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Unemployment convergence in Central and Eastern European countries: driving forces and cluster behaviour

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Abstract

Employing a nonlinear logistic smooth transition autoregression system and co-movement analysis, we find that the German business cycle has acted as a common driver affecting the cyclical behaviour of unemployment rates in Central and Eastern European countries. In addition, we identify two convergence clubs in unemployment dynamics. The first comprises the Baltic States, Hungary and Poland, and the second group of countries is composed of the Czech Republic and Slovakia. Interestingly, this classification matches the labour market policies and institutional divergences observed among these countries.

JEL classification: C22, E32, F15.

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

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1 Introduction

The Central and Eastern European (CEE) countries have achieved two remarkable transitions in a short period of time. The first was a shift from a planned to a market economy; the second their rapid economic integration into the European Union (EU). Much of the transition from planned to market economies occurred in the 1990s. After the initial transformational recession of the early 1990s, and in preparation for EU membership, the accession countries had to fulfil the Accession Criteria agreed at the EUs 1993 Copenhagen Summit. These addressed economic, political and legislative conditions that had to be met before they could be considered for membership.

The development model in CEE countries has, to a large extent, been based on integration with Western Europe (European Commission, 2009). This 'European integration-based growth model' has driven a catch-up process in CEE countries through a combination of political integration, institutional development, trade integration, foreign direct investment (FDI), financial integration and labour mobility. While these factors were also present in the EU15 countries' convergence processes, net capital inflows and trade integration in CEE economies have been larger than the levels observed in the EU15.

Given the small size of CEE countries, their economic integration process is likely to be strongly affected by the business cycle of their most important trading partner, i.e., the euro area and, in particular, Germany (Firdmuc and Korhenen, 2004)[1]. Following Boone and Maurel (1999), in this paper we evaluate the degree of economic convergence in the CEE countries by analysing cyclical fluctuations in unemployment. In the context of economic integration, unemployment is a key variable facilitating the adjustment process through macroeconomic equilibrium. Unlike Boone and Maurel (1999), instead of analysing the degree of correlation or similarity between the German and the CEE countries' business cycles, we analyse the extent to which unemployment rates in these countries have converged to a common steady state; and the role of Germany, as an economic engine, in this process.

Business cycle synchronisation is one of the cornerstones of optimum currency area theory (OCA): as the economies become more synchronised, the less painful is the loss of monetary policy and exchange rate controls after joining a monetary union. There is substantial evidence that, in recent years, the business cycles of the EU15 and CEE countries have become increasingly

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[1] As suggested by Firdmuc and Korhenen (2006), the synchronisation of business cycles, especially of supply shocks, positively correlates with certain indicators of transition progress and EU integration. See also Altug and Bildirici (2012).

synchronised (see Fidrmuc and Kornhonen, 2006, for a thorough literature review). The empirical literature on business cycle synchronisation between the euro area and the CEE countries falls in two major categories. In the first, synchronisation is examined from the perspective of the international transmission of business cycles. In the second, structural VAR analysis is used to recover underlying shocks.

The literature also differs with respect to the reference country used to analyse synchronisation. A number of authors have used Germany instead of the euro area as a whole, because of the strong trading links between the former and the CEE countries. According to Furceri and Karras (2008), trade has been one of the main forces synchronising the business cycles of the new member states and the EU15 countries. Schumacher (1996), emphasises that the dramatic increase in trade between Germany and the CEE countries implied by the opening of Eastern markets is significantly higher than that between the EU15 in aggregate and CEE countries. In addition, Boone and Maurel (1998) suggest that German re-unification might have accentuated the links with the CEE countries, in a framework of regional specialisation covering the Eastern Länder and the CEE countries. In addition to trade intensification, the catch-up process in CEE countries has coincided with large inflows of FDI that have played an important role in the process of economic convergence (Bijsterbosch and Kolasa, 2009).

Data on exports and FDI inflows reveal the importance that Germany may have in this 'European integration-based growth model' for the CEE countries. As a consequence of this process of trade liberalisation, and focusing on exports, the main destination of exports from CEE countries is the EU and, in particular, Germany. For instance, during the period 2000-2009, the Czech Republic, Hungary, Poland and Slovakia exported, on average, more than 31%, 28%, 26% and 20%, respectively, of their total exports to Germany. Capital flows into the CEE countries took the form of FDI, portfolio investments and loans, with a gradual and substantial increase in net FDI inflows, again with an important role for Germany. Thus, for the period 2002-2009, Latvia, the Czech Republic, Slovakia and Poland received 26%, 21%, 19% and 14% of their respective total FDI inflows from Germany[2]. Furthermore, authors such as Boone and Maurel (1999) emphasise that the correlations between industrial production and unemployment cycles in the CEE countries indicate that the CEE countries are more deeply integrated with Germany than with the EU as a whole. Hence there is plenty of evidence that supports the idea that Germany is the most important driver for these

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[2] The Data come from Direction of Trade Statistics, Yearbook.

countries' business cycles.

During the transition process, the CEE countries experienced similar labour market developments. These included a decline in participation rates, mainly caused by discouraged job-seekers, early retirees, newly registered disabled, emigrants, and an increased number of students enrolled in higher education. There has also been an increase in unemployment rates and significant labour shift across economic sectors, as the economies have undergone structural change, from industry to services and from the public to private sector. There has also been an increase in wage differentials.[3] The presence of these common features raises a question about whether the labour market experiences of CEE countries followed a common path .

In this paper, we investigate whether this common path can be attributed to the European integration-based growth model. Specifically, we test whether Germany had a crucial influence on this. To address these issues, we first test for the existence of common factors in the dynamics of CEE countries' unemployment rates after the initial transition shock, i.e., from 1994 onwards. Next, we investigate whether it is possible to use the German business cycle as a proxy to capture the economic convergence process. German unemployment could also be considered a proxy for common driving forces of unemployment in the CEE countries, however, German economic activity proxied as gross domestic product GDP, through trade and FDI spill-overs, is the driver of the economic convergence process rather than developments in the German labour market. Hence, we shall be able to provide insights into the influence that Germany has had on the process of CEE countries' economic transition to market economies and convergence with Western Europe. For this purpose, we use a flexible nonlinear methodology, based on smooth transition mechanisms, that allows us to overcome the limitations of the standard linear framework traditionally used to analyse unemployment dynamics: neglected regime shifts and asymmetries that may produce an exaggerated impression of unemployment hysteresis. In addition, this methodology allows us to introduce business cycle asymmetries to explain changes in unemployment. In the context of the integration process with Western Europe, considering the effect of the business cycle on unemployment dynamics is of crucial importance to understand the forces driving the integration process.

We find that the German GDP cycle explains the commonality observed in the evolution of these countries' unemployment rates. We can identify two groups, or clusters: the Baltic States,

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[3] Recent developments in CEE countries' labour markets were summarised in Schiff et al. (2006). From this study, a point that can be highlighted is that many of the pre-transition features changed drastically during the transition period. The authors concluded that, despite considerable variance, the CEE countries experienced common labour market developments.

Hungary and Poland; and, secondly, the Czech Republic and Slovakia. The results appear to match similarities in the countries' labour markets structures.

The remainder of the paper is organised as follows. The next section presents the data and some stylised facts. Section 3 explains the econometric methods used to analyse the existence of common trends, and in sections 4 and 5, we present our results and conclusions.

2 The Econometric approach

In recent decades there has been a growth in the amount of literature aimed at characterising empirically the nonlinear behaviour of GDP per capita (see, inter alia, Teräsvirta and Anderson, 1992, and Cuestas and Garratt, 2011) and unemployment rates (Skalin and Teräsvirta, 2002, Faria and León-Ledesma, 2008, and Franchi and Ordóñez, 2011). Franchi and Ordóñez (2011) justify the estimation of a nonlinear model for the unemployment rate in Spain, based upon the assumption of multiple equilibria. Multiple equilibria in unemployment can arise from trading and exchange opportunities (Diamond, 1982; Cooper and John, 1988), because of demand spillovers across markets (Weitzman, 1982; Murphy et al., 1989), in imperfectly competitive markets (Chatterjee and Cooper, 1989; Manning, 1990) or because of costs associated with layoffs and hiring (Saint-Paul, 1995; Moene et al., 1997).

A number of contributions have analysed the possible nonlinear relationship between unemployment and business 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. STAR models are a useful tool for analysing economic series characterised by nonlinearities and multiple equilibria, where the transition between equilibria is smooth and determined by the values of a given variable (Granger and Teräsvirta, 1993, and Teräsvirta, 1994). The use of STAR methodology is appropriate in the present study for several reasons. First, it considers the existence of different states of the world, or regimes, allowing for the possibility that the dynamic behaviour of economic variables depends on the regime that occurs at any given point in time. We believe this constitutes a natural approach to modelling time series with nonlinear models. Second, these models are quite general and highly flexible, so they can approximate satisfactorily a wide variety of actual nonlinearities encountered in observed time series. Third, this regime-switching approach assumes that the regime can be characterised by an observable variable. In our case this is of paramount importance, since we want

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to assess the link between German GDP and the unemployment rates in the CEE countries. Fourth, Teräsvirta (1994) proposes a technique for the specification and estimation of STAR models that is relative easy to implement and facilitates the economic interpretation of the results. These models can be formulated as:

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

where α, $\tilde{\alpha}$, ϕ_i, $\tilde{\phi}_i$, γ and c are parameters, ε_t is an i.i.d. error term with zero mean and constant variance σ^2, and d is the delay parameter[4]. This parameter is chosen using the linearity test as explained below. 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.

Two popular choices of transition functions are the first-order logistic function $F(\gamma, x_{t-d} - c) = (1 + \exp\{-\gamma(x_{t-d} - c)\})^{-1}$ and the exponential function: $F(\gamma, x_{t-d} - c) = 1 - \exp\{-\gamma(x_{t-d} - c)^2\}$. 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 modelling asymmetric behaviour 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.[5]

We use Granger and Teräsvirta (1993) and Teräsvirta (1994), to test for the null of nonlinearity and the appropriate transition function.

As mentioned above, linear model shortcomings have led to increasing research using nonlinear models. However, the complexity of multivariate nonlinear modelling, in terms of the

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[4] The delay parameter indicates the lag order to include in the transition function. This means that past values of the transition variable will have an effect on the present values of the left hand side variable, i.e. the unemployment rate.

[5] The logistic function defines two regimes for low and high values of the transition value with respect the threshold parameter c, while the exponential one defines the regimes in terms of high and low absolute deviations from the location parameter.

number of parameters to be estimated and the loss of degrees of freedom, leads us to test whether economic reasoning and data allow us to simplify this modelling. One possible simplification stems from the presence of common nonlinear components. Therefore, let us assume that within a given set of variables there is nonlinear behaviour of each individual variable with respect to the same transition variable. If this is the case, we can test whether there is 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:

$$y_t = \pi_{A0} + \pi_A(L)y_t + F(z_t)[\pi_{B0} + \pi_B(L)y_t] + \varepsilon_t \tag{2}$$

be the multivariate version of the LSTAR model, where y_t is a $n \times 1$ vector time series, π_{A0} and π_{B0} are $n \times 1$ vector of constants, $\pi_A(L)$ and $\pi_B(L)$ are matrix polynomial of degree p in the lag operator, ε_t is a $n \times 1$ i.i.d. $(0, \Sigma)$ sequence and $F(z_t)$ is a $n \times n$ diagonal matrix containing the transition functions for each series $F(z_{it})$, and z_{it} is one of the np lagged regressors in $ylags_t = (y'_{t-1}, y'_{t-2}, ..., y'_{t-p})'$. If the LSTAR nonlinearity is common to the y_t series, testing for common nonlinearities consists of 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.

3   Empirical analysis

3.1   Data and Stylised Facts

The data for this paper 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.[6] Unemployment data come from the IMF's International Financial Statistics database,[7] and the German real GDP data were obtained from the OECD Main Economic Indicators database.

As our analysis is concerned with the cyclical behaviour of unemployment, we need to select

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[6] Data for Slovenia were not available for the full period, which is why this country has not been included in the analysis.
[7] The definition of unemployment is that used by the International Labour Organization: 'the unemployed comprise all persons above a specific age who during the reference period were without work, currently available for work and seeking for work'. For details on specific countries see: http://laborsta.ilo.orh/applv8/data/SSM3/E/SSM3.html. Data are seasonally adjusted.

one of a variety of filtering techniques to decompose unemployment into trend[8] and cycles. The most straightforward filtering technique is the logged fourth difference of quarterly unemployment. Baxter and King (1999) noted that first differences remove a trend from a series but potentially at the cost of both a shift in the peaks and troughs of the differenced series, and high 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 remains after differencing. Figure 1 depicts 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 favoured the use of the Hodrick-Prescott filter, so for the sake of comparability with this literature, we shall use the Hodrick-Prescott filter to decompose the unemployment series.

Table 1 shows the correlation matrix within the estimated cyclical component of unemployment. According to the degree of correlation, two distinct groups of countries can be distinguished: the first consists of the Baltic States, while the second group contains the Czech Republic and Slovakia. Poland seems to be more correlated with the Baltic States, whereas Hungary does not show a clear pattern. In fact Hungary even shows a negative correlation with Lithuania and Poland. However, despite this, Hungary achieves at the end of the sample a very similar level of cyclical unemployment as the Baltic States and Poland. This evidence suggests the existence of some kind of cluster convergence among the analysed countries. In the next subsection, we test this hypothesis statistically.

3.2 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 construction of the nonlinear model. 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 this paper ensures the stationarity of the variable used in subsequent analysis. Table 2 displays the test statistics for the null hypothesis of linearity against STAR nonlinearity. These tests are performed for each variable using German real GDP as the transition variable, i.e., x_t in

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[8] Although the unemployment rate is bounded between 1 and 0, it is possible to find a nonlinear trend that may fluctuate over time.

equations (1) and (2). Linearity is rejected for all variables using the Granger and Teräsvirta (1993) linearity test. This result has two implications. First, all variables exhibit nonlinear behaviour within two extreme regimes; and, second, the transition between both regimes is driven, at least partially, by the cyclical component of German real GDP.

Adjustment to changes in the transition variable can be either symmetric or asymmetric. As noted previously, if the transition function is exponential, the implied adjustment will be symmetric, while if the transition function is logistic, the adjustment is asymmetric. Table 2 presents the Granger and Teräsvirta (1993) tests for selecting between the ESTAR and the LSTAR models. According to these test statistics, the LSTAR representation of the data is preferred to ESTAR, 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 behaviour of these components is explained, at least partially, by an asymmetric response from these variables to the cyclical component of German real GDP.

It is important to be clear that from the outset that we have considered the German business cycle as the transition variable in our nonlinear model. In other words, the German business cycle has been considered to be the driving force within the system of CEE countries' unemployment rates under what we have called the European integration-based growth model. However, economic development in the CEE countries might have been affected not only by German GDP but also by EU GDP. Furthermore, it remains to be determined whether the CEE countries have been integrated into the world, rather than just the EU, economy. To analyse both possibilities, we conduct linearity tests using not only the German business cycle as the transition variable, i.e., as the driving force behind each unemployment rate, but also both the Euro12 and US business cycles, the latter being a proxy for the world business cycle. Linearity tests can be used to determine the most relevant transition variable. The procedure for doing so is simple, the most suitable transition variable is the one for which linearity presents the strongest rejection (the lowest p-value). The results for the linearity test using the US and the Euro12 business cycles are reported in Table 2. Linearity tests do not allow us to reject the null of linearity when using the American business cycle as the transition variable, with the exception of Poland, and thus we can exclude the possibility that integration of CEE countries has been with the world, rather than the EU, economy. In addition, the rejection of the null of linearity is more apparent when using the German rather than the Euro12 business cycle as the transition variable, despite the important contribution of Germany to euro area GDP. Thus,

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unemployment dynamics in the CEE countries appear to be more significantly linked with the German business cycle than with the Euro12 business cycle. These results are similar to those found by Boone and Maurel (1998), IMF (2000) or Karmand and Weimann (2004). Furthermore, in a recent paper, Brüggemann et al. (2008) suggest that it may be reasonable to consider the German pre-EMU data for studying economic problems in the euro area, because data for the aggregate euro area may pose some problems. Similarly, our results also suggest that German data are preferable when analysing Economic and Monetary Union (EMU) accession countries. This result casts doubt on the rather optimistic view which suggests that new countries can simply be added to the EU and strengthening business cycle synchronisation with the entire EU. Monfort et al. (2013) show that real convergence in the EU has occurred in the form of club convergence, meaning that the EU countries converge to group-specific long-run growth rather than to a common EU steady-state. According to these findings, the economic integration process in the EU has been unable to reduce the basic structural divergences among countries. This implies that the EU business cycle might not play a major role in the cyclical behaviour of CEE countries' unemployment rates but, rather, the business cycles of specific countries such as Germany.

One useful method of testing for common nonlinear features within the STAR methodology is the 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 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, while the null that there is only one factor is not rejected. Furthermore, according to this test, we can find up to two of these common nonlinearities (three if we consider the 10% significance level). These tests therefore provide evidence that the nonlinear behaviour of the cyclical component of our CEE countries' unemployment rates share common features that may be linked to the economic convergence process, which can be captured in an appropriate manner using the cyclical component of German real GDP as the common driving force.

Once we have identified the existence of common nonlinear components, a nonlinear multivariate system can be estimated for all of the cyclical components of the unemployment rates for our CEE countries, under the restriction of common nonlinear factors. 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 the variables.

We have determined that the cyclical components of the CEE countries' unemployment rates share at least two nonlinear components that are driven by the German business cycle, which acts as the exogenous transition variable. The existence of two or more nonlinear common components for the system of CEE countries' unemployment rates may suggest that these countries are club converging. To analyse this, we apply the panel convergence methodology developed by Phillips and Sul (2007).[9] The methodological approach of this test is based on the club convergence hypothesis, suggested by Fischer and Stirböck (2004), which assumes that certain countries or regions adjust through a club-specific steady-state. The Phillips and Sul (2007) procedure is based on a nonlinear time-varying factor model that incorporates the possibility of transitional heterogeneity or even transitional divergence. In addition, no specific assumptions concerning the stationarity of the variable of interest and/or the existence of common factors are necessary. Finally, and more importantly in the context of this methodology, countries can be grouped into convergence clusters by means of a simple empirical algorithm. In other words, we can identify groups of countries that converge to different steady-states. Moreover, the approach allows individual countries to diverge. According to the Phillips and Sul (2007) methodology, we cannot reject the null of club convergence.[10] The first convergence club comprises the Baltic States, Hungary and Poland, while the second cluster is composed of the Czech Republic and Slovakia. The same country-groupings can be derived from the results of the linearity test,[11] where the rejection of linearity was typically obtained for low values of the delay parameter for the second group, but for greater values of the delay parameter for the first group.

Interestingly, this classification matches the labour market policies and institutional divergences observed within CEE countries quite well. Recent studies emphasise the link between labour market institutions and business cycle comovement. Artis, et al. (2008), Sachs and Schleer (2009) and Fonseca, et al. (2010) find that greater similarity in Labour Market Institutions enhances business cycle comovement. The Czech Republic and Slovakia have applied strict criteria for unemployment benefits and have reduced their participation rates towards those of low-income OECD countries. In contrast, Hungary and Poland have sought to protect their workers from redundancy, and hence early retirement is much less common and youth employment is high. Active

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[9] The interested reader can see a description and discussion of this methodology in the Appendix

[10] The null of club convergence is rejected if the conventional t-statistic of the so-called log t regression is lower than -1.65. In our case, the value of the t-statistic is -1.24.

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

labour policies in the Czech Republic and Slovakia combined with rigorous administration of unemployment support have limited long-term joblessness successfully. The effectiveness of the employment offices in the Czech Republic and Slovakia, which transmit information to workers who are still learning how to search effectively for new employment opportunities, and the effective targeting of marginal rather than intra-marginal groups, may provide an effective response to current adverse labour market conditions compared to responses by other CEE countries (Schiff et al., 2006).

Table 4 displays the estimates for the nonlinear system under the restriction of two common factors. Two nonlinear common components were estimated: $F(\text{gdp}_{t-4}) = (1 + \exp[-\underset{(0.23)}{0.47}\,\text{gdp}_{t-4}])^{-1}$ and $G(\text{gdp}_{t-9}) = (1 + \exp[-\underset{(5.61)}{10.29}\,\text{gdp}_{t-9}])^{-1}$ where standard errors are reported in parentheses and each of the nonlinear common components has a different time lag of the transition variable[12] gdp. The first common component is shared by the Czech Republic and Slovakia, while the second is shared by the Baltic States, Hungary and Poland. We find that the Baltic States, Hungary and Poland exhibit a more rapid transition speed than the Czech Republic and Slovakia. This implies that the transition between the two equilibria for the values of the unemployment cycles is more rapid among the first group of countries.

Although the cyclical components of the unemployment rate of the countries analysed share commonalities, this does not mean that all of them react to shocks to German GDP in the same manner. To analyse 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 properties of impulse-response functions for linear models do not hold for nonlinear models. In particular, the impulse-response function for a linear model is invariant with respect to the initial conditions and future innovations. With nonlinear models, in contrast, the shape of the impulse-response function is not independent with respect to 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, et al., 1996). In this paper, the impulse-response functions are calculated through Monte Carlo simulation.[13] Figure 2 plots the impulse-response functions for a positive shock to

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[12] In both cases the threshold parameter c appears to be non-significant and takes a small value.

[13] The generalised impulse response functions are based on stochastic simulations, using random disturbances generated from a

German GDP. As we can see, unemployment falls in all countries, as expected. However, we find that for the Baltic countries, the impact on unemployment is stronger than for the other countries. The stronger effect of an increase in German GDP on the unemployment rates of the Baltic countries, relative to the Central European countries, may be explained by using recent findings from 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, such those operated by the Baltic Countries over the last two decades, the pass-through of changes in import prices tends to be stronger than under flexible exchange rate systems (i.e., such as the exchange rate systems maintained by our target Central European countries for the period analysed). Therefore, a shock to the German economy will have a stronger effect on those of our target countries with more rigid exchange rate systems, such as the Baltic economies. An increase in German disposable income will increase the prices of German products. As the exchange rates with the Baltic Countries are fixed, products produced by the Baltic States become more competitive, and a substitution effect may occur between German and Baltic products in Germany. Moreover, the prices of German exports to our target Baltic economies will eventually tend to reduce the value of imports from Germany, thereby improving the current account.

4 Conclusions

Countries from Central and Eastern Europe have undergone a transition process from planned to market economies. The development model in the CEE countries has, to a large extent, been based on integration with Western Europe. This European integration-based growth model has driven a catch-up process in CEE countries through a combination of political integration, institutional development, trade integration, financial integration, FDI and labour mobility.

In this paper, we provide evidence of the influence that Germany has had in the CEE countries' convergence with Western Europe. In particular, we focus on the behaviour of unemployment rates. Within the context of economic integration, unemployment is a key variable facilitating the adjustment process through macroeconomic equilibrium in the presence of large structural shocks, such as those associated with opening economies to trade at world prices. In this

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normal distribution with zero mean and variance σ^2. The effect of the shock is obtained by comparing the average path with this shock applied at t and zero-mean random shocks thereafter to the average path when all shocks from t onwards are random. The results are based on 10,000 replications and the final response corresponds to the average of the Monte Carlo draws. The size of the shock is one standard deviation of German GDP.

paper, we investigate whether unemployment dynamics in CEE countries followed a common path in the run-up to, and entry into, the EU; and whether this common path can be attributed to the European integration-based growth model. Specifically, we test whether Germany had a crucial influence. To address these issues, we first tested for the existence of common factors in the dynamics of the unemployment rates in CEE countries after the initial transition shock, i.e., from 1994 onwards. Next, we investigated whether it is possible to use the German business cycle as a proxy to capture the economic convergence process. If so, we shall be able to provide some insights into the influence that Germany has had on the CEE countries' process of economic transition to market economies and their convergence with Western Europe.

For this purpose, we employ a flexible nonlinear methodology, based on smooth transition mechanisms, that allows us to overcome the limitations of the standard linear framework traditionally used to analyse unemployment dynamics. Such limitations arise from the fact that neglected regime shifts and asymmetries may provide an exaggerated impression of unemployment hysteresis. In addition, this methodology allows us to introduce business cycle asymmetries in explaining changes in unemployment. In the context of the process of integration with Western Europe, considering the business cycle's effect on unemployment dynamics is of crucial importance in understanding the forces driving the integration process. In light of the increasing dependence of these countries on FDI and trade with the older EU member states (mainly with Germany), we used the German business cycle as a common factor that may help to explain the common nonlinearities present in the unemployment rate cycles in our target countries that may be linked to the convergence process.

We found evidence of a causal relationship running from the German business cycle to the CEE countries' unemployment rates. In addition, we found that unemployment dynamics in the CEE countries have been more strongly linked with the German business cycle than with the EU or US business cycles. This finding implies that the overall EU business cycle might not play a major role in the cyclical behaviour of unemployment rates in CEE countries; but, given the extent of economic integration and ties with specific countries, and with Germany in particular, the business cycles of countries such as Germany may play such a role.

Through an analysis of common nonlinear factors, we found that there are two different common nonlinear components of unemployment cycles within our target countries. The existence of two nonlinear common components for the system of CEE countries' unemployment rates may

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suggest that these countries are club converging. We identified two clubs. The first is the Baltic States, Hungary and Poland, and the second club is made up of the Czech Republic and Slovakia. Interestingly, this classification matches the labour market policies and institutional divergences observed within CEE countries quite well. An impulse-response analysis revealed that unemployment rates in the Baltic States are more sensitive to shocks to German GDP. This can be explained by the different degrees of exchange rate pass-through between these two groups of countries, as a result of their different foreign exchange rate systems during the sample period covered in the analysis. Overall, the hypothesis that Germany exerts a significant influence on the cyclical behaviour of unemployment in these two groups of countries cannot be rejected.

Appendix: Phillips and Sul (2007) approach

In this paper we have used Phillips and Sul (2007) method in order to identify the existence of clusters of convergence. According to Phillips and Sul (2007), any set of variables with panel dimension X_{it} can be written as follows

$$X_{it} = \{x_{1t}, x_{2t}, ..., x_{Nt}\} = \delta_{it}\mu_t \tag{3}$$

where μ_t is a common component and δ_{it} is an idiosyncratic component, the latter being time varying and contains also some source of randomness.

The idea is to measure how different the idiosyncratic component δ_{it} is with respect to a potential steady state δ. Of course, δ can be different from different groups or clusters of individuals/countries. To model δ_{it} Phillips and Sul (2007) propose the following cross-sectional mean square transition differential H_1/H_t,

$$H_t = \frac{1}{N}\sum_{i=1}^{N}(\hat{h}_{it} - 1)^2 \tag{4}$$

where $h_{it} = \delta_{it} \Big/ \frac{1}{N}\sum_{i=1}^{N}\delta_{it}$ is a relative measure of the position of the indiosyncratic component

with respect to the average of the panel. In other words, h_{it} measures individual/country i's relative distance from the common steady-state path μ_t. When there is a common limiting transition behaviour across individuals/countries, then $h_{it} = h_t$. To compute the null of convergence, Phillips and Sul (2007) propose the following model,

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$$\delta_{it} = \delta_t + \left\{ \sigma_i \xi_{it} \middle/ L(t) t^\alpha \right\} \tag{5}$$

where $\xi_{it} \sim iid(0,1)$ for all i, L(t) is a time increasing variable, and α is the speed of adjustment or convergence. Accordingly, δ_{it} converges to δ_t for any positive value of α, as $t \to \infty$. The null can be expressed as

$$H_0 : \delta_{it} = \delta \text{ and } \alpha \geq 0 \tag{6}$$

and the alternative:

$$H_A : \delta_{it} = \delta \text{ for all } i \text{ with } \alpha < 0 \tag{7}$$

or

$$H_A : \delta_{it} \neq \delta \text{ for some } i \text{ with } \alpha \geq 0, \text{ or } \alpha \leq 0$$

Club convergence can be tested under the alternative

$$H_A : \delta_{it} \to \begin{cases} \delta_1 \text{ and } \alpha \geq 0, \text{if } i \in G_1 \\ \delta_2 \text{ and } \alpha \geq 0, \text{if } i \in G_2 \end{cases} \tag{8}$$

for the case of two clusters or clubs, where G stand for a specific club. Testing for the null is based upon the following auxiliary regression:

$$\log(H_1/H_t) - 2\log(\log(t)) = \hat{a} + \hat{b}\log(t), \tag{9}$$

for $t = [rT], [rT]+1, \ldots, T$ with some $r > 0$. Phillips and Sul (2007) suggest $r = 0.3$ based on their simulation experiments. The fitted value is $\hat{b} = 2\hat{\alpha}$, according to the authors, where $\hat{\alpha}$ is the estimated value of α under the null hypothesis. If the null is rejected for the whole panel, this does not excluded convergence, since by means of an algorithm one can test whether there are clubs/clusters of convergence.

To perform this test in practice, Phillips and Sul (2007, p. 1788), propose the following three steps:

1) Compute the cross-sectional variance H_1/H_t,

2) Obtain a conventional robust t statistic, for $\hat{b}$, using equation (9)

3) Apply an autocorrelation and heteroskedasticity robust one-side t test of the inequality null hypothesis $\alpha \geq 0$, using the estimated coefficient $\hat{b}$ and HAC standard errors. At

the 5% level, the null hypothesis of convergence is rejected if the statistic has a value below -1.65.

Now, the question is how to choose which individuals belong to which cluster. Again, Phillips and Sul (2007) provide us with a three step method. First, individuals/countries need to be ordered according to the last third observation in the panel. Second, a core group, say G_k, need to be identified by means of selecting the firs k individuals in the panel to compose G_k for some $N > k \geq 2$ and then the log t regression (9) is run and the convergence test statistic $t_k(G_k)$ is obtained for this subgroup. Then, the core group size k^* is chosen by maximising t_k over k according to the criterion:

$$k^* = \arg\max(t_k), \text{subject to} \min\{t_k\} > -1.65 \tag{10}$$

This ensures that the null (6) is supported for each k. Following this approach, if the condition $\min\{t_k\} > -1.65$ does not hold for $k = 2$, then the highest individual in G_k can be removed from each cluster and new cluster can be created. Those individuals which do not satisfy the condition, are said to be divergent.

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Table 1: Correlation Matrix

	Czech Rep.	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia
Czech Rep.	1.00000						
Estonia	0.38177	1.00000					
Hungary	0.39629	0.12840	1.00000				
Latvia	0.52183	0.78281	0.35455	1.00000			
Lithuania	0.13241	0.77594	-0.06434	0.62901	1.00000		
Poland	0.04077	0.28831	-0.12204	0.31608	0.35865	1.00000	
Slovakia	0.70614	0.37670	0.15752	0.40773	0.27277	0.29437	1.00000

Table 2: Linearity test

Transition variable: German business cycle

	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

Transition variable: Euro12 business cycle

	Czech Rep.	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia
Linearity test	0.0017	0.0618	0.0441	0.0785	0.0830	0.0000	0.0179

Transition variable: US business cycle

	Czech Rep.	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia
Linearity test	0.0556	0.6887	0.5351	0.9796	0.3228	0.0385	0.1103

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

$$cze_t = \underset{(0.10)}{0.45}\,cze_{t-1} + (\underset{(0.19)}{0.69}\,cze_{t-2})\,F(gdp_{t-4}) + \varepsilon_{1t}$$

$$slk_t = \underset{(0.10)}{0.33}\,slk_{t-4} + (\underset{(0.16)}{1.49}\,slk_{t-1} - \underset{(0.19)}{0.65}\,slk_{t-5})\,F(gdp_{t-4}) + \varepsilon_{2t}$$

$$pol_t = \underset{(0.12)}{0.86}\,pol_{t-1} - (\underset{(0.19)}{0.85}\,pol_{t-1} - \underset{(0.14)}{0.58}\,pol_{t-2})\,G(gdp_{t-9}) + \varepsilon_{3t}$$

$$lat_t = \underset{(0.02)}{-0.04} + \underset{(0.13)}{0.87}\,lat_{t-1} - \underset{(0.09)}{0.25}\,lat_{t-3} + (\underset{(0.03)}{0.13} - \underset{(0.16)}{0.55}\,lat_{t-1})\,G(gdp_{t-9}) + \varepsilon_{4t}$$

$$lit_t = \underset{(0.03)}{-0.09} + \underset{(0.07)}{0.65}\,lit_{t-1} - \underset{(0.11)}{0.28}\,lit_{t-3} + (\underset{(0.04)}{0.21} - \underset{(0.16)}{0.28}\,lit_{t-4})\,G(gdp_{t-9}) + \varepsilon_{5t}$$

$$est_t = \underset{(0.02)}{-0.02} + \underset{(0.10)}{1.04}\,est_{t-1} - \underset{(0.10)}{0.18}\,est_{t-4} +$$
$$+ (\underset{(0.02)}{0.06} - \underset{(0.17)}{0.65}\,est_{t-1} + \underset{(0.16)}{0.40}\,est_{t-2} - \underset{(0.15)}{0.55}\,est_{t-3})\,F(gdp_{t-9}) + \varepsilon_{6t}$$

$$hun_t = \underset{(0.12)}{0.73}\,hun_{t-1} - (\underset{(0.16)}{0.39}\,hun_{t-1})\,F(gdp_{t-9}) + \varepsilon_{7t}$$

where: $F(gdp_{t-4}) = (1 + \exp[-\underset{(0.23)}{0.47}\,gdp_{t-4}])^{-1}$ and $G(gdp_{t-9}) = (1 + \exp[-\underset{(5.61)}{10.29}\,gdp_{t-9}])^{-1}$
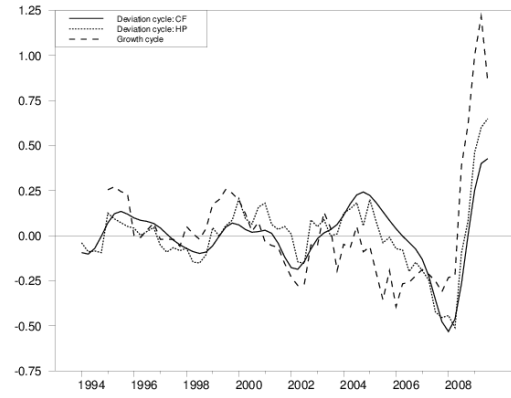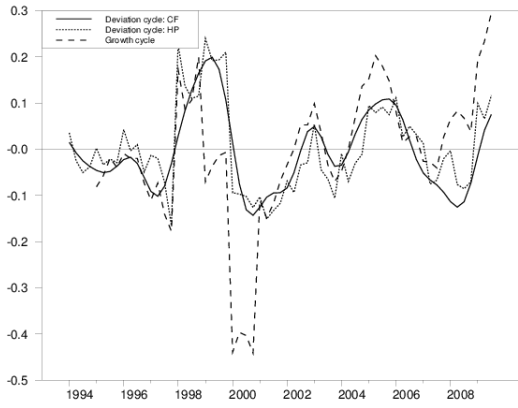
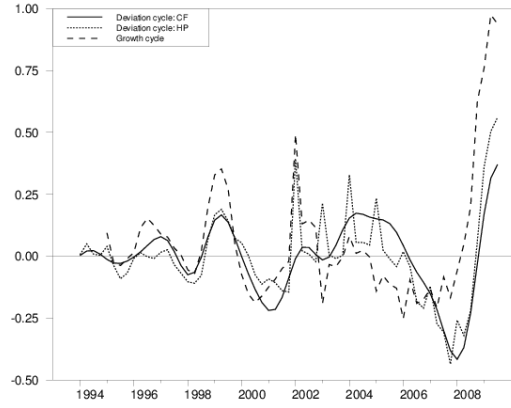Note: Standard errors are reported in parentheses.
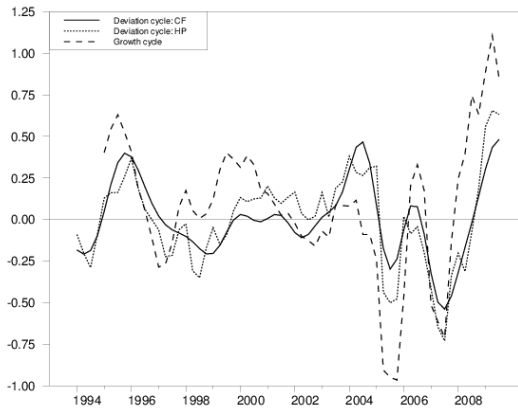
Figure 1: Growth and deviation cycles
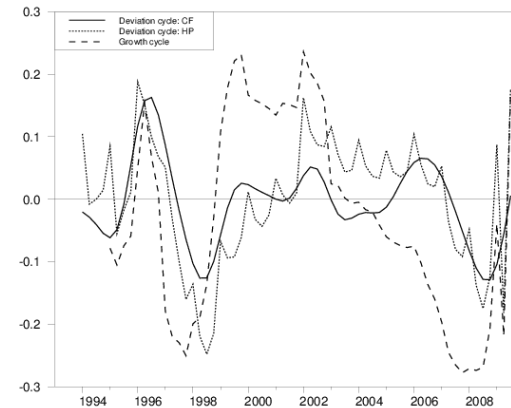

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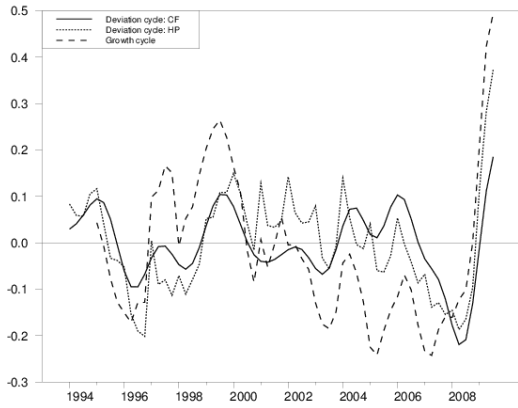
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[Hungary]

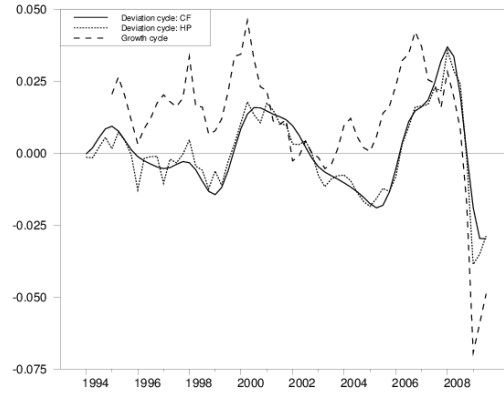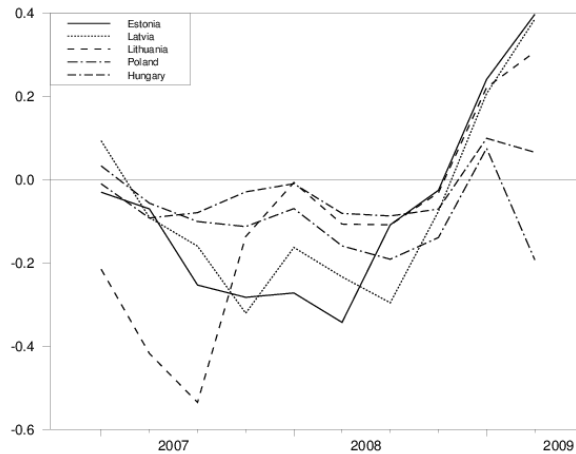[Latvia]

[Lithuania]

[Poland]

[Slovakia]   [Germany]

Figure   2: Impulse-Response functions

[Baltic States, Hungary and Poland]

[Czech Republic and Slovakia]