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ABSTRACT

In this paper we trace changes in monetary policy caused by institutional amendments in legal acts of central banks. We estimate coefficients of the Taylor Rule for central banks of Sweden, United Kingdom, Switzerland and EU15 to shed some light on monetary policy *ex ante* and *ex post* significant improvements in central bank independence. Results presented suggest differences in accommodating monetary policy in countries and support the idea that initial level of CBI matters for reactions to variability both of inflation and output gap. A pre-independence period characterizes with strong inflation targeting features, whereas a post-independence time resembles more discretionary type of monetary policy. As a spin-off from our original idea, we find that changing properties of inflation in the last decade make econometric analysis more difficult

JEL: E02, E52

Keywords: Taylor rule, central bank independence, interest rate rules

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# 1 Introduction

We agree with the common opinion that institutions matter. In this paper we answer the question: how? This paper characterizes empirically how the chosen central banks have conducted monetary policy since the beginning of the 1990s. We focus on countries with distinct institutional changes in their central banks laws. We estimate monetary policy reaction functions for Sweden and the United Kingdom, which recorded improvements in the degree of central bank independence (CBI).

The objective of this paper is to trace changes in monetary policy that could result in remodeling of central banks' institutions. In particular, our objective is to ask the question whether and how, increased independence can affect central bank's behaviour. Two motivations provoke our investigation. First, the modern model of central banking assumes the institution being at least partly autonomous from the government and other political parties. After many studies, concentrating on proving economically positive effects of higher level of CBI, countries around the world joined the trend of ensuring monetary authorities with enough independence to autonomously operate in monetary area. So far the rule applied was to look for economic effects of increased independence of monetary authority by explaining changes of inflation with variety of regressors, including CBI as one of them. Our study reaches for concrete models of monetary rules and traces correlations between institutions and economy there.

Second, in the course of our analysis, we have noticed a repeating situation when coefficients for the *ex post* period were often insignificantly different from zero. Moreover, in most of cases, these coefficients represented relation between interest and inflation rate. After many verifications of our data and making sure we do not make any data or/and calculation mistake, we have decided to accept this "astonishing stubbornness" of results. Since it was not the first time that it was difficult to show significant relationship between inflation and interest rates or other variables, we accepted the fact that in recent years properties of inflation have changed. We understand this situation, as we explain later, as a case, when the answer to changing interest rates is a stable inflation rate.

As our estimation practice, we focus on the interest-rate rule proposed by John Taylor (1993), which describes responds to inflation while setting the interest rate. Among others, Clarida et al. (1998), Hetzel (2000) and Orphanides (2003) bring theoretical discussion on the rules along with some empirical evidence. Despite its simplicity, Taylor's rule has stimulated much useful research on monetary policy. Moreover, as Clarida et al. (1999) emphesize "the rule is consistent with the main principles for optimal policy" that is: (1) it has the nominal rate adjust more than one-for-one with inflation rate; (2) real rates adjust to engineer inflation back to target, and finally; (3) the rule calls for countercyclical response do demand shocks and

accommodation of shocks to potential GDP that do not affect the output gap.

This paper is organized as follows. Section 2 summarizes the most important theoretical findings that form a foundation for this study. That is, it reviews the basic theory of solutions to optimal institutional design of central banks, along with the theory on the Taylor's rule. The methodology used for empirical estimation, as well as data description is characterized in Section 3. Section 4 presents results of estimations. Concluding remarks are in Section 5.

# 2 Theoretical background

## 2.1 The case for of an independent central bank

### 2.1.1 Institutional design of a modern central bank

The institutional design approach focuses on delegating monetary policy to a central bank, which will engage in low-inflation policies. It is possible using the legislative means as a tool. Several designing solutions, which may exist separately or overlap, concentrate on restricting a central banker's activity with either (1) a performance contract (as described in e.g. Persson and Tabellini, 1994; Walsh, 1995), (2) a targeting rule, which would specify conditions to be fulfilled by the central bank's target variables (e.g. Svensson 2005), or (3) legally transfer full/partial autonomy in conducting monetary policy. These solutions are based on arrangements that a constitutional or institutional-design stage creates principles of the central bank behavior, which cannot be easily changed because changing the institution ex post is costly or/and it can take time. This issue has also find itself in the area of criticism, in particular by McCallum (1997) and Posen (1993), who argue that some of proposed solutions "do not fix the dynamic inconsistency" but they"merely relocate it".

All three solutions are possible to find in 'real' economic practice, the latter two, however, have in recent years witnessed both theoretical attention and practical implementation. The concept of independence implies that the central bank is able to set policy without interference or restriction from other agents. That is a general explanation, which is accompanied with the other idea that an independent central bank acts as a signal to private agents about forthcoming policy actions. Theoretical justification of this institution starts with Kydland and Prescott (1977), and later Barro and Gordon(1983), who develop and explain the idea of *time inconsistency* and *credibility* of a central bank, building this way a foundation for further studies. The topic of autonomy has evolve later toward finding the optimal definition of this phenomenon and the way of quantifying it. The clusters of central bank attributes, defining its independence, include structural or-

ganization of central bank, ability to formulate monetary policy as well as its objectives, and restrictions concerning lending to the private sector. A detailed description of the problem can be found in e.g. Berger et al. (2001).

### 2.1.2 How does independence matter?

The choice of central banks, which we include into our analysis, has been led with one crucial criterion: the presence of the evolution of the legal system in area of a central bank's organization and activity. At first, we have concentrated on analyzing the history of central banking in many countries, with respect to obvious improvements in four clusters of CBI, mentioned above. The presence of inflation targeting from the beginning of the analyzed period has been important to us, as well. This way we could be ensured that changes in the monetary policy were, indeed, the result of legal changes of the Bank's institutions, rather than of a leading monetary policy rule. Both criteria have been fulfilled in case of Sweden, Switzerland and the United Kingdom.

It is also important to notice that many European countries, which adjusted their legal acts toward more independent monetary authority, could not be included here due to their joining the European Monetary Union. In many cases, law amendments were made very shortly before their EMU membership, and hence the data series would have been too short for the analysis.

The choice of countries was inspired not only by the fact of tracing consequences of institutional changes but also by our primary expectations of what kind of reaction can be found. All three countries, Sweden, Switzerland, and the United Kingdom could be called as a homogenous group if we decide to use the IMF criteria of the degree of development. In many other aspects these three countries do not differ much from one another. However, in our case, once analyzed the institutional design of central banks, these three states have varying histories.

Being the oldest in the world, the Riksbank (central bank of Sweden) has had a considerably high degree of independence for the most of its operating time. Introducing inflation targeting from January 1993 brought a certain monetary discipline. The subsequent change of the legal act granting the Bank a higher degree of independence was a natural step for the Bank. New legislation, which we are interested in, came into force on January 1, 1999 and, as monetary authority explains in their report, the new legislation gave "a legal form to the independence that monetary policy already had in practice" (Sveriges Report, 1999, p.4). It is represented by the shift on monetary policy from the General Council to an Executive Board. Moreover, external communication had improved as well with publishing of the minutes from the monetary policy meetings.

The history of the Bank of England has tied the Bank strongly to the

HM Treasury and the Government itself. The first modern legal act from 1946 enabled the Treasury to give directions to the Bank about the monetary policy. The monetary policy was strongly a part of Government policy. After all, it had been the chancellor of exchequer who, for years, had been setting interest rates. Thus, the 1998 amendment, the crucial for the Bank and for our analysis change in the Bank's legislation, shifted that major monetary responsibility from the Treasury to the Bank of England. This and many other alteration of the Bank's role aimed to fulfill the Maastricht Treaty requirements, as well as modern style of central banking.

Finally, we include Switzerland and EU15 to the sample and we treat them as our control countries. Due to the special character in financial markets, as well as high development of democratic institutions, Switzerland "developed into an island of political and economic stability, establishing itself an important financial hub" (Commemorative publication "The Swiss National Bank 1907-2007"). As its policy, The Bank chose a stability-oriented monetary policy, which became an international standards years later. These factors had certainly an impact on final evaluation of the degree the Bank pursue its policy autonomously, placing it, along with the Bundesbank, repeatedly on the top of the list. The new Federal Constitution, which includes crucial points on the type of monetary policy, was accepted in a public referendum in April 1999. The document clarifies the type of an exchange rate, as well as gives the sole right in pursuing monetary policy autonomously but it did not clearly state that the price stability would be the major goal of the central bank. This has been added in the next document, Federal Act on the Swiss National Bank. For our study, we choose to identify January 1, 2000 as a date of importance for monetary policy in Switzerland.

The intuition behind choosing EU15 as a control "country" to our study lays in the well-known disinflationary type of monetary policy accompanied by high degree of central bank independence. Even though all 15 countries are different from each other in many economic aspects, their monetary history is connected with one important goal - common currency. The 1990s witnessed a process of gradual adjustment in all countries with respect to their central bank legislation, structural organization of monetary authorities and major goals of monetary policy. Thus, our data analysis starts in 1990, when the Stage One to Economic and European Union had begun, while as a point of the "improvement in central bank independence" we choose January 1, 1999, when the Stage Three began (three stages of European integration according to the Delors Report, 1989).

From these short descriptions of institutional improvements we see that each bank recorded a change of a different kind. In our opinion, the Riksbank has made legal the process that had been effective for a long time. Both, for the market and the Bank, this change represented a "sealing of a deal", thus, in our analysis, we expect smaller differences between coefficients for

inflation and output gap in two subperiods.

Our expectations are different when it comes to the Bank of England. Granting an operational independence to the Bank shifts the monetary power from the government to the monetary authority. What follows, it sends a strong signal to the market not only about political exclusion from the policy process but also about the change in the type of monetary policy. Such a strong shift in the degree of independence has to, in our mind, influence the whole monetary policy in a significant way.

### 2.2 Taylor rule as a contemporary policy approximation

The well-known Taylor rule (Taylor, 1993) directs the central bank to react to deviations of the inflation rate from a target level. It does so without any relation to the absolute level that prices may have reached. Such concern with the inflation rate rather than the level of prices, as Woodford (2003) explains, would seem to characterize policy in all advanced countries in recent years.

Taylor proposed a rule for setting interest rates (the U.S. Federal Reserve's funds-rate operating target) based on a linear function of measures of the current inflation rate and the current gap between real and potential output. His estimation of coefficients indicate that, in order to respond properly to the rise of inflation above the target, the nominal interest rate operating target should be raised by more than the amount by which inflation exceeds the target. Thus, Fed's simple reaction function is of the form

$$i_t = \overline{\imath} + \phi_\pi(\overline{\pi}_t - \overline{\pi}) + \phi_x x_t \tag{1}$$

where $i_t$ is the funds rate, The prior four-quarter inflation rate is $\overline{\pi}_t$ and the FOMC's inflation target is $\overline{\pi}$. The output gap, $x_t$, is the percentage deviation of real GDP from a trend line measuring potential output.

Taylor proposed a feedback policy with symmetric weight 0.5 given both to inflation and output gaps. Moreover, a constant term, 2, is assigned by Taylor as well to represent long-run average of the real rate of interest and the same value for inflation target. Thus, after transformations, the Taylor rule can take the following form with estimated coefficients for the Fed

$$i_t = 0.04 + 1.5(\overline{\pi}_t - 0.02) + 0.5(y_t - y_t^p), \tag{2}$$

where we use $x_t$ and $y_t$ to represent output interchangeably.

The Taylor rule has been modified to include various elements of modern central banking. First, a static relation like equation (1)cannot capture the serial correlation present in the data, thus a modification of the rule leads to a dynamic specification. Second we see proposals of specifications in which a bank's operating target depends on forecasts. The example of the former is given by (among others) Judd and Rudebusch (1998), who estimate Fed

reaction functions according to which the fund-rate operating target adjusts in response to changes in an implicit desired level of the funds rate $\overline{i}_t$. The 'actual' interest rate $i_t$ is partially adjusted to the target according to the form

$$i_t = \rho i_{t-1} + (1-\rho) i_t^* \tag{3}$$

where $\rho$ is a parameter that measures the degree of interest rate smoothing. Substituting (1) into (3) results in the following equation

$$i_t = \rho i_{t-1} + (1-\rho)\alpha + (1-\rho)(\gamma_\pi \pi + \gamma_y y) + \epsilon_t \tag{4}$$

with

$$\alpha = r^* + \pi^T$$

where we unify notations and use $i$ for interest rate, $r^*$ is the long-run equilibrium real interest rate, and $\gamma_\pi$ and $\gamma_y$ are coefficients for inflation and output gaps respectively. Model with an interest rate smoothing parameter (or otherwise called a partial adjustment to the target) eliminates the concern that a simple rule could not capture the tendency of central banks to smooth changes in interest rates. Clarida et al. (1998) explains that the necessity to smooth interest rates is justified with the fear of disrupting capital markets, loss of credibility from sudden large policy reversal, or the need for consensus building to support a policy change.

A "forward-looking" Taylor rule is suggested by Clarida et al. (1999) who suggest a version of the simple Taylor rule:

$$i_t^* = \alpha + \gamma_\pi (E_t \pi_{t+1} - \overline{\pi}) + \gamma_x x_t \tag{5}$$

Under this rule, policy responds to expected inflation as opposed to lagged one.

**Major principle** in the Taylor rule (the so-called 'Taylor principle') assumes that the nominal interest-rate is being adjusted by more than the amount by which inflation exceeds the target. Put differently, the coefficient for inflation is expected to exceeds the unity in the case of the optimal policy. Hence, the key lessons drawn from the estimation of this policy reaction function concentrates on analyzing the coefficient for inflation gap.

If one assumes that the coefficient for inflation gap is smaller than one $\phi_\pi < 1$, that is on contrary to Taylor's principle, the expectational difference equation for the inflation rate has an infinity of bounded solutions, so that equilibrium inflation in this case is indeterminate, like in the case of pure interest-rate control (see e.g. Leeper (1991); for the analysis: Woodford (2003)). Positive coefficients much less than one on inflation for the period 1960-1979, Taylor (1999) interprets as the instability of U.S. inflation and real activity during the 1970s, that is indicate passive interest-rate responses.

# 3 Data and methodology

We perform our investigation by estimating simple and modified Taylor rules. A general critique of these methods lays in using historical data, whilst the appropriateness of the rule would require the use of 'real-time data'. To compensate the use of historical data, as well as due to the short time span, we follow Clarida et al. (1998) and Faust et al. (2001) and use monthly data (when possible). Second analysis for quarterly data is referring to those studies, which treat quarter data as more obvious frequency.

The estimated models are of the form we have presented in the theoretical description. For the sake of transparency, we bring them again with the final notations we use in this analysis

1. Specification (1) - "simple" Taylor rule

$$i_t = \alpha + \gamma_\pi \pi + \gamma_y y_t + \epsilon_t \tag{6}$$

2. Specification (2) - Taylor rule with an "interest-rate smoothing" parameter

$$i_t = \rho i_{t-1} + (1-\rho)\alpha + (1-\rho)(\gamma_\pi \pi + \gamma_y y) + \epsilon_t \tag{7}$$

The history of institutional changes in central banks of each country, as briefly described in paragraph 2.1.2, determines time intervals of our analysis. Table 1 in appendix brings detailed information on periods for each central bank. We have collected information on the data and time series directly from central banks related countries and their statistical offices. We have also benefit hugely from the Statistical Office of the European Communities (Eurostat) and partly data was downloaded from the OECD statistical resource engine. Here we would like to mention that previous versions of this paper included larger variety of countries (for instance from Central and Easter Europe). However, due to a problem with reliability of data and many revisions of data since the political and economic transition, we decided not to include them in the final version. Perhaps that is material for further work.

**Nominal short-term interest rate** In his original study, Taylor has used the federal funds rate, which was later replicated as the natural choice for the U.S. In other papers, which include different samples, the short-term interest rate is represented by an interbank lending rate for overnight loans, or a 3-month Treasury bill.

Here, representation of this variable differs depending on the country, data availability or time period. The choice of the final interest rate has been done based on the information provided by central banks in each country. Thus, we have included in the study the following interest rates definitions:

1. Sweden - the key interest rate - repo rate - the rate of interest at which banks can borrow or deposit funds at the Riksbank for a period of seven days (4 first quarters for repo is a marginal rate, which stopped being published after introducing repo).

2. Switzerland - the key interest rate - three-month LIBOR.

3. United Kingdom - 3-month Treasury Bill rate.

4. EU15 - money-market 3-month interest rate (EURIBOR; interchangeably with EONIA)

**Inflation rate** Due to the sample differences, the access to the inflation data has also varied significantly. Considering all the criticism of the Consumer Price Index (CPI) and various its definitions found in the literature, we have decided to use information from central bank's webpages. Thus, the relevant inflation rate for Sweden is the underlying inflation CPIX. In the case of the United Kingdom, we followed Nelson (2000) and Mihailov (2006) by including alternative indexes for inflation: the Retail Price Index (RPI), and Retail Price Index excluding the mortgage rate (for our own sake we checked also RPI excluding housing). Finally measures of inflation represented by HICP and CPI from OECD were used for the EU15 and Switzerland respectively.

**Output gap** The most difficult variable to quantify is the output gap. It is also the most vulnerable for criticism for there is a variety of ways, in which it can be calculated. Two the most common in this aspect approaches include using the real gross domestic product (GDP) or the industrial production index (IPI) for each country separately. We have performed the analysis using both of these measures whenever it was possible to find the proper data. We have tested them for seasonality using the standard Census X12 test in order to apply a Hodrick-Prescott filter (with the smoothing parameter set at $\lambda$=1600, as suggested in the literature for the quarterly data, and $\lambda$=14400 for monthly data). The actual output gap is calculated as the percent deviation of real GDP or IPI from a target, as it was originally proposed by Taylor

$$y = 100 * \frac{Y - Y^*}{Y^*} \tag{8}$$

where Y is real GDP (or more often industrial production index), and $Y^*$ is trend real GDP. In the final analysis, we have decided to represent output gap mainly with industrial production index. We made few exceptions for UK, where we replicate quarterly data both with gdp and industrial production, as well as when we found it necessary to check results with other measures.

# 4 Monetary policy and central bank independence

Major idea of the experiment in this study is to follow any changes in the monetary policy rule coefficients, as they may appear while amendments to institutional design of the central bank appear. In particular, we are interested in the improvements of central bank independence that took place within almost two decades 1990s and years 2000. Thus, we will discuss the movements of inflation and output coefficients, as well as we'll find and compare values for the equilibrium real rate. To estimate coefficients $(\alpha, \gamma_\pi, \gamma_y, \rho)$ we use mainly Least Squares regression method, corrected with Newey and West standard errors.

[Table 2 AROUND HERE]

**Inflation gap** Note first that the global pattern of inflation emerges for all countries (see Fig. 1). A common period of disinflation, started already in the 1980s, brings inflation rate to low and stable levels in the 1990s and the new millennium, despite few temporary upticks. The behavior of short-term interest rates also is characterized by two different patterns. Prior to 1999-2000 (and we use this breakpoint keeping in mind lagged reactions to monetary policy changes) central bankers kept interest rates high above the inflation rate and along the passing time we could observe significant decrease in levels of both rates. From year 1999-2000 real as well as nominal short-term rates keep low but rather stable levels.

The simple Taylor rule, estimated for Sweden and the United Kingdom, brings straightforward indication of policy rules (whenever significant). In case of Sweden, coefficients obtain level above the unity for the whole period as well as the pre-independence period. Thus, the central bank incorporates the implicit inflation targeting feature in this period. We report several estimation on the inflation gap, depending on the frequency of data and the type of the rule. Receiving coefficient $\gamma_\pi$ ranging from 1.52 to 1.91 we can say that a rise in expected annual inflation of one percent indices the Riksbank to raise real rates by 0.52 (0.91) basis points. In all cases $\gamma_\pi$ is significantly greater than one and thus the prediction that the Bank raises real rates in response to inflationary pressure is statistically significant.

We do not observe this significance in all tests in the post-independence period. Values for the second period are definitely below the unity indicating important change in the policy: strengthening of the monetary power could allow the Bank to react less aggressively to changes in inflation rate and focus on stabilizing the real economy.

Despite mostly insignificant results for UK, it is interesting to compare inflation gap coefficients between two countries. For the whole period, as well as in the first one, these coefficients are much lower than in the case of Sweden. That could indicate that the Government, while it had power to set interest rates, kept in mind fiscal goals, as well. A rise in annual inflation

of one percent induced the Riksbank to raise real rates more than in the same period the Bank of England would care to do. Clearly, explaining this difference with only a degree of independence would be an overstatement. However, we dare to claim that institutions shaping the type of monetary policy played here the crucial role, as well.

The results above mentioned were obtained using core inflation rates respectively for each country (according to the information provided by central banks and suggested by the literature). We have repeated these estimation using the "traditional" CPI. As expected, values for inflation gap coefficients differed with the previous ones but it did not change the fact, however, that these values were again much higher for Sweden than for the United Kingdom.

**Output gap** Following Orphanides, we do not focus only on analyzing coefficients for inflation gap. It is similarly important to compare changes of output gap. In the study on the U.S. economy, involving the forecasts produced by the Fed staff, Orphanides (2004) underlines not the change in the inflation coefficient but the reduction in the size of output gap estimation. This reduction was interpreted as the key to U.S. macroeconomic stability since the mid-1980s. However, this coefficient has been hardly ever significantly different from zero.

Lack of statistical significance of estimates on output gap in the pre-independence period we treat, as it was described in the part on inflation gap, as the indication that the banks focused on stabilizing inflation rate more than other parts of economy. For us one outcome is clear: changes in output gap coefficients are significantly different. First of all, in most of cases, these coefficients became significantly different from zero in the post-independence period. Second, their scale is different depending on the frequency of data.

Analyzing monetary policy reaction functions for the Bank of England we notice that the response to the output gap is much stronger in the post-independence subsample. In both tests, that is with simple and modified Taylor rule, the coefficient is significantly different from zero. Considering the loss of significance for the estimates on inflation gap in this subperiod, we draw conclusion that inflation targeting is less conservative and less contractionary under the regime with operational independence granted to the central bank. Our result is in line with findings of e.g. Mihailov (2006), who comes to similar conclusions while analyzing British monetary policy using the real-time data. To some degree this repeats with the rest of countries.

**Control countries** As described above, we repeated the same analysis for Switzerland, as our control country. We expected to obtain both steady and significant results. However, similarly to examples of Sweden and UK, all

coefficients were significant except for the one of inflation gap in the second period. Adjusting for different measures of inflation and output gap did not change the fact that the coefficient for inflation gap lost its significance, while other values for equilibrium interest rate and output gap were significant. We have also changed the length of the second period. During that process, we also have problems to find significant results for other variables.

In our subsequent tests with countries belonging to the EMU, we found the repeating pattern involving relatively high, that is around 2.0, coefficient for inflation gap in the first period, and much lower ones, though insignificant, in the second period representing recent 8-10 years. Weak stability of inflation gap coefficients was found also in this test. The scenario is similar to previous cases: the second period is characterized with increased significance of interest rate adjustment as the result to changes in output gaps variations. Meanwhile, also here, we see no connections between interest rates movements and changes (or no changes) in the degree of inflation.

These unexpected for us patterns helped us to formulate our second hypothesis that due to changing properties of inflation, represented by smoothed trends in inflation variability, there is no significant relationship between inflation and interest rate in the last 8-10 years. Thus only output gap reacts to current monetary policy. We understand that a pre-independence period is characterized with strong *inflation targeting* features that is attaching a larger weight on inflation stabilization, which, as feared by inflation targeting opponents, may act to the detriment of the stability of the real economy. The post-independence time interval, however, reminds a type of monetary policy with flexible inflation targeting in the sense that central banks not only aim at stabilizing inflation around the target but also put some weight on stabilizing the real economy, for instance output gap.

Moreover, we want to compare results of these two periods with the situation in the United States and thus we refer to Taylor rule estimation for the United States economy, done by Clarida et al. (1999). Table 3 replicates estimation of the "forward looking" version of the simple Taylor rule for periods "before Volcker" and "after Volcker". We concentrated our attention on these results because they are similar to ours in terms of values and significance of coefficients.

[TABLE 3 AROUND HERE]

In the Volcker-Greenspan period (1979:3-96:4), which characterizes with a successful and long-lasting disinflation, the estimate for $\gamma_\pi$, the coefficient on the inflation gap, is significantly above the unity. Thus, it incorporates the implicit inflation targeting feature. At the same time, the estimated coefficient on the output gap, $\gamma_x$, is not significantly different from zero. These results are in most of cases the same as our estimates for pre-independence period. Again, we understand that central banks, equipped with a moderate level of independence, focus stronger on their major goal of price stability. These similarities are met again for the other period, where, in case of pre-

Volcker period, the estimate for output gap is positive and significant, while the inflation gap coefficient is less than unity.

## 5 Concluding remarks

We have assumed that institutional designs of central banks may be reflected with the kind of monetary policy they conduct. Keeping in mind that many factors influence central bank's choices, we performed the analysis of estimated Taylor rules for few countries to trace differences in monetary policy *ex ante* and *ex post* improvements in the degree of central bank independence.

First, our estimates of Taylor rule indicate that the monetary policy has been different in the pre- and post-independence subsamples. In all countries, central banks incorporate the implicit inflation targeting feature for their monetary policy in the first period (despite officially announcing this type of policy in some of them). In all countries, coefficient on inflation gap loses statistical significance in the post-independence period.

Next, we notice that the response to the output gap is much stronger in the post-independence subsample in all countries. Considering the loss of significance for the estimates on inflation gap in this subperiod, we draw conclusion that inflation targeting is less conservative and less contractionary under the regime with higher degree of independence granted to central banks.

We have also noticed varying values of coefficients between countries. Sweden and the United Kingdom have had different levels of CBI, we see disparities in the choice of institutions between central banks. Thus, we conclude that the Riksbank has reacted more aggressively to inflation rate variability that is can be noticed in the Bank of England.

Finally, inspired by our previous studies on interactions between central banks and inflation, as well as results we found in studies of other authors, we suggest that in roughly last ten years successful monetary policy does not influence inflation rate in the short run. A long-term plan of disinflation, which had been introduced in Europe on a large scale, is possible to trace with simple monetary rules.

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# A Appendix

Table 1: Factbook for the selected countries

| | |
|---|---|
| Sweden | |
| | Inflation target = 2 percent |
| | Periods: 1993m1 - 1998m4 and 1999m1 - 2007m4 (and quarterly) |
| | January 1993 - inflation targeting |
| | January 1999 - improvement in central bank's independence |
| Official document | Sveriges Riksbank Act 1998 |
| United Kingdom | |
| | Inflation target - 2 percent |
| | Periods: 1992m1-1998m12; 1999m1-2007m12 (and quarterly) |
| | October 1992 - inflation targeting |
| | The 1998 Act brought into force on 1 June 1998 improvement in CBI |
| Official document | Bank of England Act 1998 |
| Switzerland | |
| | Inflation target = 2 percent |
| | Periods: 1991q1 - 1999q4 and 2000q1 - 2007q4 |
| | January 2000 - improvement in CBI |
| Official document | Federal Constitution of the Swiss Confederation |
| | of 18 April 1999, RS 101 |
| | Federal Act of 3 October 2003 on the Swiss National Bank |
| | (National Bank Act), RS 951.11 |
| EU15 | |
| | Inflation target - no official inflation targeting but considering a goal of 2 percent |
| | Periods - 1991m1-1998m12; 1999m1-2007m12 |
| | January 1, 1999 - improvement in CBI |
| Official document | Delors Report on economic and monetary union |
| | in the European Community |
| | The Maastricht Treaty |

Notes: Based on information provided by central banks.

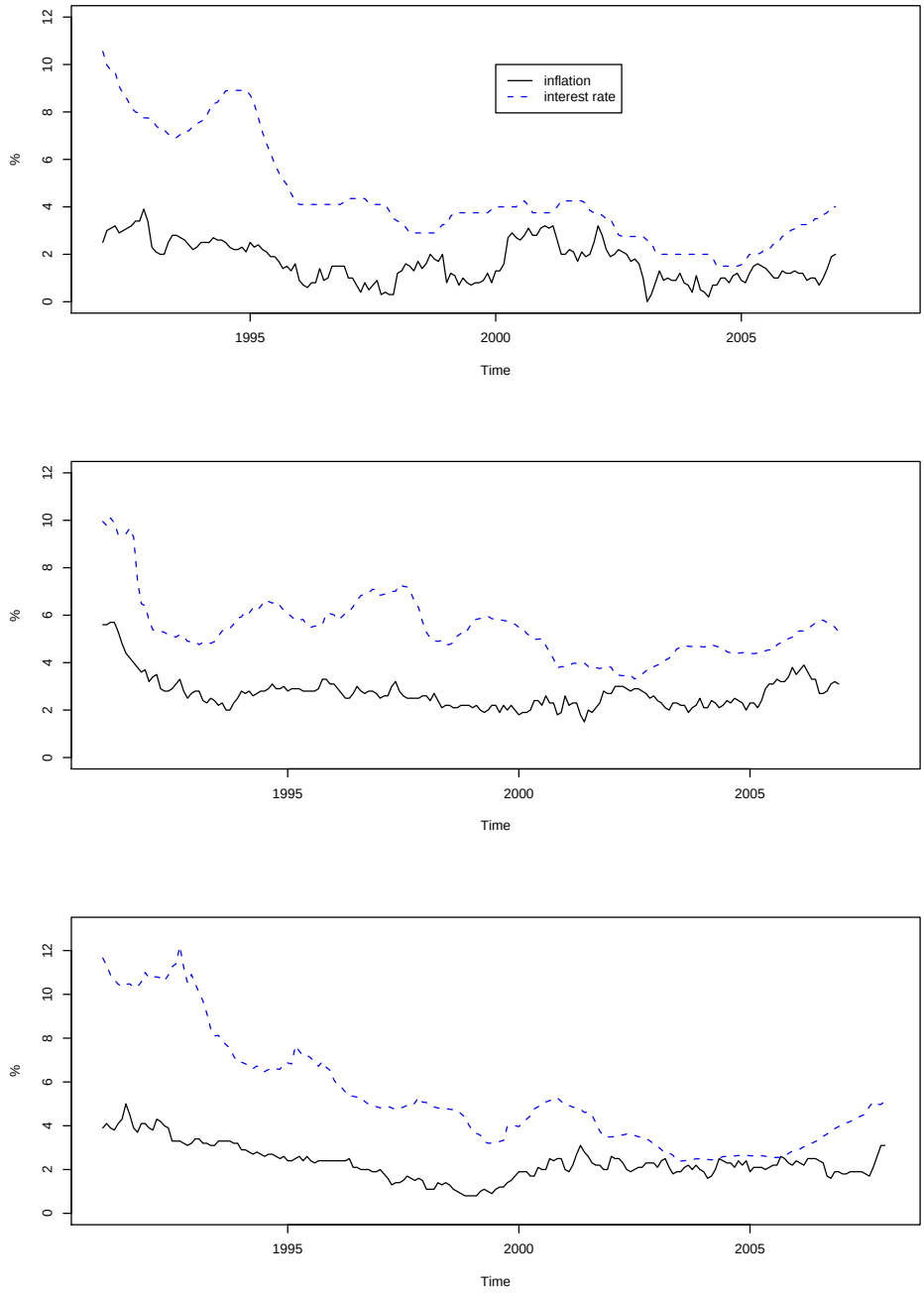


Figure 1: Interest rates vs. inflation, from the top: Sweden, United Kingdom, EU15. Source: Data from national central banks and ECB statistics.

Table 2: Estimated Taylor rules based on Hodrick-Prescott filtered output gap, 1992M1-2007M12 and 1992Q1-2007Q4 (United Kingdom)

| UK | $y_m^{sim}$ | $y_q^{sim}$ | $y_m^{smooth}$ | $y_q^{smooth}$ | $y_{q2}^{smooth}$ | $y_m^{sim}$ | $y_m^{smooth}$ |
|---|---|---|---|---|---|---|---|
| $\alpha$ | **4.73** | **5.14** | **5.3** | **5.39** | **5.17** | **4.76** | **3.89** |
| | (24.11) | (16.76) | (6.74) | (6.32) | (6.11) | (28.43) | (6.15) |
| $\gamma_\pi$ | **1.44** | **1.19** | 0.53 | 0.71 | 0.72 | 0.28 | 1.43 |
| | (10.58) | (8.1) | (0.58) | (0.85) | (0.86) | (1.26) | (1.44) |
| $\gamma_y$ | *0.26* | *0.58* | 0.56 | 0.54 | 0.70 | *0.29* | 1.34 |
| | (2.04) | (2.93) | (1.04) | (1.38) | (0.71) | (2.15) | (1.9) |
| $\rho$ | | | **0.90** | *0.62* | **0.75** | | **0.96** |
| | | | (14.53) | (2.67) | (3.69) | | (43.47) |
| No. of obs. | 72 | 28 | 71 | 27 | 27 | 120 | 119 |
| Ad. $R^2$ | 0.75 | 0.70 | 0.95 | 0.75 | 0.78 | 0.06 | 0.98 |
| DW | 0.36 | 0.86 | 1.15 | 1.17 | 1.45 | 0.10 | 1.15 |
| Sweden | $y_m^{sim}$ | $y_q^{sim}$ | $y_m^{smooth}$ | $y_q^{smooth}$ | | $y_q^{sim}$ | $y_q^{smooth}$ |
| $\alpha$ | **6.65** | **6.48** | **5.19** | **5.84** | | **3.45** | **3.58** |
| | (33.15) | (35.98) | (9.5) | (20.12) | | (24.81) | (7.92) |
| $\gamma_\pi$ | **1.91** | **1.6** | **1.54** | **1.52** | | **0.79** | 0.77 |
| | (10.14) | (12.54) | (5.53) | (8.68) | | (6.85) | (1.36) |
| $\gamma_y$ | *0.16* | *0.75* | *1.06* | *1.99* | | *0.44* | 3.01 |
| | (2.29) | (3.12) | (2.97) | (2.78) | | (2.46) | (1.05) |
| $\rho$ | | | **0.93** | **0.71** | | | **0.92** |
| | | | (44.41) | (8.94) | | | (12.38) |
| No. of obs. | 72 | 24 | 71 | 23 | | 36 | 35 |
| Ad. $R^2$ | 0.76 | 0.84 | 0.99 | 0.97 | | 0.44 | 0.92 |
| DW | 0.42 | 1.66 | 1.09 | 1.41 | | 0.73 | 1.76 |
| Switzerland | | $y_q^{sim}$ | | $y_q^{smooth}$ | | $y_q^{sim}$ | $y_q^{smooth}$ |
| $\alpha$ | | **1.4** | | **2.89** | | **1.52** | *1.89* |
| | | (3.81) | | (3.24) | | (6.58) | (2.67) |
| $\gamma_\pi$ | | **1.27** | | **1.05** | | 0.04 | 0.188 |
| | | (11.74) | | (5.68) | | (0.19) | (0.33) |
| $\gamma_y$ | | 0.11 | | 0.53 | | **0.83** | **0.30** |
| | | (1.67) | | (1.01) | | (6.50) | (5.58) |
| $\rho$ | | | | **0.85** | | | **0.69** |
| | | | | (8.57) | | | (5.9) |
| No. of obs. | | 40 | | 39 | | 39 | 39 |
| Ad. $R^2$ | | 0.87 | | 0.97 | | 0.69 | 0.94 |
| DW | | 0.47 | | 1.74 | | 0.60 | 0.94 |
| EURO15 | $y_m^{sim}$ | | $y_m^{smooth}$ | $y_{m2}^{smooth}$ | | $y_{m(eonia)}^{sim}$ | $y_{m(eonia)}^{smooth}$ |
| $\alpha$ | **5.98** | | **4.72** | **4.62** | | **3.06** | **3.28** |
| | (34.85) | | (4.46) | (3.62) | | (20.26) | (8.18) |
| $\gamma_\pi$ | **2.19** | | **2.01** | **1.96** | | 0.14 | -0.84 |
| | (13.72) | | (7.04) | (6.14) | | (0.51) | (-1.01) |
| $\gamma_y$ | 0.12 | | 1.13 | 1.18 | | **0.39** | *1.49* |
| | (1.17) | | (1.18) | (1.07) | | (3.61) | (2.58) |
| $\rho$ | | | **0.94** | **0.95** | | | **0.95** |
| | | | (20.31) | (19.56) | | | (48.11) |
| No.of obs. | 96 | | 95 | 95 | | 108 | 107 |
| Ad. $R^2$ | 0.82 | | 0.99 | 0.99 | | 0.25 | 0.98 |
| DW | 0.21 | | 2.00 | 1.89 | | 0.19 | 1.95 |

Notes: T-statistics in brackets;
$y_m^{sim}$ and $y_q^{sim}$ - specification based on a simple rule with monthly and quarterly data;
$y_m^{smooth}$ and $y_q^{smooth}$ - specification based on smoothing rule with monthly and quarterly data.

Table 3: Estimates of policy reaction function

| | $\gamma_\pi$ | $\gamma_x$ | $\rho$ |
|---|---|---|---|
| Pre-Volcker | 0.83 (0.07) | 0.27 (0.08) | 0.68 (0.05) |
| Volcker-Greenspan | 2.15 (0.40) | 0.93 (0.42) | 0.79 (0.04) |

Source: Clarida et al. (1999), "The Science of Monetary Policy: A New Keynesian Perspective", *Journal of Economic Literature*, Vol. XXXVII.

Notes: $\gamma_\pi$ - coefficient for inflation gap;
$\gamma_x$ - coefficient for output gap;
$\rho$ - smoothing parameter.

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