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How big is the *German locomotive*? A perspective from Central and Eastern European countries' unemployment rates

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Abstract

Countries from Central and Eastern Europe have undergone a process of transition from communism to markets economies. The economic convergence, in terms of income, that these countries have achieved in recent years has been one of the cornerstones in the economic integration with Western Europe. In this paper we aim to analyze the degree of co-movement of unemployment rates in a sample of Central and Eastern European transition economies, and the role of German as the 'locomotive' in this process. We intend to test two hypotheses; first, is it possible to identify common patterns that are possibly linked to the economic convergence process in the unemployment rates cycles for this group of countries? And, second, is it possible to identify one of the main economic fundamentals that has acted as an attractor towards economic convergence? By means of nonlinear logistic smooth transition autoregressions and co-movement analysis we found that the German business cycle has acted as a common factor affecting the cyclical behavior of the unemployment rates in these countries.

JEL classification: C22, E32, F15.

Keywords: Transition economies, unemployment, economic cycle, nonlinearities, economic integration.

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1 Introduction

It is usually argued that Germany was the economic locomotive of Western Europe during the process of economic integration, which achieved the adoption of the common currency. The beginning of the third stage in the process of European monetary integration was coupled by an intense academic debate about the role of Germany as a leader in the process of financial integration.[1] The so-called German Dominance Hypothesis established that the EMS worked in an asymmetric way, with Germany assuming the leading role and the remaining countries passively adjusting to German monetary policy actions.

Far less has been researched about the convergence in real terms of Central and Eastern European countries (CEECs) and the role of Germany in this process. Given the small size of these economies, exports and foreign direct investment are important sources of income. Focusing on the exports side, the main destination of exports from CEECs are the EU and, in particular, Germany. For instance, during the period 2000-2009, the Czech Republic, Poland and Slovakia exported, on average, more than 33%, 27% and 20%, respectively, of their total exports to Germany. This situation was probably boosted by the Europe Agreements, which had bilateral free trade areas between each candidate and the EU-15, removing thus, trade barriers on industrial goods well before accession.[2]

In this paper we provide evidence on the influence that Germany has had in the process of economic transition to market economies and the convergence of CEECs with Western Europe. In particular, we intend to test whether the German economic cycle has brought the cyclical components of these countries' unemployment rates together, given that their economies are quite dependent on Germany's expenditure. Unemployment behavior is of crucial importance in the enlarged EU. Potentially high unemployment

[1]See Fratianni and von Hagen (1990), von Hagen and Fratianni (1990), Katsimbris (1993), Karfakis and Moschos (1990), Henry and Weidman (1994) and Camarero and Ordóñez (2001).

[2]http://ec.europa.eu/enterprise/policies/single-market-goods/international-aspects/enlargement/.

rates in the CEECs, in comparison with Western Europe, may have important effects on the migratory flows of labor between the new and old EU member states. In addition, within the context of economic integration, unemployment is one of the key variables facilitating the process of adjustment through macroeconomic equilibrium.

In a recent contribution, Schiff et al. (2006) summarize the recent developments of these countries' labor markets. From this study, it is possible to highlight that many of the pre-transition features changed drastically during the transition period. This include a decline in participation rates, an increase in unemployment rates, more mobility between different occupations, and an increase in wage differentials. According to these authors, the drop in labor participation for these group of countries was mainly due to exit from the market of discouraged job seekers, early retirement, entrance onto disability rolls, an increase in higher education participation as well as emigration flows. In their thorough description of these countries' labor market evolution, Schiff et al. (2006) also point out that the transition process has been characterized by movements of workers from public to private sector, and significant shifts of labor across economic sectors, with a clear shift from industry to services. Also, the authors highlight the fact that long-term unemployment has increased in countries like the Czech Republic and Hungary. In terms of these countries' labor policies, Schiff et al. (2006) pinpoint their degree of flexibility, compared with the EU-15, in spite of high labor taxes, social benefits and minimum wages. The latter may have been some of the reasons for the decrease in the participation rate.

Analysis of the dynamic statistical properties of unemployment rates has, in recent decades, become a popular topic within the applied macroeconomics literature. The are two main reasons for this. First, high unemployment rates have not only economic but also political and social consequences (Layard et al., 2005). Second, although Western European unemployment rates have been traditionally high and persistent, the recent 2008-2009 economic crisis has pushed unemployment rates even higher. This situation casts doubts on the empirical fulfillment of the natural rate of unemployment (NAIRU) theory.

Although the literature on the empirical assessment of the NAIRU hypothesis is quite substantial for industrialized countries, there is little evidence for European transition economies (for the latter countries, see Camarero et al., 2005 and 2008, León-Ledesma and McAdam, 2004, and Cuestas and Gil-Alana, 2009). However, in this paper we are not strictly interested in the long-run behavior of CEECs' unemployment rates but in the main forces that have brought together the unemployment rates of this group of countries. In a recent contribution, Cuestas and Ordóñez (2011) analyzed the degree of co-movement of the CEECs' unemployment rates. These authors found evidence on the existence of a common trend shared by these countries' rates of unemployment. However, this common trend is identified as a nonlinear deterministic trend, with no economic meaning, i.e. is a proxy of an unknown common factor. In this paper, we aim to go a step further in this analysis by identifying one of the common factors that has driven the labor markets, after the initial transition shock, i.e., from 1994 onwards. Thus, there are two hypotheses to be tested in this empirical research; H1: Is there any statistical evidence of common trends within the cycles of CEECs' unemployment rates? H2: If so, can we find evidence of the fact that the process of economic integration has pulled the unemployment rates of these countries together? Can we use the German economic cycle as a proxy to capture the process of economic convergence? If so, we will be able to provide some insights into the influence that Germany has had on the process of economic transition to market economies and convergence with Western Europe, in particular on its power to affect unemployment rates.

The remainder of the paper is organized as follows. In the next section we summarize the recent contributions to the theoretical literature that link business cycles and unemployment. The third section provides a simple theoretical model which explains the influence of German expenditure on the CEECs' unemployment rates. Section four explains the econometric methods applied to analyze the existence of common trends, whereas in sections five and six we present the results and the conclusions from our findings, respectively.

2 Unemployment, business cycle and economic integration

It is generally acknowledged, within the literature on economic growth, that cycles are present in a number of fundamental macroeconomic variables. In addition, it is quite apparent that economic cycles are asymmetric: contractions tend to be faster and more damaging than the positive effects of an economic expansion (Jones, et al., 1994). The real business cycle (RBC) literature characterizes the dynamics of aggregate output as periods of high rates of growth followed by periods of low, or even negative, growth, as we have seen in many countries during the 2008-2010 global economic crisis. However, early theories of the RBC focused on the effects that technology shocks have on the path of production, consumption and investment, where involuntary unemployment was null. The complexity of contemporary economies has cast doubts on the validity of such models, as we have seen with the important increases and decreases (counter-cyclical behavior) of unemployment in most industrialized economies during the last few years.

Within this framework, in an early contribution, Hamilton (1988) proposed a model which explained the cyclical behavior of unemployment as a consequence of the specialization of labor and energy shocks. If an increase in the price of energy reduces the purchases of energy-using goods, the excess of supply of these goods needs to be reduced by means of redundancies. Given the specialization of labor, workers are not able to relocate immediately to another sector. This process is rather smooth, and hence the cyclical behavior of unemployment. However, although Hamilton (1988) called this transitory unemployment "involuntary", the model clears the markets in equilibrium.

In addition, as stated by Galí (1995), the traditional macroeconomic literature on unemployment has been restricted mainly to static or partial equilibrium models that are unable to account for the cyclical behavior of unemployment rates, such as the Kydland and Prescott (1982) model.

In that seminal contribution, Galí (1995) proposed a model which linked the gap between business cycle modeling strategies and traditional models of unemployment with imperfect competition in labor markets. His model is an augmentation of the RBC insofar as he assumes that technology shocks are the only source of fluctuations and the economy is populated by a continuum of identical infinite-lived consumers. In the new model, involuntary unemployment is defined as the difference between hours of work that a perfectly competitive agent wishes to work given the current wages and interest rates, and actual number of hours employed. The reason why involuntary unemployment exists in Galí's model is because of the existence of insiders, who exercise market power in order to bring wages above the market-clearing equilibrium. According to Galí (1995), the cyclical variations in that difference are due to the cyclical variations in workers' degree of market power. For market power to exist, it is necessary to assume the presence of imperfect competition in the markets for goods. All in all, Galí's (1995) model stresses the importance of market power and imperfect competition as a source of involuntary unemployment within a RBC framework (see Galí, 1996).

In recent decades there has been a steady growth in the amount of literature aimed at empirically characterizing the nonlinear behavior of the gross domestic product (GDP) per capita (see Teräsvirta and Anderson, 1992, and Cuestas and Garratt, 2011, amongst many others) and unemployment rates (Skalin and Teräsvirta, 2002, Faria and León-Ledesma, 2008, and Franchi and Ordóñez, 2011) during the last decades. More interestingly for the purposes of the present paper, a number of contributions have analyzed the nonlinear relationship between unemployment and economic cycles. For instance, Acemoglu and Scott (1994) used smooth transition autoregression (STAR) models to provide evidence of a clear counter-cyclical relationship between unemployment and the business cycle in the United Kingdom. Similar results were found by Bodman (1998) who estimated a Markov switching model for the Australian case.[3] STAR models are a suitable approach for analyzing this issue, since there is normally some lag in the transmission of shock from the GDP to the labor market.

Given the process of economic convergence that our target CEECs started in the mid-90s (in preparation for EU membership), in this paper we aim to explain the apparent co-movement in the unemployment cycles amongst these countries. In a recent contribution, Égert (2007) provided a detailed description of the indicators of economic convergence in this group of countries.[4] His paper shows a clear convergence path toward the EU. More recently, Cuestas and Harrison (2010) tested for the real interest rate parity between the CEECs and the EU, and found that the degree of market integration (good markets and financial markets) is quite strong, although the results vary from country to country.

Business cycle synchronization (BCS) theory plays a key role in understanding this apparent co-movement in unemployment rates. Since unemployment reacts in a counter-cyclical manner to aggregate demand, the degree of BCS in these countries with the rest of the EU may explain the synchronization of unemployment rate movements. BCS is also one of the cornerstones of the optimum currency areas (OCA), given that the more synchronized the economies become, the less painful the loss of monetary policy and exchange rate controls after joining a monetary union will be. There are a number of papers which provide evidence of the fact that, during the last few decades, business cycles have synchronized between old EU member states and new EU countries from Central and Eastern Europe (see Furceri and Karras, 2008, Artis et al., 2008, and Savva et al. 2007, amongst many others). In a recent contribution, Fidrmuc and Kornhonen (2006), provided a thorough literature review of papers analyzing BCS for CEECs; and a number of authors have used Germany as the reference country, because of the strong trading

[3]See also Alexopoulos (2004) for an analysis in the USA and Canada, and Moshiri and Brown (2004) for a comparison of different nonlinear estimation methods.

[4]See also Staehr (2010).

links between the latter and the CEECs. There is also strong evidence supporting the claim that the business cycles of the CEECs synchronized during the transition period.

Furthermore, according to Furceri and Karras (2008), trade has been one of the main forces bringing together the business cycles of the new member states and the older EU countries. Altavilla (2004) observed that the adhesion of new countries to the European Monetary Union (EMU) would strengthen business cycle synchronization within the union. This has also been pointed out by Staehr (2008), in the sense that, according to this author, recent government intervention in the CEECs may suggest that the lack of monetary autonomy after accession to the EMU will not lead to an increase in output volatility.

BCS can also be analyzed using unemployment rates. For instance, Boone and Maurel (1999) used dynamic common factor analysis to study the BCS of CEECs with Germany and the EU. These authors found that the degree of BCS was stronger with Germany than with the EU.

Now, the question is: what are the main forces that bring the unemployment rates of this group of countries together? Since Germany is the most important trading partner for these countries, especially in terms of exports, we aim to explain the co-movement in unemployment rates in terms of the German GDP. This follows from deriving the unemployment rate as a function of the German GDP in the next section. In particular, we are interested in explaining the cycle (nonlinearities) in the unemployment rates of CEECs using the German business cycle.

3 A simple theoretical model

The negative relationship between Germany's imports from a given country i from the CEECs and that country i's unemployment rate, can easily be obtained following a mathematical derivation of the aggregate demand. As we know, in equilibrium, aggregate demand, which is the sum of consumption (C), investment (I), government expenditure (G) and the difference between exports (X) and imports (M), should be equal to income (Y). That is,

$$Y = C + I + G + (X - M) \tag{1}$$

According to Blanchard et al. (2010, p. 154), unemployment (u) can be written as a function of income:

$$u = 1 - \frac{Y}{L} \tag{2}$$

where L is the labor force. This derives from the assumption that the productivity of workers is equal to 1. If we now solve equation (2) for Y, we obtain,

$$Y = (1 - u)L \tag{3}$$

which can be substituted in equation (1) and solved for u thereby obtaining:

$$u = -[C + I + G + (X - M)]/L + 1 \tag{4}$$

Let us write relationship (1) for the most important destination of exports of most of the CEECs, i.e., Germany:

$$Y^* = C^* + I^* + G^* + (X^* - M^*) \tag{5}$$

where the symbol (*) applies to all German variables. Consumption (C^*) can be taken as the sum of imports from country i, say M_i^*, and from other destinations including German production (N^*):

$$C^* = M_i^* + N^*. \tag{6}$$

We can define M_i^* as a linear function of German disposable income (Y_d^*), such as

$$M_i^* = m_1^* + m_2^* Y_d^* \tag{7}$$

where $m_j^* > 0$ for $j = 1, 2$.

Let us now focus on the exports of country's i. These can be defined as:

$$X = M_i^* + E = m_1^* + m_2^* Y_d^* + E \tag{8}$$

where E refers to exports to any country other than Germany. If we plug equation (8) into equation (4), we obtain:

$$u = -[C + I + G + (m_1^* + m_2^* Y_d^* + E - M)]/L + 1 \tag{9}$$

We can consider that I, G, E and M as being exogenous. However, C is a function of unemployment through disposable income (Y_d):

$$C = c_1 + c_2 Y_d \tag{10}$$

and disposable income is a function of income (Y). Assuming that country i's level of taxation is proportional to income, we can rewrite the equation for C as:

$$C = c_1 + c_2(Y - \tau Y). \tag{11}$$

where $c_j > 0$, for $j = 1, 2$. Thus, C is also a function of u:

$$C = c_1 + c_2 \left[(1-u)L - \tau(1-u)L\right]. \tag{12}$$

where $0 \leq \tau < 1$.

Now, if we introduce equation (12) into equation (9) and we solve for u, we obtain:

$$u = -\frac{1}{L[1 - c_2(1 - \tau)]}[I + G + (m_1^* + m_2^* Y_d^* + E - M)] + 1 \tag{13}$$

Hence the effect of an increase in Y_d^* is negative provided that $c_2 < \frac{1}{1-\tau}$, which implies that country i's marginal propensity to consume should be less than 1, in the limit case of $\tau = 0$:

$$\frac{\Delta u}{\Delta Y_d^*} = -\frac{m_2^*}{L[1 - c_2(1 - \tau)]} \tag{14}$$

The effect of an increase in Y_d^* could be even greater in magnitude if we assume that $L = L(Y_d^*)$, and $L'(Y_d^*) < 0$ i.e. the labor force will migrate to Germany or other destinations as Y_d^* increases. Moreover, if we relax the assumption of exogeneity of I, so as to have $I = I(Y_d^*)$, and $I'(Y_d^*) > 0$ through foreign direct investment, the effect of an increase in Y_d^* on u will be even greater.

4 Data and stylized facts

The data for this empirical research consist of quarterly unemployment rates for the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland and Slovakia, and German real GDP from 1994:1 to 2009:3.[5] Unemployment data come from the *International Financial Statistics* database from the International Monetary Fund,[6] whilst data for the German real GDP were obtained from the *OECD Main Economic Indicators* database.

Given that our analysis deals with the cyclical behavior of unemployment, we need to decide from a variety of filtering techniques which one we will use to decompose

[5] Data for Slovenia were not available for the whole period, that is why this country has not been included in the analysis.

[6] For the definition of unemployment, see the International Labor Organization.

unemployment into trend and cycle. The most straightforward filtering technique is the fourth difference of quarterly unemployment (in logs). Baxter and King (1999) pointed out that first differences remove a trend from a series but potentially at the cost of a shift in the peaks and troughs of the differenced series and large volatility. Filters such as the Hodrick and Prescott (1997), Baxter-King and Christiano and Fitzgerald (2007) have been proposed in the literature to eliminate both high- and low-frequency noise that differences still leave. Figure 1 shows the detrended unemployment series using fourth differences (growth cycle), and the Hodrick-Prescott and the Christiano-Fitzgerald filters. As can been seen, fourth differences are highly noisy, whereas both filters deliver very similar detrended series. The empirical literature on cycles has favored the use of the Hodrick-Prescott filter, so for the sake of comparability with the literature we will use the Hodrick-Prescott filter to decompose the unemployment series.

The filtered data are plotted in Figure 2.[7] Two groups of countries with similar cyclical unemployment behavior can be distinguished: the first group consists of the Baltic Republics plus Hungary, whereas in the second group we find the rest of the countries that were analyzed.[8] On comparing the two graphs, two distinctive features can be observed: first, the degree of co-movement among the second group of countries appears to be stronger than in the first group, probably because of the geographic proximity to Germany, which facilitates adjustment in the labor markets. Second, within the first group of countries, a higher degree of volatility can be seen toward the end of the sample, which is particularly important for Lithuania.

Furthermore, Germany's GDP cycle is shown in Figure 3. As we can see when comparing Figures 1 and 2, there is a quite clear counter-cyclical behavior, as expected, between the German GDP and the CEECs' unemployment rates. This counter-cyclical path is even stronger in the second half of the sample, which coincides with the initial period of

[7]The vertical axis measures the difference between the actual values of unemployment (in logs) and the long-run trend obtained by means of the Hodrick-Prescott filter.

[8]This classification obeys to the results of the linearity tests and similarities in exchange rates regimes, as stated in section 6.

preparation for EU membership, and effective membership in 2004.

Table 1 presents a simple test for causality between the unemployment cyclical components and the German business cycle. Granger causality tests are often sensitive to the number of lags used. Here the reported results are for the test using four lags, each one year long, because domestic factors tend to dominate business cycles in periods shorter than one year. Thus, the transmission effect of external shocks may be offset by spurious common domestic factors. The test results suggest that movements in the German business cycle "Granger-cause" movements in the unemployment cyclical components of Estonia, Hungary, Latvia, and Slovakia.

According to Péguin-Feissolle and Teräsvirta (1999), the linear approach to causality testing has low power to detect certain kinds of nonlinear causal relations. These authors proposed a statistical method for uncovering nonlinear causal relations that, by construction, cannot be detected by traditional linear causality tests. Their approach uses Taylor expansion series to approximate the true nonlinear relationship. Table 1 presents the nonlinear Granger causality test under the heading "Nonlinear test". Tests based on Taylor expansion approximation require a huge number of cross-products and are very data-demanding, thereby causing a dramatic decrease in the degrees of freedom when the lag length increases. However, for the Péguin-Feissolle and Teräsvirta (1999) test it is not necessary to take a large number of cross-products or lags on endogenous or exogenous variables to build the test since, as shown by the authors, simulation generally give appreciable results even for low lag values. We therefore chose to take four lags on the variables and three for the Taylor expansion. According to these results (shown in Table 1) there is far more evidence of causality now than when using the linear causality test. Specifically, Germany Granger-causes all the unemployment rates that were analyzed. It seems that nonlinearities are an important feature of the data in terms of explaining the causal relationship linking the German business cycles and the cyclical components of unemployment in Eastern European countries.

5 Econometric approach

STAR models are a useful tool to model economic series, which are very often characterized by nonlinearities and more than one equilibrium, where the transition between equilibria is smooth and determined by the values of a given variable (Granger and Teräsvirta, 1993, and Teräsvirta,1994). These models can be formulated as:

$$y_t = (\alpha + \sum_{i=1}^{p} \phi_i y_{t-i})(1 - F(\gamma, x_{t-d} - c)) + (\tilde{\alpha} + \sum_{i=1}^{p} \tilde{\phi}_i y_{t-i})F(\gamma, x_{t-d} - c) + \varepsilon_t, \quad (15)$$

where α, $\tilde{\alpha}$, ϕ_i, $\tilde{\phi}_i$, γ and c are the parameters to be estimated, and ε_t is an i.i.d. error term with zero mean and constant variance σ^2, and d is the delay parameter. The transition function $F(\gamma, x_{t-d} - c)$ is continuous, non-decreasing and bounded between 0 and 1. The exogenous variable x_{t-d} is the so-called transition variable and determines the regimes of the endogenous variable.

This STAR model can be interpreted as a regime-switching model allowing for two regimes associated with the extreme values $F(\gamma, x_{t-d}-c) = 0$ and $F(\gamma, x_{t-d}-c) = 1$, each corresponding to a specific state of the economy. When x_{t-d} deviates from the constant threshold value c, there is a transition between regimes whose speed is governed by the parameter γ.

Two popular choices of transition functions are the first-order logistic function:

$$\text{LSTAR: } F(\gamma, x_{t-d} - c) = (1 + exp\{-\gamma(x_{t-d} - c)\})^{-1}, \;\; \gamma > 0, \quad (16)$$

and the exponential function:

$$\text{ESTAR: } F(\gamma, x_{t-d} - c) = 1 - exp\{-\gamma(x_{t-d} - c)^2\}, \;\; \gamma > 0. \quad (17)$$

The first one delivers the logistic STAR (LSTAR) model and encompasses two possibilities, depending upon the transition speed γ. When $\gamma \to \infty$, the logistic function approaches a constant and the LSTAR model becomes a two-regime threshold autoregressive (TAR) model, for which changes between regimes are sudden rather than smooth. When $\gamma = 0$, the LSTAR model reduces to a linear AR model. Due to its different responses to positive and negative deviations of x_{t-d} from c, the LSTAR specification is convenient for modeling asymmetric behavior in time series. This is not the case of the exponential STAR (ESTAR) specification, in which these deviations have the same effect, i.e. what matters is the size of the shock, not the sign. Consequently, this model is only able to capture nonlinear symmetric adjustment.

Following Granger's (1993) "specific-to-general" strategy for building nonlinear time series models, Granger and Teräsvirta (1993) and Teräsvirta (1994) developed a technique for the specification and estimation of parametric STAR models. This procedure can be summarized in four steps (van Dijk *et al.*, 2002): (i) Specification of a linear AR model of order p for the time series under investigation; (ii) Test of the null hypothesis of linearity against the alternative of STAR; (iii) Selection of the appropriate transition function for the transition variable, if linearity is rejected; and (iv) Model estimation.

Testing linearity against STAR is a complex matter because, under the null of linearity, the parameters in the STAR model are not identified. Granger and Teräsvirta (1993) suggested a sequence of tests to evaluate the null of an AR model against the alternative of a STAR model. These tests are conducted by estimating the following auxiliary regression for a chosen set of values of the delay parameter d, with $1 < d < p$:[9]

$$y_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} y_{t-i} + \sum_{i=1}^{p} \beta_{2i} y_{t-i} x_{t-d} + \sum_{i=1}^{p} \beta_{3i} y_{t-i} x_{t-d}^2 + \sum_{i=1}^{p} \beta_{4i} y_{t-i} x_{t-d}^3 + \epsilon_t. \qquad (18)$$

The null of linearity against a STAR model corresponds to: $H_0 : \beta_{2i} = \beta_{3i} = \beta_{4i} = 0$ for $i = 1, 2, ..., p$. The corresponding LM test has an asymptotic χ^2 distribution with $3(p+1)$

[9]Equation (18) is obtained by replacing the transition function in the STAR model (15) by a suitable Taylor series approximation (see Granger and Teräsvirta, 1993).

degrees of freedom under the null of linearity. If linearity is rejected for more than one value of d, the value of d corresponding to the lowest p-value of the joint test is chosen. In small samples, it is advisable to use F-versions of the LM test statistics because these have better size properties than the χ^2 variants (the latter may be heavily oversized in small samples). Under the null hypothesis, the F version of the test is approximately F distributed with $3(p+1)$ and $T-4(p+1)$ degrees of freedom.

If linearity is rejected, we need to test for LSTAR against ESTAR nonlinearity. For this purpose, Granger and Teräsvirta (1993) and Teräsvirta (1994) proposed the following sequence of tests within the auxiliary regression (18):

$$H_{03} : \beta_{4i} = 0 \;\; i = 1, 2, ..., p$$
$$H_{02} : \beta_{3i} = 0 | \beta_{4i} = 0 \;\; i = 1, 2, ..., p$$
$$H_{01} : \beta_{2i} = 0 | \beta_{3i} = \beta_{4i} = 0 \;\; i = 1, 2, ..., p.$$

An ESTAR model is selected if H_{02} has the smallest p-value, otherwise the selected model is the LSTAR.

As mentioned above, linear model shortcomings have led to increasing research in nonlinear models. However, the complexity of multivariate nonlinear modeling, in terms of the amount of parameters to be estimated and the losing of degrees of freedom, leads us to test whether economic reasoning and data allow us to simplify this modeling. One possible simplification stems from the presence of common nonlinear components. Therefore, let us assume that within a given set of variables there is a nonlinear behavior of each individual variable with respect to the same transition variable. If this is the case, we can test whether there is a nonlinear co-movement within this set of variables. In order to address this issue we test for common LSTAR nonlinearities following the methodology proposed by Anderson and Vahid (1998) based upon canonical correlations. Accordingly, let

$$y_t = \pi_{A0} + \pi_A(L)y_t + F(z_t)[\pi_{B0} + \pi_B(L)y_t] + \epsilon_t$$

be the multivariate version of the LSTAR model, where y_t is the vector of variables under analysis, $\pi_i(L)$ is a matrix polynomial of degree p in the lag operator, ϵ_t is i.i.d., and $F(z_t)$ is a diagonal matrix containing the transition functions for each series. Testing for common nonlinearities consists in testing whether some α exists such that $\alpha' y_t$ does not exhibit the type of nonlinearity which is present in the mean of each individual y_t. The test statistic is based on canonical correlations and is asymptotically distributed as $\chi^2_{(3p-1)5s+s^2}$, where p denotes the maximum lag length and s is the number of common nonlinearities. Rejection of the null hypothesis provides evidence of the presence of at most s common nonlinearities.

6 Empirical results

Before proceeding with the estimation of the STAR models, it is necessary to test for the null of linearity. If linearity is not rejected for a country, we can exclude it from the nonlinear model-building efforts. As mentioned above, linearity tests are only valid under the assumption of stationarity. Although the original unemployment series are non-stationary, the detrending approach applied in the paper ensures the stationarity of the variable used for further analysis. Table 2 displays the test statistics for the null hypothesis of linearity against STAR nonlinearity. These tests are performed for each variable using the German real GDP as the transition variable, i.e. x_t in equations (15) and (18). According to the results, linearity is rejected for all variables using the Granger and Teräsvirta (1993) linearity test. This result has a twofold implication. First, all variables exhibit a nonlinear behavior within two extreme regimes and, second, the transition between both regimes is at least partially driven by the cyclical component of the German real GDP.[10]

[10]Besides testing for linearity, linearity test can be used to choose the appropriate transition variable in the STAR model. This choice includes not only the lag for the transition variable but the transition variable itself. In this paper we have made use of both the German and the US business cycle as candidates for the transition variable. Our aim is to assess whether CEEC's unemployment rates are

Adjustment to changes in the transition variable can be either symmetric or asymmetric. As pointed out before, if the transition function is exponential, the implied adjustment will be symmetric, whereas if the transition function is logistic, the adjustment is asymmetric. Table 2 presents the Granger and Teräsvirta (1993) tests for choosing between the ESTAR and the LSTAR models. According to these test statistics, the LSTAR representation of the data is preferred to the ESTAR one, i.e., H_{02} does not present the smallest p-value for the unemployment rates. This result provides us with further insights into the asymmetric nature of the cyclical component of unemployment rates. The asymmetric behavior of these components is at least partially explained by an asymmetric response of these variables to the cyclical component of the German real GDP.

Once the linearity hypothesis has been rejected for each of the cyclical components of unemployment and that the nonlinearities are linked to the German economic cycle, it is possible to determine, in a multivariate context, whether this nonlinear component is common to all the countries. In this framework of stationary variables, the analysis of common deterministic trends is similar to the analysis of cointegration in the I(1) framework. In the former, a nonlinear common trend implies the existence of a linear combination of nonlinear variables where the nonlinear components cancel out. In the context of cointegration, however, there is said to be a cointegrating relationship between I(1) variables when the stochastic trends of the variables cancel out, thereby implying that the cointegrating vector is stationary. Thus, in both cases there is a long-run co-movement among the variables. In the case of a common nonlinear component among the unemployment cycles of our target countries, there is a co-movement between them, which could be attributed to the process of economic integration, approximated in this particular case by the German GDP.

driven by a global economic trend (captured by the American GDP cycle) rather than by the German cycle. Results clearly point out that the German business cycle accounts for most of the nonlinearities observed in these unemployment rates, against the American cycle, so that the former is confirmed as our transition variable. Results are available from the authors upon request.

One useful method for such a purpose is the testing procedure for common nonlinear components proposed by Anderson and Vahid (1998). Table 3 presents the results for the common LSTAR nonlinearities test proposed by these authors. These results are obtained using the cyclical component of the German real GDP as the (common) transition variable. Taking five percent as the critical value, as is standard procedure, the null that there are no nonlinear factors in the system is rejected, whereas the null that there is only one factor is not rejected. Furthermore, according to this test, we might find up to two of these common nonlinearities (three if we consider the 10% significance level). These tests therefore provide evidence for the fact that the nonlinear behavior of the cyclical component of our central and eastern European countries' unemployment rates share common features that are possibly linked to the economic convergence process, which can be captured in an appropriate manner by using the cyclical component of German real GDP as the common driving force.

Once we have identified the existence of a common nonlinear component, a nonlinear multivariate system can be estimated for all the cyclical components of the unemployment rates for our CEECs, under the restriction of one common nonlinear factor. The advantage of estimating an economic system with common components is twofold. First, it allows for parsimony, which is particularly important in the case of nonlinear models, and, second, knowledge about these common components can also help us to understand economic linkages between variables.

We have determined that the cyclical component of unemployment rates share at least two nonlinear components, driven by the cyclical component of German real GDP as the exogenous transition variable. Table 4 displays the estimate for the nonlinear system. We have been able to estimate two nonlinear common components:

$$F(gdp_{t-4}) = (1 + exp[\underset{(0.10)}{-0.18}\, gdp_{t-4}])^{-1} \tag{19}$$

and

$$F(gdp_{t-9}) = (1 + exp[\underset{(2.62)}{-5.57}\, gdp_{t-9}])^{-1} \tag{20}$$

where standard errors are reported in parentheses, and each of the nonlinear common components has a different time lag of the transition variable[11] gdp. The first common component is shared by the Czech Republic, Slovakia and Poland while second is shared by the Baltic countries Estonia, Lithuania and Latvia, and Hungary. This classification was performed in accordance with the results from the linearity test[12], where rejection of linearity was typically obtained for low values of the delay parameter for the former group, but for greater values of the delay parameter for the latter group. Although the classification has been done according to statistical tests, the groups of countries share similarities in their exchange rates regimes, which determines the pass through of external shocks, and hence the reaction of output and unemployment.

Hence, we find that the Baltic Republics plus Hungary present a faster transition speed, a greater γ parameter, than the central European economies. This implies that the transition between two equilibria for the values of unemployment cycles is faster for the first group of countries. This less smooth transition is depicted in Figure 1(a), as the cycles behave in a rather more 'erratic' way (fast transition between positive and negative values) than the countries in Figure 1(b). As mentioned earlier, this may be caused by the relative geographical isolation of the Baltic economies, compared to central European countries.

Although the cyclical components of the unemployment rate of the countries analyzed share commonalities, this does not mean that all of them react in the same way to shocks to the German GDP. In order to analyze potential differences between the countries, it is necessary to run dynamic stochastic simulations. The standard tool for measuring dynamic adjustment in response to shocks is the impulse-response function. The prop-

[11] In both cases the threshold variable c appears to be non-significant.

[12] Results are available from the authors upon request.

erties of impulse-response functions for linear models do not hold for nonlinear models. In particular, the impulse-response function of a linear model is invariant with respect to the initial conditions and to future innovations. With nonlinear models, in contrast, the shape of the impulse-response function is not independent with respect to either the history of the system at the time the shock occurs, the size of the shock considered, or the future path of the exogenous innovations (Koop, Pesaran and Potter, 1996). In this paper we calculate the impulse-response functions by Monte Carlo simulation. Figure 4 plots the impulse-response functions for a positive shock to the German GDP. As we can see, the reaction is negative for all the countries, as expected. However, we find that for the Baltic countries and Hungary the impact on unemployment is stronger than for the Czech Republic, Poland and Slovakia. Moreover, we observe that in the first of these two groups of countries, there is an over-reaction, since unemployment rates increase above normal levels, probably due to the sensitivity of these countries to decreases in aggregate demand in western Europe, as mentioned above. The stronger effect of an increase in the German GDP on the unemployment rates of the Baltic countries, in comparison to the Central European countries, may be explained by using recent findings within the exchange rate pass-through literature. According to Flamini (2007), imperfect pass-through tends to insulate the economy from foreign shocks and monetary policy control. With currency boards, like the ones held by the Baltic economies during the last few decades, the pass-through of changes in import prices tends to be stronger than with flexible exchange rate systems (i.e., like the exchange rate systems held by our target Central European Countries for the period analyzed). Hence, a shock in the German economy, will have a stronger effect on those of our target countries with more rigid exchange rate systems, that is the Baltic economies. An increase in the German disposable income will increase the prices of German products. Since the exchange rate with Eastern European Countries is fixed, products produced by the Baltic States become more competitive, and a substitution effect may occur between German and Baltic products in Germany. At the same time, the prices of products that are imported to our target Baltic economies from Germany will tend to eventually reduce the value of imports from Germany, thus improving the current account.

7 Conclusion

The aim of this paper is to provide further insights into the analysis of unemployment rates in CEECs. In particular, we have analyzed the apparent co-movement of unemployment rates in this group of countries.

In our contribution we test two specific hypotheses; (1) that there is evidence of common trends amongst our target group of CEECs and (2) that Germany has acted as a locomotive during the process of economic transition and convergence between them and Western Europe. The last point is particularly relevant in getting some insights into the current role of Germany as economic engine of the EU.

In this paper we have paid particular attention to the role that BCS plays in the process of economic integration. In view of the increasing dependence of these countries on foreign direct investment and trade with the old EU member states, mainly with Germany, we used the German economic cycle as the common factor which explains the nonlinearities present in the cycles of unemployment rates in our target countries.

We found evidence of a causal relationship running from the German economic cycle to the CEECs' unemployment rates. Through an analysis of common nonlinear deterministic trends and STAR modeling, we also found that there are two different common trends in unemployment cycles within our target countries. The first is the Baltic Republics and Hungary, with a quick transition between equilibria. The second group of countries is made up of the Czech Republic, Poland, and Slovakia which are less sensitive to shocks to the German GDP per capita. This difference in the sensitivity of their unemployment rates to shocks in the German economy may be explained by the different degrees of exchange rate pass-through between these two groups of countries, given their different foreign exchange rate systems during the sample covered in the analysis. Although further research would be desirable on this matter, this does not fall within the scope of this paper. Overall, the hypothesis that Germany exerts a significant influence on the cyclical behavior of unemployment in this group of countries cannot be rejected.

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Table 1: Granger causality test

Linear test:

H_0: Germany does not Granger-cause:

Lags	Czech Rep	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia
4	0.380	**0.100**	**0.089**	**0.000**	0.210	0.170	**0.042**

Nonlinear test:

H_0: Germany does not Granger-cause:

Lags	Czech Rep	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia
4	**0.075**	**0.008**	**0.076**	**0.002**	**0.015**	**0.032**	**0.006**

Notes: P-values for the F test are reported. Figure in bold implies rejection of the null of absence of causality at the 10% significance level.

Table 2: Linearity test

	Czech Rep.	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia
Linearity test	0.0000	0.0015	0.0283	0.0080	0.0000	0.0000	0.0095
H_{01}	0.0005	0.0011	0.0243	0.0057	0.0001	0.0074	0.3541
H_{02}	0.0056	0.0989	0.1207	0.2030	0.0599	0.0015	0.0246
H_{03}	0.0100	0.1736	0.2165	0.7022	0.0850	0.0001	0.0200

Note: p-values are shown.

Table 3: Test for common LSTAR nonlinearities

Null hypothesis	**Alternative hypothesis**	**p-value**
The system is linear	At least one of the variables has a LSTAR nonlinearity	0.015
The system has at most 1 common LSTAR nonlinearity	The system has at least 2 common LSTAR nonlinearities	0.027
The system has at most 2 common LSTAR nonlinearities	The system has at least 3 common LSTAR nonlinearities	0.088
The system has at most 3 common LSTAR nonlinearities	The system has at least 4 common LSTAR nonlinearities	0.364
The system has at most 4 common LSTAR nonlinearities	The system has at least 5 common LSTAR nonlinearities	0.762
The system has at most 5 common LSTAR nonlinearities	The system has at least 6 common LSTAR nonlinearities	0.974
The system has at most 6 common LSTAR nonlinearities	The system has at least 7 common LSTAR nonlinearities	0.999

Table 4: Estimated nonlinear system with common components

$$cze_t = \underset{(0.07)}{0.46}cze_{t-4} - \underset{(0.06)}{0.68}cze_{t-5} + (\underset{(0.08)}{0.62}cze_{t-1}) \times F(gdp_{t-4}) + \epsilon_{1t}$$

$$slk_t = \underset{(0.11)}{0.43}slk_{t-4} + (\underset{(0.14)}{1.70}slk_{t-1} - \underset{(0.22)}{1.22}slk_{t-5}) \times F(gdp_{t-4}) + \epsilon_{2t}$$

$$pol_t = \underset{(0.06)}{0.86}pol_{t-1} + (\underset{(0.20)}{0.66}pol_{t-4} - \underset{(0.20)}{0.60}pol_{t-5}) \times F(gdp_{t-4}) + \epsilon_{3t}$$

$$lat_t = -\underset{(0.02)}{0.04} + \underset{(0.13)}{0.80}lat_{t-1} + \underset{(0.11)}{0.35}lat_{t-4} - \underset{(0.11)}{0.45}lat_{t-5} + (\underset{(0.04)}{0.11} - \underset{(0.19)}{0.38}lat_{t-1} - \underset{(0.12)}{0.22}lat_{t-3}) \times F(gdp_{t-9}) + \epsilon_{4t}$$

$$lit_t = -\underset{(0.03)}{0.11} + \underset{(0.07)}{0.69}lit_{t-1} - \underset{(0.11)}{0.40}lit_{t-3} + \underset{(0.11)}{0.34}lit_{t-4} + (\underset{(0.06)}{0.23} - \underset{(0.13)}{0.34}lit_{t-5}) \times F(gdp_{t-9}) + \epsilon_{5t}$$

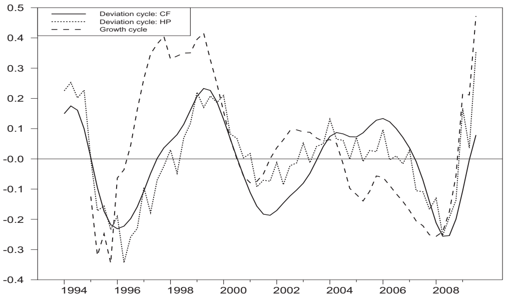
$$est_t = -\underset{(0.02)}{0.03} + \underset{(0.08)}{0.64}est_{t-1} + (\underset{(0.03)}{0.09} - \underset{(0.12)}{0.24}est_{t-1} - \underset{(0.10)}{0.50}est_{t-3}) \times F(gdp_{t-9}) + \epsilon_{6t}$$

$$hun_t = \underset{(0.15)}{0.67}hun_{t-1} + \underset{(0.13)}{0.20}hun_{t-2} + (-\underset{(0.02)}{0.03} - \underset{(0.31)}{0.70}hun_{t-1} + \underset{(0.21)}{0.47}hun_{t-5}) \times F(gdp_{t-9}) + \epsilon_{7t}$$

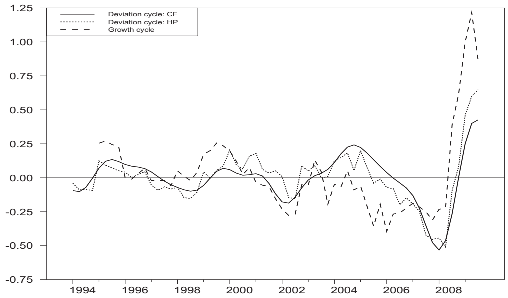
where: $F(gdp_{t-4}) = (1 + exp[-\underset{(0.10)}{0.18}\, gdp_{t-4}])^{-1}$ and $F(gdp_{t-9}) = (1 + exp[-\underset{(2.62)}{5.57}\, gdp_{t-9}])^{-1}$

Note: Standard errors are reported in parenthesis.

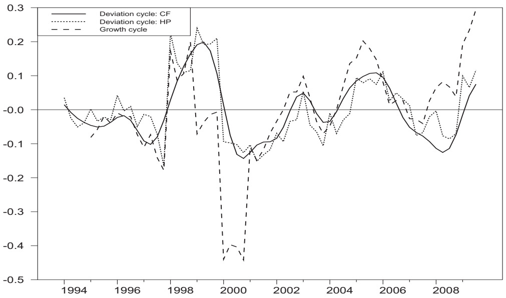
Figure 1: Growth and deviation cycles



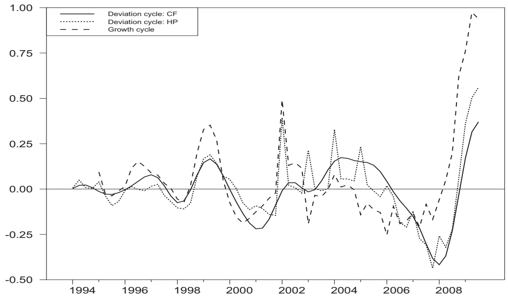
(a) Czech Republic



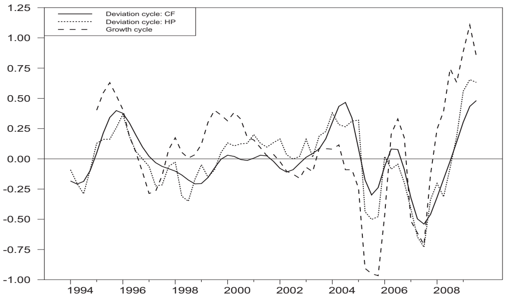
(b) Estonia



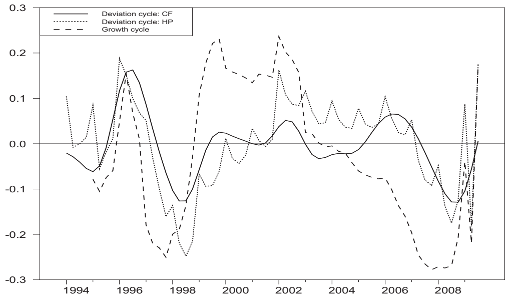
(c) Hungary



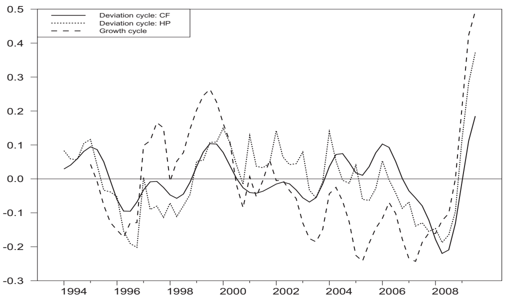
(d) Latvia



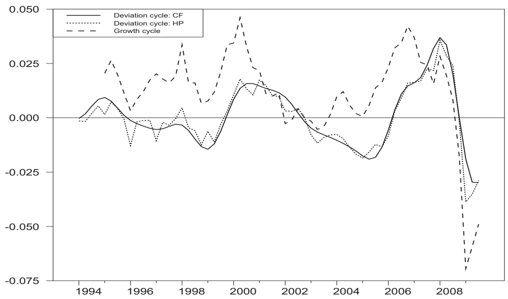
(e) Lithuania



(f) Poland

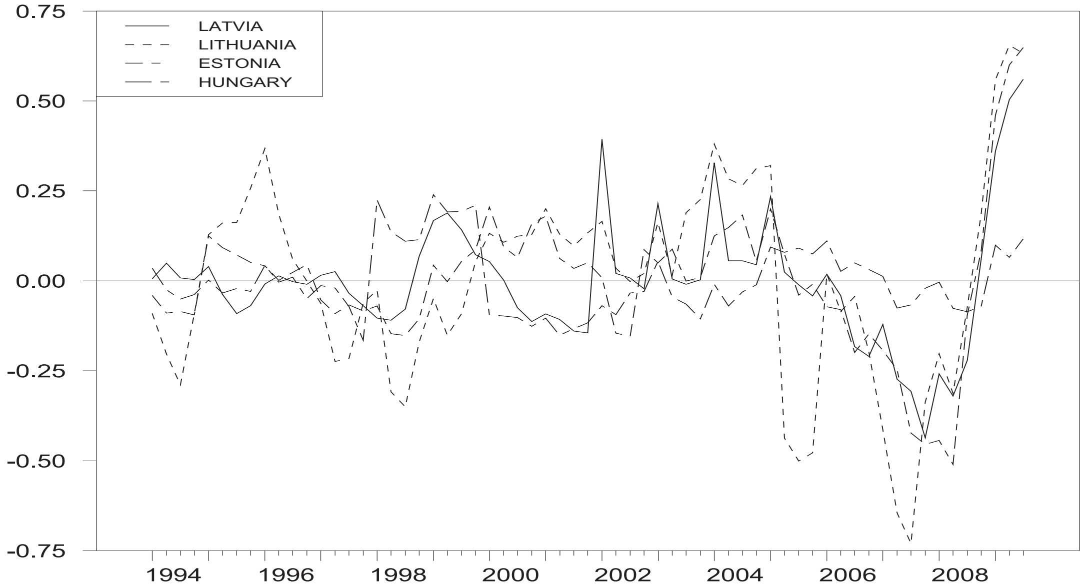


(g) Slovakia

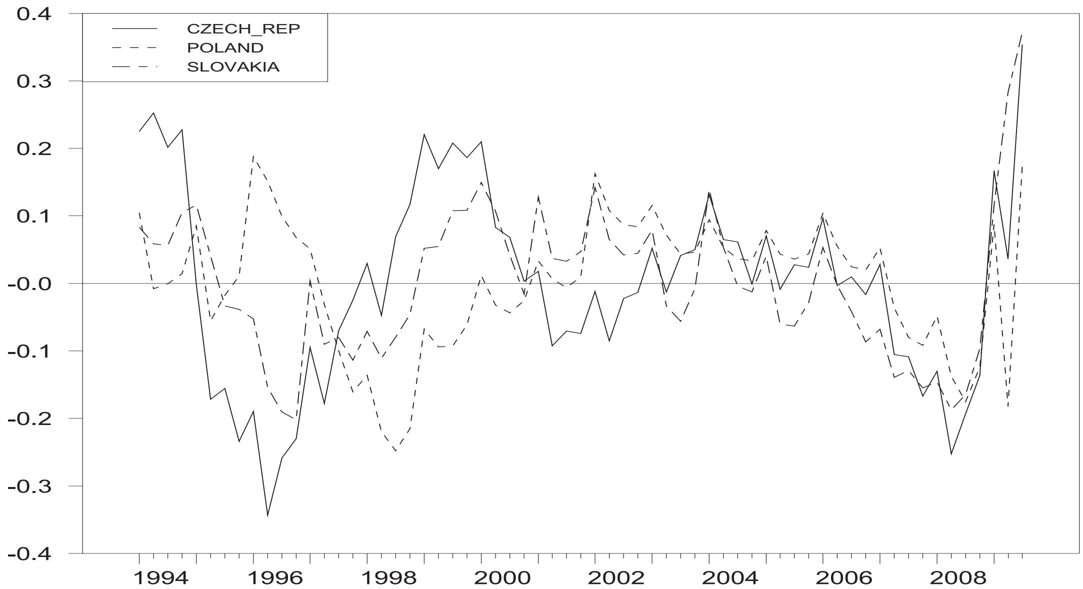


(h) Germany

Figure 2: CEECs' unemployment rate cycles



(a) Baltic Republics + Hungary



(b) Czech Rep., Slovakia and Poland

Figure 3: German GDP cycle

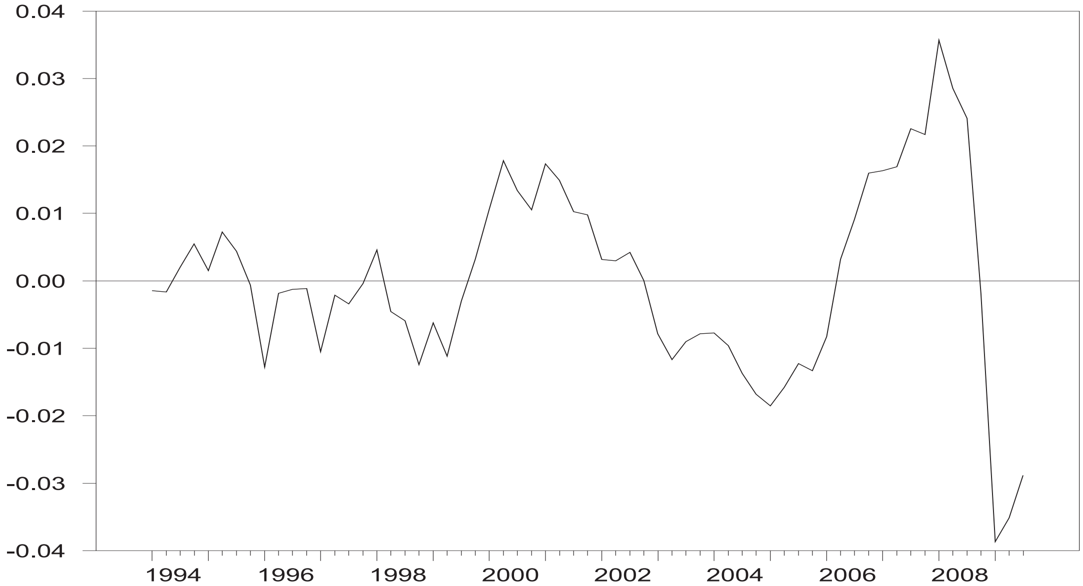
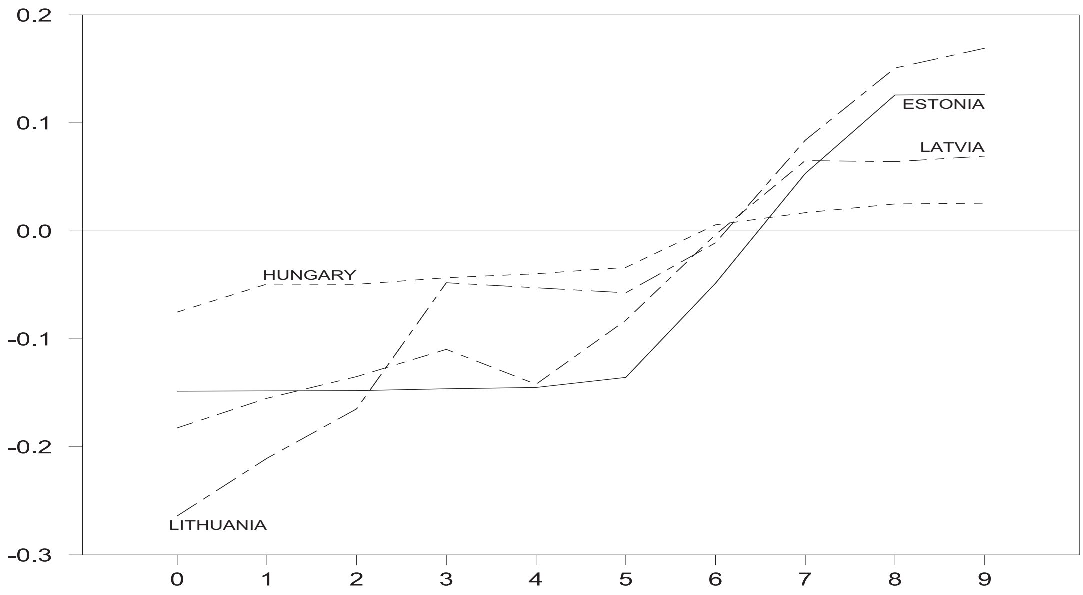
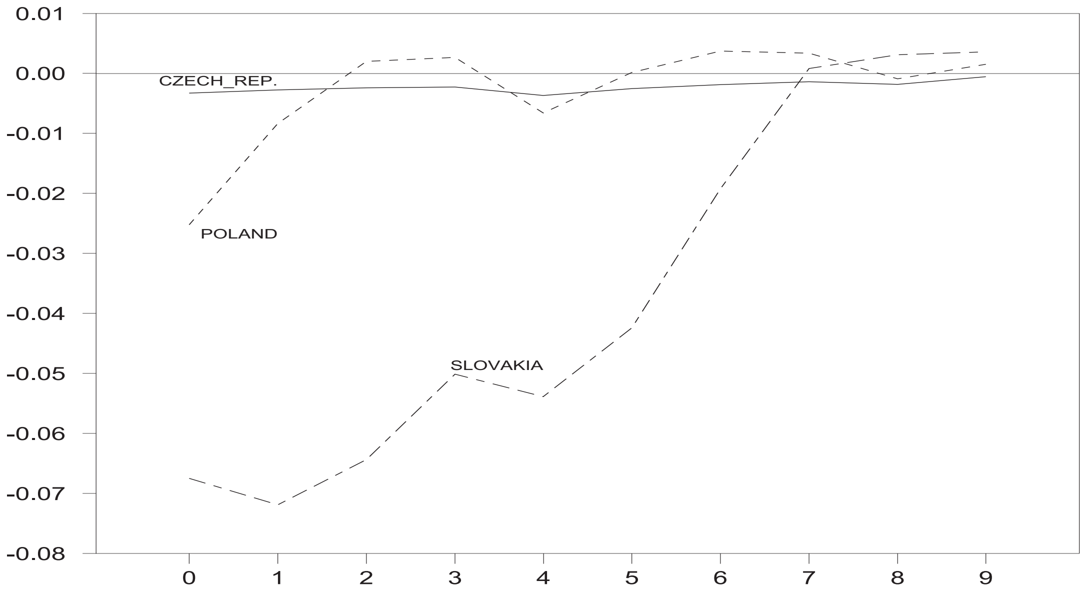


Figure 4: Impulse-Response functions



(a) Baltic Republics + Hungary



(b) Czech Rep., Slovakia and Poland