Portugal and the European Monetary Union.

*Investigating an alternative interest rate development using the Taylor Rule.*

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Abstract

The objective of this study is to investigate how the development regarding the short-term nominal interest rate in Portugal would have differed from that set by the ECB 1999-2011 in a situation where they did not enter the European Monetary Union. To do this, we use the Taylor rule, which incorporates economic activities such as inflation and output and how these deviates from their target. Constructing the Taylor rule, we estimate its reaction functions using an Ordinary Least Square Regression on annual data from the period 1988-1998. The reaction functions serve as weights on the deviations for inflation and output. The result reached is that the interest rate set by the ECB since 1999 is far below that interest rate required by the Portuguese economic situation. Further, we discuss how the influence in the setting of the ECB interest rate differs considering the member countries size.

Keywords: Monetary Policy, European Monetary Union, Central Bank, Taylor Rule, Optimum Currency Area.
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>2</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>4</td>
</tr>
<tr>
<td>1.1 BACKGROUND</td>
<td>4</td>
</tr>
<tr>
<td>1.2 OBJECTIVE AND PROBLEM STATEMENT</td>
<td>7</td>
</tr>
<tr>
<td>2. PREVIOUS STUDIES</td>
<td>8</td>
</tr>
<tr>
<td>3. THEORETICAL BACKGROUND</td>
<td>10</td>
</tr>
<tr>
<td>3.1 EXCHANGE RATES</td>
<td>10</td>
</tr>
<tr>
<td>3.2 THE FISHER EQUATION</td>
<td>11</td>
</tr>
<tr>
<td>3.3 THE THEORY OF OPTIMUM CURRENCY AREAS</td>
<td>12</td>
</tr>
<tr>
<td>3.4 THE TAYLOR RULE</td>
<td>14</td>
</tr>
<tr>
<td>4. EMPIRICAL SECTION</td>
<td>17</td>
</tr>
<tr>
<td>4.1 REGRESSION MODEL</td>
<td>17</td>
</tr>
<tr>
<td>4.2 CHOICE OF TIME PERIOD</td>
<td>20</td>
</tr>
<tr>
<td>4.3 DATA</td>
<td>22</td>
</tr>
<tr>
<td>4.4 REGRESSION ANALYSIS AND RESULTS</td>
<td>22</td>
</tr>
<tr>
<td>5. DISCUSSION</td>
<td>27</td>
</tr>
<tr>
<td>6. CONCLUSION</td>
<td>29</td>
</tr>
<tr>
<td>FURTHER RESEARCH</td>
<td>31</td>
</tr>
<tr>
<td>7. REFERENCES</td>
<td>32</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>36</td>
</tr>
</tbody>
</table>
1. Introduction

1.1 Background

Every day we are overthrown by news concerning the European monetary union and the Euro’s future. Although this is the case, the Euro has been a goal for the European Union since the establishment in 1957. The hope that these diverse countries could become one single and strong economy under one monetary system was a thought that remained and was put into action in 1992 with the signing of the Maastricht Treaty. This agreement contained regulations concerning, amongst other things, a common foreign- and security policy but in particular the formation of a monetary union. Much of the current situation can be traced back to the huge differences among the economies within the currency union, which have made the less competitive economies worse off. These countries are today more commonly known as the PIIGS countries (Portugal, Ireland, Italy, Greece and Spain). In the current turbulent situation in the Euro area with Greece close to default, Italy’s growing national debt and increasing long-term interest rates, the costs of joining the monetary union seems higher than ever. Is this the fact or was the development inevitable even from the start?

In 1957, six countries together create the European Economic Community (EEC) with the signing of the Rome Treaty. These countries were France, Germany, Belgium, Italy, Netherlands and Luxemburg. Together, they had a desire of preserving peace in Europe after the two World Wars that had passed. Over the following decades the EEC expanded and new countries entered the community. At the meeting in The Hague 1969 the member countries formulated a new goal for the European integration, the European Monetary Union. This was put into action a few times but with little success. In 1979, the European Monetary System (EMS), a system with fixed but adjustable exchange rates, was created. The EMS succeeded in reducing exchange rate fluctuations between the member countries, and 1992, the Maastricht Treaty was signed, formulating the three steps in which the
common currency were to be introduced. Today, 17 of the 27 countries in the EU have integrated the third step and have the Euro as their currency. Portugal is one of them, carrying a history of tough economic development.

In 1974, Portugal, as the last nation in Western Europe became a democracy after a bloodless coup called the Carnation Revolution. With this coup, the Portuguese colonial empire disappears after struggling in a colonial war in Africa for nearly 15 years. The long war had drained Portugal of its financial resources and now, more than one million Portuguese citizens returns home from the nations lost colonies. This was of course a huge chock for the new democracy, which had struggled with large unemployment and budget deficits. Earlier, in October 1973, the Arabic OPEC countries proclaimed an oil embargo, making oil prices increase radically. This made inflation increase drastically all over the world, especially in Portugal, which during the 70’s and 80’s had the second highest inflation in the European Community, only surpassed by Greece (Abreu 2001, p. 18).

Alongside this, the long dictatorship and years of war had resulted in a lack of investments in education and high tech industries. The focus of Portugal’s industry had instead been textile, shoes, agriculture and more labour intense industries (Vanda Almeida, Gabriela Castro and Ricardo Mourinho Félix, p. 68-70). Because of the big number of low skilled labour, the salaries in comparison with the rest of Europe were relatively low. This gave Portugal a comparative advantage in agriculture making it a large share of their total output during the late 1980’s and early 1990’s. Likewise, the share of Portuguese workers in agriculture was far above the average in Europe. Portugal’s main agricultural products have for a long time been wine and cork and today Portugal is the world’s largest producer of cork with nearly 50 per cent of the worlds cork production. During the 1980’s and the early 1990’s, the Portuguese economy grew faster than the other European countries with a growth rate above 5 per cent per year. (Almeida et al. p. 70-71)

A new Portuguese setback came during the 1990’s, with Eastern Europe opening up after the fall of the Soviet block and with China joining the WTO (World Trade Organisation).
These countries could now compete with Portugal’s low salaries, which caused the labour intense industries to go out of business. Because such a big share of the labour force was relatively unskilled they had problem moving to more advance industries. This struck Portugal hard and in 1998, growth started to decline as seen in figure 1.

*Figure 1: Portugal’s annual growth rate 1996-2011*

![Portugal annual growth rate 1996-2011](image)

In the beginning of the 1990’s however, a way out of the downward spiralling situation appeared. This was the European Monetary Union, which would connect all the European economies to one market and later one currency. With this, the member countries would give up their own monetary policy, making ECB the policy maker for the whole euro area. This means that the member countries peg their exchange rates, abandoning the floating exchange rates within the union, only operating with floating exchange rates towards the rest of the world. Moreover, now the short-term nominal interest rate, at which economic institutes may borrow money from the central bank, is decided by the ECB for several countries, both competitive countries like Germany and Finland as well as less competitive
countries like Portugal and Ireland. To make this an effective stabilizing tool, it requires economic development between countries to be alike, even if it today involves 17 countries.

Portugal have since joining the European Union been one of the largest receiver of financial aid from within the union. The ambition was to put an end to this by joining a system with prosperous countries such as Germany and Finland. However, the optimism lasted only a short time. Today, Portugal struggles with a huge budget deficit, an enormous national debt that keeps increasing and one of Europe’s largest unemployment figures.

1.2 Objective and Problem statement

By examining the inflation rates, output and nominal interest rates in Portugal during the run up to the European Monetary Union (EMU) we hope to shed some light on how the entry and the abandoning of an independent central bank has affected the Portuguese economy. To do so, we will investigate how the development of the interest rate had pursued if Portugal had maintained their central bank. A prerequisite for the implementation of this study is to assume that the Portuguese Central Bank before the EMU entry strictly followed a policy rule called the Taylor Rule. This policy rule consists of economic activities such as inflation and output and how these deviates from their targets and potential equilibrium. How the central bank reacts to these deviations are determined through weights that the central bank gives inflation- and output deviations respectively. The weights, or coefficients, will be estimated by running an Ordinary Least Square Regression (OLS) on historical data for Portugal before the EMU entry. Further more, we will use the coefficients to determine the following years of development in interest rates considering Portugal stood outside the monetary union and had maintained their independent central bank.

Our question of investigation is formulated as follows:
*With Taylor rule as a reference, how would the development of the nominal interest rate in Portugal have been if she had maintained her independent Central Bank and continued to follow the same policy rule?*

The question is highly relevant in today's Europe with increasing national debts, causing monetary policy to increase in popularity in contrast to fiscal policy. Moreover, the increase in the number of member countries in the EMU eventually makes each country’s influence smaller when determining the monetary development. With Portugal as a relatively small country in comparison to Germany or France, this thesis will hopefully show to which extent a small economy will influence the interest rate set by the European Central Bank (ECB), where high deviation of interest rate could indicate low influence.

The structure of this paper will follow a somewhat chronological path, beginning with the background to the study and objective in section 1. Section 2 will contain previous research regarding policy rates under the concept of the Taylor rule. In section 3, the theoretical background will be presented, in which we describe the theory of optimum currency areas as well as the properties of the Taylor rule in more detail. Furthermore, section 4 will include the empirical part of the study where the regression analysis and its result will be presented. Finally, in section 5, we will discuss the results; following section 6 with conclusions and give suggestions of further research.

### 2. Previous studies

Studies investigating how the euro would affect different European countries took place already before the euro was introduced. Many of them had the objective to put the costs of a euro entry in contrast to the benefits from such. One good example of this type of study is the one conducted for Sweden by Gottfries (2003). Here, the author focuses on the concept of asymmetric chocks that affect only one country. This event will, in the absence of an independent central bank, lead to a stabilization cost for the affected country that is greater than the benefits.
Furthermore, many studies have been conducted from a post entry perspective, investigating the historical development. A popular topic has been to investigate a country’s economic development before and after entering the monetary union. Many of these studies uses the concept of the Taylor rule to estimate how a country’s monetary policy would have developed without an entry. Clausten and Meier (2003) investigate if the Bundesbank followed a Taylor rule between 1973-1998 and find that the Taylor rule rate lays close to the actual interest rate path. This theory is confirmed by Sauer and Sturm (2003) and their study using Taylor rules to understand ECB monetary policy before and after the creation of the monetary union. They find clear data showing that ECB accommodate changes in inflation and thereby following a destabilizing policy. Even though this study was made short after the introduction of ECB, the authors state that it is “sometimes hard to distinguish between the policy rule followed by the Bundesbank versus that of the ECB”. They show that a calculated Taylor rule rate lies close to the one set by the German central bank, Bundesbank, before the introduction of the ECB and that it after the introduction still is found close to the rate set by the ECB (see figure 5 in the Appendix).

In contrast to the many studies made on ECB and other European countries, few studies has been made on Portugal. Geni and Munteanu (2010) has in their thesis *Could the crisis in the PIIGS countries have been avoided with a independent central bank* made a broad study applying a Taylor rule to all the so called PIIGS countries to investigate how their interest rates would have differed if they did not give up their independent central bank. The Taylor Rule they use in their thesis is based on reaction coefficients that are not estimated thru a regression. Instead they assume values by weighing how the ECB would react to changes in inflation and output. They find that there have been significant deviations from Portugal's hypothetical Taylor rule rate to the actual ECB rate up until 2003. After 2003 the deviations are not that significant and in 2005 they find the Portuguese rate to fall below the rate set by the ECB. In contrast, we will use an OLS regression to estimate the values of the reaction function. This will hopefully isolate the effects on Portugal rather than on all the PIIGS countries.
3. Theoretical background

3.1 Exchange rates

Ever since the Bretton Woods system of fixed exchange rates was abandoned in the 1970’s the exchange rate developments have been far more volatile than anyone had expected. Bretton Woods was a system in which the world’s currencies were fixed to the dollar, which in turn was fixed to the gold. After this system was abandoned most exchange rates were allowed to float, even though many European currencies maintained their fixed exchange rates, now to the German D-Mark.

With a fixed exchange rate, the central bank sets a price on its currency and is ready to buy or sell the currency to maintain the same price. This will give a situation where the money supply will adjust to the level that will keep the price of the currency stable. As a result, the central bank explicitly commits to a single monetary goal, keeping the exchange rate at its announced level. This makes the instrument of monetary policy limited, why floating exchange rates are more commonly used today. In the case of the European Monetary Union, member countries gave up their floating exchange rates within the union, only allowing the Euro to float against the rest of the world. As a result, countries gave up their ability to use their own monetary policy as a stabilizing instrument, now relying entirely on the monetary policy conducted by the ECB.

The alternative to a fixed exchange rate is to let the currency float freely against other currencies. In this case, the price on a currency is set by the market forces at work. It allows the exchange rate to fluctuate in response to economic variations. As with a good, the price of a currency is determined by supply and demand. When there is change in demand for a currency, the price of the currency adjust to reach a new equilibrium in the goods and money markets. In contrast to a fixed exchange rate, a floating exchange rate allows for the
central bank to pursue other alternative goals besides maintaining a stable exchange rate, such as stabilizing inflation or lower unemployment. A floating exchange rate gives the central bank many alternatives when it comes to stabilizing economic fluctuations and respond to shocks. Despite this, a floating exchange rate also raises uncertainty in the case of trade between countries. Because of the possibility for the exchange rate to vary, large amounts of money are spent securing exchange rates when trading in different currencies.

3.2 The Fisher Equation

To see how a common interest rate not always have the same outcome in the countries operating with it we use the Fischer Equation. The Fisher Equation shows the relationship between the nominal and the real interest rate. The real interest rate can be seen as the nominal interest rate adjusted for inflation. It is the interest rate that in real terms affects borrowers and lenders. See equation 1.

\[ r = i - \pi \]  

(1)

where \( r \) represents the real interest rate, \( i \) is the nominal interest rate and \( \pi \) represent inflation. This equation clearly shows how differences in inflation rates between countries result in different real interest rates even though the nominal interest rate is set commonly across the union. The problems arise when one country in contrast to the rest of the area is experiencing an economic boom and needs to pursue contractionary monetary policy i.e. increasing nominal interest rate which in turn increases the real interest rates in order to dampen the increasing inflation. Instead, the nominal interest rate is kept unchanged and increasing inflation gives an even lower real interest rate according to the Fisher Equation above.
3.3 The theory of Optimum Currency Areas

A *currency area* is where several countries decide to peg their exchange rates to each other. With this, the exchange rate of that area can only fluctuate with the world outside the currency area, or union. *Optimality* is in Mongelli (2002) defined by several attributes, some of which are; labour mobility, resemblance in size and inflation rates, flexibility in prices and wages, and fiscal and political integration. When these attributes are shared by a number of countries, the need for a flexible exchange rate between those countries is reduced.

Robert Mundell first introduced the concept of Optimum Currency Areas (OCA) in 1961 even though papers about exchange rate regimes had already been written, for example Friedman (1953). However, Mundell stipulate a number of criteria’s that a country should attain if an economy is to consider entering a currency area. He stresses the importance of factor mobility and in particular labour mobility, as a key criterion for building a currency area. The degree of labour mobility depends mainly on how homogenous different countries are, both regarding language and culture. With reference to this, Mundell state; “The optimum currency area is not the world” (Mundell 1961 p. 659). Further, he means that the borders of an optimum currency area need not to correspond with national borders. He speaks of regional currency areas, rather than country-based currency areas. For example, if demand shifts from region A to region B, this will lead to unemployment in region A and increased inflationary pressure in region B. If they operate under a fixed exchange rate, they need another mechanism to counteract this shift in balance-of-payments\(^1\). With mobile labour, this shift will be offset simply by workers moving from region A to region B. Unemployment will not be caused, inflationary pressure will be dampened and the need for a flexible exchange rate disappears. Mundell (1961) take Canada and the US as an example, where they instead of operating with national exchange rates, divide their two countries

\(^1\) Method used to monitor monetary transactions between countries to determine the amount of money that move in and out of a country.
into regions, East and West, within which mobile labour is used to counteract cyclical changes between the two regions. With this, the need for a flexible exchange rate is reduced.

Since the OCA theory was introduced in 1961 contributions have been made. In 1963, McKinnon (1963) introduced a new criterion for a currency area to be considered optimum. He stipulated that a common currency would benefit more open economies to a greater extent since it has a bigger impact on their stability. Because of extensive trade the uncertainty with exchange rate variations is reduced with a common currency. Six years later, another criterion was added to the theory by Kenen (1969). He meant that a more diversified economy runs a bigger chance to adjust to external shocks than an economy represented by specialized production.

Moreover, the size of the currency area is also of importance. As a currency area grows bigger, the probability of divergent economic development between countries increases. This could lead to localized recessions as well as economic booms. Gottfries (2003) argues that when a currency area grows too big, the risk for asymmetrical shocks in one country increases. These asymmetrical shocks are then something that might be problematic to counteract with monetary policy actions if a country has renounced its independent central bank.

Although the theory of optimum currency areas is quite clear, many critics point to the difficulty to operationalize the theory. The strength of the relationship between theory and empirics have for a long time been questioned. One of which to do this are Bayoumi and Eichengreen (1996) and their study trying to determine an OCA index to represent how ready a country is to enter a monetary union. They find that a high mobility of labour does not play a significant role in their calculations, even though the OCA theory states that this plays a big part in stabilizing asymmetric disturbances. Further, much critique has been pointed towards the inconsistency in evaluating the characteristics the OCA theory is built
on. When analysing whether or not a country is ready to join a currency area, the theory can point in two directions. This was something that caught the attention of Tavlas (1994) where he stated that different OCA criteria’s could point both towards a floating exchange rate as well as towards a fixed exchange rate. A country can have large trade with a small number of trading partners, giving incentive to fix their exchange rate. At the same time they can have a low mobility of factors of production where a floating exchange rate would benefit the country. (Mongelli 2008, pp. 4) He means that the structure lacks a unifying framework.

In addition to the above-mentioned criticism, much criticism has been pointed towards the institutional differences a monetary union faces. Differences in labour markets, with labour unions that don’t work over borders and employment policies on a country-specific basis. These differences affect how well labour mobility works. Further, differences’ regarding legal institutions makes it more difficult to reach integration between countries making a currency union less successful. These legal differences do in turn create differences in financial markets and house markets, increasing the risk of a monetary shock to be spread differently across countries making it hard to counteract. This type of criticism often points out that a successful union like the EMU needs to integrate the countries in more than just monetary policies. It is in need of political integration between countries to minimize the costs of entering a union. The case of political integration is mentioned by Mongelli (2002) as an attribute for a currency union to be considered optimal and should not be underestimated. Many stress the importance of making the EMU-area more politically integrated to avoid asymmetric disturbances.

### 3.4 The Taylor rule

During the 1970’s, a big part of the world and especially the US experienced increased inflation. With this, the concept of a more credible, rule based monetary policy grew stronger. Until this point the discretionary monetary policy, where the possibility to
instantly offset a shock or dampen a boom, was seen as the most appropriate method for setting the interest rate. But when economist started to criticise the time inconsistency problem\(^2\) the relevance for rule based, more credible, alternatives increased.

In 1993 the Taylor rule was introduced by the economist John Taylor (1993). The original Taylor rule was based on empirical observations where the US Federal Reserve appeared to set the nominal interest rate according to a formula that takes into account economic variables as inflation and output. The formula has become popular for its simplicity but also for its ability to work both as a normative tool, by calculating a future path of the short-term interest rate according to the underlying values of the formula, as well as a descriptive tool, where it can be used to see previous developments of the interest rate. The Taylor rule has since it was first introduced in 1993 been modified by many economists and used frequently to evaluate central banks reaction functions. The version of the Taylor rule this thesis will consider has the same variables as Taylor’s original, only rewritten.

\[
i = r^* + \pi^* + \beta_1 (\pi - \pi^*) + \beta_2 \left[ \frac{(y - y^*)}{y} \right]
\]

\(i\) is the Taylor Rule interest rate  
\(r^*\) is the neutral real interest rate or equilibrium real interest rate  
\(\pi^*\) is the central banks inflation target  
\(\pi\) is the actual inflation rate  
\(\frac{(y - y^*)}{y}\) is the output gap, where \(y\) is the growth level of output and \(y^*\) is the potential growth level of output

\(^2\) Time inconsistency were introduced by Kydland and Prescott (1977) and stipulates that policy makers are not consistent over periods when setting the policy rate. When not constrained by rules monetary policy tends to be expansionary on avarage to lower unemployment which creates high average inflation.
\( \beta \)'s are reaction coefficients with values that correspond to the type of policy the central bank pursues. Higher values when the central bank dislikes deviations from inflation target, positive or negative output gap.

The model considers an equilibrium state where inflation is at target and output gap equals zero. In this state the nominal interest rate equals the “neutral” nominal interest rate, \( r^* + \pi^* \), which can be seen as an equilibrium rate where the economy is neither expansionary nor contractionary. In contrast, Taylor argues that an inflation brought over target as well as a positive output gap should give central banks incentive to increase the policy rate in order to keep the economy stable and not risk over heating. Likewise, when inflation is below target or output gap is negative, the central bank should stimulate the economy by a lower policy rate. The rates at which these short-term adjustments are made, depends on the values of the reaction coefficients, the \( \beta \)'s. In order to make the rule effective the following condition must hold; \( \beta_1 \geq 1 \) and \( \beta_2 \geq 0 \), otherwise the nominal interest rate will increase but the real rate will decrease, making the rule unsustainable. This condition has later been known as the “Taylor principle”. In Taylor’s original rule, applied on the US economy, theses reaction coefficients had the values 1.5 and 0.5 respectively. Additionally, he considered a 2 per cent inflation target together with a natural real interest rate of 2 per cent generating a neutral nominal interest rate of 4 per cent. Together, these values gave an interest rate development not different from the actual interest rate set by the Fed during 1987-1992.

A frequent debated subject concerning the Taylor rule is the presence of additional variables, other than those presented above. One of which are so called lagged variables, which reflects previous periods interest rate when estimating the current periods. These variables work as smoothing parameters that remove the possibility for large interest rate changes between periods. Peersman and Smets (1998) argue that this makes the central bank more credible when the market expects small gradual changes in interest rates. When considering the methodology of setting interest rates in reality this seem appropriate, since
most interest rate changes are made gradually by the ECB and other central banks. Another variable that has been considered is an exchange rate variable that reacts to changes made in the exchange rate. This however, has been shown not to help stabilizing inflation and output.

In contrast to the simplicity and educational characteristics of the backward looking Taylor rule, it is important to have in mind that when using it in forecasting interest rate developments, problems regarding expectations arise. These are however, left out of this paper, why it only investigates previous periods.

Further, it is important to also keep in mind the practical implications that arise when setting the interest rate, whether it is through rule based or discretionary methods. One can compare it with steering a ship, the change of course does not occur directly after turning the steering wheel. It takes a couple of seconds for the ship to respond. The same can be applied for the changing of the interest rate and is called a lag. The type of lag monetary policy primarily faces is called an outside lag. It refers to the time it takes between a policy action, to the point when the whole effect can be seen. The challenge to change the interest rate at the right time the get the best effect is something every central bank struggles with.

4. Empirical section

4.1 Regression model

To thoroughly apply the Taylor rule as a policy rule in Portugal, we will run an Ordinary Least Square Regression (OLS) on the pre EMU period to estimate the reaction coefficients the Taylor rule entails. To do so, we assume the Portuguese central bank to strictly follow the Taylor rule in the run up to the monetary union 1988-1998. The values of the reaction
coefficients will serve as weights on inflation- and output deviations when calculating the annual policy rate after the EMU entry, considering Portugal still had an independent central bank that strictly followed the Taylor rule. To estimate the equation it is important to clarify that certain assumptions are made. Before entering the EMU, the Portuguese central bank did not follow an inflation target. Instead they had an exchange rate target. To make the Taylor rule equation applicable on the Portuguese economy however, we assume that if they would have had an inflation target, it would not unlike the ECB target, have been at 2 per cent. In order to make equation 2 compatible with the properties of OLS estimation, we rewrite it as follows:

\[ i = \alpha + \beta_1 \pi_{gap} + \beta_2 y_{gap} \]  

(3)

where;
\[ i \] is the annual actual nominal interest rate 1988-1998
\[ \alpha \] is the annual natural nominal interest rate \((r^* + \pi^*)\) 1988-1998
\[ \pi_{gap} \] is the annual inflation gap \((\pi - \pi^*)\) 1988-1998
\[ y_{gap} \] is the annual output gap \(\left(\frac{y - y^*}{y}\right)\) 1988-1998 measured in per cent

Further, the Taylor rule involves parameters that are unobservable in the economy, e.g. potential output and the neutral real interest rate. The neutral real interest rate is included in the first part of the rule and is denoted \(r^*\). This value, together with the inflation target \(\pi^*\), at 2 per cent will yield the neutral nominal interest rate \((r^* + \pi^*)\), which determines the Taylor rule interest rate when inflation is at target and the output gap is zero. These where in Taylor (1993) estimated to 2 per cent (inflation target) and 2 per cent (neutral real interest rate), yielding a neutral nominal interest rate at 4 per cent. In this paper, the neutral nominal interest rate will be estimated in the OLS as a constant, and yield the intercept term. Taking the estimated value of the constant and subtracting the inflation target, 2 per cent, we have the neutral real interest rate for the period, which represent a real interest rate when the economy is at target. As for Portugal’s potential GDP, we will
use a linear trend line on Portugal’s annual GDP from 1988-1998 (see figure 1). This trend line will represent the economy’s annual potential output. This is not to be confused with maximum utilization of resources for then it would be contradictory to show a graph with actual output higher than potential output. Instead, potential output is the level of output that is consistent with stable inflation.

Figure 2: GDP and linear potential GDP 1988-1998

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The linear function shows actual output and how it deviates from potential output. The values of annual output and its potential output are summarized in Table 1 (see appendix).
4.2 Choice of time period

The time period this thesis will investigate is 1988-2011. The reason we begin our study with the year 1988 is due to gaps in the statistics for variables in previous years. We are aware that this lack in number of observations lowers the credibility of the study. Using quarterly or monthly data would provide a broader basis for analysing fluctuation, for example within a year the nominal interest rate can fluctuate between quarters. However, we believe it is enough to show tendencies relevant for the investigated topic.

The period 1988-1998 will be used in the OLS regression model to estimate the values of the coefficients. These coefficients will later be used to calculate the interest rate according to the Taylor rule equation during the period 1999-2011. To do this, we assume the Portuguese Central Bank to strictly follow the Taylor Rule during 1988-1998, the period we build our study on. This will give values that represent a situation where Portugal, considering their economic situation, set the interest rate according to the Taylor Rule. The relationship found will then be used to estimate how the second periods, 1999-2011, interest rate development would have looked if they had stayed out of the European Monetary Union and instead continued to set their interest rate according to the Taylor Rule. We are however aware of that the economic situation in Portugal and the Euro area as a whole is dynamic and the relationship that prevailed in the first period may not be representative for the following period. An entry into a monetary union affects many aspects of the economy, many of which are difficult to isolate. However, the values of the coefficients represent a mentality that prevails within the central bank council. They serve as weights, showing how much consideration each variable should be given. In this matter, this paper assumes the same mentality to prevail within the Portuguese central bank in the first period as well as in the hypothetical second period. With this, it also assumes the mentality to stay the same during the second period. As stated above we are aware of that the economic situation is dynamic and that the probability of the Portuguese central bank to change its mentality cannot be excluded. However, this is an outcome that is not
considered in this thesis. In addition, this assumption is consistent with similar papers using the Taylor Rule. Further, the similarities in interest- and inflation rates could also justify the assumption that the relationship is credible over the two periods. The year 1999 will serve as the start for the ECB controlled interest rate. This is because 1999 is the year the common currency was introduced electronically and the ECB was introduced as the common central bank, which Portugal was a part of. But even though 1999 was the year for ECB’s establishment, we are aware that the nations road towards the Euro started even earlier. Associated with the signing of the Maastricht Treaty 1992, the twelve member states in agreement decided that seven years later, a common currency would be introduced. As a result of this run-up period, countries like Portugal knew they had to adjust their monetary policy towards the Euro criteria’s long before it was actually introduced. This can be seen when studying the Portuguese interest rate development over the period. There is a steady decline in Portugal’s nominal interest rate from 1992 until 1999, which can be seen in figure 3 below. However, we choose to study the period after ECB was introduced, even though we are aware of the adjustments made in Portugal during the run-up to the common interest rate introduced in 1999.

*Figure 3: Portugal’s nominal interest rate 1988-2011*

![Portugal nominal interest rate 1988-2011](image)

*Source: OECD Statistical Data Base, Annual nominal interest rate Portugal 1988-2011*
4.3 Data

The data we will use when estimating the values of the Taylor rule coefficients and in calculating the Taylor rule interest rate are all gathered from OECD’s statistical database. We use annual data of inflation, output and nominal interest rate. The reason why annual data is used is because the quarterly data available only stretch back to 1995. We believe that using only data between 1995-1998 when estimating the coefficients might be misleading because much of the adjustments done in the run up to the Euro will be left out. Hence, this thesis only considers annual data. This is together with the issue discussed in the time period section above; another subject that we are aware of lowers the credibility of the study.

4.4 Regression analysis and results

To estimate the Taylor rule intercept and its reaction coefficients for Portugal, we use the annual data on nominal interest rate, inflation gap and output gap for the pre Euro period 1988-1998. The data is summarized in table 2.

<table>
<thead>
<tr>
<th>Year</th>
<th>Interest Rate</th>
<th>Inflation Gap $(\pi - \pi^*)$</th>
<th>Output Gap $(y - y^*)/y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>0.1297</td>
<td>0.0766</td>
<td>-0.0380</td>
</tr>
<tr>
<td>1989</td>
<td>0.1483</td>
<td>0.1061</td>
<td>0.0018</td>
</tr>
<tr>
<td>1990</td>
<td>0.1690</td>
<td>0.1137</td>
<td>0.0212</td>
</tr>
<tr>
<td>1991</td>
<td>0.1774</td>
<td>0.0849</td>
<td>0.0440</td>
</tr>
<tr>
<td>1992</td>
<td>0.1671</td>
<td>0.0745</td>
<td>0.0277</td>
</tr>
<tr>
<td>1993</td>
<td>0.1325</td>
<td>0.0671</td>
<td>-0.0198</td>
</tr>
<tr>
<td>1994</td>
<td>0.1110</td>
<td>0.0342</td>
<td>-0.0364</td>
</tr>
</tbody>
</table>

Table 2: Time series data for estimating Taylor Rule 1988-1998
When running the regression analysis, Gretl is used. The nominal interest rate serves as the dependent variable and the independent variable are represented by inflation gap and output gap. The summarized result can be displayed in table 3 (the original result is found in the appendix) and the Taylor rule equation for the period of study, 1999-2011 is displayed as equation 4.

Table 3: OLS regression results period 1988-1998

<table>
<thead>
<tr>
<th>Year</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>0.0979</td>
<td>0.0218</td>
<td>-0.0179</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>0.0737</td>
<td>0.0109</td>
<td>-0.0183</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>0.0574</td>
<td>0.0032</td>
<td>0.0057</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>0.0431</td>
<td>0.0078</td>
<td>0.0224</td>
<td></td>
</tr>
</tbody>
</table>

Source: OECD Statistical Data Base, Annual inflation, output and interest rate Portugal 1988-1998

Descriptive statistics can be found in appendix as table 4.

\[ \text{Interest rate} = 0.0626 + 1.03 \times \text{Inflation Gap} + 0.101 \times \text{Output Gap} \]  
\[ T = 11, \text{R-squared} = 0.841 \]
The above table show values of the intercept, \( \alpha \), \( (0.0626) \) and the reaction coefficients, \( \beta' s \), for inflations gap \( (1.03) \) and output gap \( (0.101) \) respectively. As the intercept term is defined as the neutral nominal interest rate \( (r^* + \pi^*) \), we can by subtracting the inflation target at 2 per cent get the neutral \( \text{real} \) interest rate that yield 4.26 per cent. Also, surprisingly the p-value for the estimation of the output gap shows no statistical significance, meaning that one cannot statistically say that the setting of the interest rate depends on the output gap in the case of Portugal. This result will change the structure of the original Taylor rule described earlier in that matter that the output gap will not be considered when estimating the interest rate for period 1999-2011. As a result, the Portuguese central bank will only focus on deviations from inflation target when setting the interest rate 1988-1998, not the output gap, as the following calculations will show.

These values give equation 4 for estimating future interest rate. Combining equation 2 and 4 will give:

\[
t = 0.0626 + 1.03(\pi - \pi^*)
\]  

Equation 5 represents the annual Taylor rule function with which one can combine the annual data for the second periods (1999-2011) inflation gap. To clarify, the intercept calculated for the period 1988-1998 will be used when calculating the period 1999-2011. Because this paper assumes the same inflation target both periods (2 per cent) the changes in the intercept term would in theory only affect the neutral real interest rate. Because we investigate a hypothetical scenario where Portugal never entered the union, it seems only fair to use the same neutral real interest rate as in the previous period, 1988-1998. The variables and the results are summarized in table 4.
Table 5: Annual data for calculating Taylor Rule 1998-2011 and results considering equation 5.1 and 5.2 respectively

<table>
<thead>
<tr>
<th>Year</th>
<th>Inflation Gap</th>
<th>Taylor Rule Interest Rate</th>
<th>ECB Nominal Interest Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>0.0335</td>
<td>9.70%</td>
<td>2.96%</td>
</tr>
<tr>
<td>2000</td>
<td>0.0087</td>
<td>7.20%</td>
<td>4.39%</td>
</tr>
<tr>
<td>2001</td>
<td>0.0235</td>
<td>8.70%</td>
<td>4.26%</td>
</tr>
<tr>
<td>2002</td>
<td>0.0156</td>
<td>7.90%</td>
<td>3.32%</td>
</tr>
<tr>
<td>2003</td>
<td>0.0127</td>
<td>7.60%</td>
<td>2.33%</td>
</tr>
<tr>
<td>2004</td>
<td>0.0036</td>
<td>6.60%</td>
<td>2.11%</td>
</tr>
<tr>
<td>2005</td>
<td>0.0029</td>
<td>6.60%</td>
<td>2.18%</td>
</tr>
<tr>
<td>2006</td>
<td>0.0110</td>
<td>7.40%</td>
<td>3.08%</td>
</tr>
<tr>
<td>2007</td>
<td>0.0045</td>
<td>6.70%</td>
<td>4.28%</td>
</tr>
<tr>
<td>2008</td>
<td>0.0057</td>
<td>6.80%</td>
<td>4.63%</td>
</tr>
<tr>
<td>2009</td>
<td>-0.0283</td>
<td>3.40%</td>
<td>1.23%</td>
</tr>
<tr>
<td>2010</td>
<td>-0.0061</td>
<td>5.60%</td>
<td>0.81%</td>
</tr>
<tr>
<td>2011</td>
<td>0.0166</td>
<td>8.00%</td>
<td>1.39%</td>
</tr>
<tr>
<td></td>
<td>Annual average interest rate</td>
<td>7.09%</td>
<td>2.84%</td>
</tr>
</tbody>
</table>

Source: OECD Statistical Data Base and own calculations

The table shows the annual inflation gap from 1999-2011. Multiplying each year’s variable with its coefficient and adding the intercept term, gives the annual Taylor rule interest rate seen in column 3. The Taylor rule interest rate is also plotted against the ECB interest rate in figure 4 to show how they would have differed if Portugal maintained their independent central bank and it strictly followed the Taylor rule.
In the graph above we see a clear distinction between the nominal interest rates set by the ECB and the Portuguese interest rate calculated with the properties of the Taylor rule. It is clear that the interest rate set by the ECB follows a too low path than is required by the economic situations in Portugal. During the period of study, the annual ECB interest rate and the Taylor rule interest rate differ with as much as 6 per cent and during the first two years the interest rate development from the Taylor rule is the opposite the one in the Euro area. However, during the financial crisis that struck the world in late 2008, the graph shows relative small interest rate deviations for ECB rate and that calculated using the Taylor rule. During the following years however, interest rate deviations once again started to increase. Overall, table 4 shows an annual average rate for the calculated Taylor rule interest rate at 7.09 per cent in contrast to the average ECB rate at 2.84 per cent.
5. Discussion

Before evaluating the result found above, it is important to make a few clarifications. When calculating the Taylor rule interest rate, this thesis assumed that the neutral nominal interest rate during the ECB era 1999-2011 was the same as the one estimated on data from the period 1988-1998. This is only an assumption for we cannot appropriately estimate a new value for the ECB era; instead we assume that this is the neutral nominal interest rate that would have prevailed if Portugal maintained their independent central bank. Despite this, the results show that the interest rates differ with on average +4.25 per cent over the 12 years since the creation of the ECB and the introduction of a common interest rate. With this as a reference, it is clear to see that the setting of the Euro interest rate takes little consideration of the economic situations in Portugal. This goes hand in hand with the findings by Francis and Oliver (2010) and their study of Ireland using the Taylor rule. Not unlike this study, they find the ECB rate to lie far below what the situation in Ireland required. Considering the increased number of Euro countries, it is not far fetched to reach the same conclusion when studying other relatively small countries in the EMU. With an area containing 17 countries, the fact that the economic situation in some of these countries differs is obvious. They all have their own histories, different cultures, different languages and different competitiveness. Therefore, it is not surprising that they react differently to cyclical changes or for that matter, economic crises. With the abandonment of their own monetary policy, they now have to rely on the monetary policy conducted by the ECB to counteract cyclical changes or asymmetric shocks.

The discussion above gives new relevance for the topic of optimum currency areas discussed in the theoretical section. An optimum currency area requires certain properties to be successful. It should not be too big, for it may cause localized recessions. It should involve countries that are homogenous, with similar size and inflation rate. Today, the Euro area contains 17 countries, all of which differ in size and in competitiveness. With this as a
background, none of these properties can be considered attained when referring to the EMU, why the Euro cannot be described as an optimum currency area.

Further, the determination of the real interest rate in countries using the Fisher equation also explained in the theoretical section strengthens what Mundell (1961) stated as a requirement for an optimum currency area, namely similar inflation rates. As inflation rates between countries differ, the real interest rates between countries will differ, making cyclical recession tough to get out of. If one country has an inflation rate higher than the rest of the area, the real interest rate in that particular country will be lower causing inflation rate in that country to continue to increase. This can be seen as a negative spiral, a spiral that a common nominal interest rate contributes to and makes it hard to get out of.

This scenario is a result of operating with a fixed exchange rate, where the country’s independent monetary policy is abandoned. In the case of the Euro, the ECB however pursue other goals than only keeping the exchange rate at its level as the theory implies. Instead, the Euro countries operate with a fixed exchange rate within the union whereas outside of the union, the exchange rate is allowed to float. The implications arise when the countries, which operate with a fixed exchange rate towards each other, differ in their economic situation. Then the market forces are not able to adjust to a new equilibrium as they would if the exchange rate were allowed to float. Many economists argue that these asymmetric shocks are a stabilizing cost that is greater than the benefits of a fixed exchange rate, one of which is increased trade. With fixed exchange rates, the uncertainty with exchange rate variations are reduced, giving incentives to increased trade. For Portugal it is difficult to evaluate these possible effects for they have always operated with a fixed exchange rate. If they instead of fixing their exchange rate to the Euro had released it to float, the situation might have looked different. Because of their specialized production, a floating exchange rate may have prevented the low demand they are experiencing. Instead, the currency could have adjusted to the economic situation, as in the case of the Swedish krona during the recent economic crisis. When demand fell, the value of the krona depreciated, making it cheaper in terms of foreign currencies. This fall in the
exchange rate served as a counterforce to the declining demand. The possibility for Portugal to counteract a fall in demand as Sweden did has due to the Euro been limited, contributing to the continuous low demand. The size of the EMU is large and Portugal plays a small role in contributing to its economic situation. In contrast, Germany is the largest economy within the union, why it is not surprising that the Euro exchange rate adjust more to the situation in Germany rather than the one in Portugal. Further, it is also not surprising that the interest rate set by the ECB would follow the German economic situation quite well. This hypothesis is confirmed by Sauer and Sturm (2003) where they find that the Taylor rule interest rate calculated for the Bundesbank and the ECB follows the German conditions before and after the introduction of the common central bank (see figure 5 in the appendix).

6. Conclusion

The main objective of this study is to evaluate how the development of the Portuguese interest rate would have differed from the interest rate set by the European Central Bank if Portugal had maintained their independent central bank instead of entering the European Monetary Union. The instrument with which we try to answer this question is the Taylor rule. The Taylor rule do, as described earlier, work as a function which incorporates economic activities like inflation and output to determine a policy rate that, in theory, motivates an appropriate act regarding the dynamics of a nation’s monetary policy at that time. Our study finds that using the Taylor rule results in a nominal interest rate development far different from the one set by the ECB.

In contrast to previous studies such as Geni and Munteanu (2010), our findings show a higher deviation in Taylor rule rate and ECB rate for Portugal. However, when defining the Taylor Rule equation, this thesis use an OLS regression to determine the values of the reaction coefficients the Taylor Rule incorporates. In comparison, Geni and Munteanu (2010) have used values that they believe represent the ECB policy fairly well, and applied
these to all the PIIGS countries, while this thesis solely considers values based on the situation in Portugal. As their conclusion points to the fact that the common interest rate has had little effect on the situation in Portugal since the Euro entry, this thesis stresses just that.

Conclusively, this study is not enough to state that the low interest rate set by the ECB has been the reason for the economic setback in Portugal the recent decade, but it clearly shows that it has not been beneficial. It is also important to remember that the Taylor rule is only a model by which we calculate the hypothetical interest rate set by the central bank and is therefore not to be considered the true interest rate. However, it shows an indication on how the path of the interest rate would have developed given the variables it considers, i.e. deviations in inflation and output, in a reality where Portugal did not enter the monetary union.
Further Research

The result reached in this study along with the results of similar studies confirms our hypothesis regarding countries influence in the setting of the interest rate. It is clear in Francis and Oliver (2010) that Ireland has not benefitted from the relatively low interest rate set by the ECB. Further, Geni and Munteanu (2010) and their study regarding the PIIGS countries also show Taylor rule calculated interest rate that differs from the one set by the ECB. These studies, along with this study of Portugal, made us think about how these countries would have developed if they fixed their exchange rates to each other and created their own monetary union, parallel with the Euro area. This could be considered more accurate the properties by which an optimum currency area should be created according to Mundell (1961). They all come from a past characterized by agriculture. They can be considered more or less homogenous, all lacking the competitiveness the Euro area today requires. The theory that the PIIGS countries together would form a currency area more suited for their situation is something that crossed our minds while writing this paper and a topic that would be appropriate for further research.
7. References

Literature:

Abreu Marta. (2001). *From EC Accession to EMU participation: the Portuguese disinflation experience*. Lisabon, Portugal; Banco de Portugal


Doran David, Hickey Rónán. (2009). *A Discussion of the Taylor rule*. Bank of Ireland,


Geni Jurinda, Munteanu Jasmina. (2010). *Could the crisis in the PIIGS countries have been avoided with an independent central bank? A study using the Taylor rule.* Uppsala Universitet. Uppsala. BA.


Internet:
European Union, “The history of the European Union”.


Investopedia, “Bonds and Economics 2009: What is the balance of payments?”
http://www.investopedia.com/articles/03/060403.asp (2012-05-17)

Konjunkturinstitutet, National Institute of Economic Research, Forecasts.

OECD Statistical Data Base.
http://www.oecd.org/document/0,3746,en_2649_201185_46462759_1_1_1_1,00.html (2012-04-20)

OECD Statistical Data Base: *Nominal GDP growth, forecast (EO91, May 2012)*

OECD Statistical Data Base. *Inflation rate, change over one year*

OECD Statistical Data Base. GDP in US dollars, current prices and PPPs

OECD Statistical Data Base. Short-term interest rates


## Appendix

*Table 1: Summary annual output gap Portugal 1988-1998*

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP (Millions USD)</th>
<th>Potential GDP (Millions USD)</th>
<th>Residuals (Y-Y*)</th>
<th>Output Gap (Y-Y*)/Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>92405,7863</td>
<td>95914</td>
<td>-3508,2137</td>
<td>-0,0380</td>
</tr>
<tr>
<td>1989</td>
<td>102082,2017</td>
<td>101900</td>
<td>182,2017</td>
<td>0,0018</td>
</tr>
<tr>
<td>1990</td>
<td>110218,1121</td>
<td>107886</td>
<td>2332,1121</td>
<td>0,0212</td>
</tr>
<tr>
<td>1991</td>
<td>119109,7332</td>
<td>113872</td>
<td>5237,7332</td>
<td>0,0440</td>
</tr>
<tr>
<td>1992</td>
<td>123266,9027</td>
<td>119858</td>
<td>3408,9027</td>
<td>0,0277</td>
</tr>
<tr>
<td>1993</td>
<td>123398,7872</td>
<td>125844</td>
<td>-2445,2128</td>
<td>-0,0198</td>
</tr>
<tr>
<td>1994</td>
<td>127195,5760</td>
<td>131830</td>
<td>-4634,4240</td>
<td>-0,0364</td>
</tr>
<tr>
<td>1995</td>
<td>135395,2998</td>
<td>137816</td>
<td>-2420,7002</td>
<td>-0,0179</td>
</tr>
<tr>
<td>1996</td>
<td>141215,9660</td>
<td>143802</td>
<td>-2586,0340</td>
<td>-0,0183</td>
</tr>
<tr>
<td>1997</td>
<td>150645,1749</td>
<td>149788</td>
<td>857,1749</td>
<td>0,0057</td>
</tr>
<tr>
<td>1998</td>
<td>159349,0154</td>
<td>155774</td>
<td>3575,0154</td>
<td>0,0224</td>
</tr>
</tbody>
</table>

*Source: OECD Statistical Database and own calculations*
Table 3 (extended): OLS regression results

Model 1: OLS, using observations 1988-1998 (T = 11)
Dependent variable: Interest_Rate

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.0625784</td>
<td>0.0111253</td>
<td>5.6249</td>
</tr>
<tr>
<td>Inflation_Gap</td>
<td>1.03127</td>
<td>0.167843</td>
<td>6.1442</td>
</tr>
<tr>
<td>Output_Gap</td>
<td>0.100927</td>
<td>0.247706</td>
<td>0.4074</td>
</tr>
</tbody>
</table>

Mean dependent var 0.118824  S.D. dependent var 0.046353
Sum squared resid 0.003424  S.E. of regression 0.020687
R-squared 0.840663  Adjusted R-squared 0.800829
F(2, 8) 21.10408  P-value(F) 0.000645
Log-likelihood 28.80402  Akaike criterion -51.60804
Schwarz criterion -50.41436  Hannan-Quinn -52.36049
rho 0.557436  Durbin-Watson 0.895729

^Interest_Rate = 0.0626 + 1.03*Inflation_Gap + 0.101*Output_Gap
(0.0111) (0.168) (0.248)

T = 11, R-squared = 0.841
(standard errors in parentheses)

Source: Gretl
Table 4: Descriptive Statistics, using the observations 1988 – 1998

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest_Rate</td>
<td>0.118824</td>
<td>0.129680</td>
<td>0.043100</td>
<td>0.177375</td>
</tr>
<tr>
<td>Inflation_Gap</td>
<td>0.0546077</td>
<td>0.0670700</td>
<td>0.00319434</td>
<td>0.113700</td>
</tr>
<tr>
<td>Output_Gap</td>
<td>-0.000690909</td>
<td>0.00180000</td>
<td>-0.0380000</td>
<td>0.0440000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Std. Dev.</th>
<th>C.V.</th>
<th>Skewness</th>
<th>Ex. kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest_Rate</td>
<td>0.0463533</td>
<td>0.390101</td>
<td>-0.314488</td>
<td>-1.19456</td>
</tr>
<tr>
<td>Inflation_Gap</td>
<td>0.0404203</td>
<td>0.740195</td>
<td>0.0399630</td>
<td>-1.46437</td>
</tr>
<tr>
<td>Output_Gap</td>
<td>0.0273884</td>
<td>39.6412</td>
<td>0.103230</td>
<td>-1.23371</td>
</tr>
</tbody>
</table>

Source: Gretl

Figure 5: The nominal interest rate and the Taylor rule in Germany and in the Euro area