Charles University in Prague

Faculty of Social Sciences

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MASTER THESIS

ECB Monetary Policy: “One Size Doesn’t Fit All” Problem and Its Impact on Credits Volume

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Declaration of Authorship

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Prague, July 29, 2014

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Abstract

In this work, I analyse inappropriateness of single monetary policy in the euro area and its impact on credit growth for the oldest twelve euro members and a time period spanning 1999Q1-2013Q3. The inappropriateness is expressed by deviations of actual interest rate from Taylor rule prescriptions. The obtained results are in line with a majority of existing literature since they show that the ECB's single interest rate was the least suitable for the so called PIIGS countries prior to the recent economic crisis. The impact of the deviations on credit growth is estimated econometrically by dynamic panel data estimation. The findings confirm my hypothesis that the deviations from the Taylor rule have a significant positive effect on credits volume, i.e. the higher is the Taylor rule prescription above the actual rate, the higher is the credit growth.

JEL Classification	E44, E51, E52, E58
Keywords	Taylor rule, single monetary policy, euro area, credit growth

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Abstrakt

V této práci analyzuji nevhodnost jednotné měnové politiky v eurozóně a její vliv na růst úvěrů pro dvanáct nejstarších členů eurozóny a časové období 1999Q1-2013Q3. Zmíněná nevhodnost je vyjádřena odchylkami skutečné úrokové míry od úrokových měr doporučovaných Taylorovým pravidlem. Získané výsledky jsou v souladu s většinou již existující literatury, neboť ukazují, že jednotná úroková míra ECB byla před nedávnou ekonomickou krizí nejméně vhodná pro takzvané země PIIGS. Vliv odchylek na růst úvěrů je zjištěn ekonometricky pomocí metody dynamických panelových dat. Zjištěné výsledky potvrzují moji hypotézu, že odchylky od Taylorova pravidla mají signifikantní pozitivní účinek na množství úvěrů, jinými slovy čím výše je doporučení Taylorova pravidla nad skutečnou úrokovou mírou, tím vyšší je růst úvěrů.

Klasifikace	E44, E51, E52, E58
Klíčová slova	Taylorovo pravidlo, jednotná měnová politika, eurozóna, úvěrový růst

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Master Thesis Proposal

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Proposed Topic:

ECB Monetary Policy: "One Size Doesn't Fit All" Problem and Its Impact on Credits Volume

Topic Characteristics:

The basic topic of my Master Thesis is so called "One size doesn't fit all" problem in the eurozone and its impact on the volume of credits provided by banking sector. The monetary policy of the ECB has some drawbacks arising from the fact that the ECB sets one single interest rate for all euro area member countries. Since the member countries differ in many economic variables and characteristics, the single interest rate may not fit to all of them equally well. In my thesis, I will investigate to which member states the ECB interest rate fits well, to which it fits worse and how it has developed over time. The theoretical background used for this analysis will be the Taylor rule, suggesting the optimal interest rate the central bank should set. Subsequent section will be focused on investigation of the impact of deviations between the actual interest rate and theoretically desired rate in member countries on the volume of provided credits. A statistically significant impact is expected, since for instance, too low interest rate should theoretically lead to credit expansion. Finally, in the last section I will try to outline some possible solutions to the "One size doesn't fit all" problem.

Hypotheses:

1. The actual interest rate set by the ECB is approximately in compliance with the Taylor rule suggestions
2. The ECB interest rate is the least suitable for PIIGS countries
3. The deviation of actual interest rate from theoretically suitable interest rate has a statistically significant impact on the volume of provided credits

Methodology:

The first parts of the thesis will be focused on the comparison between actual interest rates and theoretically optimal interest rates derived by the Taylor rule. In order to compute the Taylor rule interest rates for individual euro area member countries, I will use real data provided especially by the main international institutions (European Central Bank, International Monetary Fund, Eurostat etc.) and national central banks. To study the impact of the deviations of actual from theoretical rates, I will create an econometric model to estimate the parameters. Panel data will be used for the estimation, consisting of figures for all euro area member states from the euro introduction till today.

Outline:

1. Introduction
2. Review of the literature on the "One size doesn't fit all" problem
3. Theoretical background – Taylor rule

4. Single interest rate of the ECB – development and compliance with Taylor rule
5. “One size doesn’t fit all” problem
    - To which countries does the ECB interest rate fit best and worst?
    - How big are the deviations of actual rate from theoretical rate?
    - How do the deviations develop over time?
6. Impact of the deviations on credits volume
    - Theoretical expectations about the impact
    - Econometric model and estimation based on real data
7. Possible solutions to the “One size doesn’t fit all” problem
8. Conclusions

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Acronyms

2SLS	Two-stage least squares
BIS	Bank for International Settlements
CPI	Consumer price index
ECB	European Central Bank
EME	Emerging market economies
EMU	Economic and Monetary Union (in the European Union)
EU	European Union
GDP	Gross domestic product
GMM	Generalized Method of Moments
HP	Hodrick-Prescott (filter)
IMF	International Monetary Fund
IV	Instrumental variable
MIG	Mean interest rate gap
OCA	Optimum currency area
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least squares
PIIGS	Portugal, Italy, Ireland, Greece and Spain
QoQ	Quarter-on-quarter
RMSIG	Root mean squared interest rate gap

At	Austria	**Ie**	Ireland
Be	Belgium	**It**	Italy
Cy	Cyprus	**Lu**	Luxembourg
De	Germany	**Mt**	Malta
Ee	Estonia	**Nl**	Netherlands
El	Greece	**Pt**	Portugal
Es	Spain	**Si**	Slovenia
Fi	Finland	**Sk**	Slovakia
Fr	France		

1 Introduction

The first of January in 1999 is marked by a significant event in the history of Europe. On this day, eleven members of the European Union introduced the euro, a single currency common for all of them, and delegated their independent monetary policy to the European Central Bank. Since then, monetary policy of these eleven countries has been conducted from Frankfurt in Germany where the ECB has its headquarters. Several other EU members have gradually extended the monetary union and some others are about to enter in future. Nowadays, the Economic and Monetary Union in the European Union, widely known as the euro area or the eurozone, has eighteen member states.

Creation of the monetary union was a further step in achieving closer and closer economic and also political integration among European countries. There are many relevant advantages of the monetary unification, from facilitation of travelling for the Europeans, removal of exchange rate risk, increase in the volume of trade, up to bigger competition on the common market and related benefits. Such advantages raise standard of living, rationalizing the suitability of the euro creation.

Nevertheless, like a vast majority of all real projects, also the euro project has some weighty drawbacks. Besides fiscal policy, monetary policy is used to affect economic development as well, optimally to achieve stable and sustainable progress. The countries used to tailor the monetary policy to their needs in order to cool down overheating or to bolster crawling economy. However, since entering the eurozone, the countries do not have this possibility because the ECB has to determine only one set of nominal interest rates common for all members of the union.

It would be perfectly fine if the countries in the group were sufficiently similar to each other in terms of economic characteristics, but it is really not the case in Europe. The euro area is currently composed of eighteen European countries.[1] There are representatives of Northern, Western, Southern, Central and even Eastern Europe. They have different wealth, different levels of technology, different preferences, etc. The quality of institutions varies a lot. The states may even be in dissimilar stages of business cycles. This all leads to the situation that the individual euro area countries have various needs, regarding the monetary policy.

[1] Germany, France, Italy, the Netherlands, Belgium, Luxembourg, Spain, Portugal, Ireland, Austria, Finland, Greece, Slovenia, Malta, Cyprus, Slovakia, Estonia and Latvia

As a result, the actual interest rates may be too high or too low for them, possibly leading to destabilization of economy. This problem is usually referred to as the so called “One size doesn’t fit all” problem.

What are potential positive or negative consequences of this issue? The positive ones are definitely in a clear minority, if they exist at all. When interest rates are lower than optimal, the economy is boosted a lot, which leads to higher economic growth. It is positive at first sight, but such a growth is likely to be unsustainable. It can prevail only in short-term because too low interest rates contribute to building of huge macroeconomic imbalances. To mention an example, it can lead to high inflation, loss of competitiveness or excessive indebtedness. The imbalances are often the beginnings of economic breakdown.

In this Thesis, I focus on one particular possible consequence of the mentioned problem. This consequence is that too low interest rates may cause immoderate growth of credit volume, leading to increase in indebtedness of households and firms to unsustainable oversized levels. Or, on the contrary, too high rates may decelerate economic growth since money is expensive and cost of funding is high and so people consume less and companies postpone investments.

Specifically, I study the impact of deviations from optimal levels of interest rates on the growth rate of credit provided to domestic private sector, using econometric estimation. The theoretically optimal levels of nominal interest rates are derived from the Taylor rule. Then, value of actual market interest rate is subtracted from them to find out the deviations. Data sample comprises twelve oldest euro countries (eleven founding members plus Greece) and covers a time span from the first quarter of 1999 till the third quarter of 2013.

I expect the impact of the deviations from the Taylor rule on credit growth to be positive. The reason for this expectation is that the higher is the deviation in positive values, the deeper is the cost of funding below some stabilizing optimum, and so the higher should be the growth rate of provided credit.

The main contribution of this Thesis lies in the fact that I do not describe only the extent of inappropriateness of the single monetary policy in the euro area, but I also analyse its consequences. The “One size doesn’t fit all” problem and related deviations of actual interest rates from optimal rates are already quite widely covered in the literature. However, some extensive empirical research of possible consequences is still missing. This work tries to fill in this gap. It connects the inappropriateness of the ECB’s single interest rate with analysis of its impact on credit growth. In addition, my dataset spans a period from the beginning of the EMU till 2013, which enables to study an effect of the 2008-2009 economic crisis on the impact.

The Thesis comprises two key parts. One part is about the “One size doesn’t fit all” problem. In this part, I study whether the problem really exists in the euro area and how extensive it is. The second key part is dedicated to the impact of the problem on credit growth. Specifically, the structure of this work is as follows. Section 2 just after the introduction describes the inappropriateness of the ECB’s monetary policy. It contains a literature review related to this topic, a description of the Taylor rule which forms theoretical basis for my analysis. Further, it contains characterization of the methodology and data and, finally, results of the deviations from the Taylor rule for individual member states of the eurozone. Section 3 is a kind of complementary section. It mentions some stylized facts about credit expansion in several European countries and its consequences in order to make a picture why it is relevant to study an effect just on credits volume. Section 4 is the crucial part of the whole work since it is focused on exploring the impact of the “One size doesn’t fit all” problem on growth rate of provided credit. Again, it depicts a review of existing literature related to this topic at the beginning. Then, there is a description of the model to be estimated, including data and used methodology. After that, the estimation results are stated, explained and compared to the existing literature. Finally, section 5 concludes the work and main findings.

2 “One size doesn’t fit all” problem

Since there is a single monetary policy common for all countries in the euro area, the ECB has to set its policy rates to fit to the needs of the eurozone as a whole. The member states have lost the independence in determining optimal monetary policy to flexibly react to their specific needs. This role was delegated to the ECB which is not fully flexible in this field at individual country level. In addition, there is a problem that the member states are not sufficiently similar and their monetary needs may differ substantially. As a result, the ECB’s policy is not equally appropriate for everyone. In this section, I investigate to which countries it fits the worst and to which the other way round.

The basic hypothesis for this section is that the ECB’s interest rate was the least suitable for the PIIGS countries prior to the recent economic crisis. The reason for such a hypothesis is as follows. Especially Ireland, Greece and Spain experienced relatively high inflation rates and highly positive output gaps. To cool the economy down, they needed to raise the interest rates. Nevertheless, they were not able to do that since the monetary policy had been in hands of the ECB and the interest rates had been tailored to the whole eurozone. It probably contributed to even greater overheating and greater deviations from optimum.

2.1 Literature review

2.1.1 Discussions and opinions

The „One size doesn’t fit all” problem has been one of the central points of discussions and debate from the time when it was obvious that a currency union was going to be created in the EU. Opinions about appropriateness of single monetary policy in a group of relatively heterogeneous countries have been developing in quite a changing way, depending not only on past experience, but also on that time economic and political atmosphere.

The Economic and Monetary Union in Europe was launched on the 1st of January, 1999. Nevertheless, the decision to create the currency union was made by the European Council already in 1991 in Maastricht and then enshrined in the Maastricht Treaty (European Commission, 2014). Just since then, a debate about prospects of the currency union in Europe was further strengthened. As Issing

(2005) stated, prior to the establishment of the eurozone, there were a lot of objections to the single monetary policy in Europe from economic professionals who were sceptic about its future success. The professionals built their doubts mainly on the so called optimum currency area theory, initially suggested by Mundell (1961). This theory says that common currency should be introduced only in a group of states which meet some specific criteria. In other words, some necessary conditions must be met so that single monetary policy works well in a currency union. There are no doubts that the eleven founding members of the EMU (plus the first accessing country – Greece) did not form the optimum currency area (OCA). It was admitted also by Otmar Issing, a member of the Executive Board of the ECB (Issing, 2005).

There were several reasons of the OCA non-fulfilment. For instance, national labour markets were not sufficiently interconnected. Despite free movement of workers, labour migration was imperfect (Fox, 1998). Business cycle positions of the member states differed a lot, being expressed by differences in growth rates and inflation (Dunn, 1999). Convergence among the states is really important for proper functioning of monetary union. Therefore, Maastricht convergence criteria were introduced to achieve the convergence prior to the introduction of the euro. However, Sheridan (1999) mentioned that the Maastricht criteria ensured nominal convergence, not the real one that is required by the optimum currency area theory. Sheridan (1999) further added that the eurozone lacked also appropriate price and wage flexibility and a proper fiscal transfers system on the supranational level. That’s why he expressed concerns that the euro would cause troubles to some member countries, potentially leading to disintegrating pressures. Also George (1998), a Governor of the Bank of England at that time, stated that the single monetary policy may lead to a contraction in some countries (in case of restrictive policy) or to excessive inflation in others (in case of expansionary policy). Roche (1998) predicted the latter, namely overheating in peripheral euro countries due to too low interest rates.

Despite many concerns pronounced by professionals prior to the creation of the monetary union, the euro was launched in eleven EU countries in 1999. During the first decade of the 21st century, macroeconomic development in the eurozone was generally favourable (especially in 2005-2007) and objections to appropriateness of the single monetary policy in Europe weakened fairly a lot. On the contrary, there appeared many opinions claiming that the single-size monetary policy of the ECB had worked very well and the experts’ concerns had not come true. These opinions were based primarily on the fact that the single monetary policy managed to anchor inflation expectations and that inflation in the eurozone as a whole moved constantly very close to 2 %, the ECB's target rate (Trichet, 2006). Tumpel-Gugerell (2004) said that the euro had contributed pretty much to bigger macroeconomic stability and resistance to financial crises. As far as the important question about the appropriateness of the single-size interest rate for all members of the euro area is concerned, Issing (2005) provided several reasons why divergence of real interest rates among the euro countries since the creation of the European currency union had not been so large. He firmly concluded that one size did fit all. Also Garganas (2007) mentioned some channels through which common European currency had led to improving conditions and therefore better and better functioning of the monetary union because monetary needs of individual members had converged.

Nevertheless, for example, Goodhart (2007) claimed that the eurozone still did not form optimum currency area since the required adjustment mechanisms were not properly developed. Despite relatively successful years since the euro introduction, some authors did not consider the single monetary policy to be a success. They said that common interest rates had not been tailored to individual national needs enough and that they had failed to further decrease inflation differentials.[2]

The year 2008 brought an inception of a very deep economic crisis, sometimes called the Great Recession. And just the crisis has been critical for the monetary union in Europe since it has fetched many pessimistic opinions about usefulness and suitability of single monetary policy for a group of European countries. Someone even blamed the euro for economic troubles which some countries (especially the PIIGS states) have been going through. For instance, Konstantinidis (2012) said that the euro had caused a failure of the eurozone and that it was a mistake that such different nations as Greece and Germany had a common currency and monetary policy. Most authors recently claim that the single monetary policy with its single-size interest rate has not been appropriate for peripheral countries in the eurozone, particularly for Portugal, Ireland, Greece and Spain.[3] These countries were growing relatively fast and evinced higher than target inflation in the period before the recent crisis. Because of this, they needed higher interest rates to reduce overheating of their economies. However, the ECB must take into account all member countries when setting the rates and so the actual interest rates were too low for them, leading to creation of macroeconomic imbalances. Of course, there are many statements that the euro is not the main culprit of the financial problems currently in the euro area, as for example a statement by Wenkel (2012) in his article. However, to demonstrate

[2] See for example Ewing, Reed and Kline (2005) or Ciobanu (2007).
[3] Such opinions appeared in Smaghi (2011), The Economist (2009) or Nechio (2011).

also an example from the opposite group of views, Elliott (2010) said: "Greece has underlined the design flaws in the euro project, the immense difficulty in bolting together different economies and forcing them to operate under a one-size fits all monetary policy."

In order to mention several notes to the literature review describing opinions about the "One size doesn't fit all" problem provided above, I would like to say that it is quite natural that development of opinions is affected by contemporary economic and political atmosphere. Prior to the start of the monetary union, there must have been sceptical views since it was a step into the unknown and the eurozone obviously did not fulfil the optimum currency area conditions. Then, the number of concerns naturally decreased a lot during successful years. When the development is favourable, only few people dare to declare that the system does not work properly. On the contrary, a crisis period definitely must lead to considerations and statements that something is wrong with the system.

2.1.2 Empirical studies

There is quite high number of works studying the inappropriateness of the ECB's single monetary policy empirically. The inappropriateness is usually expressed by deviations of actual interest rates from theoretically optimal levels prescribed by the Taylor rule.

Moons and Van Poeck (2008) used the very original form of the Taylor rule to compute the deviations from the Eonia rate. Data is quarterly from 1999Q1 to 2003Q4. Their findings say that the ECB monetary policy was on average relatively optimal for Italy, France and Austria, whereas inappropriate for Spain, Greece, Portugal, the Netherlands and especially Ireland. The Eonia rate was on average too low for the latter countries (specifically, for Ireland the actual rate was on average 6.5 percentage points lower than the desired rate). On the other side of the spectrum, Germany experienced too high rates during this period. Furthermore, they concluded that the gaps were not decreasing over time. Besides the individual deviations, the authors also tried to find out whether the ECB's rate had been in line with needs of the whole eurozone, using Taylor rate derived as a weighted average of the individual prescribed rates. They discovered that the simple rule traced actual interest rate quite well in the mentioned time span.

Ahrend, Cournéde and Price (2008) also used the original form of the rule. However, their results differ a bit from the ones mentioned above. The analysis covers a period from 1985 to 2007. I will focus my description only on period of the euro existence.

They found out that actual short-term interest rates were too low for the euro area as a whole between the years 2001 and 2005. Regarding the individual member states, the single policy rate was relatively optimal for Austria, Belgium and also for Finland (from 2003 to 2007). German needs were often below the reality. On the contrary, huge and persistent gaps were found for Ireland, Portugal, Spain and Greece.

The original values of the coefficients in the Taylor rule were used also by Fendel and Frenkel (2006). However, they assumed both the equilibrium real interest rate and inflation target to be 1.5 % (not 2 %). Then, they compared the computed values to the Eonia rate. In the first year of the EMU, the optimal rate for the eurozone was below the Eonia. But then till the end of their analysis in 2003, the Eonia kept constantly below the Taylor, especially in 2000 and 2001. The authors also applied the rule with smoothing term (they set $\rho = 0.8$). In this case, both curves plotting the interest rates paths move very close to each other throughout the whole period.

Based on her estimation of the ECB's reaction function, Eleftheriou (2003) showed that the Eonia rate was more or less in line with the prescribed rate for the whole union (nevertheless, her analysis ends in June 2002 and so it covers very small part of the euro existence). Only from July 1999 to April 2001, the policy was looser than justified by economic conditions. Similarly to other studies, the largest gap upwards was discovered especially for Ireland, then also for Spain, Portugal and the Netherlands. Conversely, the Eonia rate was above the prescription for France, Germany or Austria.

Geni and Munteanu (2010) dealt with the question whether the PIIGS countries could have avoided the crisis with independent monetary policy. They simply studied deviations from the Taylor rule, here with different size of the coefficients (2.0 for inflation and 0.8 for output gap). Their findings show that in Greece, Ireland and Spain, nominal interest rates were constantly deeply below prescribed levels in period 2000-2008. The exception is the span 2003-2005 for Ireland. Portugal was highly 'below Taylor' till 2003. Italy was more or less in line.

Nechio (2011) employed slightly different form of the rule. She replaced the output gap with unemployment gap with coefficient of size 1.0. Based on this model, she concluded that the ECB's target policy rate was too low from 2001 to 2005, but since 2005 it matched the recommended rate quite well. In addition, she divided the countries into two groups – core and peripheral (composed of Ireland, Greece, Spain and Portugal). The division confirms the findings from above mentioned and most probably also many other studies, namely that the peripheral countries needed much higher interest rates prior to the recent crisis, whereas needs of the core states were somewhat in line with the reality. On the contrary, since 2009 the periphery would have needed lower rates (even negative, which is impossible), the core slightly higher.

The Fernanda Nechio's analysis was slightly adjusted and extended by Srivangipuram (2012). Unemployment gap was replaced by output gap and the deviations were computed for all individual member states of the euro area. Results are again in accordance with most of previous studies. The policy was somewhat optimal for Germany or France, except for years 2007 and 2008 when it was too loose. Conversely, Greece, Spain, Ireland, Portugal and Italy experienced large and persistent upward gaps (the ECB's nominal rates were too low) prior to the crisis. Also the Netherlands had lower rates than needed in 1999-2003.

The analysis of Nechio (2011) was extended also by Darvas and Merler (2013). They covered the same data sample like me, specifically a period 1999Q1-2013Q3 for twelve oldest euro area states. They concluded that actual interest rate was higher than Taylor rate for the euro area as a whole till 2001. Then, it was significantly lower in 2001-2005 and it was below Taylor also during the crisis. Only in 2013, the Taylor rate got below the actual one as it fell to approximately 0.4 %. The authors did the analysis also for the individual member states and found out expectedly that the ECB's monetary policy was the least suitable for Ireland, Greece and Spain.

To sum up the literature review, it seems that the single monetary policy and single interest rate determined by the European Central Bank has most probably been the least suitable for the peripheral member states, i.e. the PIIGS countries. Thus, my main hypothesis for this section should be confirmed. In the subsequent subsections, I perform my own analysis investigating the deviations from the Taylor rule.

2.2 Theoretical background - Taylor rule

Taylor rule is a widely used approach when assessing monetary policy. This rule determines the optimal interest rate that is supposed to affect the economy in such a way to maintain inflation on a specific target and output on its potential level. Therefore, it determines what short-term interest rates central bank should set if it wants to keep stable inflation and output. As Geni and Munteanu (2010) state, it is the most common instrument rule that is applied by monetary authorities under inflation-targeting regime.

2.2.1 Specification of the rule

The Taylor rule was developed by John B. Taylor in 1993. In his influential paper, Taylor (1993) mentions the evaluation of few different monetary policy rules performance by several researchers. The researchers evaluated interest rate rules in which interest rates were adjusted in response either to (1) deviations of money supply, (2) deviations of exchange rate, or (3) deviations of inflation and real output from some target. They found that policies responding directly to inflation and output brought the best performance (regarding output and price variability).

John Taylor confirmed this by his own research. His results show that inclusion of real output into the interest rate reaction function (alongside the inflation) works better than pure price rule. Based on these findings, he suggested a policy rule which can be written in the following general form:

$$i_t = r_t^* + \pi_t^* + \alpha(\pi_t - \pi_t^*) + \beta y_t \tag{1}$$

where

i_t is the nominal interest rate at time t,

r_t^* is the equilibrium real interest rate at time t,

π_t^* is the inflation target at time t,

π_t is the rate of inflation over previous four quarters at time t,

y_t is the deviation of real GDP from its potential (i.e. output gap) at time t,

$y_t = \frac{Y_t - Y_t^*}{Y_t^*}$ where Y_t is real GDP and Y_t^* is potential real GDP at time t.

The parameters α and β express the weights which central bank gives to deviations of inflation and output. The higher the α, the stronger the response of monetary policy to deviation of inflation from its target. In other words, the higher the α, the more central bank dislikes instability of price level. Similar explanation applies to the parameter β as well. The higher the β, the stronger the reaction to positive or negative output gap. As Belke and Klose (2011) point out, the parameter α should be greater than one so that the nominal interest rate increases more than inflation rate, leading to growth in real interest rate. This is referred to as Taylor principle. Real interest rate is important for consumption and investment decisions and so a rise in real rate cools down the economy and reduces inflationary pressures.

Taylor (1993) in his original paper suggested $\alpha = 1.5$ and $\beta = 0.5$. However, his suggestion was targeted at the U.S. Fed. For Europe, the coefficients may probably be different. Geni and Munteanu (2010) say that they should be rather set at $\alpha = 2.0$ and $\beta = 0.8$ to reflect higher dislike of inflation in case of the ECB. Of course, there exist many research studies which try to estimate the size of the coefficients for the euro area by employing data.[4] Their results are on average quite close both to the original Taylor's values of 1.5 and 0.5 and to the alternative ones 2.0 and 0.8 respectively.

Simple Taylor rule is a good guideline for interest rate setting. However, central banks often use much more complicated modifications of this rule in reality to be as efficient in conducting the policy as possible. Belke and Klose (2011) describe two basic extensions of the Taylor rule. The first one is the inclusion of smoothing term in the equation. Central banks usually use this extension because they do not want too sharp changes in the rates, but rather to smooth the interest rate movements. That's why the setting is affected also by past values of the rates. The equation is then in the following form (ρ is the smoothing parameter):

$$i_t = \rho i_{t-1} + (1-\rho)[r_t^* + \pi_t^* + \alpha(\pi_t - \pi_t^*) + \beta y_t] \tag{2}$$

Again, there are many research papers investigating the magnitude of the smoothing parameter ρ for the eurozone countries.[5] The estimated magnitude most frequently ranges approximately from 0.6 to 0.9.

The second basic extension is the inclusion of forward-looking perspective. Since the effect of change in monetary policy is delayed to some extent, central bank when setting the rate should take into account levels of inflation and output gap that are expected to occur in future period when the change becomes effective. It means that the current inflation and output gap are replaced by expected inflation and expected gap in the policy rule equation.

2.3 Methodology and data

2.3.1 Form of the Taylor rule

As described above, there are many possible forms of the Taylor rule that can be used, regarding either the basic shape of the equation or size of the coefficients.

[4] Belke and Klose (2011), Eleftheriou (2003), Castelnuovo (2003), Belke and Klose (2009), Gerlach and Schnabel (1999), Adema (2004), etc.

[5] Belke and Klose (2011), Castelnuovo (2003), Belke and Klose (2009), Adema (2004), etc.

As far as the shape is concerned, I use the general form of the Taylor rule, augmented by the smoothing parameter. Specifically, the equation is the following:

$$i_t = \rho i_{t-1} + (1-\rho)[r_t^* + \pi_t^* + \alpha(\pi_t - \pi_t^*) + \beta y_t] \quad (3)$$

The reason for including the smoothing parameter is as follows. Large and sudden changes in policy rates may increase uncertainty on markets and undermine credibility of the central bank. Thus, the central bank wants to maintain continuity of its policy by smoothing the interest rates development (Eleftheriou, 2003). That's why the optimal rates should be driven not only by pure Taylor rule, but also by interest rate smoothing.

In my primary model, I set $\alpha = 2.0$ and $\beta = 0.8$, following Geni and Munteanu (2010). To check robustness, I will also use the original Taylor's coefficients $\alpha = 1.5$ and $\beta = 0.5$ as alternative. Since values resulting from estimation of the coefficients by various researchers are more or less similar to the suggested values, we can assume that the coefficients' magnitudes used here in my analysis are well-working proxies for theoretically optimal values. The assumption is that the coefficients are identical for all euro members.

As far as the smoothing parameter is concerned, I set $\rho = 0.75$, the middle of the interval in which estimated values of this parameter (from existing research studies) lie most often. Nonetheless, I perform the analysis also with the border values, 0.6 and 0.9, to check the sensitivity of my findings to changes in the Taylor rule specification.

The inflation target π_t^* is set to be constant over time and equal to 2 %, which is in line with the principal objective of the ECB (European Central Bank, 2014). Much more tricky issue concerns the equilibrium real interest rate r_t^*, sometimes referred to as real neutral interest rate or natural real interest rate. It is such an interest rate when inflation and output gap are at their targeted and potential level (Laubach & Williams, 2001). It is quite common in literature[6] that researchers fix this variable at $r_t^* = 2$ % (just like Taylor did in his original paper) when using the Taylor rule to analyse monetary policy. Nevertheless, it is highly probable and to some extent also evidenced that the real neutral interest rate is time-varying, not constant over time (Ahrend, Cournéde, & Price, 2008). The problem is that it is not observable, it must be somehow estimated. Horváth (2007) describes several methods how to estimate it. The simplest one is to apply some univariate trend such as Hodrick-

6 See for example Moons and Van Poeck (2008), Srivangipuram (2012), Nechio (2011), Malkin and Nechio (2012).

Prescott filter (HP filter onwards) on real interest rate series. However, results based on this method may be misleading, especially in periods of high inflation volatility. The period from the beginning of the EMU is marked by low and relatively stable inflation. Therefore, the mentioned concern is not so strongly present here. Of course, there are still left some shortcomings of this method of equilibrium real interest rate estimation. As Garnier and Wilhelmsen (2009) mention, it does not necessarily take into account determinants of the natural interest rate. Rather, this way is closer to a pure statistical approach. However, I am convinced that it is more appropriate than to fix the natural rate. It should be obvious especially for the years of the recent economic crisis when the equilibrium rate was most probably much below the 2% level and also much below the level during a couple of years just before the crisis. As a result of these reasons, I have decided to use the HP filter to obtain the equilibrium real interest rates. The same did, for instance, Chetwin and Wood (2013) or Belke and Klose (2011). For better insight, in the Appendix A, you can see differences in the deviations from the Taylor rule when fixed number and when filtered numbers for the neutral rates are used.

The output gap is computed as $y = \frac{Y-Y^*}{Y^*}$, where Y is real GDP and Y^* is potential GDP.[7] The potential GDP is not directly observable, it must be estimated. A conventional way is to estimate it by applying the Hodrick-Prescott filter on real GDP series.[8] I follow the convention in literature and do it in the same way. The smoothing parameter for the HP filter is set to $\lambda = 1600$, a frequently used value for quarterly data.

The HP filter puts a trend through the real GDP time series and the trend is then considered to be the potential GDP. Thus, it is really an easy method since it requires only data about real GDP. As Williamson (2012) remarks, in comparison with using a linear trend, the HP filtering has an advantage that it allows the growth trend to change over time. It most probably happened in a downward direction during the recent economic recession, which is confirmed also by Bullard (2012) for the US case. Nevertheless, there are several quite serious difficulties with the HP filter. Williamson (2012) strongly points out that it is not optimal for measuring potential GDP because the HP filter is a pure statistical procedure and no economics is involved. Further, if we assume that it really captures the potential GDP reasonably well, there are some more shortcomings, stated by Giorno et al. (1995). First, there is

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7 This form of output gap is used, for example, by the OECD or the IMF in their statistical databases. In literature, we can also find the gap being expressed as $\log \mathrm{Y} - \log Y^*$.

8 The HP filter is used, for example, in Srivangipuram (2012) or Belke and Polleit (2007). Fendel and Frenkel (2006) and Belke and Klose (2011) use also linear and quadratic trend to compute the potential GDP (besides the HP filter) to check robustness.

uncertainty what smoothing parameter λ to choose. This parameter determines how smooth is the trend and so it affects the estimated deviations of actual from potential GDP. Second, structural breaks are typically smoothed over by the HP filter. And third, there is the so called end-point problem. The trend can be biased for the first and the last few observations because the filter does not take into account data before and after the studied sample. It could be a serious problem in my analysis since my sample ends in the third quarter of 2013 when some economies are still likely not to have recovered from the recession. That could significantly underestimate the trend output at the end of my sample. I deal with this problem by adding GDP forecasts for a few following quarters (namely for years 2014 and 2015). It is not so precise, but it definitely has some power. To deal with the end-point problem at the beginning of the sample (from the year 1999), I apply the HP filter on data sample starting in the first quarter of 1991.[9]

I do not use any kind of forward-looking form of the rule. It is quite apparent that a central bank when setting the policy rates most probably should take into account forecasted values of the variables because change in monetary policy has an effect on real economy with some lag. However, to discover the appropriateness of the rates for individual countries, I do not use the forward-looking perspective from several reasons. First, I follow convention in the related literature. Second, the forward-looking Taylor rule requires data for real-time forecasts which are highly complicated to collect. Ex-post data cannot be used, to my mind, instead of real-time forecasts for the forward-looking variables because they may differ a lot. For instance, if central bank guesses that there is going to be a high inflation several periods ahead, it amends its monetary policy in a corresponding way and so the actual rate of inflation in that future time will be most probably different from the forecast. And third, most importantly, real-time forecasts of inflation and especially output gap are based mainly on past observations and may be imprecise. On the contrary, using ex-post data for computing output gaps is much better since not only past but also some future realizations of output are available and are precise (not guessed or estimated).

The issue of choice between ex-post and real-time data for evaluating monetary policy rules is a subject of substantial debate. Orphanides (2001) says that ignoring the so called informational problem[10] and using ex-post revised data may lead

[9] For Spain, Portugal and Luxembourg, the data starts in 1995Q1, for Ireland in 1997Q1 and for Greece in 2000Q1.

[10] The informational problem means that central bank has only limited information about future development of economy (and so about future inflation and output gap) needed for determining monetary policy.

to significant biases in findings. However, as mentioned above, I reckon that using ex-post data is more suitable for computing the deviations of interest rates from optimum because these data (for inflation and especially for output gap) should be much closer to the truth. Nevertheless, applying real-time data into the analysis instead of the ex-post data could be a subject to further research.

2.3.2 Measurement of the problem

After computing the theoretical interest rates prescribed by the Taylor rule, using the equation (3), I derive deviations from the Taylor rule. The deviations are expressed as a difference between the Taylor-based rates and actual nominal interest rates for each point in time. In other words, the deviation is defined as the Taylor-based rate less the actual nominal rate. It means that if the deviation is positive, the corresponding country would need higher interest rate. If the deviation is negative, the opposite is true.

For the actual nominal interest rate in the euro area, I use the Eonia rate.[11] It is equivalent to the US Federal Funds Rate which Taylor (1993) counted with when compiling his rule. The Eonia rate together with Euribor rates of various maturities are the most important reference rates in the euro area money market as they further determine price of other financial products. These interbank rates are directly affected by the ECB's official nominal interest rates and so they are useful when investigating how monetary policy is transmitted into the markets.

Further, I need to compute theoretically desired interest rate (based on the Taylor rule) for the euro area as a whole to check whether the actual interest rate follows the theoretical prescription. According to Moons and Van Poeck (2008), the Taylor-based interest rate for the euro area can be expressed as a weighted average of the Taylor-based rates for the individual member states where the weights are shares of the countries' nominal gross domestic product (GDP) in the GDP of the whole eurozone. In other words, the eurozone Taylor-based rates are computed as follows:

$$i_{euro,t} = \sum_{i=1}^{n} \left(i_{i,t} * \frac{GDP_{i,t}}{GDP_{euro,t}} \right) \tag{4}$$

where $i_{i,t}$ is the Taylor-based rate for member country *i* at time *t*, computed by the equation (3) stated above. Then, I can compare these values to the Eonia rate.

[11] The Euro Overnight Index Average (Eonia) is the effective overnight reference rate for the euro, computed as a weighted average of all overnight unsecured lending transactions in the interbank market (Euribor-EBF, 2012).

To assess the appropriateness of the ECB's rates for individual members, I follow a methodology by Moons and Van Poeck (2008). For each country, I compute the so called root mean squared interest rate gap, defined as:

$$RMSIG_i = \sqrt{\frac{\sum_{t=1}^{T}\left(i_{i,t} - EONIA_t\right)^2}{T}} \tag{5}$$

where $i_{i,t}$ is again the Taylor-based rate, $EONIA_t$ is the Eonia rate at time t and T is the total number of periods. The higher is the root mean squared interest rate gap, the less was the actual nominal rate suitable for the country on average throughout the monitored period of time (notice that this measure does not specify sign of the deviations).

To specify the 'direction' of inappropriateness of the ECB's monetary policy for individual states, I compute another indicator, following Moons and Van Poeck (2008). The indicator is the so called mean interest rate gap, defined as:

$$MIG_i = \frac{\sum_{t=1}^{T}\left(i_{i,t} - EONIA_t\right)}{T} \tag{6}$$

with the same variables as in the $RMSIG_i$.

Unlike the root mean squared interest rate gap, the mean interest rate gap can be negative. It expresses the average difference between the Taylor-based rate and the actual nominal interest rate (the Eonia rate) for every single member country.

2.3.3 Data

The data is quarterly, from the first quarter of 1999 (the beginning of the European monetary union) to the third quarter of 2013.

The Taylor-based rate for the whole eurozone takes into account changing composition of the union. In the first two years, there are eleven countries included (Germany, France, Italy, Belgium, the Netherlands, Luxembourg, Ireland, Spain, Portugal, Austria and Finland). Greece is added in 2001 when it entered the eurozone. Slovenia is there from 2007, Malta and Cyprus from 2008, Slovakia from 2009 and Estonia from 2011. The newest member of the euro area, Latvia, entered in 2014 and so it is not included in the dataset.

Data for nominal GDP is taken from the Eurostat database and transformed into real GDP using GDP deflator. Inflation is based on the CPI index and taken from the OECD database.[12] Real interest rates are computed as 3-month money market rates less inflation rates. The Eonia rate figures are from the ECB statistics (quarterly frequency, average of observations through the period).

2.4 Deviations from the Taylor rule

2.4.1 Deviations for the whole euro area

To get a broader picture, let's check first whether the actual interest rate has been in line with the Taylor rule for the euro area as a whole.

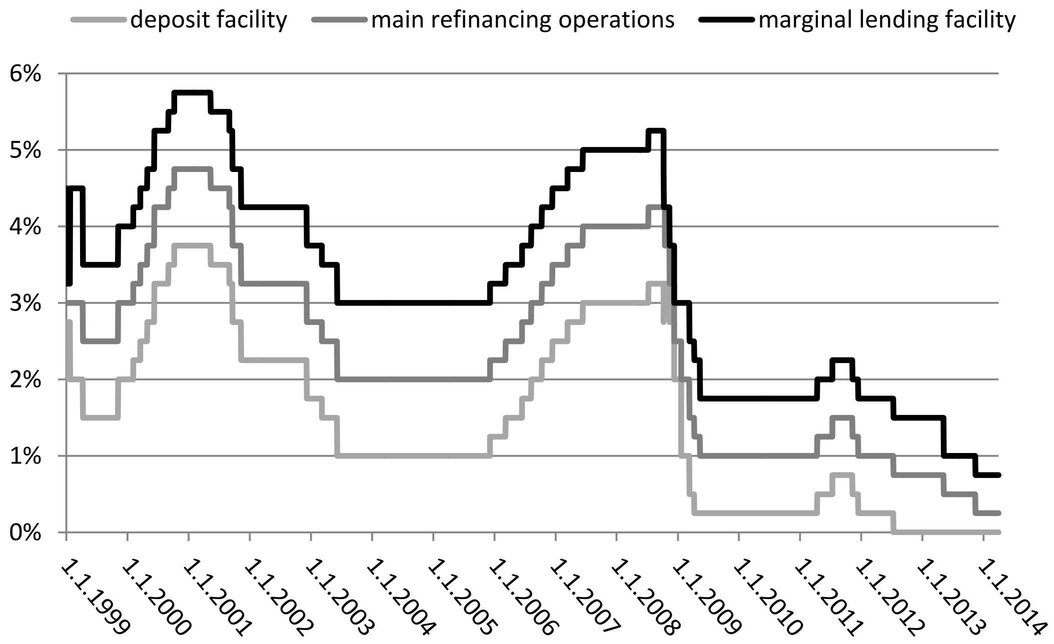
The primary objective of the ECB's monetary policy is to maintain price stability in the whole euro area in medium-term horizon. The ECB conducts its policy in order to target inflation rate at levels below, but close to 2 %. In addition, the ECB should also support economic policies in the euro area to avoid excessive fluctuations in output and employment, but only if it is in line with its primary objective. In achieving the fundamental objective, it uses a typical set of monetary policy instruments, comprising open market operations, standing facilities and minimum reserve requirements for credit institutions (European Central Bank, 2014).

The ECB sets three key nominal interest rates through which it affects interest rates on interbank market and, consequently, the whole real economy. In Figure 1, you can see the development of the three key rates from 1999. The adjustments more or less copy economic cycles since the bank tries to minimize impacts of boom and bust periods and maintain price level and also output stable.

The deposit facility and marginal lending facility interest rates form the lower and upper bounds for interest rates on the interbank market, the rates at which banks and other financial institutions lend to each other. Thus, the interbank market rates should more or less go in line with the central bank's nominal interest rates. Consequently, the interbank rates determine interest rates on customers' deposits, consumer loans, etc. These rates together with expected inflation are important for consumption and investment decisions and so their changes affect economic activity.

[12] Since Malta and Cyprus are not members of the OECD, their data for inflation is taken from the Eurostat.

Figure 1: Development of the ECB's key nominal interest rates

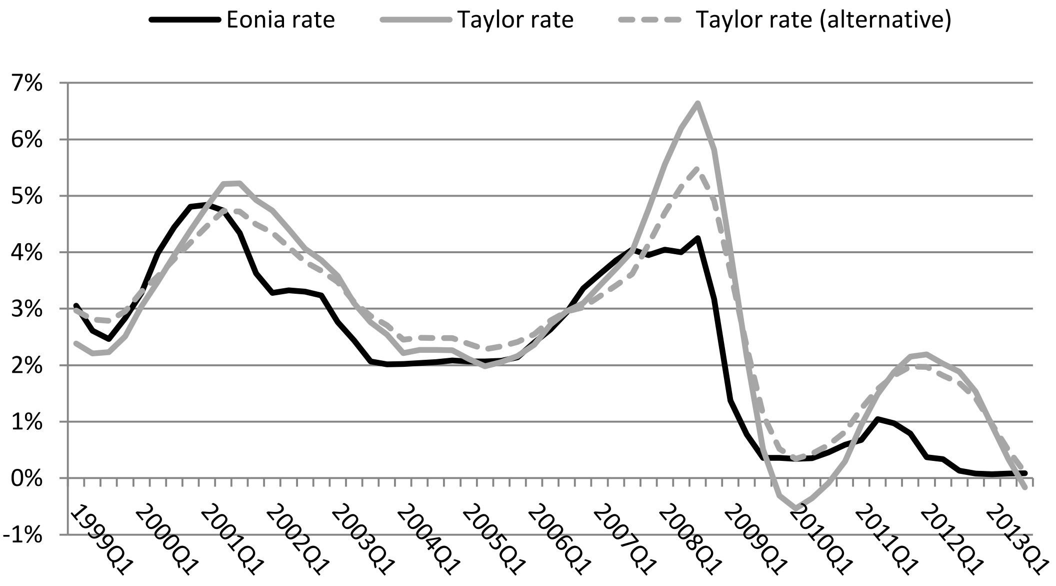


Source of data: ECB

To assess the optimality of the nominal interest rates prevailing on markets (and thus the optimality of the ECB's monetary policy), I need to compare the Eonia rate with the theoretically suitable rate for the euro area, computed by equation (4). Such a comparison is depicted in Figure 2. The 'Taylor rate (alternative)' curve is a plot of rates computed from the rule with coefficients of 1.5 for inflation and 0.5 for output gap.

We can see that in the first two years, the market nominal interest rate was slightly above the prescribed level. On the contrary, from 2001 to 2004 it kept below, suggesting too loose monetary policy of the ECB. During the years 2005 and 2006, both rates were more or less in compliance, but several quarters prior to the start of the crisis, the nominal rate should have been higher to cool economies down. For period of the deepest crisis, the Taylor rule recommended even negative rates, which is not possible in reality. From 2011, the ECB should have raised the rates more thanks to recovery mainly in core member states. However, this step would probably have been highly controversial and criticised since the recovery was very fragile. Regarding the alternative form of the Taylor rule with the original size of the coefficients, the result is very similar. The only difference is that the curve is a little bit smoother.

Figure 2: The Eonia rate vs. the Taylor-based optimal rate for the euro area



Source of data: ECB, Eurostat, OECD

The results correspond to existing literature. Most of studies have evidenced that at the beginning of the EMU, the rates were too tightening, followed by the opposite situation during several subsequent years. As I have already written in the literature review section, the 'below Taylor period' in 2001-2005 found, for example, Ahrend, Cournéde and Price (2008) or Nechio (2011). Movement of the two rates in the latter paper is comparable to my analysis also for the years just prior to and during the crisis. Sizes of the recommended rates slightly differ, which is probably caused by different specification of the policy rule used. For example, the recommended rate reached approximately 5 % just prior to the crisis, whereas in the deepest crisis around the year 2009, the recommendation fell to roughly 0.5 % (Nechio, 2011). My computations show numbers of 6.6 % and -0.5 % respectively as the two extreme values before and during the crisis. Comparison for the recent years can be done with the study by Darvas and Merler (2013). Their recommendation for the year 2012 moved around 2% level and in the first half of 2013, it fell to approximately 0.4 %. My results are in line with them.

By all means, there are several potential drawbacks of this simple analysis. First, it is the method of computing the euro area Taylor-based optimal rate. It is only a suggestion to consider it as a weighted average of the individual members' amounts. Or, maybe the weights should be in a different form, not related just to GDP. Nevertheless, if we compute the Taylor rate for the euro area from the equation (3), using data for inflation and output gap for the eurozone as a whole, we come to almost the same shape of the paths. The only slightly bigger difference is at the very beginning of the period when the second way of computation recommends even lower interest rates.

Some other potential drawbacks stem from the form of the Taylor rule and are already described in previous sections. To repeat them briefly, there can be objections to size of the coefficients or to the HP filter method used to obtain the equilibrium real interest rates and potential GDP.

All in all, the actual interest rate development has not perfectly complied with the path prescribed by the Taylor rule in the form used in this analysis. The deviations are evidenced in 2001-2004 and especially in the years just before and from the recent Great Recession. In the next subsection, I study how much the ECB's single monetary policy has fitted the needs of individual member states.

2.4.2 Deviations for individual member states

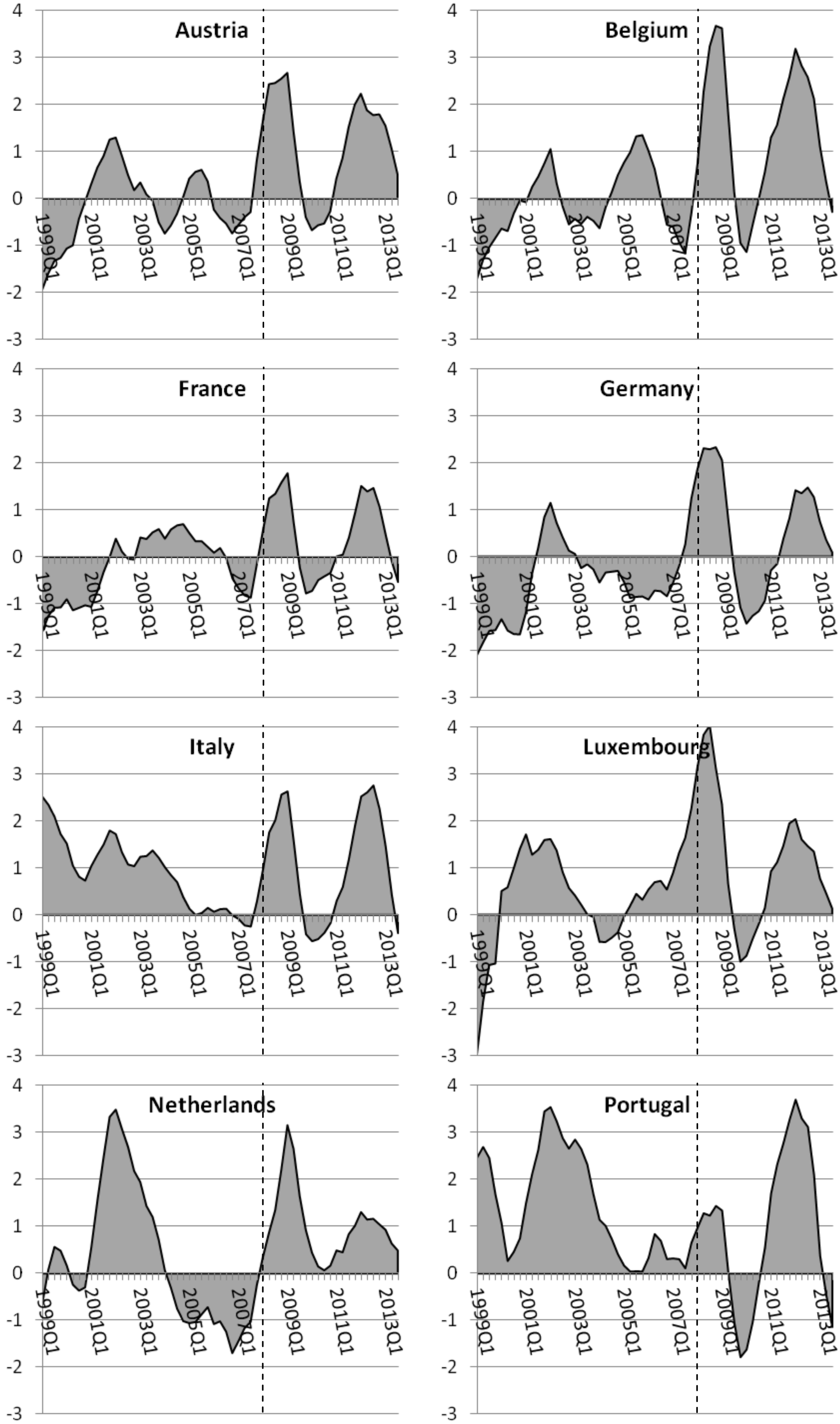
Once again, the central hypothesis for this section is that needs of the PIIGS countries were fulfilled the least. In other words, the theoretically optimal rates for these countries were moving farthest from the actual nominal interest rates.

At first, let's look at simple deviations of actual interest rates from the desired rates. The deviations are defined as the Taylor-based rate minus the Eonia rate. The figures for the oldest twelve euro members are displayed in Figure 3 and Figure 4.[13] The dashed lines show the boundary between the years 2007 and 2008, expressing approximately the boundary between pre-crisis and crisis period.

Regarding firstly the pre-crisis period, there are several countries for which the deviations oscillate closely around the zero line. It is apparent primarily for Austria, Belgium and France. For them, the single monetary policy of the ECB seems to have fitted the best. Further, it can be seen to some extent also for Germany, Luxembourg, the Netherlands and Finland. However, Germany and Finland have the areas below zero bigger than above zero, indicating that for them the policy rates were probably a little bit more tightening than optimal prior to the crisis. For Luxembourg and the Netherlands, the opposite is true. The curves oscillate around the zero line, but the areas in positive values dominate.

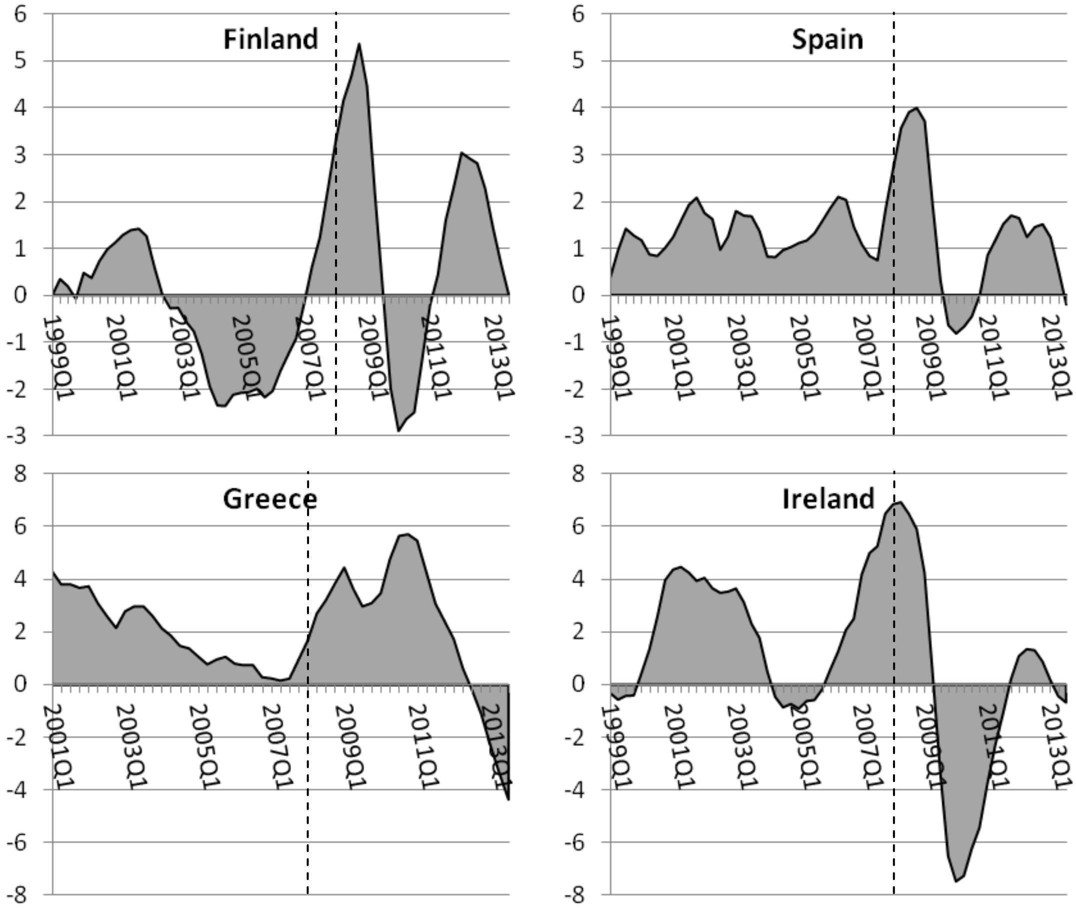
[13] Notice that in Figure 4, the vertical axes may have different scale. Thus, be careful when comparing.

Figure 3: Deviations from Taylor (in pp)



Source of data: ECB, Eurostat, OECD

Figure 4: Deviations from Taylor (in pp) – cont.



Source of data: ECB, Eurostat, OECD

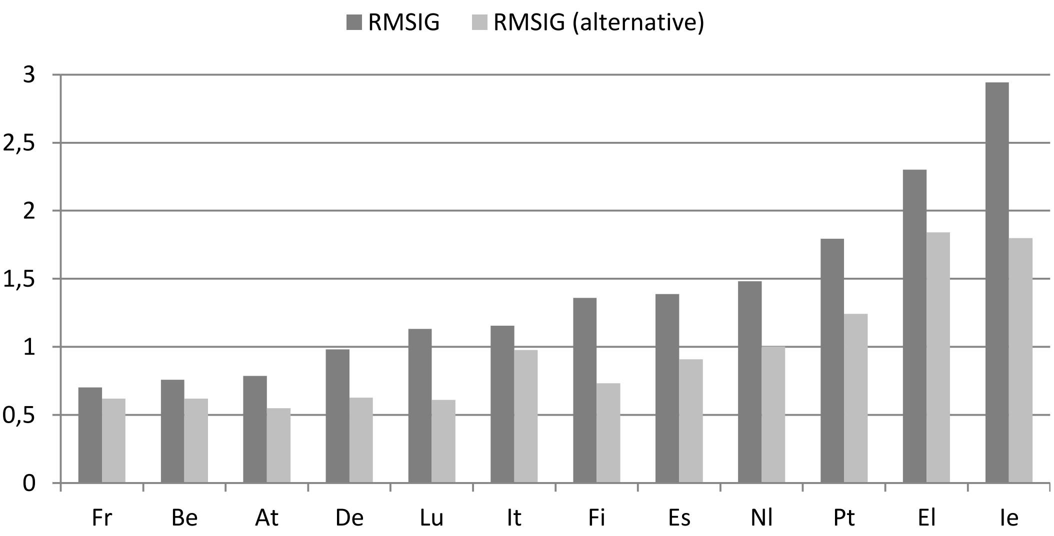
On the contrary, the deviations for all the PIIGS countries kept constantly above zero prior to the crisis (with small exceptions), which says that the policy rates were too low all the time. For Greece, Ireland and Portugal at the beginning of the 21st century, the deviations were very high in comparison to the others.

As far as the crisis and post-crisis periods are concerned, the deviations are much higher both to the positive and to the negative direction. For all states, we can see a huge rise in the deviations size around the years 2007 and 2008, followed by a huge drop to negative values. The only exception is maybe Portugal where the rise is not so big, and especially Greece where the huge drop began as late as in 2011. The Greek Taylor-based rates kept high in 2010 due to bigger inflation rates.

Now, I perform an analysis of appropriateness of the ECB's policy based on the two indicators stated by equations (5) and (6), the root mean squared interest rate gap and mean interest rate gap. Figure 5 shows the RMSIG for the twelve euro states for the pre-crisis period from 1999Q1 to 2007Q4. This period is marked by much less turbulent economic development and so the potential drawbacks of the used methodology are likely not to cause big difficulties. Therefore, the results for this sub-period are more credible. Again, the 'RMSIG (alternative)' displays figures using the original size of the Taylor rule coefficients.

The highest RMSIG is found for Ireland, which indicates that the single interest rates in the eurozone were on average the least suitable just for this country before the crisis. Then, in descending order it is Greece, Portugal, the Netherlands, Spain, Finland, etc. The last member of the PIIGS group, Italy, lies in the middle. On the other side of the scale, there are France, Belgium and Austria. That corresponds to what I have written in the description of Figure 3. As far as the alternative specification of the Taylor rule is concerned, the values are smaller, but the order is not so different. Perhaps, a mentioning-worthy change is that the highest inappropriateness is now found for Greece and Ireland equally, and Italy has moved a little bit to the right.

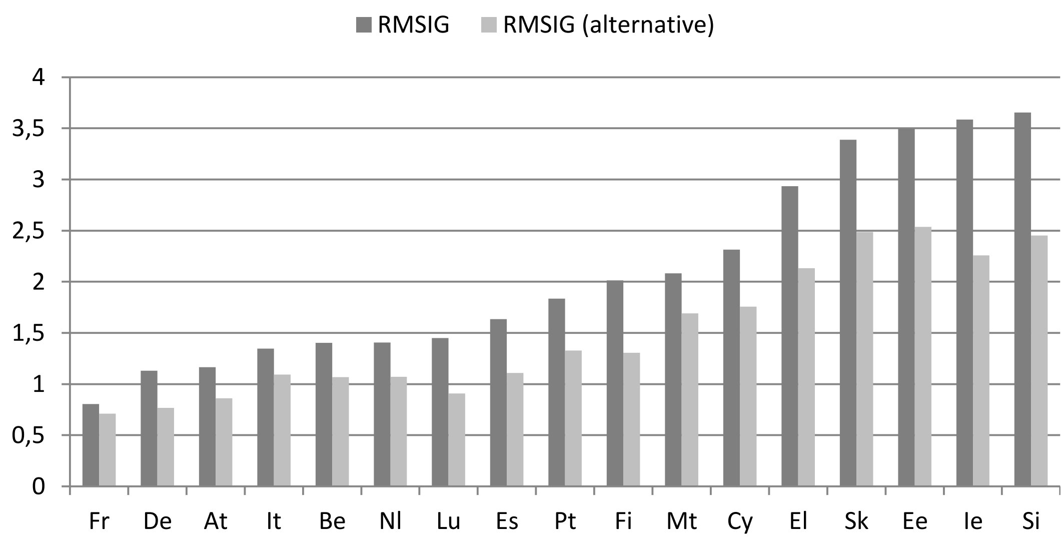
Figure 5: Root mean squared interest rate gap 1999Q1-2007Q4 (in pp)



Source of data: ECB, Eurostat, OECD

To complete the RMSIG analysis, Figure 6 comprises the computed values for the whole time span 1999Q1-2013Q3 for all euro area member states (except for Latvia which entered only in 2014). Now, the picture has changed a lot. The largest gaps are found for the new euro members. Ireland and Greece are still there on the right side of the scale, but Portugal and Spain are now in the middle and Italy even has the fourth lowest average gap. However, these findings may be very misleading since the new members comprise data only for the crisis period and the crisis has changed the world significantly. From Figure 3 and Figure 4, it is obvious that the deviations were larger in the second sub-period and just this fact contributes significantly to the order in Figure 6. Some more time is needed to be able to credibly evaluate the appropriateness of the single monetary policy for the new member states.

Figure 6: Root mean squared interest rate gap 1999Q1-2013Q3 (in pp)



Source of data: ECB, Eurostat, OECD

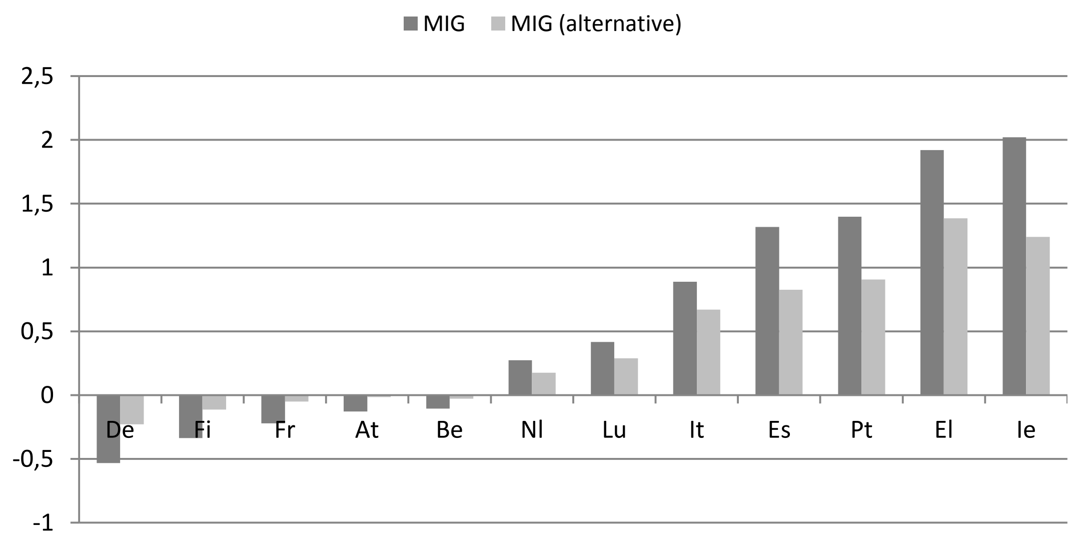
In order to discover signs of the average deviations, I compute the mean interest rate gap, defined by the equation (6). This indicator shows whether the actual nominal interest rate was on average too low (in case of positive MIG) or too high (in case of negative MIG) for a particular country. To examine the results for the pre-crisis period, see Figure 7.

At first sight, we can see that some countries are below zero, some are above, but the positive values obviously dominate. It could lead to a conclusion that the ECB kept interest rates too low on average and so most member states were deeply below their optimal levels. It could also indicate that the central bank rather allows overheating somewhere, not to depress economies somewhere else by too tightening policy.

Taking a closer look, what else does Figure 7 say? Five out of twelve states are in negative values of the mean interest rate gap, namely Germany, Finland, France, Austria and Belgium. In case of the two named first, the gap downwards is the biggest. It is basically in compliance with the findings from Figure 3 and Figure 4 where the areas below zero for these two countries clearly dominate. To particularize, Germany needed on average half a percentage point lower interest rates prior to the crisis. Close to the zero line, there are France, Austria, Belgium and the Netherlands. Together with the findings from Figure 5, we can conclude that for France, Austria and Belgium, the actual nominal interest rates were the most suitable on average and prior to the crisis. On the contrary, in case of the Netherlands, the mean is close to zero, but quite high RMSIG points out on large variance of the deviations.

Places on the right side of the scale are occupied by all the five PIIGS countries. It is due to large and constantly positive deviations till the year 2007. Ireland has the highest value of the MIG. Specifically, it needed on average two percentage points higher interest rates than the ECB maintained. Greece is also close to two percentage points gap. Portugal and Spain are between 1.0 and 1.5 and Italy is almost on 1.0.

Figure 7: Mean interest rate gap 1999Q1-2007Q4 (in pp)



Source of data: ECB, Eurostat, OECD

Extending the time span and number of member states again changes the picture significantly. Similarly to the graph with the RMSIG, the highest gaps are found for the new member states plus Greece and Spain. This time, Ireland is in the middle with the average gap of approximately one percentage point. The interesting thing is that the only one in negative values is Germany. All the others are above zero. Checking the individual deviations depicted in Figure 3 and Figure 4 helps a lot in clarifying it.

Further, it is also relevant to ask whether the deviations are decreasing in time. Based on the results provided above, it does not seem so. Of course, we would need longer time period to evidence it more powerfully. In addition, the recent economic recession has disrupted the development substantially. However, the deviations from optimal interest rates definitely do not contribute to stabilizing the economies. As a result, the extent of inappropriateness may persist a long time, although it fluctuates sometimes.

To sum up this section, my findings quite strongly confirm one of the central hypotheses of this Thesis, namely that the single monetary policy of the ECB was the least suitable for the PIIGS countries prior to the crisis. Maybe, I can exclude Italy from this statement, but for Ireland, Greece, Portugal and Spain, it definitely holds. These findings are more or less in line with the existing literature, covered above.

In the next section, I describe potential consequences of the non-optimality of the ECB's policy. I provide also some stylized facts to see whether these consequences are relevant in reality.

3 Credit expansion

To explore what are the consequences of inappropriateness of the single-size interest rate policy, I will focus mainly on the boom period prior to the crisis. To my mind, it is much more important to study how and why the system does not work in relatively normal favourable times than in turbulent times. The reason for this opinion is that economic crisis often turns various theories on the head and obstructs mechanisms which normally work. To mention an example, Smaghi (2011) stated that the crisis had led to possible huge differences in monetary policy transmissions among the individual member states of the eurozone. Such differences cause significantly different effects of single monetary policy and, consequently, they contribute a lot to economic performance differentials. In economic crisis, interest rates as the basic monetary policy tool of central banks have more difficulties in affecting the real economy, and especially in a monetary union composed of very heterogeneous countries. Thus, we cannot indeed blame the single monetary policy for not working properly during such a deep recession as we have experienced recently. The situation is diametrically different in economically favourable times. If the monetary policy contributes to creation of malign macroeconomic imbalances, we should address it and try to fix it.

Now, what in fact are the potential consequences of the “One size doesn’t fit all” problem? There is quite nice brief description of them by De la Dehesa (2012). The eurozone was and still is a group of heterogeneous countries. There are differences in growth rates, inflation rates, productivities. Flexibility of labour and product markets varies and the national economies do not have similar structure. As De la Dehesa (2012) writes, this fact may lead to divergent price development, i.e. inflation differentials. Since there is a single-size interest rate common for everyone in a monetary union, the inflation differentials create a divergence in real interest rates across the member states.

Just the real interest rate, not the nominal one, is the decisive variable for households’ consumption behaviour and firms’ investment decisions. According to Fisher equation, real interest rate is equal to nominal rate less expected inflation. The nominal rate is the same for all countries in a monetary union, but inflation rates and thus probably also expected inflation rates vary. Countries with higher levels of inflation experience lower real interest rates, which may cause a bigger credit growth and domestic demand. Increase in domestic demand usually leads to higher economic growth and lower unemployment, but also to further rise in inflation. Wages may grow faster than productivity of workers, leading to loss of competitiveness. Import increases because of high demand, export decreases because of the loss of competitiveness. Therefore, current account balance deteriorates, external debt soars. Huge macroeconomic imbalances accumulate, country is overheating. In the second case, countries with lower levels of inflation may go through the opposite experience.

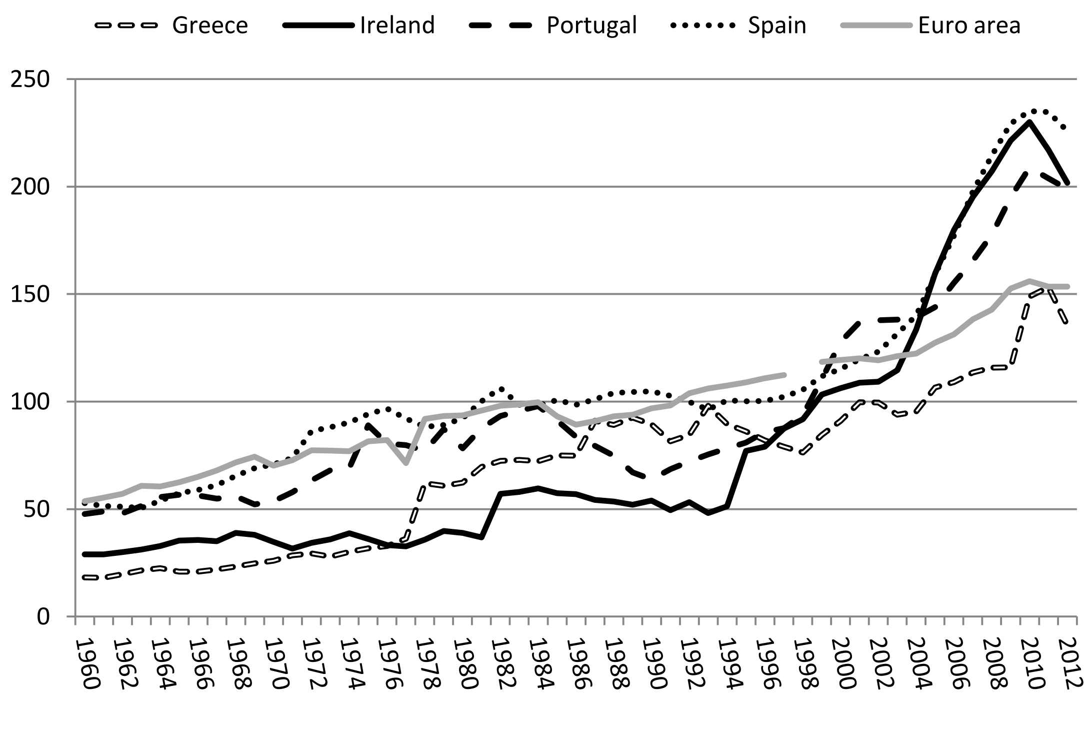
3.1 Stylized facts about credit expansion

What has happened in reality during relatively short life of the eurozone? The first couple of years were marked by high economic growth basically in all member states. The European Central Bank kept its policy rates high to keep inflation under control. In October of the year 2000, the main refinancing rate reached a level of 4.75 % and stayed there till May 2001. But then, an economic slowdown spread from the USA also to Europe. It hit especially Germany, France and Italy, three largest economies of the euro area. In Germany, GDP even decreased a bit in 2003. Since the ECB sets its rates according to weighted inflation and growth rates of all members and the weights are connected to national shares in total eurozone's GDP, the central bank had to significantly reduce its policy rates (De la Dehesa, 2012). The main refinancing rate dropped from the mentioned 4.75 % in 2001 to 2.00 % in June 2003, staying there till December 2005.

This policy measure probably helped the big countries to get out of trouble, but it most likely contributed significantly to strengthening of boom in fast-growing states with higher inflation, particularly Ireland, Greece and Spain. The result was that their real interest rates fell even below zero in between 2002 and 2005 as nominal rates were pushed down by the ECB's policy change. As already mentioned, the real interest rate is the decisive rate for economic agents' behaviour and decisions. Thus, it was indeed justified that in such favourable economic times, households started to borrow money in order to buy houses and other assets or just to consume goods. Firms had a bigger tendency to take loans to make investments and spread their production or other activities when real cost of borrowing was very low or negative. In other words, the single monetary policy may have contributed to stronger credit expansion.

Looking at the data plotted in Figure 8, we can see that there really was a huge credit boom in Ireland and Spain. In the Spanish case, a rapid increase in the volume of provided credit relative to GDP began just around the years 2002 and 2003 when there was the mentioned drop in the main policy rates of the ECB. The value jumped from approximately 123 % in 2002 to more than 235 % in 2010. As far as Ireland is concerned, there was a short rapid growth of the ratio in the middle of the 1990s, followed by a small calming of the pace. But then, since 2003 the indicator rocketed again until the Great Recession emerged. The provided credit accounted for 109 % of GDP in 2002, while in 2010 it climbed to 230 %. In Greece, the development of this indicator was not so dynamic as in Spain and Ireland. Portugal also experienced quite steep increase in the value. However, it was caused especially by low economic growth (credit growth was only average, as you will see further in the text). The last PIIGS member, Italy, did not experience an extraordinary credit development, it was more or less in line with the whole euro area and so the curve for Italy is not included in the graph.

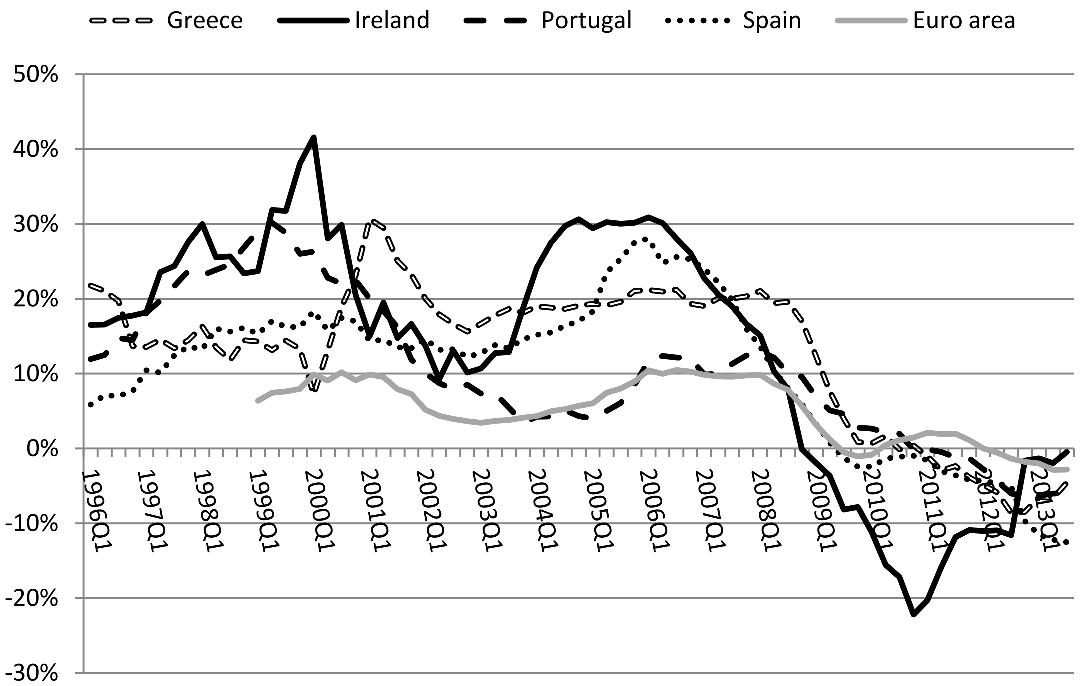
Figure 8: Domestic credit provided by banking sector as % of GDP (annual)



Source of data: The World Bank

From the next graph in Figure 9, it is obvious that growth rate of credit volume in some of the PIIGS countries was much higher than in the whole eurozone before the recent economic recession. The exception is Italy with a pace of credit growth comparable with the eurozone's one and to some extent also Portugal where the pace was higher, but then declined to the average around the year 2003. In Ireland, Greece and Portugal there were strong credit booms in years around entering into the EMU when their economies were adjusting to lower-rates environment. Then, there was a calming down followed by another strong credit boom mainly in Ireland and Spain around the years 2005 and 2006.

Figure 9: Annual growth rate of credit to private nonfinancial sector (quarterly)



Source of data: BIS

From the two charts above, it is quite obvious that there was a significant credit expansion in some of the PIIGS countries, whatever were the reasons. Now, it is also important to mention what may be the consequences of that.

3.2 Consequences of credit boom

Credit expansion definitely leads to higher domestic demand. Households borrow cheap money to consume more, firms take loans to invest in production extension, and also governments may take advantage of low interest rates to increase their expenditures. According to basic economic theory as well as common sense, this all leads to higher economic activity and, thus, higher economic growth. It is the positive side of credit expansion. Nonetheless, if the credit expansion is too large and unsustainable (which undoubtedly was at least in Spain and Ireland prior to the crisis), then it is likely to bring highly negative consequences.

An unsustainable boom in domestic demand improves economic growth, but it also may keep inflation above some optimal level. Price level growth usually pulls also wage growth, especially in rigid labour markets, seen in most European countries. Wages then may rise faster than productivity of workers, implying loss of country's competitiveness (Wenkel, 2012; The Economist, 2009). The loss of competitiveness reduces export, which together with increase in demand for imported goods raises current account deficit.

Furthermore, every new credit implies an increment to indebtedness. It increases risks on markets since there is a bigger probability of companies' defaults or bigger probability of non-performing loans. The latter may be strengthened by one additional factor, big share of the so called Adjustable Rate Mortgages. Garcia-Herrero and Fernández de Lis (2008) pointed out a significant characteristic of credit boom in Spain, namely a 98% share of the Adjustable Rate Mortgages in total stock of mortgages. This fact may get the debtors into troubles in case of interest rate increases. Moreover, domestic banks usually finance the magnified demand for credit to a significant extent by loans from abroad since domestic deposits do not reach a sufficient level.[14] Thus, the system is highly dependent on inflow of foreign capital, making the countries vulnerable in case of capital inflows freezing. High indebtedness is likely to deteriorate the situation in crisis period because financial markets reduce their confidence in the countries, leading to higher spreads and lower ratings (De la Dehesa, 2012). Therefore, debt burden of the debtors jumps further. The recent crisis has confirmed it.

I must mention one more possible negative consequence of the credit boom, namely the emergence of a housing bubble. This consequence came into reality mainly in Spain and Ireland, agreed for instance by Smaghi (2011), The Economist (2009) or De la Dehesa (2012). Regarding Ireland, the boom in house prices began already in the mid 1990s. The whole country average price of second-hand houses was around 85,000 euro in 1996, while in 2007 it reached a peak of almost 378,000 euro, an increase by 345 % in eleven years.[15] As far as Spain is concerned, average price per square meter jumped from 930 euro at the beginning of 2001 to 2,101 euro

[14] A development of deposits compared to credits is nicely described, for example, by Garcia-Herrero and Fernández de Lis (2008) for Spain and by Kelly (2009) for Ireland.

[15] Data obtained from Department of the Environment, Community and Local Government (2014). A good brief description of Irish housing bubble is in Kelly (2009) or Hay (2009).

in the first quarter of 2008, equalling to 126% increase in seven years.[16] Another important characteristic was a massive oversupply of new dwellings. According to Garcia-Herrero and Fernández de Lis (2008), the number of dwellings built in Spain exceeded, in some years, new construction in Germany, France, UK and Italy combined. To put it in figures, in 1990-1996 the average number of housing starts was 240,000 annually, whereas at the beginning of the 21st century it jumped to more than 500,000 and continued to grow to reach a peak of 760,179 housing starts in 2006. One million new properties, accounted for 20 % of the total housing stock in 2009, remained unsold (Global Property Guide, 2012).

Why is a housing bubble bad? First, rising residential prices obviously raise indebtedness of home-buyers since they must borrow more and more money to be able to purchase the property. Second, the price development during the bubble is undoubtedly unsustainable and a steep downward correction is basically inevitable. Unfortunately, the decline largely reduces value of the properties, usually used as collateral to credits, resulting in serious troubles for the debtors as well as for the banks. Third, although it temporarily fuels economic growth, the bubble substantially contributes to emergence of imbalances. Due to immense demand, big portion of investments goes to non-productivity-improving construction sector. The shares of housing investments in Ireland and Spain in 2005 were 14 % and 9 % respectively, far above relatively normal 5 % - 6 % in Germany or France (Conefrey & Fitz Gerald, 2010). It makes the economies too dependent on this sector and largely vulnerable in case of housing and construction bust. Moreover, the development of other sectors may lag behind because of crowding out effect. And fourth, the increasing significance of construction sector attracts many low-skilled workers from abroad, especially from developing countries, opening a risk of social tensions. The situation may get even worse in crisis when many of the workers must be fired and are not able to find another job.

[16] Source of data: BIS

4 Impact of the deviations from Taylor rates on credits volume

In this section, I am trying to assess the impact of the deviations of actual interest rates from the Taylor rule prescription, described in previous sections, on the volume of provided credits. At first, I provide a literature review on the impact and, generally, on determinants of credit growth. Subsequently, I employ an econometric technique on data for euro countries to draw some findings.

What are theoretical expectations about the impact? Interest rate can be considered as a price of credit, or a price of money. The Taylor rule should express optimal interest rate to keep inflation and output stable. If the actual interest rate is below the Taylor benchmark, it is too low, money is too cheap, which should lead to higher credit growth. On the contrary, if it is above, money is too expensive, leading to lower credit growth.

The central hypothesis is that there is a positive impact of the deviations on credit. In other words, the higher the deviations (in terms that the actual rate is more and more below the prescription), the bigger should be the credit growth.

4.1 Literature review on determinants of credit growth

There is a wide range of research papers studying the determinants of credits volume growth. They usually include output growth, interest rate, GDP per capita and inflation as the main drivers of credits. However, the issue concerning the impact of deviations from the Taylor rule on credits volume is not covered so extensively. Although there is quite a lively debate about it, especially in recent years, there are only few works testing it using some sophisticated econometric methods.

Ahrend, Cournéde and Price (2008) looked at the influence of the deviations, but only using a simple graphical representation of correlation between the deviations and various measures of housing activity (such as house loans, house prices or construction investments). They found that “below Taylor” episodes often coincide with strong increases in mortgage credit as well as total credit to private sector. Nonetheless, they also concluded that there were number of cases of credit or housing booms in period when actual interest rates were not below what the Taylor rule prescribed. The roots were probably in financial innovations and liberalization. The summary of their results can be that "below Taylor" states probably contribute to build-up of financial imbalances, but they are not a necessary condition.

Kahn (2010) did an analysis for the United States of America. Similarly like me, he also computed deflections from the Taylor precept to find out whether interest rates were optimal or not. Then, he estimated the effect of them on asset prices and other financial imbalances indicators. In addition to the deviations, also the Taylor prescriptions themselves were included in the regression to distinguish between effects of prescribed interest rates changes and changes in the deviations. His findings say among others that the Taylor rule deviations did help predict housing prices growth. Kahn also mentioned findings of John Taylor who concluded that the housing boom in the USA in the first decade of the 21st century would not have been so strong if the federal funds rate had followed Taylor rule prescriptions. Ben Bernanke, the Fed's Chairman, objected to this opinion by claiming that the strong asset price appreciation was caused mainly by extensive capital inflows from emerging markets.

This conflict is being solved by Merrouche and Nier (2010) who tried to discover contributions of capital flows, too loose monetary policy and poor supervision and regulation on build-up of financial imbalances (expressed by the ratio of bank credit to deposits, ratio of bank credit to GDP and some more). Both for OECD countries and only for the eurozone members, they found[17] that capital flows had a strong impact on build-up of the imbalances, whereas deviations from Taylor rule benchmarks not. Furthermore, they split the period into bust regime (1999-2002) and boom regime (2003-2007). For the boom the results are unchanged, for the bust period most variables lost significance.

As Lin and Treichel (2012) remind, introduction of the euro promoted financial integration in the eurozone, triggering large capital flows from core to periphery. Moreover, interest rates fell sharply in relatively high-inflation states, which led to significant increase in consumer lending. This together with financial deregulation and innovations contributed to growth of imbalances, particularly in the PIIGS countries.

To repeat again, there are many research studies about credit growth determinants. They use various data samples, time periods or explanatory variables. They employ various econometric techniques for estimation. On several lines below, I mention some of them.

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[17] Using panel data regressions for data from 1999-2007.

Kiss, Nagy and Vonnák (2006) estimated effects on credit to nominal GDP ratio, using error-correction framework and pooled mean group estimator. Their data sample consists of yearly 1980-2002 data for twelve euro countries. Various explanatory variables were tried in alternative models. Three of them were always significant – GDP p.c., inflation and short real interest rate. The coefficients on the real rate and inflation rate have negative signs, the opposite is true for the per capita GDP.

Égert, Backé and Zumer (2006) also took private credit to GDP ratio as the dependent variable. The baseline specification comprises GDP p.c., nominal lending rates, inflation, credit to public sector and financial liberalization indicator (spread between lending and deposit rates). Then, they add or replace some of them to check robustness. The estimation was carried out for 43 countries, composed of OECD states and also some emerging states. Their results are somewhat mixed for some variables for different countries. As far as the interest rate is concerned, in most states the nominal lending rates turned out to be negatively linked to private credit.

Data for six Pacific region countries from 1982-2009 were collected by Sharma and Gounder (2012) to discover drivers of bank credit to private sector. They included six regressors, namely lending rate, GDP, inflation, bank deposit to GDP, bank assets to GDP and a dummy for existence of stock market. GMM method was utilized to deal with possible endogeneity. Among others, they found that lending rate is negatively correlated with the credit to private sector (result highly significant).

Relationship between real loans to private sector and real interest rate was studied, for instance, by Hofmann (2001) and Brzoza-Brzezina (2005). The former incorporated 16 industrialized countries for 1980-1998, the latter only Ireland, Portugal and Greece from early 80s till 2004. Both authors evidenced a negative impact of real rates on real lending.

Slightly different approach was done by Guo and Stepanyan (2011) who used growth rate of credit to private sector as dependent variable. Of course, they included the "basic" regressors like many other authors, but they also added some less frequent ones such as growth rate both of deposits and of non-resident liabilities. Data covers a period 2001Q1-2010Q2 and 38 EMEs (emerging market economies). Their results fulfil expectations concerning signs of the coefficients. Namely, higher deposit rate leads to less credit growth. The interesting thing is that only for the pre-crisis period, the deposit rate turned to be insignificant.

Lastly, I mention a paper by Fitzpatrick and McQuinn (2007) that is based on time series 1980Q1-2002Q4 data only for Ireland. The model consists of four-equation system. Credit equation expresses new mortgages as a function of income, house prices and mortgage interest rate. Interestingly, they found a positive (very small) effect of interest rates on credit.

Basic information about the mentioned literature on determinants of credit growth, such as variables included, estimation methods used and main findings, are stated in Table B1 in Appendix B.

4.2 Model

The central topic of this Thesis is to study the impact of the "One size doesn't fit all" problem, expressed by the deviations of the actual nominal interest rate from the Taylor-based rates, on growth rate of credit provided to private sector. In order to estimate this relationship, I create an econometric model in which I regress the dependent variable, growth rate of credit volume, on several explanatory variables including the deviations from the Taylor.

Since it is reasonable to check robustness of the results obtained, I estimate also some alternative specifications of my model. These specifications contain, for instance, replacing the dependent variable by a substitute one, replacing some explanatory variables or extending the number of them included, or applying different values of the parameters in the Taylor rule.

4.2.1 Data and variables

In my analysis, I employ quarterly panel data series. The time span covers a period from the beginning of the euro area, specifically the first quarter of 1999, till the third quarter of 2013 which is the most recent quarter for which I have found a complete set of data. We can see that the covered period contains both the years of economic boom approximately around the middle of the first decade in this century and the years of a deep economic and financial crisis from 2008. This fact offers us a possibility to shorten the data sample into the pre-crisis period and compare it with the whole one in order to discover whether the crisis has changed the relationships or not.

The dataset is compiled only for the old euro area members, namely for twelve European countries: Germany, France, Italy, the Netherlands, Belgium, Luxembourg, Spain, Portugal, Ireland, Austria, Finland and Greece. Inasmuch as Greece entered later in 2001, the panel is not balanced. The reason for not including the incomers into the eurozone from 2007 is such that the data period would be too short for them, especially for Estonia. Moreover, from a vast majority, it would span crisis years during which various mechanisms may have worked somewhat abnormally. That could possibly lead to biases in the results.

The data have been obtained from several trustworthy sources, namely from the databases of the Eurostat, the International Monetary Fund, the European Central Bank, the Organisation for Economic Co-operation and Development and the Bank for International Settlements.

Unfortunately, a part of the dataset for Greece is not fully comparable to the other countries because Greek seasonally adjusted data for nominal gross domestic product ends in the first quarter of 2011. Thus, the real gross domestic product (that is needed for computation of the Taylor-based rates and real GDP growth rate) of Greece for the years 2011-2013 is calculated using the IMF's data for real GDP growth rate. Furthermore, Greece is missing also data for GDP per capita in 2011Q2-2013Q3 in the Eurostat database. I also lack data about credit growth for Luxembourg in 1999Q1-2003Q1.

List of the dependent and independent variables, which I include in the estimation, is based on the existing literature studying the determinants of credit growth.

Starting with the dependent variable, in my basic specification of the model, I use *quarter-on-quarter growth rate of credit volume*, in other words percentage change compared to previous period. The credit volume is the value of domestic bank credit provided to private nonfinancial sector, adjusted for breaks and prevailing at the end of period. Data is obtained from the BIS.

In alternative specifications of the model, the basic dependent variable mentioned in the previous paragraph is replaced by the following one: *QoQ growth rate of credit to GDP ratio*, where the credit volume is bank credit to private nonfinancial sector and it is divided by nominal GDP obtained from the Eurostat database.

As far as the explanatory variables are concerned, I include the main ones which appear very frequently in existing research papers studying the determinants of credit expansion. Since they are really in a vast majority of the literature sources, it seems to be necessary to add them in order to obtain credible results. Moreover, I also input some additional ones. Specifically, the following explanatory variables are added into the regression.

Deviations from the Taylor rule, computed in the second section. This explanatory variable is the monitored one as it captures the "One size doesn't fit all" problem. Studying the impact of the deviations on credit growth is a central topic of this Thesis and so the sign and size of the coefficient on this variable is of the main interest. As already stated above, I expect the coefficient to be positive.

Real GDP growth rate. Real GDP is considered to be the broadest measure of real activity and, therefore, it is supposed to have a significant positive effect on amount of provided credit. The real GDP data is derived from the nominal one via GDP deflator.

Inflation rate, based on consumer price index. Since inflation influences real cost of funding, it should have an effect on nominal credit volume. A negative correlation is expected.

Long-term interest rates, expressed by 10-year government bond yields. This variable is included in order to distinguish the effects of changes in interest rates from changes in the deviations from the Taylor rule. The effect is assumed to be negative since lower market interest rates should promote credit growth.

Current account to GDP ratio, serving as a proxy for cross-border capital flows. Current account deficits tend to be offset by capital inflows and vice versa. High capital inflows may reduce long-term interest rates and, thus, the cost of funding (Merrouche & Nier, 2010). I expect a negative coefficient.

Crisis period, a dummy variable to account for quarters highly affected by the economic recession. It is equal to one for five quarters from 2008Q4 to 2009Q4, otherwise it is zero. I anticipate a negative sign of the coefficient because period of the deepest crisis certainly brought a drop in credit volume growth. The roots of the drop should lie particularly in loss of confidence and high uncertainty about future development among people and companies.

GDP per capita growth rate, to capture economic development of countries. This variable is used as a substitute to the real GDP growth rate. An increase in the GDP per capita is expected to boost credit growth and so I expect the coefficient to be positive. Quarterly data for nominal GDP per capita (seasonally adjusted) is obtained from the Eurostat. Unfortunately, data for Greece for 2011Q2-2013Q3 is missing.

Net international bank positions, specifically a logarithm of the ratio between the claims of resident banks towards rest of the world and liabilities of the resident banks towards non-residents. This variable is used as an alternative for cross-border capital flows. A negative relationship is anticipated.

Short-term interest rates, expressed by 3-month money market interest rates. It is used as a robustness check to the long-term interest rates since there may be a high correlation among both (Égert, Backé, & Zumer, 2006).

Loans to government sector, to capture possible crowding out effect. This variable is defined as QoQ percentage change in the loans to general government. Since there may be a crowding out effect, an increase in the loans to government might lead to a decrease in the credit to private sector. Thus, I expect a negative effect.

Trade openness, i.e. export plus import as percent of GDP. This variable is a significant indicator of an economy's structure. Higher trade openness may raise credit volume, but in crisis, it may turn over (Aisen & Franken, 2010). Thus, I expect positive impact, but I suspect that the impact will be small and insignificant.

Although there definitely are some other determinants of the credit growth (the existing literature sources mention for example bank deposits to GDP, bank assets to GDP, house prices, indices of financial liberalization, quality of banking supervision and regulation, etc.), I cannot include them in the regression since a consistent quarterly dataset for these variables for all incorporated countries and time periods is not simply available.

List of the incorporated variables, together with their acronyms and expectations about signs, is depicted in Table 1.

Table 1: List of dependent and explanatory variables

Variable	Description	Expected sign
Baseline variables		
CR (dep.)	QoQ growth rate of credit volume	
DEV	deviations from the Taylor rule	positive
Y	real GDP growth rate	positive
INF	inflation rate	negative
BOND	long-term interest rates	negative
CU	current account to GDP ratio	negative
Alternative and additional variables		
CR2 (dep.)	QoQ growth rate of credit/GDP ratio	
CRIS	crisis period (dummy variable)	negative
CAP	GDP per capita growth rate	positive
IPOS	net international bank positions	negative
EUR	short-term interest rates	negative
GL	loans to government sector	negative
TO	trade openness	positive

4.2.2 Basic specification

To discover the impact of the deviations on credit growth, I estimate the following linear model:

$$CR_{it} = \alpha_0 + \beta_0 CR_{it-1} + \beta_1 DEV_{it} + \beta_2 Y_{it} + \beta_3 INF_{it} + \beta_4 BOND_{it} + \beta_5 CU_{it} + \mu_i + \varepsilon_{it}$$

$$i = 1, \dots, 12\ ;\ t = 1, \dots, 59 \qquad (7)$$

where the intercept α_0 and the coefficients β_k are the parameters to be estimated, μ_i is an unobserved country specific time-invariant effect and ε_{it} is an error term.

Following a majority of research papers, I include the country-fixed effects because there may be some unobserved time-invariant heterogeneities among the countries which may affect the dependent variable, the credit growth. The fixed effects term enables to control for such heterogeneities and to address potential omitted variable biases (Merrouche & Nier, 2010).

The equation (7) is the basic specification of my model. Later on, I will mention also several alternative specifications, used to check the robustness of obtained results.

4.2.3 Methodology

There are several econometric issues necessary to be addressed. First, we should discuss stationarity of the time series data since estimating non-stationary time series may potentially lead to spurious regression problem. I applied widely used Augmented Dickey-Fuller unit root test to check the stationarity of the individual data time series used in my analysis. Unfortunately, in most cases I was not able to reject the null hypothesis of a unit root at conventional significance levels (10 % at the highest). It means that we are not able to say that the series are stationary.

Nevertheless, agreed also by Clarida, Galí and Gertler (2000), I find it reasonable to assume that the variables included in the regression are stationary. The reason for this confidence is the following. Most variables are in differences, not in levels, causing the stationarity highly probable. Further, there are various kinds of interest rates and their spreads or deviations. From a general perspective, these variables move around some long-term mean with little and finite variance, particularly for the developed eurozone countries in the last fifteen years. The tricky one may be the current account to GDP ratio. However, there should be mechanisms pushing the current account of countries towards balance in longer-time horizon. In addition, current account to GDP ratio has been empirically proved to be stationary, see for example Taylor (2002) or Clower and Ito (2011).

Second, it is necessary to realize that there is very likely to be an endogeneity problem in the regression. In other words, there may be a correlation between the error term and some explanatory variables. Zero correlation between regressors and disturbances is one of the basic classical assumptions, needed to be fulfilled in order to have the OLS estimators unbiased and consistent.

The risk is the biggest probably for the GDP growth. There may be a reverse causality, i.e. not only the effect going from real GDP growth to credit growth, but simultaneously also in the other direction from credit growth to real output growth. This would lead to endogeneity bias in the estimates.

And third, there may be a measurement error problem. It concerns mainly the deviations of actual interest rates from optimal rates because there is a relevant uncertainty about the measurement and computation of the theoretically optimal interest rates. Specifically, the uncertainty is about the exact specification of the policy rule computing the optimal rates.

Since the endogeneity and measurement error problems are most likely present, we have to somehow deal with them, using more complicated estimation methods than simple OLS. I have decided to employ dynamic panel data estimation in Generalized Method of Moments (GMM) framework which is a widely used framework among empirical researchers recently.[18]

The GMM is based on population moment conditions that are derived from assumptions of the econometric model. It finds parameters' values such that the sample moment conditions are satisfied as closely as possible (University of Vaasa, 2007). The Generalized Method of Moments can be viewed as a unifying framework since OLS and IV estimators are special cases of the GMM (Baum, Schaffer, & Stillman, 2003).

The dynamic panel data estimation is used because it is able to address several serious econometric problems arising from estimating the equation (7), specifically the potential endogeneity of the regressors (caused, for example, by the reverse causality), a correlation between explanatory variables and time-invariant country specific effects and autocorrelation due to presence of the lagged dependent variable among the regressors (Mileva, 2007). Also the measurement error problem is addressed by the estimator thanks to using instruments.

[18] A detailed description of theoretical specification of the GMM is in Wooldridge (2002). Further, the GMM estimation is explained for example in Hansen (2007).

I employ a one-step system GMM estimator, using a function ‘xtabond2’ in the Stata software, well described by Roodman (2009). Standard errors are set to be robust to any pattern of panel-specific autocorrelation and heteroscedasticity. The one-step variant is used instead of the two-step because the two-step estimates of standard errors tend to be downward biased (Arellano & Bond, 1991). Dynamic panel data estimation deals with the country fixed effects by first differencing. The system GMM in comparison to difference GMM contains also levels equation besides the differenced equation, forming a two-equation system. The system GMM is employed because it applies stronger set of instruments and so it should improve efficiency (Roodman, 2009).

I follow convention in the literature and employ four lags of the endogenous variables to use as the gmm-style instruments.[19] All right-hand-side regressors are treated as endogenous. The instruments should be relevant, i.e. correlated with the endogenous regressors, and valid, i.e. orthogonal to the errors. The validity is necessary for the estimator to be consistent. We test for this condition via the Hansen test of over-identifying restrictions.

Further, we have to perform second order autocorrelation test since moment conditions are valid only if there is no serial correlation in the idiosyncratic errors. We check for the first order serial correlation in the errors by looking at second order serial correlation in differences. If the null at AR(2) is accepted, the moment conditions are valid (Sharma & Gounder, 2012).

One more comment to the estimator should be noted. Since my data sample contains rather large number of time periods relative to number of countries, it would lead to too high number of instruments. It could cause some troubles in finite samples, such as weak Hansen test.[20] Therefore, I have to reduce the number. Besides reducing the amount of lags used for instruments to four, I also use the ‘collapse’ command in the ‘xtabond2’ function. This command further restricts instrument proliferation. Function of the ‘collapse’ command is more thoroughly described by Roodman (2009). Nevertheless, there still may be the problem of too many instruments left to some extent.

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[19] Similar number of lags is used for example in Clarida, Galí and Gertler (2000), Belke and Klose (2011) or Arestis and Chortareas (2006).

[20] The potential troubles are described by Roodman (2007).

4.2.4 Alternative specifications

The basic specification of my model, stated by the equation (7), contains widely used variables which are very likely to have an effect on credit growth. Nonetheless, it is worth checking robustness of obtained results from the baseline model estimation by estimating also several alternative specifications. These specifications are created by adding additional explanatory variables or replacing some of the explanatory variables by their substitutes.

Specifically, I run the following alternative models:

Model A1, where the dummy variable for the deep crisis period is added.

$$CR_{it} = f(CR_{it-1}, DEV_{it}, Y_{it}, INF_{it}, BOND_{it}, CU_{it}, CRIS_{it}) \quad (8)$$

Model A2, in which the real GDP growth rate is replaced by the per capita GDP growth rate.

$$CR_{it} = f(CR_{it-1}, DEV_{it}, CAP_{it}, INF_{it}, BOND_{it}, CU_{it}) \quad (9)$$

Model A3, in which the current account balance is substituted by the net international bank positions, an alternative measure of cross-border capital flows. I am including this alternative measure in order to thoroughly control for the capital flows. The capital inflows are an important banks' source of funding credits and so they should have a significant effect on credit growth (Merrouche & Nier, 2010).

$$CR_{it} = f(CR_{it-1}, DEV_{it}, Y_{it}, INF_{it}, BOND_{it}, IPOS_{it}) \quad (10)$$

Model A4, where the long-term interest rates are replaced by the short-term interest rates.

$$CR_{it} = f(CR_{it-1}, DEV_{it}, Y_{it}, INF_{it}, EUR_{it}, CU_{it}) \quad (11)$$

Model A5, where the deviations are slightly adjusted since the alternative specification of the Taylor rule is used (size of the parameters is 1.5 for inflation gap and 0.5 for output gap).

$$CR_{it} = f(CR_{it-1}, DEV2_{it}, Y_{it}, INF_{it}, BOND_{it}, CU_{it}) \quad (12)$$

Model A6, into which the variable loans to government sector is added, other things unchanged in comparison to the baseline model.

$$CR_{it} = f(CR_{it-1}, DEV_{it}, Y_{it}, INF_{it}, BOND_{it}, CU_{it}, GL_{it}) \quad (13)$$

Model A7, with the trade openness variable as an additional regressor. The other explanatory variables are equivalent to the baseline model.

$$CR_{it} = f(CR_{it-1}, DEV_{it}, Y_{it}, INF_{it}, BOND_{it}, CU_{it}, TO_{it}) \quad (14)$$

After all, I estimate the equations also with the alternative dependent variable, namely the QoQ growth rate of credit to GDP ratio. In addition, I check the results for different values of the smoothing parameter in the Taylor rule specification, namely for the values 0.6 and 0.9.

I perform the analysis both for the whole time span and also for the pre-crisis period from 1999Q1 till 2008Q3. Since the former one contains both boom and bust years, the results might differ a lot.

4.3 Estimation results

The analysis is done using the Stata software. The estimation results for the baseline specification of my model are reported in Table 2. I compare results for the two time periods, the full data sample is in the first column and the pre-crisis data sample is in the second column.

Regarding firstly the full data sample, all coefficients are significant and with the expected signs. Credit growth rate with one quarter lag has a positive effect on current level, indicating a presence of some persistence in the series. A significant finding is that the coefficient on the variable of the main interest, deviations from the Taylor rule, has also expected sign since it is positive. It is significant at 10% significance level, with p-value of 8.2 %. The size of the coefficient says that a one percentage point increase in the deviation leads to 21.3 basis points increase in growth rate of credit provided to private sector.

Real GDP growth rate has a positive and highly statistically significant influence on the dependent variable. Quite highly significant effect is found also for inflation rate, but with the opposite direction compared to the GDP. Long-term interest rate, as expected, is negatively correlated with the amount of provided credit. However, size of the effect is quite low and also the significance is weaker. An increase in the current account to GDP ratio contributes negatively to credit growth as well. The estimate is significant at 5 %. It means that capital inflows are indeed a relevant determinant of credit growth, which is in line with the findings of Merrouche and Nier (2010). Results on the other variables correspond to existing literature as well.

Moving the attention from the full sample to the pre-crisis sample leads to a discovery that signs of the coefficients are unchanged, but sizes are slightly bigger. The exception is the lagged credit growth which is not significant at all now. That is quite interesting result. Impact of the deviations is still positive and even more significant (p-value is 3.0 %). The size of the estimated parameter is bigger, suggesting that a percentage point increase in the deviation would cause 30.3 basis points rise in credit growth. The biggest change is in the effect of long-term interest rates. It is still negative, but approximately five times higher for the pre-crisis data sample than for the full sample.

Table 2: Estimation results - baseline specification

	coefficients	
	Full sample (1999Q1-2013Q3)	Pre-crisis sample (1999Q1-2008Q3)
Lagged credit growth	0.435 *** (0.000)	-0.017 (0.852)
Deviations from the Taylor rule	0.213 * (0.082)	0.303 ** (0.030)
Real GDP growth rate	0.272 *** (0.000)	0.466 *** (0.000)
Inflation rate	-0.296 ** (0.020)	-0.452 * (0.057)
Long-term interest rates	-0.105 * (0.085)	-0.561 * (0.095)
Current account to GDP ratio	-0.122 ** (0.049)	-0.249 *** (0.001)
Constant	0.014 *** (0.001)	0.046 ** (0.016)

Note: p-values are in parentheses below the coefficient estimates. *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively

From the comparison of the two periods covered, it is obvious that the recent economic crisis has changed the dynamics and relationships between credit growth rate and the incorporated explanatory variables, but not completely upside down.

For both cases, the Hansen test does not show any evidence of over-identifying restrictions since p-values are very high. It means that the instruments used are valid, i.e. they are orthogonal to the errors. Nevertheless, as I have mentioned above, although I use the command ‘collapse’ to reduce the number of instruments in the estimation, there is still a risk that the Hansen test may be weakened.

The Arellano-Bond test for autocorrelation indicates that first order autocorrelation in differences is present as the null hypothesis is rejected both for the full and the pre-crisis period. However, it was expected due to first differencing. More important is that the null hypothesis of no autocorrelation of second order is not rejected at 5% significance level, implying that there is no autocorrelation in the errors, moment conditions are valid and the estimates are consistent.

Now, it is worth checking how the estimated coefficients change with a slight modification of the model to see whether the results are robust. I estimate all the alternative specifications of the model, stated by equations (8) – (14). The estimation results for the first three of them for the whole time period are displayed in Table 3. The table contains also the baseline specification for the purpose of comparison.

Model A1 includes dummy variable to control for the effect of the crisis around the year 2009. The variable CRIS has an expected negative sign, but it is strongly insignificant. The other estimates are more or less unchanged. Only the long-term interest rate is now even more significant.

In model A2, the real GDP growth rate is replaced by the per capita GDP growth rate as another proxy for measuring economic activity. We can see that the new variable is also positive and highly significant, as expected. Coefficient on the deviations is lower now and it has lost significance. However, the 10% significance boundary is exceeded only slightly (p-value is 10.4 %) and so we can still consider it somewhat statistically significant. The effect of long-term interest rate (as well as significance) remains approximately the same. Inflation rate and current account to GDP ratio have turned to be insignificant under this alternative specification.

The last column in Table 3 shows results for the model A3 with net international bank positions instead of current account to GDP ratio compared to the baseline specification. In this case, the deviations are not significant, but the p-value is again very close to the 10% boundary. The new variable has the expected negative sign, but is insignificant. An interesting result is for the interest rate which is now estimated very close to zero and so very insignificant.

Table 3: Estimation results for full data sample

	basic model	model A1	model A2	model A3
CR lagged	0.435 *** (0.000)	0.438 *** (0.000)	0.649 *** (0.000)	0.364 *** (0.008)
DEV	0.213 * (0.082)	0.228 * (0.056)	0.089 (0.104)	0.224 (0.112)
Y	0.272 *** (0.000)	0.264 *** (0.005)		0.247 ** (0.021)
INF	-0.296 ** (0.020)	-0.321 * (0.073)	-0.109 (0.284)	-0.262 (0.126)
BOND	-0.105 * (0.085)	-0.108 ** (0.022)	-0.150 * (0.093)	0.000 (0.993)
CU	-0.122 ** (0.049)	-0.126 ** (0.036)	-0.070 (0.245)	
CRIS		-0.002 (0.866)		
CAP			0.118 *** (0.002)	
IPOS				-0.035 (0.193)
const.	0.014 *** (0.001)	0.015 *** (0.000)	0.010 ** (0.034)	0.012 *** (0.000)

Note: p-values are in parentheses below the coefficient estimates. *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively

Table 4 displays estimation results for the remaining four alternative specifications of the model. Model A4 brings quite strange findings, namely that short-term interest rate (which replaced the long-term one) has a significant positive effect on credit growth. I am not able to come up with any explanation of this result. Regarding the other variables, the deviations again lie on the boundary between insignificance and statistical significance at 10% level. The remaining regressors have more or less expected results.

In model A5, I use the alternative specification of the Taylor rule and so the deviations are slightly different. It is obvious that a small change in the inflation and output gap weights in the Taylor rule does not affect the estimated relationships substantially. The only thing is that the deviations estimate is now slightly less significant as the p-value is 12.1 %.

Model A6 augments the basic one in a way of adding one more variable, loans to government sector. The added variable has surprisingly a positive sign, but it is quite strongly insignificant. Again, the other estimates are similar to the baseline model. They are only a bit bigger in absolute terms and even more significant.

The last one from the set of robustness-checking model specifications, model A7, inputs another additional variable, the trade openness expressed as a ratio of import plus export and gross domestic product. The estimation shows again quite consistent results. The coefficient on the deviations is positive and significant at 10% level. The other variables have expected signs. The new variable, the trade openness, is highly insignificant, which was perhaps expected a little bit. It means that the trade openness most probably does not have a relevant influence on credit.

Table 4: Estimation results for full data sample - cont.

	model A4	model A5	model A6	model A7
CR lagged	0.243 *** (0.000)	0.458 *** (0.000)	0.287 *** (0.002)	0.421 *** (0.000)
DEV	0.211 (0.103)		0.320 ** (0.031)	0.216 * (0.081)
Y	0.316 *** (0.000)	0.258 *** (0.000)	0.347 *** (0.003)	0.277 *** (0.000)
INF	-0.464 *** (0.001)	-0.230 ** (0.046)	-0.373 ** (0.028)	-0.316 ** (0.022)
BOND		-0.103 * (0.066)	-0.174 ** (0.027)	-0.099 * (0.088)
CU	-0.174 * (0.067)	-0.136 ** (0.025)	-0.164 *** (0.008)	-0.121 * (0.070)
EUR	0.302 ** (0.035)			
DEV2		0.256 (0.121)		
GL			0.023 (0.275)	
TO				0.005 (0.704)
const.	0.008 ** (0.032)	0.013 *** (0.001)	0.019 *** (0.001)	0.011 (0.231)

Note: p-values are in parentheses below the coefficient estimates. *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively

For all of the alternative model specifications, the Arellano-Bond test for AR(2) in first differences does not reject the null hypothesis of no second order autocorrelation and the Hansen test of over-identifying restrictions shows that the instruments are properly chosen regarding their validity. Nevertheless, the risk of too many instruments problem is still present.

The next step in the robustness analysis is to change the dependent variable and perform the estimation again. Therefore, the growth rate of credit volume is replaced by growth rate of credit to GDP ratio. From some perspective, this variable could indicate a credit boom better than the former one because the ratio of credit volume relative to gross domestic product cannot grow vigorously to infinity. In addition, the old euro area member states are relatively high-developed economies, not just after some in-depth transition period and so there should not be a rapid convergence towards a long-term equilibrium level of the ratio. In other words, a huge growth in the ratio is likely to indicate a credit bubble.

Comparison of the estimation results for the basic and alternative dependent variables is stated in Table 5. The results are related to estimation of the baseline model specification (regarding the included regressors). The biggest difference is seen in the first row. The lagged credit growth rate is now highly insignificant, suggesting that there is no persistence in this data series. Coefficient on the deviations is bigger and highly significant with p-value of only 0.3 %. Inflation rate has also bigger coefficient in absolute terms compared to the original basic model. The other variables are more or less similar.

As far as the second dependent variable in the alternative specifications is concerned, the results are more or less consistent with the description of the comparison in Table 5. The thing common for all of them is the insignificance of the lagged credit growth rate. On the contrary, the deviations from the Taylor appear to be even more significant under the second dependent variable than under the original one. It is a good news regarding confirmation of my central hypothesis. The effect of real GDP growth rate is not always significant now. It may be due to the fact that the GDP is in the denominator of the dependent variable.

Table 5: Estimation results for various dependent variables

	CR (basic)	CR2 (alternative)
CR lagged	0.435 *** (0.000)	-0.055 (0.740)
DEV	0.213 * (0.082)	0.577 *** (0.003)
Y	0.272 *** (0.000)	0.241 ** (0.033)
INF	-0.296 ** (0.020)	-0.480 * (0.082)
BOND	-0.105 * (0.085)	-0.143 ** (0.033)
CU	-0.122 ** (0.049)	-0.217 *** (0.001)
const.	0.014 *** (0.001)	0.017 ** (0.016)

Note: p-values are in parentheses below the coefficient estimates. *, ** and *** indicate significance at the 10%, 5% and 1% levels respectively

As I have written above, I perform a sensitivity analysis of effects of slight modifications in the Taylor rule, specifically a change in the smoothing parameter size, on the estimated relationships. When I set the smoothing parameter to be 0.6, the estimates are very similar to the case with $\rho = 0.75$. The coefficients on the deviations are positive and significant or close to the 10% boundary of p-value. Also the other variables are more or less the same, regarding sizes and p-values. This is not true for the second case when the smoothing parameter is 0.9. For this value, the deviations turned out to be insignificant for most specifications. In order to examine the sensitivity in detail, I have estimated the models also with $\rho = 0.0$, in other words with the form of the Taylor rule without the smoothing parameter. I have found out that this specification leads to strongly insignificant estimates for the deviations.

In the end, few notes about the pre-crisis sample could be reported. The estimation results for the pre-crisis period for the baseline model are already stated in Table 2. For the alternative model specifications, the results are more or less similar. Coefficients on the deviations from the Taylor rule are always positive and highly significant. You can see the estimates for the pre-crisis sample in Table C1 in Appendix C.

To sum it up, the main finding from the mentioned results, obtained from estimation of all the model variants, is the following one. The monitored coefficient on the deviations of actual interest rates from the Taylor rule prescriptions is either statistically significant or moves very close to the 10% boundary of significance level and is always with a positive sign. It means that my expectations about the impact are fulfilled. It seems that the deviations indeed have a positive effect on credit growth rate. Thus, my hypothesis is confirmed.

My results are basically in line with the existing literature. I have discovered that GDP growth (both real GDP and per capita GDP) positively affects the amount of credit provided, whereas the effect of inflation and interest rate is negative. It is consistent not only with my expectations, but also with a vast majority of research papers. Further, I have found that capital inflows raise credit growth (since the coefficient on the current account balance is negative), similarly as Merrouche and Nier (2010). Nevertheless, unlike them my results show that the inappropriateness of single monetary policy expressed by the deviations from the Taylor rule prescription has a statistically significant impact on credit growth.

5 Conclusion

In this Thesis, I have studied the so called “One size doesn’t fit all” problem and its impact on credit growth for euro area member states from the beginning of the EMU till recently. The “One size doesn’t fit all” problem is related to inappropriateness of the ECB’s single monetary policy for individual members. The main contribution of this work is that besides the extent of the inappropriateness, it analyses empirically also its possible negative consequences, so far only rarely covered in literature.

The inappropriateness is expressed by deviations of actual interest rates from theoretically optimal rates prescribed by the Taylor rule. In the first part of the work, I have examined to which countries the single interest rate determined by the ECB have fitted the best and to which the opposite way. The findings have confirmed my hypothesis that the monetary policy was the least optimal for the PIIGS countries prior to the recent economic crisis (starting in the second half of 2008).

In the second main part, I have estimated an econometric model studying the impact of the deviations on credit growth rate. A dynamic panel data estimator was employed to deal with several econometric problems. My hypothesis was that the deviations have a positive effect on credits volume since the lower are the actual interest rates below optimum, the higher should be the growth rate of credit. Estimation results of my baseline model have shown that the deviations indeed have a statistically significant positive impact on credit growth rate. Thus, the central hypothesis has been confirmed. Also estimates of the other variables are basically in accordance with the existing literature.

I have performed the estimation not only with the baseline model, but also with several slightly modified specifications in order to check robustness of the obtained results. Despite changing various explanatory variables or adding some supplementary regressors, the estimates remained basically intact. It could indicate that the findings are quite robust.

Besides the whole covered period spanning 1999Q1-2013Q3, the analysis has been done also for pre-crisis period 1999Q1-2008Q3. The main discovery from this data sample narrowing is that signs and significance of the coefficients remained more or less similar, only the effects are a little bit stronger. And, especially, the lagged credit growth rate as a regressor has been found to be insignificant for this sub-period.

Since it seems that the inappropriateness of single monetary policy in the euro area probably has an impact on emergence of credit bubble and other financial imbalances, there arises a clear reasonable question. How to improve the one-size-fits-all monetary policy to limit its negative consequences? The most frequently mentioned amendment is to introduce an efficient system of internal euro area income transfers or to create a single fiscal policy. Of course, creation of a single fiscal policy would need deeper political integration. De la Dehesa (2012) adds two more possible improvements. First, to extend monetary policy target (which is currently focused only on inflation), for example by incorporating money growth into the target. And second, to widen the monitored price index by asset prices. Ahrend, Cournéde and Price (2008) mention a possibility to use stricter capital requirements or time-variant administrative restrictions of credit in order to fight developing financial imbalances. The opinions about next steps vary a lot, but a majority of them agrees that some improvements are necessary in order to keep the euro project alive in longer-term horizon.

Finally, I would like to mention some last summarizing words about this Thesis. To my mind, the "One size doesn't fit all" problem is a key issue which should be addressed. There are many expert opinions claiming that the single monetary policy cannot work properly for such heterogeneous economies as the euro countries. Also the analysis in this work has shown that the single interest rate in the eurozone may contribute to creation of imbalances, namely a credit bubble. Of course, we need more research and more analyses to have robust and more precise information about the problem. In connection with this Thesis, there offer several possibilities for further research. As already mentioned, it would definitely be worth performing the analysis with real-time data to compare with the ex-post data. Further, some other variables, for which I was not able to collect quarterly data, could be included in the regression. And last but not least, a valuable work would certainly be to do the analysis also for the United States of America (which can be considered to be a monetary union since it is a federation of many smaller states) and compare it with the euro area.

Nevertheless, even if it is robustly proved that the single interest rate causes macroeconomic imbalances, it should not be a reason to immediately terminate the euro project. Besides this drawback, it definitely brings also huge advantages. The euro states must use other policies or some tools and perform needed structural reforms to limit the mentioned drawbacks in order to enjoy the benefits of currency union even more.

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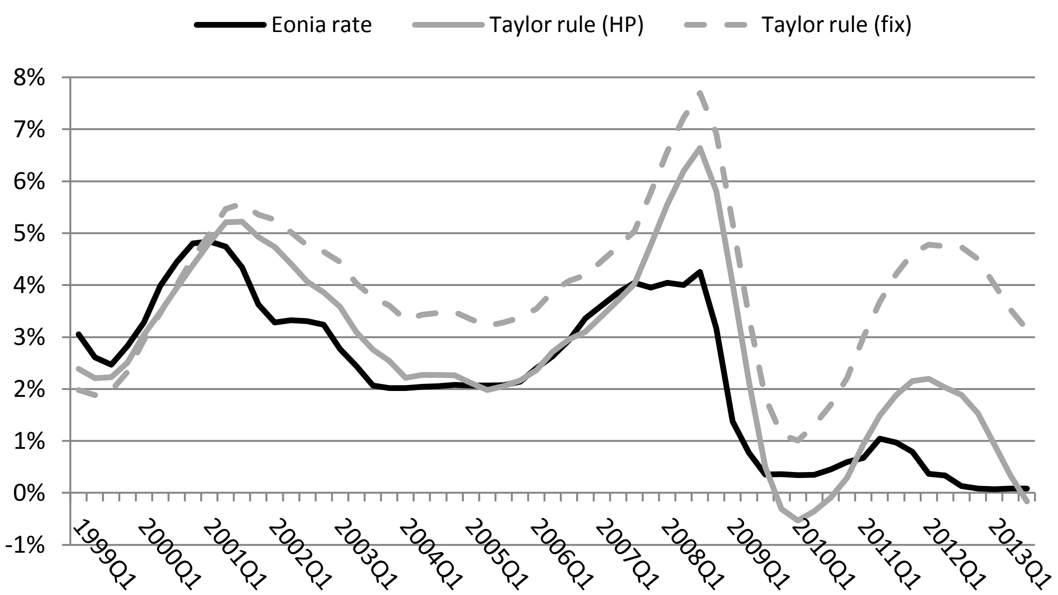
Appendix A: Fixed neutral rate

In Figure A1, I demonstrate the difference between applying HP filter to compute the equilibrium real interest rate and fixing the equilibrium rate on 2 % in the Taylor rule. The grey curve represents the Taylor-based rates with using the filter, whereas the grey dashed curve shows the rates with the fixed neutral rates.

At first sight it is obvious that the latter one, with the fixed value, is much less realistic. It would recommend very high interest rates around the years 2011 and 2012, but such rates would definitely have pushed the economies back into recession. In addition, even in the deepest crisis in 2009, it would prescribe bigger than one percentage point interest rates. However, we know that neither practically zero actual rates did help the economies to overcome the troubles easily. This all indicates that the equilibrium real interest rate is likely to be variable in time. There definitely was a drop during the crisis. Therefore, it is preferable to use the HP filter.

Figure A1: The Taylor-based rate for the euro area (HP filter vs. fixed value)



Source of data: ECB, Eurostat, OECD

Appendix B: Literature review

Table B1: Literature review on credit growth determinants

Title Authors	Data	Estimation method	Dependent variable Regressors	Results
Taylor Rule Deviations and Financial Imbalances George A. Kahn (2010)	USA 1987 - 2009	time-series estimation	asset prices (various financial indicators) lagged asset prices Taylor prescriptions deviations from Taylor rule	deviations from Taylor rule help predict housing prices growth
What Caused the Global Financial Crisis? - Evidence on the Drivers of Financial Imbalances 1999–2007 Ouarda Merrouche, Erlend Nier (2010)	OECD countries 1999 - 2007	panel data fixed effect estimator random effect estimator	bank credit to deposits (or bank credit to GDP, etc.) deviations from Taylor rule current account / GDP (or spread between long/short nom. rates) some supervision and regulation indicators	capital flows have strong impact on financial imbalances deviations from Taylor have no impact on imbalances
Credit Growth in Central and Eastern Europe: Convergence or Boom? Gergely Kiss, Márton Nagy, Balázs Vonnák (2006)	12 eurozone countries (out-of-sample estimation) yearly 1980-2002	panel data error-correction framework pooled mean group estimator	credit to nominal GDP (includes domestic and foreign loans) GDP p.c. real int. rate inflation + some additional	3 variables significant GDP positive, inflation negative, real rate negative
Credit growth in central and eastern Europe: New (over)shooting stars? Balázs Égert, Peter Backé, Tina Zumer (2006)	43 states (4 groups - small and large OECD, emerging from America and Asia, CEE transition states) quarterly, since 1975-1996 till 2004	panel data 3 techniques: fixed effect OLS, panel dynamic OLS, mean group estimator used error-correction term	private credit / GDP GDP p.c. in PPS credit to government nominal int. rates inflation house prices spread between lending/deposit rates existence of credit registries	GDP positive, credit to gov. negative, nom. int. rate negative, inflation negative, spread negative, house prices (unclear, positive only when housing bubble)

Determinants of bank credit in small open economies: The case of six Pacific Island Countries Parmendra Sharma, Neelesh Gounder (2012)	6 Pacific region countries yearly for 1982-2009	GMM method IV for endogenous variables	bank private sector credit average lending rate inflation bank deposit / GDP bank assets / GDP stock market GDP	all significant and robust lending rate negative and very significant inflation negative the others positive
Determinants of Bank Credit in Emerging Market Economies Kai Guo, Vahram Stepanyan (2011)	38 EMEs (from Europe, Asia, Africa and America) quarterly 2001Q1-2010Q2	panel data including country fixed effects	growth rate of credit to private sector deposits growth growth rate of non-resident liabilities inflation lagged GDP growth lagged deposit rate Δ in US fed funds rate + some additional	dep. growth positive liab. growth positive inflation positive GDP growth positive dep. rate negative Δ in US fed negative
The determinants of private sector credit in industrialised countries: do property prices matter? Boris Hofmann (2001)	16 industrialized countries quarterly data, 1980-1998	Dickey-Fuller unit root test (stationarity) cointegration analysis based on VAR model	real private credit real GDP short real int. rate real property prices	real GDP positive prop. prices positive real int. rate negative int. rate effect small but very significant
Lending booms in the new EU member states: Will euro adoption matter? Michał Brzoza-Brzezina (2005)	IE, PT, GR quarterly, since 1981-1995 till 2004Q2	unit root test vector error correction model separately for each country	real loans to private sector real GDP real interest rate	positive relationship between real GDP and real loans negative impact of real int. rate on real loans
House prices and mortgage credit: Empirical evidence for Ireland Trevor FitzPatrick, Kieran McQuinn (2007)	Ireland quarterly, 1980Q1 - 2002Q4	3 methods of single-equation time-series approaches dynamic OLS fully modified OLS static OLS	value of new mortgage loans divided by value of total mortgage loans new house prices mortgage interest rates disposable income per household	income and house prices have positive impact on credit demand interest rate has positive (but small) impact on credit

Appendix C: Results for pre-crisis data

Table C1: Estimation results for pre-crisis data sample

	basic	A2	A3	A4	A5	A6	A7
CR lagged	-0.017 (0.852)	0.245 (0.064)	0.002 (0.983)	-0.064 (0.452)	-0.020 (0.833)	-0.067 (0.641)	0.058 (0.529)
DEV	0.303 (0.030)	0.287 (0.004)	0.227 (0.026)	0.235 (0.065)		0.318 (0.023)	0.327 (0.016)
Y	0.466 (0.000)		0.419 (0.000)	0.473 (0.000)	0.462 (0.001)	0.479 (0.005)	0.460 (0.000)
INF	-0.452 (0.057)	-0.480 (0.016)	-0.179 (0.483)	-0.540 (0.047)	-0.376 (0.155)	-0.492 (0.069)	-0.395 (0.074)
BOND	-0.561 (0.095)	-0.299 (0.353)	-0.246 (0.485)		-0.489 (0.198)	-0.514 (0.246)	-0.570 (0.076)
CU	-0.249 (0.001)	-0.231 (0.003)		-0.235 (0.004)	-0.277 (0.001)	-0.256 (0.007)	-0.226 (0.001)
CAP		0.172 (0.100)					
IPOS			-0.078 (0.021)				
EUR				0.072 (0.782)			
DEV2					0.405 (0.004)		
GL						0.053 (0.001)	
TO							-0.004 (0.813)
const.	0.046 (0.016)	0.034 (0.040)	0.029 (0.130)	0.022 (0.036)	0.041 (0.043)	0.045 (0.060)	0.046 (0.045)

Note: p-values are in parentheses next to the coefficient estimates.