the fact that less capitalized bank deals with higher risk and therefore increases its risk premium.

Unfortunately, given the small size of our sample of individual banks' data, we were unable to examine in detail how the individual pass-throughs are changing in time and if the banks pass-throughs are becoming homogenous at some point. We therefore leave the issue for further research.

In addition to that we propose, based on our results, to have a closer look on competition among banks and its role in interest rates pass-through. In case of Slovakia, protection of competitive position seem to have an important impact on banks' behavior, it would be therefore interesting to closely examine the issue.

Finally, Slovenia did adopt the common currency on 1 January 2007, which is very close to the crisis period as well. It would be interesting to perform a similar study for Slovenia and then compare the results. Our conclusions may become more instructive in case they are reaffirmed in Slovenia.

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Appendix

Correlation matrices

Correlation coefficients, using the observations 2004:01 - 2008:12
5% critical value (two-tailed) = 0,2542 for n = 60

BRIBORON	BRIBOR1W	BRIBOR2W	BRIBOR1M	BRIBOR2M	
0,5101	0,5548	0,5495	0,5080	0,4629	HHhypFix1Yto5Y
0,2764	0,3612	0,3797	0,4008	0,4044	HHhypFix5Yto10Y
0,1460	0,2441	0,2719	0,3168	0,3507	HHhypFixover10Y
0,5480	0,5798	0,5910	0,6047	0,6199	NSloanLess1MEUR1Yto5Y
0,5522	0,6424	0,6534	0,6566	0,6563	NSloanLess1MEURover5Y
0,4092	0,4747	0,4936	0,5362	0,5698	NSloanOver1MEUR1Yto5Y
0,5011	0,4889	0,4883	0,4983	0,5236	NSloanOver1MEUROver5Y
0,6422	0,6869	0,6840	0,6635	0,6370	DepHHonDemand
0,6165	0,6869	0,7046	0,7405	0,7679	DepHHless1Y
0,3574	0,4371	0,4611	0,5081	0,5505	DepHH1Yto2Y
0,5286	0,5613	0,5611	0,5553	0,5517	DepHHover2Y
0,7955	0,7308	0,7100	0,6875	0,6646	DepNSonDemand
0,9252	0,9856	0,9837	0,9731	0,9552	DepNSless1Y
0,4187	0,5191	0,5396	0,5727	0,6042	DepNS1Yto2Y
0,4104	0,4517	0,4567	0,4674	0,4818	DepNSover2Y

BRIBOR3M	BRIBOR6M	BRIBOR9M	BRIBOR1Y	EURIBOR1W	
0,4173	0,3127	0,2350	0,1851	-0,4390	HHhypFix1Yto5Y
0,4062	0,4140	0,4284	0,4365	0,6427	HHhypFix5Yto10Y
0,3853	0,4565	0,5030	0,5319	0,6490	HHhypFixover10Y
0,6245	0,6388	0,6256	0,6131	0,2277	NSloanLess1MEUR1Yto5Y
0,6451	0,6107	0,5823	0,5658	0,1826	NSloanLess1MEURover5Y
0,5955	0,6550	0,6774	0,6842	0,4858	NSloanOver1MEUR1Yto5Y
0,5377	0,5493	0,5282	0,5028	0,0107	NSloanOver1MEURover5Y
0,6094	0,5320	0,4644	0,4196	-0,2952	DepHHonDemand
0,7878	0,8331	0,8457	0,8463	0,7227	DepHHless1Y
0,5861	0,6678	0,7086	0,7294	0,7683	DepHH1Yto2Y
0,5367	0,4822	0,4160	0,3631	-0,1478	DepHHover2Y
0,6412	0,5727	0,5197	0,4832	-0,1449	DepNSonDemand
0,9372	0,8790	0,8304	0,7950	0,1826	DepNSless1Y
0,6343	0,7023	0,7325	0,7481	0,4509	DepNS1Yto2Y
0,4831	0,4816	0,4701	0,4623	0,0892	DepNSover2Y

EURIBOR2W	EURIBOR3W	EURIBOR1M	EURIBOR2M	EURIBOR3M	
-0,4416	-0,4430	-0,4373	-0,4398	-0,4432	HHhypFix1Yto5Y
0,6376	0,6340	0,6138	0,6239	0,6318	HHhypFix5Yto10Y
0,6478	0,6462	0,6396	0,6469	0,6532	HHhypFixover10Y
0,2302	0,2327	0,2351	0,2365	0,2333	NSloanLess1MEUR1Yto5Y
0,1790	0,1751	0,1641	0,1624	0,1639	NSloanLess1MEURover5Y
0,4904	0,4923	0,4875	0,4806	0,4778	NSloanOver1MEUR1Yto5Y
0,0152	0,0182	0,0175	0,0137	0,0077	NSloanOver1MEURover5Y
-0,2973	-0,2974	-0,2947	-0,2991	-0,3029	DepHHonDemand
0,7274	0,7288	0,7191	0,7156	0,7123	DepHHless1Y
0,7722	0,7739	0,7740	0,7797	0,7801	DepHH1Yto2Y
-0,1371	-0,1333	-0,1321	-0,1478	-0,1636	DepHHover2Y
-0,1414	-0,1406	-0,1610	-0,1697	-0,1747	DepNSonDemand
0,1834	0,1818	0,1615	0,1548	0,1520	DepNSless1Y
0,4542	0,4576	0,4671	0,4791	0,4798	DepNS1Yto2Y
0,0867	0,0846	0,0818	0,0922	0,0905	DepNSover2Y

EURIBOR4M	EURIBOR5M	EURIBOR6M	EURIBOR7M	EURIBOR8M	
-0,4496	-0,4547	-0,4597	-0,4641	-0,4672	HHhypFix1Yto5Y
0,6270	0,6242	0,6222	0,6205	0,6188	HHhypFix5Yto10Y
0,6568	0,6593	0,6628	0,6656	0,6679	HHhypFixover10Y
0,2345	0,2352	0,2351	0,2355	0,2359	NSloanLess1MEUR1Yto5Y
0,1630	0,1623	0,1616	0,1602	0,1597	NSloanLess1MEURover5Y
0,4814	0,4840	0,4849	0,4857	0,4869	NSloanOver1MEUR1Yto5Y
0,0108	0,0136	0,0159	0,0193	0,0219	NSloanOver1MEURover5Y
-0,3066	-0,3100	-0,3134	-0,3152	-0,3167	DepHHonDemand
0,7136	0,7149	0,7156	0,7163	0,7166	DepHHless1Y
0,7814	0,7820	0,7823	0,7823	0,7819	DepHH1Yto2Y
-0,1655	-0,1665	-0,1672	-0,1668	-0,1671	DepHHover2Y
-0,1702	-0,1653	-0,1613	-0,1564	-0,1524	DepNSonDemand
0,1513	0,1514	0,1515	0,1519	0,1523	DepNSless1Y
0,4820	0,4827	0,4835	0,4838	0,4842	DepNS1Yto2Y
0,0900	0,0898	0,0895	0,0900	0,0899	DepNSover2Y

EURIBOR9M	EURIBOR10M	EURIBOR11M	EURIBOR1Y	EONIA	
-0,4698	-0,4709	-0,4712	-0,4709	-0,4442	HHhypFix1Yto5Y
0,6179	0,6175	0,6173	0,6175	0,6403	HHhypFix5Yto10Y
0,6711	0,6742	0,6768	0,6796	0,6357	HHhypFixover10Y
0,2360	0,2370	0,2382	0,2396	0,2102	NSloanLess1MEUR1Yto5Y
0,1590	0,1594	0,1601	0,1613	0,1773	NSloanLess1MEURover5Y
0,4870	0,4876	0,4885	0,4888	0,4780	NSloanOver1MEUR1Yto5Y
0,0236	0,0252	0,0265	0,0270	0,0095	NSloanOver1MEURover5Y
-0,3179	-0,3175	-0,3171	-0,3162	-0,2977	DepHHonDemand
0,7163	0,7162	0,7159	0,7155	0,7307	DepHHless1Y
0,7813	0,7810	0,7804	0,7802	0,7660	DepHH1Yto2Y
-0,1682	-0,1693	-0,1709	-0,1724	-0,1194	DepHHover2Y
-0,1490	-0,1449	-0,1415	-0,1381	-0,1196	DepNSonDemand
0,1524	0,1536	0,1547	0,1559	0,2033	DepNSless1Y
0,4848	0,4860	0,4873	0,4888	0,4436	DepNS1Yto2Y
0,0895	0,0898	0,0892	0,0892	0,0944	DepNSover2Y

Correlation coefficients, using the observations 2009:01 - 2013:12
5% critical value (two-tailed) = 0,2542 for n = 60

EURIBOR1W	EURIBOR2W	EURIBOR3W	EURIBOR1M	EURIBOR2M	
0,4671	0,4710	0,4897	0,4922	0,5510	HHhypFix1Yto5Y
-0,2693	-0,2671	-0,2535	-0,2515	-0,1948	HHhypFix5Yto10Y
0,2153	0,2186	0,2407	0,2385	0,2900	HHhypFixover10Y
0,5926	0,5897	0,5990	0,5898	0,6190	NSloanLess1MEUR1Yto5Y
0,4826	0,4810	0,4948	0,4894	0,5194	NSloanLess1MEURover5Y
0,0571	0,0571	0,0596	0,0689	0,1131	NSloanOver1MEUR1Yto5Y
0,2087	0,2073	0,2089	0,2156	0,2315	NSloanOver1MEUROver5Y
0,1985	0,2038	0,2229	0,2119	0,2114	DepHHonDemand
0,1828	0,1848	0,2016	0,1900	0,1759	DepHHless1Y
0,5269	0,5413	0,5684	0,5753	0,5982	DepHH1Yto2Y
0,4187	0,4337	0,4461	0,4667	0,4840	DepHHover2Y
0,8670	0,8635	0,8593	0,8515	0,8474	DepNSonDemand
0,9199	0,9247	0,9289	0,9257	0,9054	DepNSless1Y
0,4120	0,4093	0,4217	0,3989	0,3709	DepNS1Yto2Y
0,4236	0,4350	0,4543	0,4574	0,4604	DepNSover2Y

EURIBOR3M	EURIBOR4M	EURIBOR5M	EURIBOR6M	EURIBOR7M	
0,5927	0,6114	0,6178	0,6231	0,6151	HHhypFix1Yto5Y
-0,1639	-0,1498	-0,1503	-0,1521	-0,1593	HHhypFix5Yto10Y
0,3356	0,3563	0,3694	0,3816	0,3757	HHhypFixover10Y
0,6294	0,6351	0,6350	0,6312	0,6279	NSloanLess1MEUR1Yto5Y
0,5358	0,5425	0,5426	0,5422	0,5353	NSloanLess1MEURover5Y
0,1457	0,1598	0,1630	0,1662	0,1594	NSloanOver1MEUR1Yto5Y
0,2581	0,2694	0,2803	0,2907	0,2904	NSloanOver1MEURover5Y
0,2005	0,2004	0,1936	0,1806	0,1816	DepHHonDemand
0,1820	0,1924	0,2056	0,2169	0,2285	DepHHless1Y
0,6133	0,6254	0,6304	0,6296	0,6355	DepHH1Yto2Y
0,4980	0,5097	0,5175	0,5207	0,5257	DepHHover2Y
0,8309	0,8232	0,8140	0,8015	0,7978	DepNSonDemand
0,8836	0,8750	0,8695	0,8604	0,8629	DepNSless1Y
0,3583	0,3612	0,3696	0,3745	0,3815	DepNS1Yto2Y
0,4707	0,4776	0,4854	0,4935	0,4999	DepNSover2Y

EURIBOR8M	EURIBOR9M	EURIBOR10M	EURIBOR11M	EURIBOR1Y	
0,6074	0,5980	0,5880	0,5768	0,5660	HHhypFix1Yto5Y
-0,1678	-0,1804	-0,1899	-0,2007	-0,2129	HHhypFix5Yto10Y
0,3694	0,3615	0,3530	0,3439	0,3355	HHhypFixover10Y
0,6232	0,6177	0,6124	0,6056	0,5990	NSloanLess1MEUR1Yto5Y
0,5286	0,5216	0,5132	0,5049	0,4977	NSloanLess1MEURover5Y
0,1529	0,1440	0,1363	0,1275	0,1170	NSloanOver1MEUR1Yto5Y
0,2930	0,2957	0,2954	0,2944	0,2959	NSloanOver1MEURover5Y
0,1805	0,1768	0,1771	0,1774	0,1775	DepHHonDemand
0,2373	0,2449	0,2543	0,2635	0,2736	DepHHless1Y
0,6383	0,6368	0,6395	0,6412	0,6410	DepHH1Yto2Y
0,5294	0,5280	0,5316	0,5339	0,5328	DepHHover2Y
0,7937	0,7900	0,7872	0,7834	0,7790	DepNSonDemand
0,8637	0,8645	0,8669	0,8692	0,8700	DepNSless1Y
0,3867	0,3915	0,3977	0,4039	0,4121	DepNS1Yto2Y
0,5050	0,5090	0,5137	0,5182	0,5216	DepNSover2Y

Cointegration tests

Two-step Engle-Granger test

Augmented Dickey-Fuller test		
Dependent variable	**Explanatory variable**	**P-value without constant**
BRIBOR1W	Mortgages to households, fixation of interest rate 1Y – 5Y	0,1394
BRIBOR1Y	Loans to non-financial entities, amount >1M EUR, fixation of interest rate 1Y – 5Y	n/a
BRIBOR1Y	Deposits to households, maturity <1Y	0,0409
BRIBOR1W	Deposits to non-financial entities, maturity <1Y	0,1604
EURIBOR6M	Mortgages to households, fixation of interest rate 1Y – 5Y	0,1957
EURIBOR6M	Loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y	0,0310
EURIBOR6M	Deposits to households, maturity 1Y – 2Y	0,0467
EURIBOR3W	Deposits to non-financial entities, maturity <1Y	0,0611

Johanson test

<u>BRIBOR1W, Mortgages to households, fixation of interest rate 1Y – 5Y</u>

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2004:09 - 2008:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 146.782 (including constant term: -0.787546)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.18280	14.524	[0.0685]	10.497	[0.1843]
1	0.074518	4.0269	[0.0448]	4.0269	[0.0448]

<u>BRIBOR1Y, Loans to non-financial entities, amount >1M EUR, fixation of interest rate 1Y – 5Y</u>

n/a

<u>BRIBOR1Y, Deposits of households, maturity <1Y</u>

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2004:09 - 2008:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 182.996 (including constant term: 35.4261)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.14349	10.299	[0.2631]	8.0540	[0.3816]
1	0.042248	2.2447	[0.1341]	2.2447	[0.1341]

BRIBOR1W, Deposits of non-financial entities, maturity <1Y

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2004:09 - 2008:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 183.93 (including constant term: 36.3607)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.10880	6.6950	[0.6188]	5.9895	[0.6205]
1	0.013475	0.70549	[0.4009]	0.70549	[0.4010]

EURIBOR6M, Mortgages to households, fixation of interest rate 1Y – 5Y

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2009:09 - 2013:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 283.634 (including constant term: 136.064)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.16378	9.3015	[0.3445]	9.3009	[0.2679]
1	1.2503e-005	0.00065017	[0.9797]	0.00065017	[0.9797]

EURIBOR6M, Loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2009:09 - 2013:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 209.257 (including constant term: 61.6876)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.41281	30.292	[0.0001]	27.685	[0.0001]
1	0.048893	2.6067	[0.1064]	2.6067	[0.1064]

EURIBOR6M, Deposits to households, maturity 1Y – 2Y

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2009:09 - 2013:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 276.756 (including constant term: 129.187)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.30897	24.193	[0.0015]	19.218	[0.0063]
1	0.091247	4.9754	[0.0257]	4.9754	[0.0257]

EURIBOR3W, Deposits to non-financial entities, maturity <1Y

Johansen test:
Number of equations = 2
Lag order = 8
Estimation period: 2009:09 - 2013:12 (T = 52)
Case 3: Unrestricted constant

Log-likelihood = 292.257 (including constant term: 144.687)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.13811	10.569	[0.2436]	7.7288	[0.4157]
1	0.053155	2.8402	[0.0919]	2.8402	[0.0919]

Non-stationarity tests

Augmented Dickey-Fuller test

2004:01 - 2008:12	**8 lags**	
Variable	**p-value with constant**	**p-value with constant and trend**
Mortgages to households, fixation of interest rate 1Y – 5Y	0.03078	0.6557
Mortgages to households, fixation of interest rate 5Y – 10Y	0.4587	0.6971
Mortgages to households, fixation of interest >10Y	0.8484	0.2642
Loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y	0.5005	0.5205
Loans to non-financial entities, amount <1M EUR, fixation of interest rate >5Y	0.2571	0.5453
Loans to non-financial entities, amount >1M EUR, fixation of interest rate 1Y – 5Y	n/a	n/a
Loans to non-financial entities, amount >1M EUR, fixation of interest rate >5Y	n/a	n/a
Deposits to households, due immediately	0.3986	0.0001
Deposits to households, maturity <1Y	0.5908	0.4986
Deposits to households, maturity 1Y – 2Y	0.8392	0.237
Deposits to households, maturity >2Y	0.1925	0.5438
Deposits to non-financial entities, due immediately	0.4075	0.7524
Deposits to non-financial entities, maturity <1Y	0.1924	0.469
Deposits to non-financial entities, maturity 1Y – 2Y	n/a	n/a
Deposits to non-financial entities, maturity >2Y	n/a	n/a
BRIBOR O/N	0.1166	0.337
BRIBOR 1W	0.1315	0.3768
BRIBOR 2W	0.1414	0.3895
BRIBOR 1M	0.1234	0.3443
BRIBOR 2M	0.08965	0.2542
BRIBOR 3M	0.08805	0.2362
BRIBOR 6M	0.1588	0.2941
BRIBOR 9M	0.1604	0.2776
BRIBOR 1Y	0.1203	0.2729

2009:01 - 2013:12	8 lags	
Variable	**p-value with constant**	**p-value with constant and trend**
Mortgages to households, fixation of interest rate 1Y – 5Y	0.6646	0.6182
Mortgages to households, fixation of interest rate 5Y – 10Y	0.3895	0.7904
Mortgages to households, fixation of interest >10Y	0.8712	0.4015
Loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y	0.7437	0.245
Loans to non-financial entities, amount <1M EUR, fixation of interest rate >5Y	0.9576	0.8553
Loans to non-financial entities, amount >1M EUR, fixation of interest rate 1Y – 5Y	n/a	n/a
Loans to non-financial entities, amount >1M EUR, fixation of interest rate >5Y	n/a	n/a
Deposits to households, due immediately	0.6826	0.9919
Deposits to households, maturity <1Y	0.6745	0.9968
Deposits to households, maturity 1Y – 2Y	0.27	0.5975
Deposits to households, maturity >2Y	0.246	0.6843
Deposits to non-financial entities, due immediately	0.01102	0.1136
Deposits to non-financial entities, maturity <1Y	0.4066	0.7343
Deposits to non-financial entities, maturity 1Y – 2Y	0.7739	0.9946
Deposits to non-financial entities, maturity >2Y	0.8197	0.9061
EURIBOR 1W	0.3098	0.6468
EURIBOR 2W	0.3045	0.6368
EURIBOR 3W	0.4165	0.6601
EURIBOR 1M	0.3804	0.6596
EURIBOR 2M	0.5554	0.7378
EURIBOR 3M	0.6308	0.7611
EURIBOR 4M	0.7468	0.82
EURIBOR 5M	0.7855	0.8421
EURIBOR 6M	0.7847	0.8357
EURIBOR 7M	0.8359	0.8656
EURIBOR 8M	0.8389	0.8681
EURIBOR 9M	0.8121	0.8434
EURIBOR 10M	0.845	0.8648
EURIBOR 11M	0.8472	0.8679
EURIBOR 1Y	0.8252	0.8465

KPSS test

Trend included 2004:01 - 2008:12	**3 lags**			
Variable	**10% critical value**	**5% critical value**	**1% critical value**	**Test statistic**
Mortgages to households, fixation of interest rate 5Y – 10Y	0.121	0.149	0.214	0.19365
Loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y	0.121	0.149	0.214	0.224857
Deposits to households, maturity <1Y	0.121	0.149	0.214	0.172767
Deposits to non-financial entities, maturity <1Y	0.121	0.149	0.214	0.203304
BRIBOR 6M	0.121	0.149	0.214	0.165725

KPSS test, trend included 2009:01 - 2013:12	**3 lags**			
Variable	**10% critical value**	**5% critical value**	**1% critical value**	**Test statistic**
Mortgages to households, fixation of interest rate 5Y – 10Y	0.121	0.149	0.214	0.221543
Loans to non-financial entities, amount <1M EUR, fixation of interest rate 1Y – 5Y	0.121	0.149	0.214	0.0913638
Deposits to households, maturity <1Y	0.121	0.149	0.214	0.249914
Deposits to non-financial entities, maturity <1Y	0.121	0.149	0.214	0.198072
EURIBOR 6M	0.121	0.149	0.214	0.215193