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## Article

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## **Measuring Nominal and Real Convergence of Selected CEE Countries by the Taylor Rule**

### **Abstract**

We propose using a simple Taylor rule to evaluate business cycle convergence of the Czech Republic, Hungary, and Poland with the Eurozone. Our findings indicate an ongoing convergence of those CEE countries to the Eurozone, but with instabilities and heterogeneity between the countries. Especially Poland has shown a high degree of convergence in recent years. But there are still relevant differences in Taylor rates of each country to the Eurozone of about two percentage points.

**Keywords:** CEE, monetary policy, currency union, convergence, Taylor rule

**JEL:** E52, E58, F15

## Introduction

One of the characteristics of a currency union is that there exists only one central bank which has to implement a monetary policy for all its members. Since the central bank can only set one target rate common to all countries, it has to orientate itself at the weighted average of the macroeconomic conditions. Therefore, only in case that the member countries have reached a sufficient degree of convergence, in particular business cycle convergence, the monetary policy will suit all countries. In the Eurozone<sup>4</sup> countries are evaluated according to the Maastricht criteria.

However, several authors criticize that these criteria measure just a nominal convergence but not real convergence [e.g. Heylen et al., 1995]. While nominal convergence is about nominal macroeconomic variables such as inflation rates or nominal interest rates, real convergence is about real macroeconomic variables such as unemployment rates or the real GDP. Despite this criticism, the Maastricht criteria are still relevant for all Central and Eastern European (CEE) countries. Once a country fulfills the criteria, it has to abolish its national currency and adopt the Euro [De Grauwe, Schnabl, 2005].

In this paper we examine the degree of convergence to the Eurozone and the heterogeneity within the CEE countries. By applying a simple Taylor rule with an inflation rate and unemployment gap [Nechio, 2011] we derive CEE country specific Taylor rates. We also compare these CEE rates with Taylor rates for the existing Eurozone.

Our results show a convergence in Taylor rates with a high degree of heterogeneity between the CEE countries. Despite that, business cycles are still not fully synchronized so that the decision to join the Eurozone might be too early for them to take.

The remainder of the paper is structured as follows: section 2 consists of brief review of the aspects connected with the convergence of CEE countries to the Eurozone. In section 3 we describe the use of Taylor rule for convergence assessment, while we present the data and our methodology in section 4. The results are presented in section 5. We finally conclude the results in section 6.

## Convergence Between CEE Countries and the Eurozone

Central banks set interest rates to achieve stable prices or low unemployment volatility.<sup>5</sup> The optimal interest rate to accomplish those goals depends on the state of an economy. In the presence of, for example, contractionary demand shocks central banks have to decrease the interest rate to achieve its goals [Blanchard et al., 2013].

In a currency union, however, a central bank sets one interest rate for all member countries. This raises the problem that countries which are members of that currency

union will incur costs, because the common interest rate likely deviates from the optimal interest rate. These costs are relatively small in case that the economies have reached a high degree of business cycle convergence.

In that case, economies are facing the same fundamentals and shocks so that the central bank has to set roughly the same interest rate. Then, all economies of a currency union will achieve price stability and low volatility of unemployment and output. In the opposite case of a high degree of heterogeneity, a common interest rate will not satisfy the needs of individual economies so that economies bear high costs of being a member of a currency union.

For the European Monetary Union, the Maastricht criteria [Forgó, Jevčák, 2015] should ensure a sufficiently high degree of convergence. These criteria demand low inflation and low interest rates, exchange rate stability, and low government debt levels and deficits. One major critique of the Maastricht criteria is that they measure nominal convergence but not real convergence [e.g. Heylen et al., 1995]. While nominal convergence is based on nominal macroeconomic variables, real convergence is about the convergence of real macroeconomic variables such as business cycle measures (output or unemployment gaps).

The benefit of real convergence is that it lowers the costs and increases the political support of being member of a currency union [Heylen et al., 1995]. For instance, high unemployment rates in European Monetary Union (EMU) countries due to the common currency might lower its political support. Nominal and real convergence have been studied for CEE countries. Fidrmuc and Korhonen [2006] survey studies on business cycle convergence for CEE countries. They find a great variation of results depending on the country and the methodology, and the strongest evidence in favor of convergence for the Czech Republic and Poland. In the more recent study for CEE countries mostly, Gächter et al. [2013] even find evidence for a decoupling of business cycles after the global financial crisis starting in 2007 and a high degree of heterogeneity between those countries. Matkowski et al. [2016] analyze the real income convergence of CEE countries with western European countries. They find clear-cut evidence in favor of an ongoing convergence in real income. Cevik et al. [2016] examine real convergence in CEE countries by relying on several macro variables. They find a considerable convergence in trade and productivity, but there has been limited evidence of business cycle convergence.

There are several problems with existing methodologies that assess convergence. Most econometric methodologies are not very traceable or robust. For instance, the identification of supply and demand shocks in dynamic systems is difficult and nontransparent. We use the output or unemployment gap as an alternative, which also allows decomposing the business cycle into a supply and demand component and makes the identification of shocks more transparent and robust. Some other methodologies for real convergence, such as unit root tests or co-integration studies, have the problem of not measuring business cycle synchronization.

Additionally, most methodologies do not aggregate different criteria, such as inflation and unemployment. Actual interest rates measure those criteria implicitly, when assuming the central bank to react to those fundamentals. However, central banks of CEE countries which seek to become member of the EMU, might set interest rates to fulfill the Maastricht criteria or suffer from institutional deficits, which makes the convergence of actual interest rates less sensible.

## Assessing Convergence by the Taylor Rule

Monetary policy rules have gained importance in the last few years [Williams, 2015]. Within the so called 'Federal Reserve Accountability and Transparency Act of 2014 (FRAT)' Bernanke [2015] evaluates several Taylor rates related to the monetary policy implemented by the Federal Reserve. The original work of Taylor [1993] focuses on the following relationship:

$$(1) \quad i_t = 1 + 1.5 \cdot \pi_t + 0.5 \cdot (y_t - y_t^*)$$

$i_t$  is the nominal interest rate (Taylor rate) set by the central bank in percentage.  $\pi_t$  and  $y_t - y_t^*$  are the inflation rate and the output gap, respectively. Taylor [1993] assumes for equation (1) an inflation target of 2 percent and a real interest rate of 2 percent<sup>6</sup>, which is roughly suitable for the European Monetary Union.

Nechio [2011] uses a slightly different version of the Taylor rule to examine the macroeconomic conditions and the degree of heterogeneity within the Eurozone:

$$(2) \quad i_t = 1 + 1.5 \cdot \pi_t - 1 \cdot (u_t - u_t^*)$$

Nechio [2011] relies on the unemployment gap ( $u_t - u_t^*$ ) instead of the output gap ( $y_t - y_t^*$ ) to measure the business cycle.<sup>7</sup> There are some advantages of using the unemployment gap, including its availability on a monthly basis and its higher importance to voters than the output gap. We followed the work of Nechio [2011] and applied the Taylor rule defined in equation (2). In both equations, the Taylor principle is fulfilled, since the coefficient with respect to the inflation rate of 1.5 is greater than 1. In this case the monetary policy is contractionary after an increase in inflation so that the real interest rate actually increases.

Our proposal is to use a Taylor rule for aggregation of different criteria of convergence, i.e. inflation rates and the unemployment gap, to one measure in a sensible way.<sup>8</sup> Furthermore, Taylor rule uses criteria which represent important goals of central banks and it provides a single number per each period, which is easy to interpret.

There are, at least, two objections to this approach. First of all, the weights proposed by Taylor [1993] or Nechio [2011] might not describe the optimal monetary policy rule for each economy or currency union. For example, the ECB might use different weights than those proposed in the literature. We can resolve this problem by estimating a Taylor rule of the Eurozone to determine those optimal weights. Secondly, the assumption of a constant natural interest rate, which influences the intercept in a Taylor rule, is questionable. However, if the natural interest rates move in the same direction by the same amount between two economies, the difference in Taylor rates is unaffected.

## Data and Methodology

We selected the Czech Republic, Hungary, and Poland as the economically most interesting CEE countries, because they are the most likely candidates for an accession to the Eurozone. Detailed information with respect to the different data sources are given in the appendix. We use monthly sampled data from 01/1998 to 05/2016 for the inflation and unemployment rate to construct Taylor rates. Since the Non-Accelerating Wage Rate of Unemployment (NAWRU) is only available on an annual basis, we assume the NAWRU to be constant within one year.<sup>9</sup> In order to measure inflation, we rely on the consumer price index. For the OLS regression to determine alternative weights, we use data from 01/1999 to 05/2016 of the main refinancing rate of the ECB, the inflation rate, and the unemployment gap.

For the computation of Taylor rates, we use, first, equation (2), which applies the weights by Nechio [2011], and, second, an OLS specification. We present both specifications as a robustness check. For the second specification, we run an OLS regression to determine the weights and yield:

$$(3) \quad i_t = \beta_0 + \beta_1 \cdot \pi_t + \beta_2 \cdot (u_t - u_t^*) + \epsilon_t$$

Table 1 presents the full regression output. Especially the coefficient with respect to the inflation rate is lower in the OLS specification than in equation (2) so that the ECB reacts less strongly to changes in the inflation rate. Interestingly, the Taylor principle is not fulfilled.<sup>10</sup>

We assess business cycle convergence by rolling correlations and rolling volatility over a period of six years, which is roughly one business cycle:

- **Correlation:** The development of synchronization of Taylor rates is assessed by rolling correlations. It is computed by Pearson's correlation coefficient and the correlation refers to Taylor rates of the Czech Republic, Hungary, or Poland with those of the Eurozone.

- Volatility: The development of deviations of Taylor rates is assessed by a rolling volatility or dispersion measure. For period  $t$ , this volatility measure for country  $j$  (the Czech Republic, Hungary, or Poland) is:

$$(4) \quad vol_t^j = \sqrt{\frac{1}{T} \sum_{t=1}^T (tr_t^j - tr_t^{EZ})^2}$$

$T$  is the number of observations in an estimation window.  $tr_t^j$  and  $tr_t^{EZ}$  are the Taylor rates of country  $j$  and the Eurozone, respectively.

## Results

Taylor rates for the Czech Republic, Hungary, Poland, and the Eurozone are presented in Figures 1 and 2. Figure 1, by using the weights from Nechio [2011], suggests three phases. In the first phase the Taylor rate decreases tremendously in each of the CEE countries due to the decline of inflation rates, which can be seen in Figure 7. This might be attributed to the transition to market economies. The end of this phase differs between the CEE countries. While the Czech Republic experiences a relatively fast convergence towards low Taylor rates of less than 5 percent, Hungary and Poland shows slower convergence. In the second phase, from around 2001 to 2013, there are still significant differences in Taylor rates between the CEE countries and the Eurozone; and the volatility of Taylor rate in those CEE countries is higher than the volatility in the Eurozone. In the third phase starting in 2013, there is a convergence in Taylor rates in Figure 1, although there is still a difference of around two percentage points with the Eurozone. Figure 2, by using OLS weights, which put less emphasis on the inflation rate, shows less volatile Taylor rates and smaller deviations from the Eurozone interest rate. Especially in Hungary, there is a significant convergence from 2000 to 2012. From 2012 to 2016, however, the Taylor rates in CEE countries are persistently higher than in the Eurozone.

We present rolling correlation estimates in Figures 3 and 4 to assess the synchronization of Taylor rates. Each point represents the correlation with Taylor rates of the Eurozone over the past 6 years. The figures show a high degree of heterogeneity between the CEE countries after the initial phase of convergence. Poland experienced a high degree of synchronization from 2002 to 2008 and from 2011 to 2016. After the global economic crisis in 2010, however, the correlation of Taylor rates between Poland and the Eurozone was weak. The synchronization of Taylor rates between the Czech Republic and Hungary with the Eurozone was relatively stable. Especially when using OLS weights, the synchronization decreased since the global financial crisis in 2008 (see Figure 4).

In Figures 5 and 6 we present the volatility over the last 6 years in order to assess the deviations from the Eurozone Taylor rates. After the initial phase until 2004, the typical

deviations were relatively stable. The levels of deviations differ between the CEE countries. In the case of the Czech Republic the difference from Taylor rates in the Eurozone has been around or less than two percent. Poland showed higher deviations of around 4 percent, but they decreased clearly from 2009. In the case of Hungary, the deviations differ between both Figures. The results show, however, a relevant difference of Taylor rates to those in the Eurozone.

Our results are in line with previous literature. Firstly, we confirmed relevant differences between the CEE countries. This applies mostly to Poland, which differs from both other countries. Its differences in Taylor rates are still very high, although there has been clearly an ongoing convergence in recent years. Secondly, like Gächter et al. [2013], we found a decoupling in business cycle in the Czech Republic and Hungary.

## Conclusion

We analyzed the development of inflation rates and unemployment gaps for the Czech Republic, Hungary, and Poland by using Taylor rates. Our findings suggest an ongoing convergence among countries. There have been relevant deviations from the Eurozone in those countries in recent years.

There has been a synchronization of Taylor rates, however, the results are not very stable over time. There are differences between the Czech Republic, Hungary, and Poland so that every country should be evaluated on its own. In recent years Poland has shown a clear convergence to Taylor rates of the Eurozone. This holds for the business cycle synchronization and for absolute deviations. The Czech Republic showed a high degree of convergence from 2004 to 2011. The convergence although has been lower in recent years. Hungary experienced a slower convergence than the Czech Republic and Poland. Our results indicate that accession of the Czech Republic, Hungary, and Poland to the Eurozone might be an option in the following years, which can be regarded as a positive development. The deviations from Taylor rates of the Eurozone in recent years are not larger than for peripheral countries of the Eurozone [Nechio, 2011].

The results of Nechio [2011] show that it is highly questionable whether the Eurozone is an optimal currency area in itself, which is shown by the experiences of some EMU countries during the economic crisis since 2007. Taking this point as well as the uncertainty about convergence into consideration and facing the fact that it is easier to join the Eurozone than leaving it, it seems sensible to wait a couple of years to have evidence of business cycle convergence over a longer period.



## Notes

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<sup>4</sup> Currently, the Eurozone consists out of the following 19 countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

<sup>5</sup> In the case of the European Monetary Union, the single main objective is price stability, which is defined by an inflation rate measured by consumer prices of below but close to 2 percent in the medium term. But since many central banks also care about unemployment, such as the Federal Reserve, and since both goals are related to each other [Blanchard, Gali, 2007], we focus in our analysis on both inflation and unemployment.

<sup>6</sup> This is consistent with equation (1), since  $4 + 1.5 \cdot (\pi_t - 2) + 0.5 \cdot (y_t - y_t^*) = 1 + 1.5 \cdot \pi_t + 0.5 \cdot (y_t - y_t^*)$ .

<sup>7</sup> Both Taylor rules would lead to the very same level of the Taylor rate in case that the following relationship holds perfectly:  $0.5 \cdot (y_t - y_t^*) = -1 \cdot (u_t - u_t^*)$ . The term in brackets on the left-hand side symbolizes the output gap and the term in brackets on the right-hand side symbolizes the unemployment gap.

<sup>8</sup> See, for example, Woodford [2001] who argues that a Taylor rule satisfies several properties of optimal monetary policy.

<sup>9</sup> See European Commission [2013] for a detailed description of the procedure to calculate the NAWRU.

<sup>10</sup> The t-statistic with respect to  $H_0 : \beta_1 = 1$  is  $-9.26$ . We use robust standard errors following Andrews [1991] to accommodate for autocorrelation.

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## Appendix

### Description of the Data Set

The data set was downloaded from ECB's Statistical Data Warehouse (unemployment rate, inflation rate, main refinancing rate) and from the AMECO Database (NAWRU) on 30/08/2016.

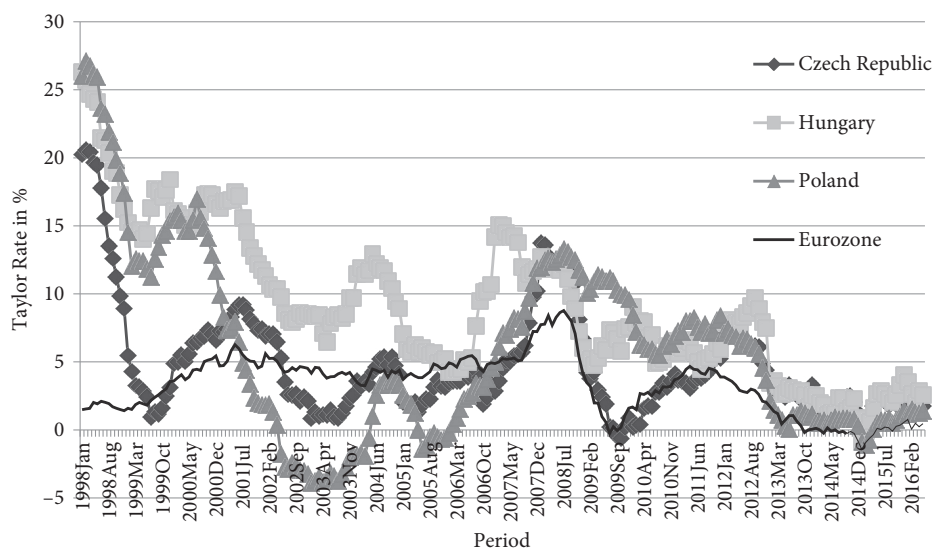
- **Inflation Rate:** Harmonized consumer price index; annual growth rate; ICP.M.CZ.N.000000.4.ANR (Czech Republic), ICP.M.HU.N.000000.4.ANR (Hungary), ICP.M.PL.N.000000.4.ANR (Poland), ICP.M.I8.N.000000.4.ANR (Eurozone (EA 19))
- **Unemployment Rate:** Standardized unemployment; total; STS.M.CZ.S.UNEH.RTT000.4.000 (Czech Republic), STS.M.HU.S.UNEH.RTT000.4.000 (Hungary), STS.M.PL.S.UNEH.RTT000.4.000 (Poland), STS.M.I8.S.UNEH.RTT000.4.000 (Eurozone (EA 19))
- **Non-Accelerating Wage Rate of Unemployment (NAWRU):** AMECO Database; ZNAWRU (for Czech Republic, Hungary, Poland, and Eurozone)
- **Main Refinancing Rate:** FM.B.U2. EUR.4F.KR.MRR\_FR.LEV (Eurozone), data from 01/1999 to 05/2016

TABLE 1. Regression results of the OLS Taylor rule estimation

Variable	Estimated coefficient
Intercept	1.61*** (11.89)
Inflation rate	0.42*** (6.60)
Unemployment gap	-0.93*** (-19.52)
Adjusted R2	0.76
Observation	209

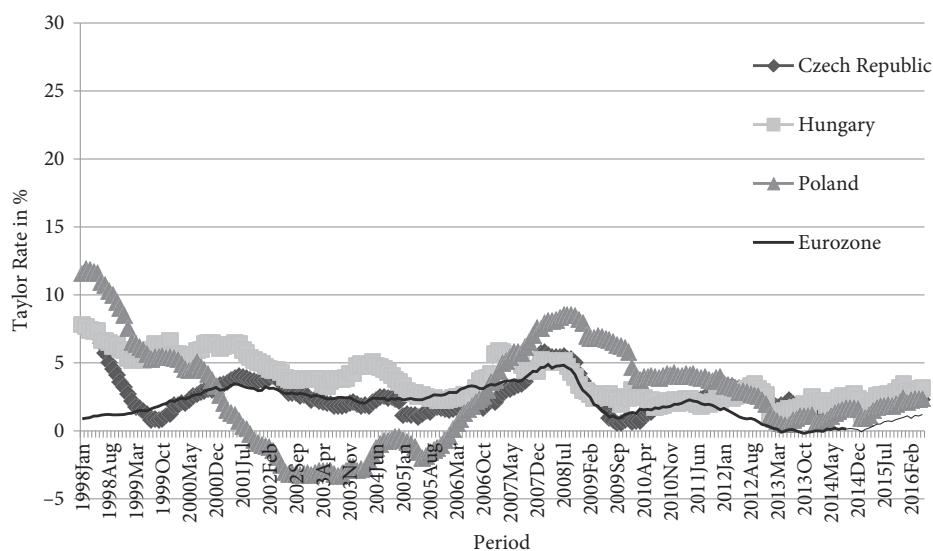
Note: \*\*\* refers to a significance level of 1%. The parenthesis shows the t-statistic with respects a null hypotheses of  $H_0: \beta_k = 0$ . We use robust standard errors following Andrews [1991] to accommodate for autocorrelation.

S o u r c e: ECB, Eurostat, own elaboration.

**FIGURE 1. Taylor rates using weights by Nechio [2011]**

Note: The Taylor rates are computed by the following specification:  $i_t = 1 + 1.5\pi_t - 1(u_t - u_t^*)$ .

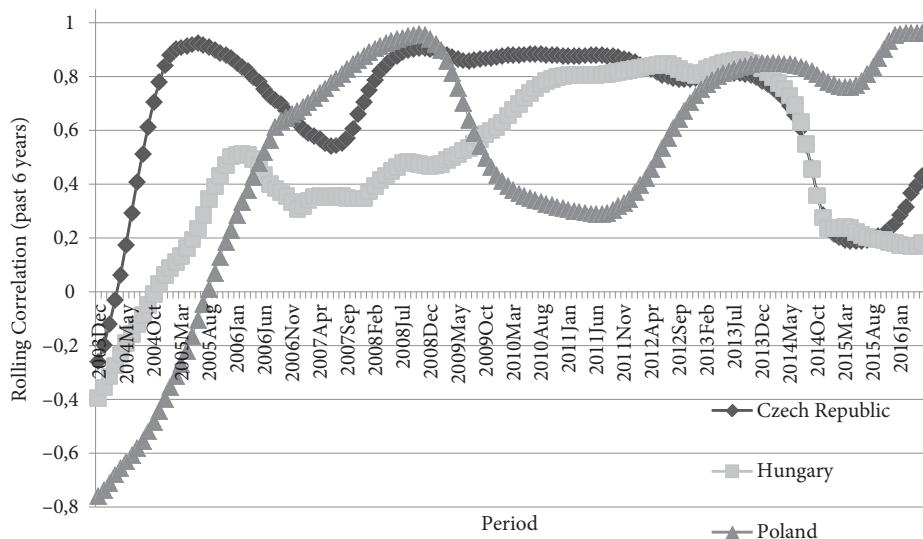
Source: ECB, Eurostat, own elaboration.

**FIGURE 2. Taylor rates using OLS weights of the Eurozone**

Note: The Taylor rates are computed by the following specification:  $i_t = 1.61 + 0.42\pi_t - 0.93(u_t - u_t^*)$ .

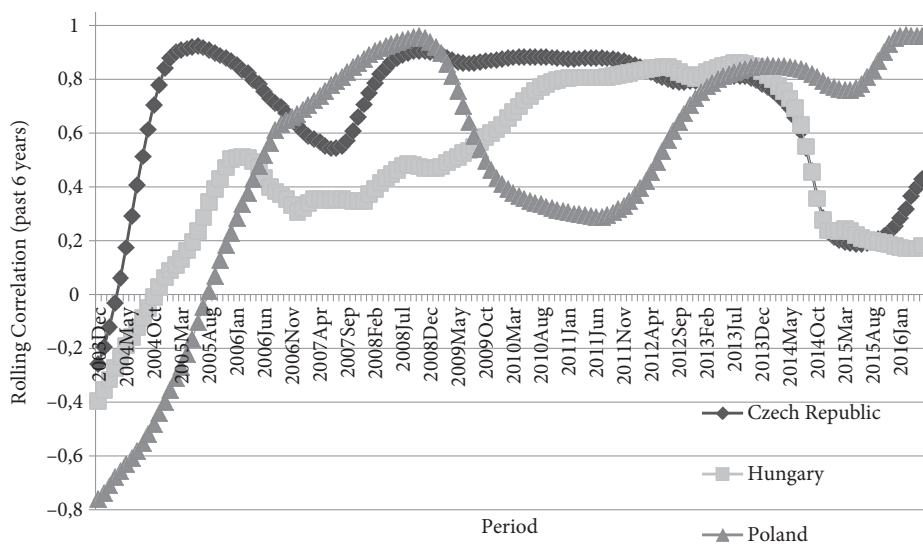
Source: ECB, Eurostat, own elaboration.

**FIGURE 3. 6-year rolling correlations with the Eurozone Taylor rate (Nechio [2011] weights)**

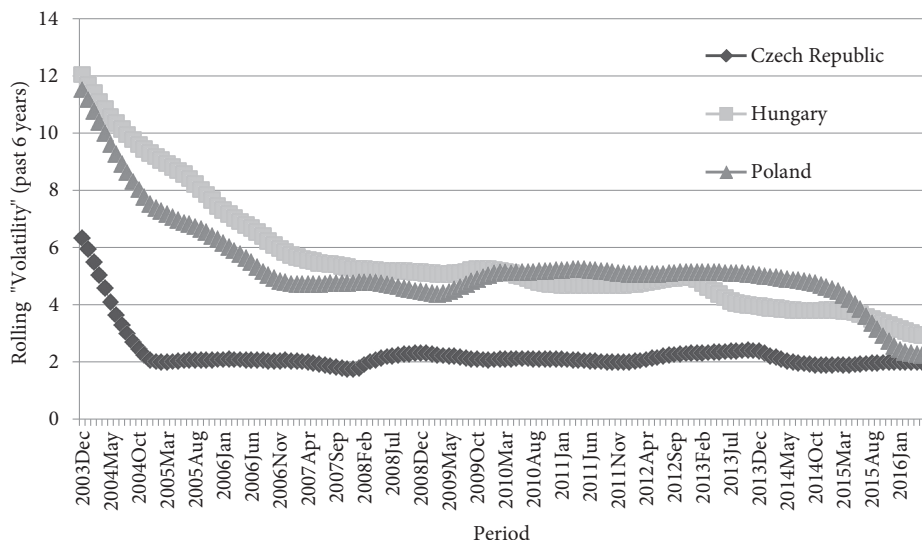


Source: ECB, Eurostat, own elaboration.

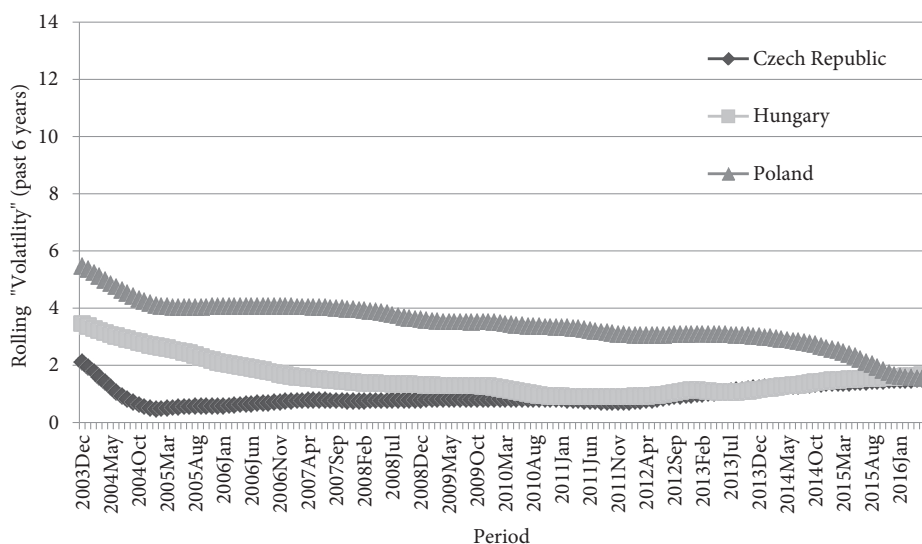
**FIGURE 4. 6-year rolling correlations with the Eurozone Taylor rate (OLS weights)**



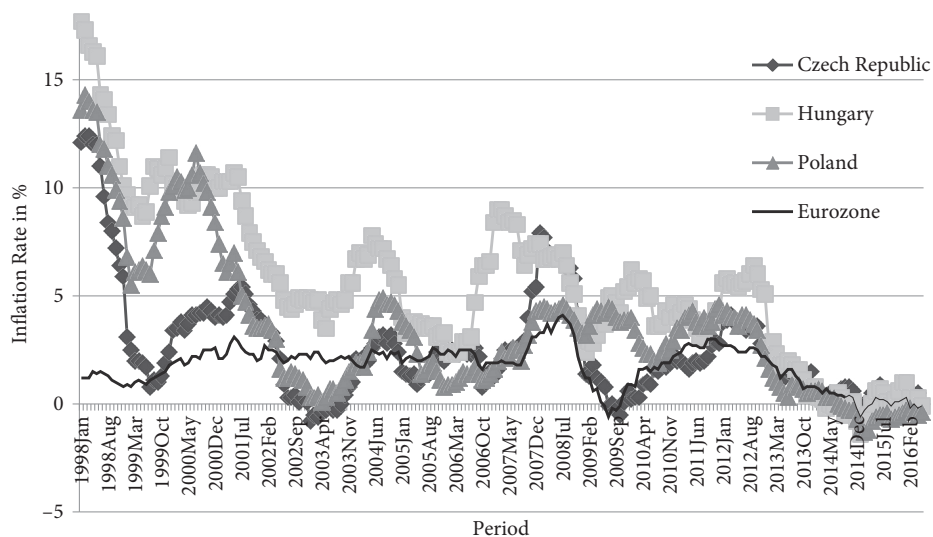
Source: ECB, Eurostat, own elaboration.

**FIGURE 5. 6-year rolling volatility with the Eurozone Taylor rate (Nechio [2011] weights)**

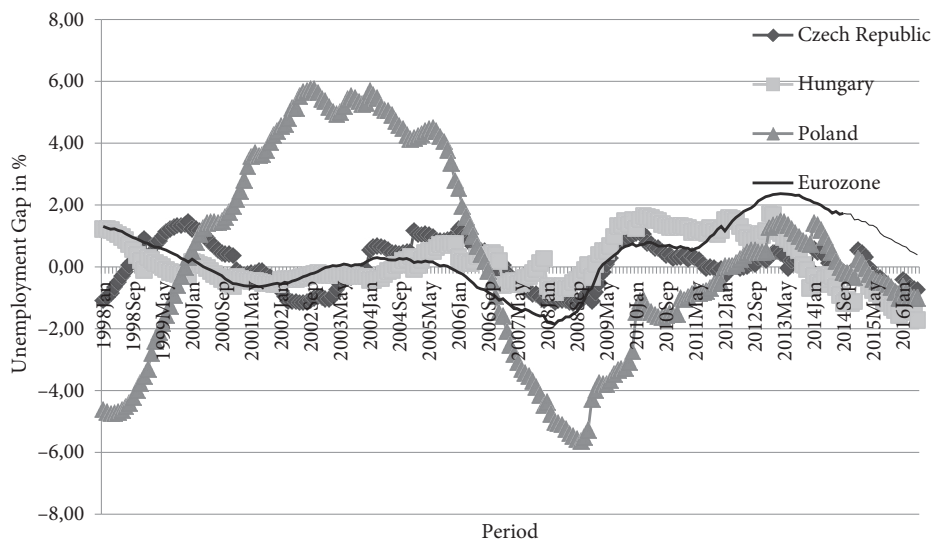
Source: ECB, Eurostat, own elaboration.

**FIGURE 6. 6-year rolling volatility with the Eurozone Taylor rate (OLS weights)**

Source: ECB, Eurostat, own elaboration.

**FIGURE 7. Inflation rate**

Source: ECB, Eurostat, own elaboration.

**FIGURE 8. Unemployment gap**

Source: ECB, Eurostat, own elaboration.