EUROPEAN CENTRAL BANK
EUROSYSTEM

WORKING PAPER SERIES
NO 827 / NOVEMBER 2007

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In 2007 all ECB publications feature a motif taken from the €20 banknote.

1 We would like to thank Paul Hiebert, Hans-Joachim Klöckers, Reiner Martin, Klaus Masuch, Andrew Scott, three anonymous referees and seminar participants at the European Central Bank and the 11th International Conference on Macroeconomic Analysis and International Finance, Department of Economics, University of Crete, 24-26 May 2007, for helpful comments. The views expressed herein are those of the authors and may not reflect the view of the European Central Bank.

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ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

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Abstract

The purpose of this paper is to evaluate the empirical relevance of real convergence on the process of nominal convergence for the new EU Member States. We discuss two of the main channels through which real convergence could affect relative prices with respect to the euro area: productivity growth and increased trade openness. Productivity growth can have a positive effect on price levels via the Balassa-Samuelson effect, whereas increased openness leads to reductions in mark-ups and costs and therefore can have a negative impact on prices. In order to assess their empirical relevance, we used a Structural VAR model to which we applied a model reduction algorithm. This method accounts for endogeneity and simultaneity and circumvents the problem of limited data availability. Our findings show that, in general, openness has had a negative impact and productivity growth a positive one on price level convergence with respect to the euro area.

Keywords: real convergence, nominal convergence, inflation, new EU Member States.

JEL-Codes: O52, E31.

Non-technical summary

One of the most important economic developments for the new EU Member States (EU-10) in the coming years is the process of real economic convergence to the euro area. Although remarkable progress in terms of catching-up has been made in the past, most EU-10 countries display GDP per capita and price levels which are still considerably below the ones of the euro area. Catching-up in income levels is usually accompanied by a rise in price levels (Rogoff, 1996) and hence *nominal convergence*, a phenomenon usually related to the Balassa-Samuelson effect. If price levels in the EU-10 countries rise due to ongoing real convergence, this would imply that, transitorily, this is a potential source of inflation differentials vis-à-vis the euro area. This becomes particularly relevant as the EU-10 are expected to join the euro area in the future for which, inter alia, the Maastricht inflation criterion needs to be fulfilled in a sustainable manner. Furthermore, once the new Member States have joined the euro, structural inflation differentials might complicate effective monetary policy making.

In this paper we pose the question of how real convergence is currently affecting price levels in the EU-10. We focus on two main factors: productivity growth and trade openness. The potential impact of both variables has good theoretical groundings. Productivity growth can potentially have positive effects on price levels through the Balassa-Samuelson effect and openness can have a negative impact due to increased competition reducing mark-ups through pro-competitive effects and because it increases the commitment of monetary policy to price stability. Both variables, though, could also have the opposite effect. Productivity growth, by increasing market size and product variety, could drive down mark-ups and prices. Greater openness might generate higher price levels to the extent that the prices of tradable goods catch up with international ones through the law of one price.

In our analysis we proceed in two steps. We first show that price level convergence has been an important source driving inflation in the EU-10 countries. We then use a SVAR model to analyze the impact of productivity growth and openness on the price level of these countries relative to the euro area. We estimate a SVAR model including the variables of interest and a set of control variables and apply a model reduction algorithm that allows for more precise estimates of the coefficients of the SVAR given the typical short data spans available for these countries.

Our results show that, with some exceptions, productivity growth in the EU-10 countries have had a positive impact on price level convergence to the euro area and openness a negative one, confirming the theoretical priors. The inflationary pressures stemming from real convergence through the BS effect are attenuated if countries open up to trade at the same time. The results also show that there is a high degree of heterogeneity across this sample of countries. In general, our paper provides a framework against which researchers can study the impact of real convergence on inflation.

1. Introduction

One of the most important economic developments for the new EU Member States (EU-10)[1] in the coming years is the process of real economic convergence to the euro area, i.e. their catching-up in standards of living with those of the old EU member states. Although remarkable progress in terms of catching-up has been made in the past, most EU-10 countries display GDP per capita and price levels which are still considerably below the ones of the euro area. Catching-up in income levels is usually accompanied by a rise in price levels (Rogoff, 1996) and hence *nominal convergence*, a phenomenon usually related to the Balassa-Samuelson effect. Thus, in transition, the process of *real convergence* in the EU-10 may play an important role for future inflation developments in these countries as the process of nominal convergence takes place. If price levels in these countries rise due to ongoing real convergence, this would imply that, transitorily, this is a potential source of inflation differentials vis-à-vis the euro area. This becomes particularly relevant as the EU-10 are expected to join the euro area in the future for which, inter alia, the Maastricht inflation criterion needs to be fulfilled in a sustainable manner. Furthermore, once the new Member States have joined the euro, structural inflation differentials might complicate effective monetary policy making.

Against this background, there is a need for an in-depth analysis of how real convergence is currently affecting price levels in the EU-10. Although real convergence has potentially many dimensions, in this paper we focus on two main factors: productivity growth and trade openness.[2] Specifically, we ask the question of what has been the impact of productivity growth and openness to trade on nominal convergence for the new Member States of the EU. Catching-up has undoubtedly important effects on the pace of productivity growth in these countries, with the potential consequences that this may have on the price level due to Balassa-Samuelson effects. Also, as productivity grows and EU-10 countries experience a process of structural transformation and specialisation, openness to trade increases substantially. There is a growing interest in the literature and by policy makers on the impact that this globalisation process has on home prices (see, for instance, BIS, 2005,

[1] In this paper the term EU-10 countries relate to those countries that joined the EU in May 2004; i.e. Cyprus, Czech Republic, Estonia, Hungary, Latvia Lithuania, Malta, Poland, Slovakia and Slovenia.
[2] In this paper we focus on these two channels only. For a comprehensive discussion and analysis of sources for price level convergence and inflation differentials see Égert (2007).

IMF, 2006, and Greenspan, 2005). Hence, our analysis can shed light on important policy issues such as the likely impact that these real (convergence-related) variables will have on future inflation developments in these countries.

We therefore proceed in two steps. First, we show that price level convergence has been an important source driving inflation in the EU-10 countries in the last 15 years.[3] Second, we estimate the impact that productivity growth and openness has had on the process of price level convergence between the new EU Member States and the euro area. In doing so, we first discuss the theoretical channels through which these two variables can have an impact on price levels. We then evaluate empirically this impact using a separate VAR model for each new EU member state where we include both productivity growth and openness and a set of other control variables. The typically short sample of data available for these countries has so far not allowed to empirically analyzing the influence of each of these channels in a dynamic time series model. To circumvent this problem, we use a general to specific model reduction algorithm for VAR models. Departing from a general recursive VAR model, the algorithm selects the variables that enter significantly in the system reducing dramatically the number of parameters to be estimated. The general to specific reduction process is designed to ensure that the parsimonious subset VAR will convey all the information embodied in the original VAR. This allows us to check the channels through which productivity growth and openness affect price level convergence and carry out impulse response and variance decomposition analyses. Our findings show that, with some exceptions, productivity growth has a positive impact on price level convergence and openness a negative one confirming the theoretical priors. There is, however, a high degree of heterogeneity across this sample of countries. Given that nominal convergence appears to have had an important impact on inflation, future developments in both productivity growth and trade openness should be considered when assessing the timing of euro adoption in these countries and the appropriate conversion rate.

The paper is structured as follows. In Section 2 we discuss the potential role of real convergence on nominal convergence focusing on productivity and trade openness. Section 3 presents empirical evidence on how nominal convergence has influenced inflation rates in EU-10 countries in the last 15 years. Section 4 presents the methodology for the VAR analysis. Section 5 discusses the results and Section 6 concludes.

[3] In actual facts our analysis excludes Cyprus due to data unavailability.

2. The role of real convergence for nominal convergence

As mentioned earlier, the process of real convergence has diverse consequences on the economic structure of transition economies. Because of their potential importance and the role attributed to them in previous studies, here we focus on two channels. The first channel, productivity growth, is most commonly related to the Balassa-Samuelson (BS) effect (Balassa, 1964 and Samuelson, 1964). According to the BS effect, a catching-up economy with high rates of productivity growth is assumed to experience more rapid convergence of productivity levels in the tradable goods sector than in the non-tradable goods sector. Stronger productivity growth in the tradable goods pushes up wages in this sector. Under the assumption of perfect labour mobility across sectors, wages rise in the whole economy. As productivity growth in the non-tradable sector is assumed to lag behind that of the tradable sector, higher wages in this sector translate into higher prices of non-tradable goods and hence an increase in the overall price level. This is often referred to as the internal version of the BS effect,[4] while the external version of the BS effect compares productivity growth differentials between the tradable and non-tradable sector and its impact on the real exchange rate. Assuming that the nominal exchange rate is determined by purchasing power parity in the tradable sector, an increase in the price level in the catching-up economy following an increase in productivity will ceteris paribus result in an appreciation of the CPI-based real exchange rate in the EU-10. In this paper, we only focus on the internal version of the BS effect. Empirical evidence for the existence of the internal BS effect in the new Member States has been found in several studies, an excellent survey is provided in Mihaljek and Klau (2004).[5] The main conclusion of these studies is that productivity differentials explain

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[4] The domestic version of the Balassa-Samuelson effect is often referred to as the Baumol-Bowen effect (Baumol and Bowen, 1966).

[5] For studies on the BS effect in the new Member States see also Backé et al. (2003), Blaszkiewicz et al. (2004), Coricelli and Jazbec (2004), Égert (2005), Égert et al. (2003), Flek et al. (2002), Halpern and Wyplosz (2001), Kuzmina and Lobakovs (2004), MacDonald and Wojcik (2003), Mihajlek and Klau (2003, 2005), Rother (2000), National Bank of Hungary (2002), Sinn and Reutter (2001) and Wagner and Hlouskova (2004). Égert et al. (2006a), Halpern and MacDonald (2006) provide an excellent survey of the existing empirical literature on the external version of the BS effect.

on average between 0.2 and 2.0 percentage points of annual inflation differentials vis-à-vis the euro area.[6]

While the BS effect is a supply side phenomenon, real convergence can also affect inflation through the demand side (Bergstrand, 1991). This relates mainly to changes in the consumption pattern, as it can be expected that, with increasing income, the demand for non-tradable goods and services will increase relative to tradable goods. This phenomenon is known as the Linder hypothesis (Linder, 1961). An increasing weight of non-tradable goods in the HICP consumption basket would amplify the upward pressure of the Balassa-Samuelson effect on price levels.

In contrast to the BS effect, which assumes a positive impact of productivity growth on price levels, there are also theoretical reasons to argue that higher productivity growth in the tradable sector could potentially lead to a reduction in prices. Rising productivity growth in the tradable sector generates market size gains which are usually accompanied by increases in product variety. Increasing product variety would imply more competition in this sector, which in turn would force firms to reduce their mark-ups.[7] This effect would lead to a reduction of price levels. This so-called competition effect would gain even more importance if it were accompanied by a rising degree of trade openness. MacDonald and Ricci (2002), for instance, developed a new trade theory model where they relaxed the assumption of price equalisation and perfect substitutability of tradables across countries. According to this model, higher productivity growth in the tradable sector would have two opposing effects. On the one hand, prices in the tradable sector would decline due to higher

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[6] The BS effect has been often criticised for its underlying assumptions. This relates in particular to the assumption of perfect labour mobility across sectors, the argument of rather low productivity growth in the service sector and the law of one price in the tradable sector. From an empirical point of view, the data on job flows as well as relative wage developments do not support the assumption of perfect labour mobility in the EU-10. There is, however, evidence of productivity growth in the tradable sector being higher than in the non-tradable sector in most EU-10, although it is worth noting that the estimates of the BS effect could be distorted due to difficulties in distinguishing between tradable and non-tradable goods. There is also some evidence against the assumption that PPP holds in the EU-10 (DeBroeck and Slok, 2006 and Égert et al. 2006b, Lommatzsch and Lahreche-Revil, 2006). Also frequent changes in administered prices could disfigure the actual size of the BS effect, as they mainly relate to the sector of non-tradable goods and services and thereby lead to relative price changes. In the EU-10, most administered prices have been gradually increased closer towards cost recovery levels, which can partly explain the higher inflation rate in the service sector in the past years, in particular as the share of administered prices in the consumer basket appears to be relatively high in most of these countries (Égert et al., 2006a, Halpern and MacDonald, 2006).

[7] This is a standard result in dynamic models of growth through variety expansion. See Grosman and Helpman (1991).

competition following larger product variety, which would force firms to reduce their mark-ups. On the other hand, wage equalisation across sectors (just as in the BS framework) implies an increase in the price of non-tradables. This shows that, although a priori due to BS effects one would expect price levels to rise with real convergence, this may be attenuated by pro-competitive effects induced by variety expansion. This also links directly with the second channel: trade openness.

Real convergence implies a process of structural transformation that might lead, through increased specialisation and productivity expansion, to a higher degree of trade openness, as firms are likely to become more export-intensive and with a higher share of import penetration.[8] Lee et al. (2004), for instance, find that there is a robust impact of GDP per capita growth on openness. In turn, greater openness can have an effect on price levels in both directions. On the one hand, greater openness might generate higher price levels, to the extent that the prices of tradable goods catch up with international ones through the law of one price.[9] Moreover, the structure of imported goods might change over time, as with real convergence countries are more likely to import goods of higher quality. This in turn could imply higher prices for tradable goods.[10] On the other hand, however, there are several arguments to assume that higher openness will have a negative effect on prices.[11] The arguments are well summarized in a paper by Chen et al. (2004; 2007) who identify two channels via which openness lowers prices. The first is via the effect of openness on productivity and mark-ups. In their model, in the style of Melitz and Ottaviano (2005), the import share in a sector in a given country depends on relative productivity between countries and trade costs. Falling trade costs lead to more openness by increasing the import share and the number of firms in the given sector. More firms increase competition which in turn reduces mark-ups and lowers prices. Furthermore, lower prices have a crowding out effect on firms with lower productivity, which increases average productivity and thereby again reduces costs and prices. The second channel Chen et al. introduce in the model operates via the effects on monetary policy. As openness reduces mark-ups, output is closer

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[8] The causality can be also the other way around, namely that increased openness leads to more real convergence, especially if countries share a single currency, as predicted by the literature on endogeneity of the OCA criteria (see de Grauwe and Mongelli (2005) for a recent survey).
[9] See Kravis and Lipsey (1988) and Maier (2004).
[10] See IMF (2006), chapter 3, for a survey. For empirical evidence for a positive relationship between openness and inflation, see Sachsida et al. (2003), Gruben and McLeod (2004).
[11] See Romer (1993) and Terra (1998) for the initial literature on the impact of openness on inflation.

to its natural level. Hence, the incentive for discretionary policy makers to create surprise inflation is lower in more open economies, particularly as the ability to temporarily stimulate domestic output is smaller. This is similar to the arguments put forward in Romer (1993) and operates through a macroeconomic rather than microeconomic channel. Chen et al. (2004) empirically confirm the negative impact of openness on prices for the euro area. They show that competitive effects of greater openness contributed to lower prices by squeezing mark-ups and lowered costs as productivity increases. They also show that openness reduces the inflationary bias.

Overall the process of real convergence leading to productivity growth and increased trade openness can have important impacts on the price level of the EU-10 countries relative to the euro area and hence nominal convergence. Theoretically both effects may have positive and negative impacts on price levels, although a priori we can expect positive effects dominating through the productivity channel and negative ones through openness. It is then important to analyze empirically to what extent these channels have affected nominal convergence in the new Member States. From a policy perspective, though, inflation is the relevant variable and we first show how the process of price level convergence has affected inflation in these countries since the mid-1990s.

3. The role of nominal convergence for inflation

Nominal convergence in price levels is a one off process. However, given that this adjustment process may take long, it may be one of the main variables driving inflation rates, which is the policy relevant variable, for a substantial period of time. During the transition process inflation is likely to be strongly driven by nominal convergence (Cihak and Holub, 2001). The slower the adjustment process, the more long-lasting will the effects of convergence be. In this section we use a simple statistical model to show the importance of nominal price level convergence on inflation in our sample of the new Member States before proceeding to analyzing the determinants of nominal convergence.

We estimated an Error Correction Model (ECM) for the inflation rate for each of the countries in which the adjustment to the long run is forced by the price level of the country relative to that of the euro area. The ECM takes the following form:

$$\Delta p_t = \alpha + \sum_{l=1}^{L} \delta_l \Delta p_{t-l} + \sum_{l=1}^{L} \delta_l^{EU} \Delta p_{t-l}^{EU} + \lambda \left[\frac{p_{t-1}}{p_{t-1}^{EU}} \right] + \varepsilon_t \ , \qquad (1)$$

where p_t is the (log) price level, Δp_t is the inflation rate, a superscript EU indicates the variable for the euro area and ε_t is an error term. Here the term $\left[\frac{p_{t-1}}{p_{t-1}^{EU}} \right]$ is the lagged (logarithm) of relative prices, which is our nominal convergence variable. The coefficient λ indicates the speed of convergence towards equilibrium and is a measure of the importance of nominal convergence as a driving force for inflation. Coefficient λ allows us to test the significance of the impact of the price level gap on inflation and its value allows us to calculate half lives of deviations from equilibrium. This can serve as an indication of how long-lasting the effects of nominal convergence are on inflation in the transition towards equilibrium. It has to be noted, however, that this is not intended to be a fully-fledged model of inflation for the EU-10, but it should rather be viewed as a statistical method to analyze the role of nominal convergence on inflation in the EU-10 countries during the sample period available.

We used quarterly data on CPIs for the period 1995:1 to 2007:1. The CPIs for EU-10 are from IMF's IFS database and are seasonally adjusted. For the euro area, since CPI indexes from IFS only start in 1998, we used the HICP index obtained from the ECB.[12] We transformed the data so that all indexes use the year 2000 as base year.[13] Inflation is the quarter-to-quarter log difference of the price indexes. Given our short time span, with about 50 observations for each country, we restricted the lag length (l) to a maximum of 5 and used a general-to-specific procedure to find the optimal lag. In some cases, the short-run coefficients of the euro area inflation rate appeared not to be significant and they were dropped from the model to obtain a parsimonious representation. We first analyzed the stationarity properties of the relative price variable. These are reported in Table 1. Only in

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[12] The seasonally adjusted CPI index of IFS matches almost exactly the HICP index for the period in which both are available for the euro area.

[13] Alternatively, cost of living measures could be used to benchmark the price indexes. Yet, in our analysis we are mainly interested in the time series evolution of our data and not in a cross-country comparison of the price level. Re-basing the data to an absolute price level would, however, not affect the properties of the data.

the case of Malta could we not reject the null of non-stationarity. For the rest of the countries we could confirm a stationary relative price level although for the Slovak Republic only at the 10% level. We also report, in Table 1, unit root tests for the inflation rates of the different countries in the sample. Inflation appears to behave as a stationary process with a drift in all countries except for Hungary.[14]

Table 2 reports the results from the ECM model. It shows the estimated λ coefficient, its t-ratio, the partial R^2 of the ECM term, the optimal lag length l, the estimated half life of the deviation from equilibrium and p-values of error diagnostic tests (error autocorrelation, heteroskedasticity and normality). Considering the fact the model is highly stylized, most of the ECMs appear to behave remarkably well with the possible exception of Lithuania which fails several diagnostic tests. With the exception of Latvia, all the ECM coefficients are significant and have the expected sign. The partial R^2 shows that nominal convergence appears to be driving a large part of the inflation variability especially for Estonia, Hungary, Lithuania, Czech Republic and Poland. The adjustment is typically slow with half-lives ranging from 35 quarters for Slovenia and the Slovak Republic to almost 5 quarters for Estonia. These results show that nominal convergence appears to be an important driving force behind the inflation rates of the EU-10 and that these transition effects are also long-lived.[15] Hence, the relation between real convergence and nominal convergence has important implications for inflation stabilization policies. Although the impact of nominal convergence is likely to diminish over time as price convergence takes place, to the extent that there are still important price differentials between the EU-10 and the euro area, nominal convergence will remain an important issue in the years to come.

4. Methodology, data, and model reduction strategy

Analyzing the impact of productivity and openness on price convergence necessarily entails modelling complex relationships between the variables involved. One approach could consist of running single equation estimates of relative prices on these variables and some

[14] KPSS tests for the null of stationarity yielded the same results. For the case of Hungary, the KPSS test with a time trend could not reject the null of stationarity.
[15] This finding confirms earlier estimates of Cihak and Holub (2001). They conclude that the degree of differences in the structures of relative prices in transition economies vis-a-vis EU economies has a strong negative relationship to price levels in the transition economies.

controls to account for nominal shocks, business cycle effects and monetary policy. However, these variables are likely to be correlated with each other in a dynamic context and single equation methods would not allow us to separate the effects of shocks to each variable. For these reasons it is necessary to work with a VAR model. A VAR allows us to address issues related to causation and isolating primitive shocks. We hence build a separate VAR model for each country, analyze its performance and use impulse-response functions and variance decomposition analysis to unveil the impact of shocks to these real variables on price convergence.

Each VAR model contains our three variables of interest, namely, relative prices ($\frac{p_t}{p_t^{EU}}$), productivity growth ($prodg_t$), and openness ($open_t$) plus a set of control variables. These control variables are: real oil price growth (oil_t), euro area inflation (π_t^{EU}), the rate of depreciation of the nominal exchange rate (dER_t), the rate of growth of real wages ($rwage_t$), the output gap (GAP_t) and the money market interest rate (ir_t). Given that relative prices are stationary, we work with a stationary VAR in which all variables are I(0). For this reason, we had to first difference the nominal interest rate and the openness measure for several countries as they appeared to behave as nonstationary processes. For Slovakia the VAR had modulus of the largest roots very close to 1 and we hence had to first difference the relative price variable.[16] Oil prices aim at capturing energy price shocks and euro area inflation controls for the effect of inflation on the denominator of our relative price variable. Given that the EU-10 countries trade intensively with the EU, π_t^{EU} would also capture the impact of imported inflation from the euro area on price convergence. This is especially important for the periods in which some of these countries adopted fixed exchange rate regimes anchored to the euro or the DM. Both these variables, i.e. oil and euro area inflation, were modelled as purely exogenous to reduce the dimensionality of the VAR and because it is unlikely that the rest of the variables for these EU-10 countries will have an impact on oil prices and euro area inflation. The exchange rate variable controls for potential pass-through effects into home prices, and because it may be a relevant variable to which monetary policy reacts. Given that most of the countries in the sample adopted different exchange rate regimes with respect to the DM and the euro at different points during the last 15 years, we used the exchange rate

[16] Pre-tests for unit roots of the variables involved indicated that all the variables are I(0) with the possible exception of relative prices for Hungary.

with respect to the US dollar as an indicator of exchange rate market pressures.[17] The real wage growth variable aims at capturing labor market shocks in form of for example changes to wage bargaining, labor market regulations and labor supply that are likely to affect the price level. Real wages, however, were not available for Malta and Slovenia.[18] The output gap variable controls for business cycle effects on inflation and is the difference between GDP and HP filtered GDP.[19] The interest rate appears to control for monetary policy stance, as the reaction of monetary policy is likely to have a strong impact on inflation and the evolution of the relative price. Productivity growth is measured as the rate of growth of the seasonally adjusted GDP over total employment. Finally, openness is a standard measure of exports plus imports over GDP.

There are two main sources of data. We used EUROSTAT data for measures of output, employment, openness and wages and IMF's IFS database for inflation, interest rates, oil prices and exchange rates. We used quarterly data for the sample period 1995:1 to 2007:1.

In order to identify shocks to the different equations in our VAR, we used a standard recursive structure implying a causal ordering. This Structural VAR (SVAR) implies that the variable ordered first can have contemporaneous and lagged impacts on the rest of the variables and the variable ordered last will only have lagged impacts on the rest of the variables. In our case, we modelled oil_t and π_t^{EU} as exogenous and allowed them to have contemporaneous and lagged impacts on all the variables of the system. For the rest of the SVAR we used the following causal ordering structure: [$open_t$ $prodg_t$ dER_t $rwage_t$ GAP_t ir_t $\frac{p_t}{p_t^{EU}}$]. We model relative prices last to allow the rest of the variables to have a contemporaneous impact on it. We attempted two alternative different orderings involving the exchange rate, wages, GAP and interest rate variables, but this did not affect the impulse responses of the real convergence-related variables in an important way. Formally, the SVAR model can be represented as follows:

$$\mathbf{B}y_t = \delta + \sum_{k=1}^{p} \mathbf{\Gamma}_k y_{t-k} + \sum_{k=0}^{p} \mathbf{\Phi}_k z_{t-k} + \nu_t \qquad (2)$$

[17] For Lithuania we did not include the exchange rate variable as this country had a US dollar-based currency board between 1994 and February 2002 before it changed to a euro-based currency board.
[18] For Slovenia data on wages was only available from 1999 onwards.
[19] The results using a Band-Pass filter did not change the results qualitatively.

where $\mathbf{B}$, $\mathbf{\Gamma}$ and $\mathbf{\Phi}$ are coefficient matrices, y_t = [$open_t$ $prodg_t$ dER_t $rwage_t$ GAP_t ir_t P_t/P_t^{EU}] is the 7x1 vector of endogenous variables and z_t= [oil_t π_t^{EU}] is the 2x1 vector of exogenous variables with v_t a zero mean vector-white-noise process with variance-covariance matrix Ω such that $v_t \sim NID(0,\Omega)$. The recursive structure of the VAR is achieved by imposing contemporaneous restrictions on the coefficient matrix $\mathbf{B}$ so that

$$\mathbf{B} = \begin{bmatrix} 1 & 0 & ... & 0 \\ b_{12} & 1 & ... & 0 \\ . & . & ... & . \\ b_{17} & ... & b_{67} & 1 \end{bmatrix}.$$

Our SVAR has a maximum of 3 lags (p = 3) and a constant, which implies that the number of parameters to estimate is 238. The equation with the largest number of parameters is the one of P/P^{EU} with 36. Given that the number of observations available is 49, it is clear that the precision of our estimates would be very low. For this reason, it is necessary to reduce the dimension of the SVAR by eliminating the lags and contemporaneous variables that appear insignificant. A rigorous way of doing this is by making use of the Gets (General-to-specific) model selection algorithm of Hendry and Krolzig (2005).[20] An advantage of using a model reduction algorithm is also that the impact of the recursive structure imposed on the VAR would be reduced, as several of the contemporaneous variables may appear to be insignificant and are hence eliminated from the system.

The Gets algorithm specifies an initial General Unrestricted Model (GUM). Then we have to specify the variable selection significance level and the model selection criteria, which can include specification tests and information criteria such as the Swartz Information Criteria. From here, the algorithm searches using a multiple-path between each feasible initial variable deletion. The model selection continues until we have a well-specified model for each initial path where all variables are significant. Once all paths have been explored, all terminal models are tested against each other and their union until a final model is selected.

In the case of VAR models, we follow Brüggemann et al. (2002) and Krolzig (2003) who discuss the properties of model selection algorithms for VAR models. One of the

[20] See also Hoover and Perez (2004).

conclusions of this literature is that equation-by-equation reduction methods such as Gets are inefficient for reduced form VARs if there is no independence between the different equations in the system. Hence, they advise to use a SVAR instead. With the contemporaneous restrictions of the SVAR, the Gets algorithm is efficient on an equation by equation basis. In our case the GUM is the SVAR model presented in equation (2). The algorithm then searches for a final model for each equation of the SVAR until we achieve a "specific" SVAR (S-SVAR) model. The S-SVAR model is not only identified like the original SVAR, but also over-identified and we can hence test for over-identification restrictions. This S-SVAR model can then be used to analyze the causal structure of the relations between the variables involved and to implement impulse-response functions with large gains in precision and accuracy relative to the richly parameterized initial SVAR.

5. Results

Tables 3 to 11 present the structure of the estimated specific SVAR (S-SVAR) model for each country. The tables report the sign of the estimated coefficients when they were selected by the Gets algorithm and a dot for the variables that were eliminated. A blank appears under the zero lag as required by the recursive structure of the VAR that imposes restrictions on the $\mathbf{B}$ matrix. The first thing to notice is that the algorithm reduces very dramatically the number of estimated coefficients, which is of key importance in our application given the short sample period. For instance, in the case of the Czech Republic the S-SVAR contains 41 estimated coefficients against the 238 of the original SVAR.

Openness appears to have a direct impact on the relative prices equation for the majority of the countries, and this effect is usually negative. Only in Hungary does openness not appear directly in the relative prices equation. In 6 out of 9 cases the impact is contemporaneous and negative. The impact of productivity growth, however, appears to be indirect in all cases except Latvia and Poland. This impact is usually linked to the effect of productivity on wages (which is compatible with BS effects) and the output gap. It is also worth mentioning the reaction of interest rates, which appear to react, according to our expectations, positively to output gap shocks, oil prices and EMU inflation. There is also significant reaction to exchange rate shocks.

Table 12 presents error diagnostic tests for the S-SVAR model. We present vector tests of autocorrelation of orders 1 to 4, normality, ARCH(1) and also an LR test of over-identification restrictions and the modulus of the largest root. The tests show that, overall, most of the models are well specified. The Czech Republic presents some normality problems and Lithuania presents problems of autocorrelation. Out of 9 countries we can reject the null of no over-identification in 6 of them. Finally, the moduli of the largest roots are typically far from one, which indicates that our model is stationary.

Figure 1 presents the impulse responses of relative prices to a one standard error shock to openness and productivity, together with the 95% confidence intervals obtained using 500 bootstrap draws from the centered residuals. Figure 2 presents the cumulative impulse response functions in order to analyze the accumulated impact of a permanent shock to openness and productivity growth. The results present a reasonable degree of heterogeneity across countries.[21] However, in general we can see that openness has a negative and significant impact on relative prices in 5 cases, an insignificant impact in 3 cases (Czech Republic, Hungary and Latvia) and a positive impact only in the case of Estonia. That is, for the majority of the countries analyzed, increased openness reduces the price level relative to the euro area. The magnitude of the impact is modest but significant, with a one standard error shock reducing relative prices by about 1% in cumulative terms. From the point of view of the theoretical models discussed in Section 2, it appears that pro-competitive effects induced by increased openness have had a dominating effect relative to the price catch-up effects.

The impact of productivity growth, however, appears to have the opposite effect. It increases relative prices in 5 countries, is not significant in two countries (Czech Republic and Latvia) and it reduces relative prices for Estonia and Malta. The magnitude of the impact is similar to that of openness. With the exception of Malta and Estonia, this appears to support the view that productivity growth increases price levels due to Balassa-Samuelson effects. Only for the Czech Republic and Latvia appears the model to be inconclusive regarding the impact of the two real convergence-related variables focus of our study.

Finally, we present the Forecast Error Variance (FEV) decomposition of the relative price variable in Table 13. We show the contribution of productivity growth and openness at

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[21] This emphasises the importance of studying their impact on a country-by-country basis rather than relying on panel methods that assume homogeneous slope coefficients.

forecast horizons of 4, 8 and 24 quarters. Productivity growth appears to explain a large proportion of the forecast error of relative prices for Poland, Malta, Estonia and, to a lesser extent, Slovakia and Lithuania. Openness, on the other hand, appears to explain a sizeable share of the forecast error variance in Lithuania, Slovakia, Slovenia, Poland, Malta and Estonia. In line with the results of the impulse response functions, these variables do not appear to have a large impact in the cases of the Czech Republic and Latvia.

Overall, our results point to the importance of real convergence-related variables in driving nominal convergence in our sample of nine new Member States. In particular, productivity growth has a positive impact on the price level, which supports Balassa-Samuelson type explanations of the impact of productivity on prices. Increased openness has a negative impact on the price level that we interpret as evidence in favour of the pro-competitive effects of international trade. Only in two cases, namely the Czech Republic and Latvia, do these mechanisms not appear to play an important role in driving nominal convergence. Hence, the inflationary pressure from productivity growth driven by the BS effect is present. However, the BS effect is countervailed in these countries in the process of real convergence that open up to international trade. The latter effect attenuates inflationary pressures from real convergence related productivity growth.

6. Conclusions

One of the most important developments in the new EU Member States in the recent past has been the process of real convergence with the rest of the EU. In this paper we pose the question of whether this process has had important implications for the process of nominal convergence or price level catch-up with the euro area. We focus here on two main channels: productivity growth and trade openness. The potential impact of both variables has good theoretical groundings. Productivity growth can potentially have positive effects on price levels through Balassa-Samuelson effects and openness can have a negative impact due to increased competition reducing mark-ups through pro-competitive effects and because it increases the commitment of monetary policy to price stability. Both variables, though, could also have the opposite effect. Productivity growth, by increasing market size and product variety, could drive down mark-ups and prices. Greater openness might generate higher price levels to the extent that the prices of tradable goods catch up with international ones through the law of one price.

We first present evidence that shows that price level convergence in the new Member States has been an important driving factor behind inflation. We then use a SVAR model to analyze the impact of productivity growth and openness on the price level of these countries relative to the euro area. We estimate a SVAR model including the variables of interest and a set of control variables and apply a model reduction algorithm that allows for more precise estimates of the coefficients of the SVAR given the typical short data spans available for these countries. Our results show that, in general, the inflationary pressure stemming from real convergence through the BS effect is attenuated if countries open up to trade at the same time: openness has had a negative impact on price levels relative to the euro area and productivity growth has had a positive impact. The results also show that this sample of countries is heterogeneous.

Our paper provides a framework against which researchers can study the impact of real convergence on inflation. It also shows that, given the relevance of nominal convergence in driving inflation for these countries, monetary policy and decisions about the timing of the euro adoption in these countries and the conversion rate of the respective national currency to the euro requires a careful consideration of the evolution of real convergence, especially the future room for productivity growth and increased trade openness.

Tables

Table 1: ADF unit root tests on relative prices and inflation rates

	Relative prices ADF (lag)	Inflation rate ADF (lag)
Czech R.	-4.45* (1)	-2.66**(3)
Estonia	-6.37* (1)	-4.88* (3)
Hungary	-4.27* (3)	-1.68 (2)
Latvia	-3.05* (3)	-3.23* (2)
Lithuania	-4.31* (2)	-3.80* (3)
Malta	-2.31 (1)	-3.54* (2)
Poland	-4.15* (3)	-2.93* (1)
Slovakia	-2.72**(0)	-3.17* (2)
Slovenia	-4.12* (2)	-3.13* (1)
Euro Area	-	-2.89**(3)

Notes: * and ** denote rejection of the non-stationarity null at the 5% and 10% respectively. The estimation sample in all cases is 1994:1-2007:1. For Hungary, using the sample period starting in 1995:4, which is the one used for the rest of our estimates, the ADF test yields a value of -2.92, which rejects the null at the 5% level.

Table 2: Estimation results of the ECM model

	λ	t-ratio	Partial-R^2	Half-life	lag	AR (p-value)	Het (p-value)	Nor (p-value)
Czech R.	-0.11	-3.45	0.24	6.64	4	0.08	0.12	0.19
Estonia	-0.15	-5.00	0.34	4.96	2	0.12	0.04	0.55
Hungary	-0.05	-4.16	0.28	14.21	5	0.06	0.16	0.22
Latvia	0.01	0.319	0.00	n.a.	5	0.26	0.69	0.32
Lithuania	-0.12	-4.03	0.26	6.12	3	0.07	0.04	0.02
Malta	-0.09	-1.97	0.09	8.04	5	0.31	0.17	0.31
Poland	-0.06	-2.97	0.19	11.9	5	0.78	0.57	0.47
Slovakia	-0.02	-1.81	0.09	35.0	4	0.14	0.89	0.38
Slovenia	-0.02	-1.98	0.11	35.0	5	0.09	0.28	0.11

Table 3: Specific SVAR: Czech Republic

	Oil				EUinf				Open				Prod				ER				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	.	+	.	.	.	.	.		-	-	.		.	.	.		+	.	.		.	.	.		.	.	.		.	.	.		.	.	.
Prod	.	.	.	.	.	.	+	.	.	.	.	.		-	-	.		.	.	.		.	+	.		.	-	.		.	.	.		.	.	-
ER	.	-	+	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.		.	.	.		.	.	.		.	.	+		.	.	.
Wage	.	.	-	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.		-	.	.		.	.	.		-	-	-		-	.	+
GAP	.	.	.	.	.	.	.	.	.	.	.	.	+	-	.	.	.	.	.	.	.	.	.	.		+	.	-		.	.	.		.	.	.
IntRate	.	.	+	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	+	.	.		-	.	.		.	.	.
RelP	.	-	.	.	.	.	.	.	-	+	.	.	.	.	.	.	.	.	+	+	-	-	.	.	.	.	-	+	.	.	-	.		+	+	.

Table 4: Specific SVAR: Estonia

	Oil				EUinf				Open				Prod				ER				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	+	.	.	.	.	.	.		+	.	.		.	.	.		+	.	.		.	.	.		.	.	.		.	.	.		.	.	.
Prod	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.
ER	-	.	.	.	.	-	-	-	-	-	-	+	+	-	.	.		.	.	.		.	.	-		.	-	.		.	.	-		.	+	-
Wage	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	-	.	.	.	-		-	.	.		.	.	+		.	.	-		.	.	.
GAP	.	.	.	.	.	.	.	-	.	.	.	.	+	-	.	.	.	.	.	+		.	.	+		+	-	.		-	.	.		.	.	.
IntRate	+	.	-	.	.	+	-	-	.	+	.	.	.	.	+	.	-	.	.	+	.	.	.	.	.	+	.	.		+	-	+		.	.	-
RelP	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	-	+

Table 5: Specific SVAR: Hungary

	Oil				EUinf				Open				Prod				ER				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	.	+	.	-	.	.	.		.	.	-		.	.	.		.	+	.		.	.	.		.	.	.		.	.	.		.	.	.
Prod	.	.	-	+	.	.	+	.	.	.	+	.		+	.	-		.	.	+		.	.	.		-	.	.		.	.	+		.	.	+
ER	.	.	.	.	+	-	.	.	.	.	.	.	.	.	.	.		.	.	.		.	.	.		.	.	.		-	-	.		.	.	.
Wage	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.		.	.	.		.	.	-		.	.	.		.	.	.
GAP	.	-	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.		+	.	.		.	.	.		.	+	.
IntRate	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.		.	.	.		.	.	+
RelP	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.		+	-	+

Table 6: Specific SVAR: Latvia

	Oil				EUinf				Open				Prod				ER				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	.	.	.	.	.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.
Prod	.	.	.	+	.	.	.	.	.	.	.	.		-	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.
ER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		+	.	.		.	.	.		.	-	.		.	.	.		.	.	.
Wage	.	.	.	.	-	+	.	.	.	-	.	.	+	.	.	.	.	.	.	.		-	+	.		.	.	-		.	.	+		.	.	+
GAP	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.		+	.	.		-	.	.		.	.	.
IntRate	.	.	.	.	.	+	.	.	.	-	.	.	.	.	.	.	-	.	.	.	-	-	.	.	.	.	.	.		+	.	.		.	-	-
RelP	.	.	.	.	-	-	.	.	-	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	+	.	.	.		+	-	+

Table 7: Specific SVAR: Lithuania

	Oil				EUinf				Open				Prod				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	.	.	.	+	.	+	.		-	-	-		.	.	.		+	.	.		.	.	.		-	.	.		.	.	.
Prod	.	-	.	.	.	.	.	-	.	.	.	+		.	.	.		+	+	+		-	+	.		+	+	-		.	-	+
Wage	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.		-	.	.		.	.	.		+	.	.		.	.	.
GAP	.	.	.	.	.	.	.	-	.	.	.	.	+	.	.	.	-	+	.	.		+	.	.		-	.	.		.	+	-
IntRate	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	+	.		+	+	.		+	-	.
RelP	-	+	.	.	+	-	.	.	-	+	-	.	.	.	.	.	.	+	-	.	.	.	+	.	.	-	+	.		+	-	.

Table 8: Specific SVAR: Malta

	Oil				EUinf				Open				Prod				ER				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	+	.	.	.	.	.	.	-		-	.	-		.	+	.		.	.	.		.	.	.		.	.	.		.	.	.
Prod	.	.	.	+	.	.	.	.	-	.	.	.		-	+	.		.	.	.		.	-	.		.	.	.		.	.	.
ER	.	.	+	.	+	.	-	.	+	.	.	.	.	.	.	.		.	.	.		.	.	.		.	.	.		.	-	.
GAP	+	.	.	+	-	.	.	.	.	.	.	.	+	+	.	-	.	.	+	.		+	+	.		.	.	-		+	.	.
IntRate	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		.	-	.
RelP	.	.	.	.	.	+	.	.	.	-	.	.	.	.	.	.	.	.	+	.	.	-	.	.	.	.	.	.		+	+	.

Table 9: Specific SVAR: Poland

	Oil				EUinf				Open				Prod				ER				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	.	.	.	.	.	.	.		-	-	-		.	.	+		.	.	+		.	.	.		.	.	-		.	-	+		.	.	.
Prod	.	.	.	.	.	.	.	-	.	.	.	.		.	.	.		.	.	+		.	.	+		-	.	.		.	.	.		.	.	.
ER	.	.	.	.	.	.	.	-	+	.	.	-	.	.	.	.		.	.	.		+	.	+		.	.	.		-	+	-		-	+	-
Wage	.	.	.	.	.	.	.	.	.	+	.	-	.	+	-	.	-	.	.	.		-	.	+		.	+	+		.	.	.		.	.	.
GAP	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.		+	.	.		.	.	.		.	.	.
IntRate	.	.	.	.	+	.	-	.	.	.	.	.	.	.	-	+	.	-	.	.	-	.	.	.	.	.	.	.		+	.	.		-	+	.
RelP	-	.	.	.	+	-	.	.	-	.	-	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	+	-	.		+	-	+

Table 10: Specific SVAR: Slovakia

	Oil				EUinf				Open				Prod				ER				Wage				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	-	.	+	.	+	.	.	.		-	-	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.
Prod	.	.	.	.	.	.	.	.	.	.	+	.		+	.	.		.	.	.		.	.	.		-	+	.		.	+	.		.	.	.
ER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		.	.	.		.	.	.		.	.	.		.	.	.
Wage	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.		.	.	.		+	-	.		.	+	.		.	.	.
GAP	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.		+	.	.		.	.	.		.	.	.
IntRate	.	.	.	.	.	.	.	.	.	-	.	.	.	.	-	.	.	.	.	.	.	+	+	.	.	.	.	.		.	.	.		.	.	.
RelP	.	.	+	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.	-	.	.	.	.	.	.	.	.	.	.	.		.	.	.

Table 11: Specific SVAR: Slovenia

	Oil				EUinf				Open				Prod				ER				GAP				IntRate				RelP			
lag	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Open	.	.	+	.	.	.	.	.		.	.	.		.	+	+		.	.	.		.	.	.		.	.	.		.	+	.
Prod	.	.	.	+	.	.	.	-	.	-	.	.		-	.	.		.	.	.		.	-	.		.	.	.		-	.	.
ER	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.		.	.	.		.	.	.		.	.	-
GAP	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.		+	.	.		.	.	.		.	.	.
IntRate	.	.	.	.	.	.	.	.	.	+	.	-	.	-	+	.	.	-	.	.	.	+	-	+		+	.	.		.	.	.
RelP	.	.	.	.	+	.	-	.	-	+	.	-	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.		+	.	.

Notes: "+" and "–" implies that the variable has been selected and has a significantly positive (+) or negative (-) impact. A "." means that the variable has been dropped by the selection algorithm. A blank cell appears under the zero lag when the recursive VAR restrictions imply that the variable does not have a contemporaneous impact.

Table 12: Vector diagnostic tests. P-values.

	AR(1-4)	Normality	ARCH(1)	LR over-identification	Modulus largest root
Czech Rep	0.452	**0.012**	0.148	0.122	0.86
Estonia	0.890	0.200	0.344	0.234	0.90
Hungary	0.144	0.526	0.286	**0.001**	0.92
Latvia	0861	0.931	0.538	**0.000**	0.85
Lithuania	**0.010**	0.996	0.663	0.101	0.91
Malta	0.432	0.114	0.585	0.228	0.88
Poland	0.287	0.240	0.166	**0.005**	0.92
Slovak Rep	n.a.	0.112	0.453	0.161	0.89
Slovenia	0.144	0.100	0.383	0.207	0.93

Notes: numbers are p-values. Bold characters indicate that the test is unable to reject the null of misspecification.

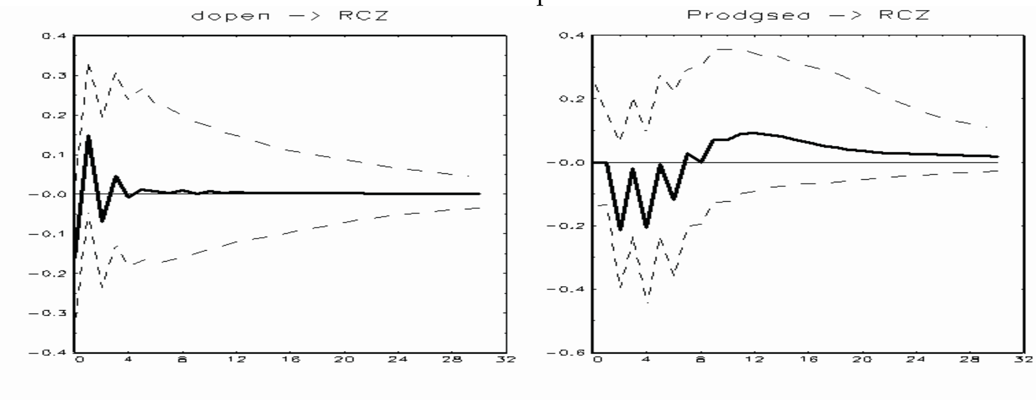
Table 13: Forecast variance decomposition of $\frac{p_t}{p_t^{EU}}$: contributions of productivity growth and openness

	Productivity growth			Openness		
	4 q	8 q	24 q	4 q	8 q	24 q
Czech Rep	0.03	0.04	0.03	0.05	0.03	0.03
Estonia	0.09	0.12	0.12	0.10	0.11	0.10
Hungary	0.05	0.06	0.06	0.00	0.01	0.00
Latvia	0.15	0.05	0.02	0.02	0.04	0.04
Lithuania	0.08	0.06	0.07	0.40	0.43	0.43
Malta	0.26	0.24	0.21	0.12	0.12	0.10
Poland	0.32	0.36	0.42	0.09	0.14	0.12
Slovakia	0.05	0.09	0.08	0.14	0.15	0.16
Slovenia	0.02	0.08	0.06	0.15	0.17	0.09

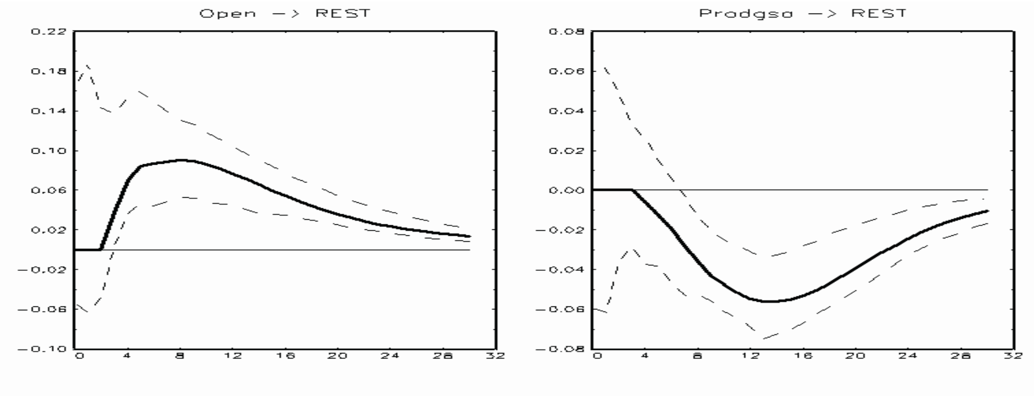
Notes: the numbers indicate the proportion of the forecast error of the relative price explained by each variable at forecast horizons of 4, 8, and 24 quarters respectively.

Figure 1: Impulse responses to a one standard deviation shock to productivity growth and openness

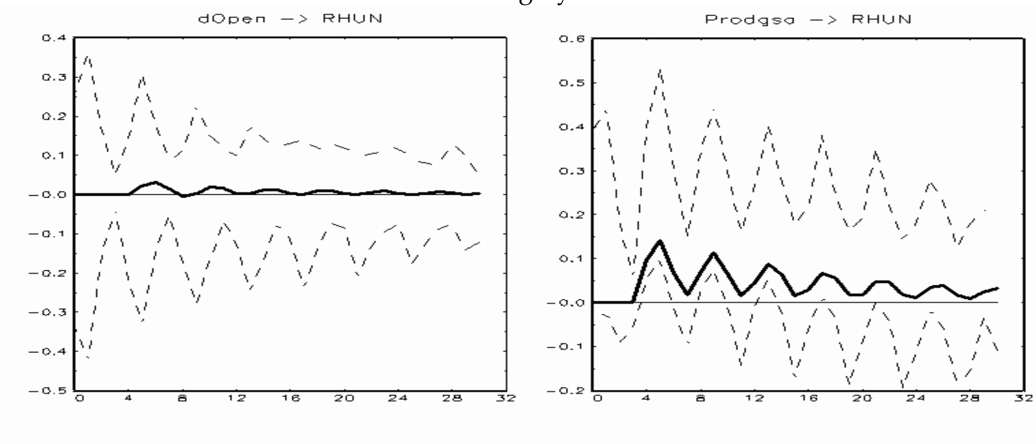
Czech Republic



Estonia



Hungary



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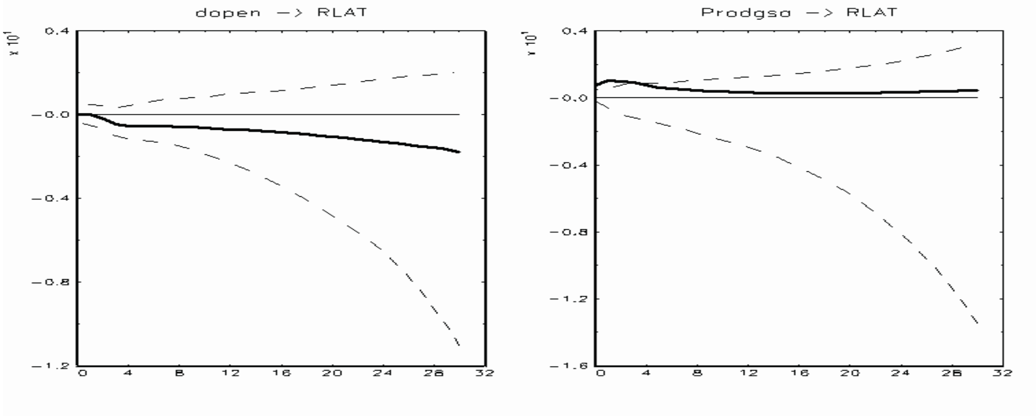

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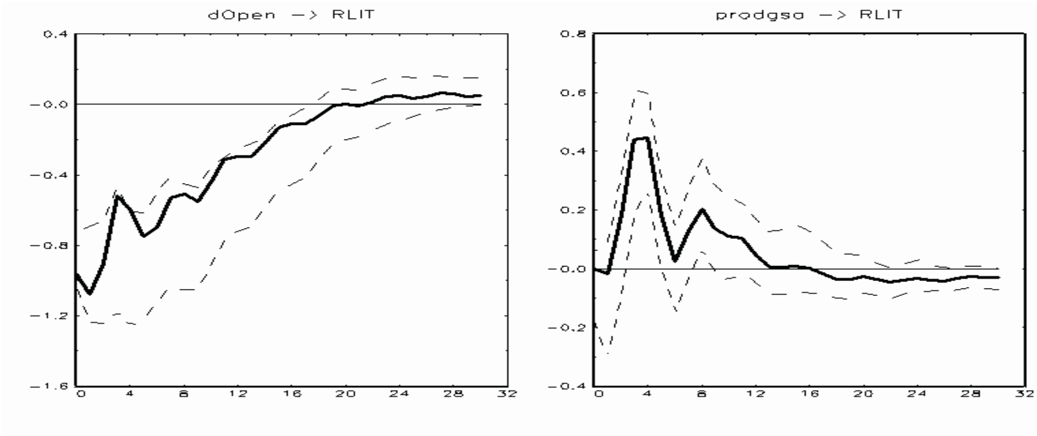

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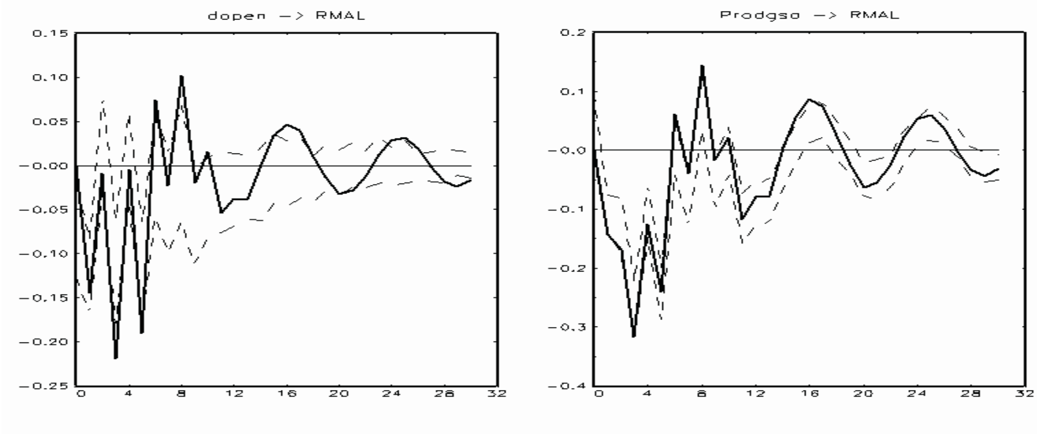

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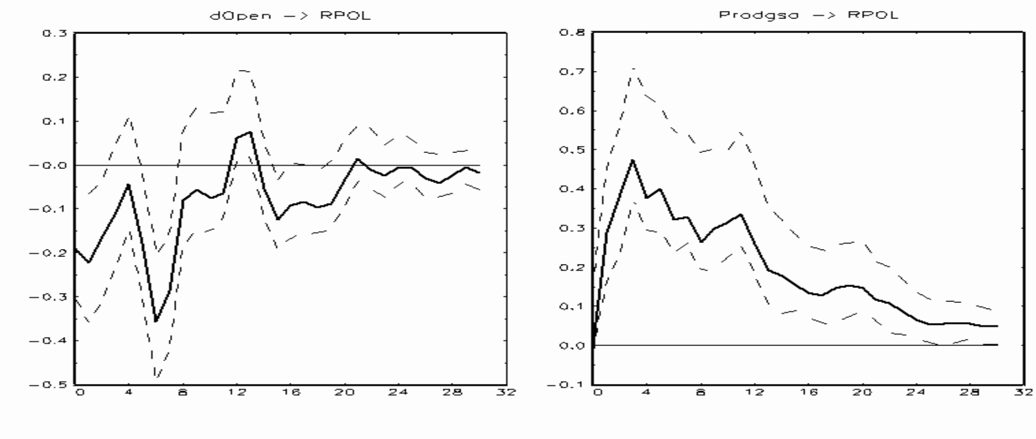

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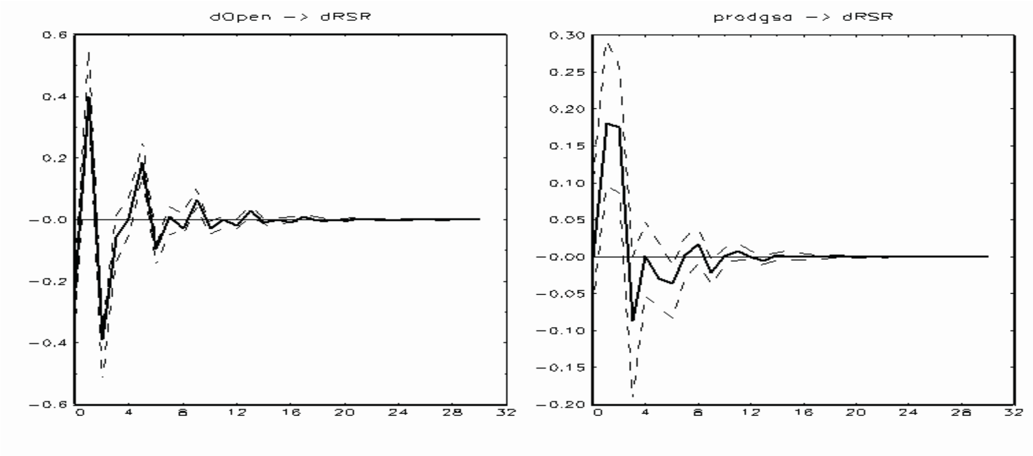

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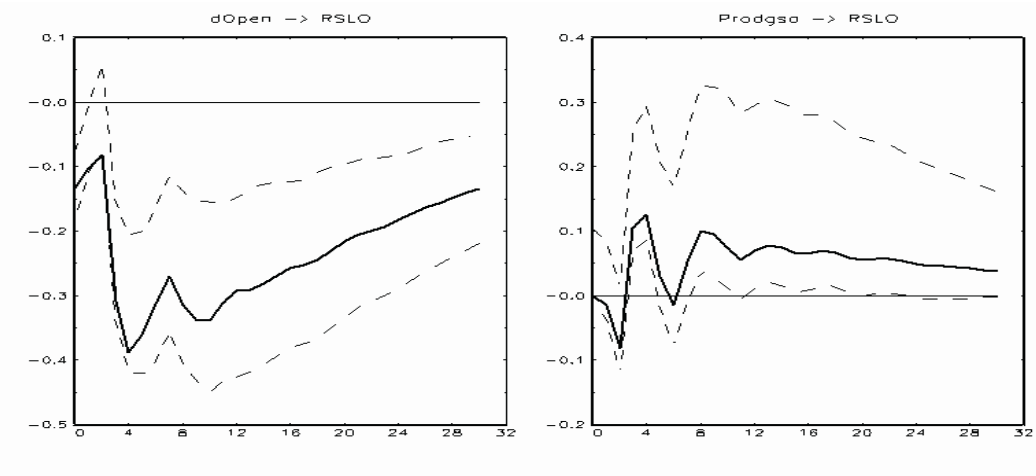
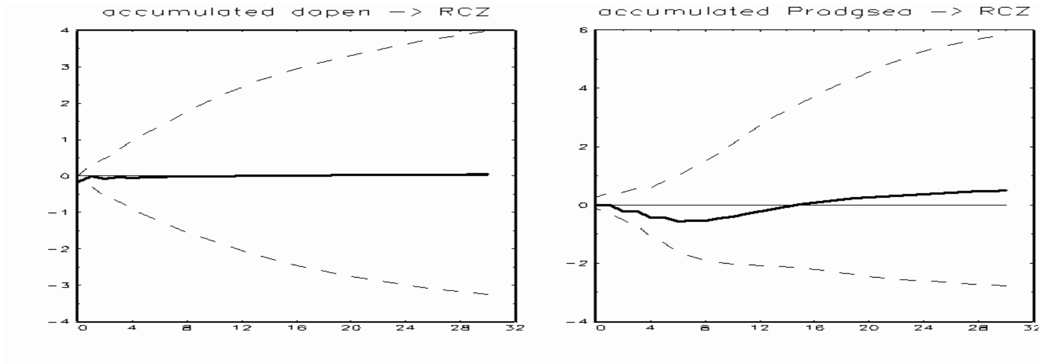


Figure 2: Cumulative impulse responses to a one standard deviation shock to productivity growth and openness

Czech Republic



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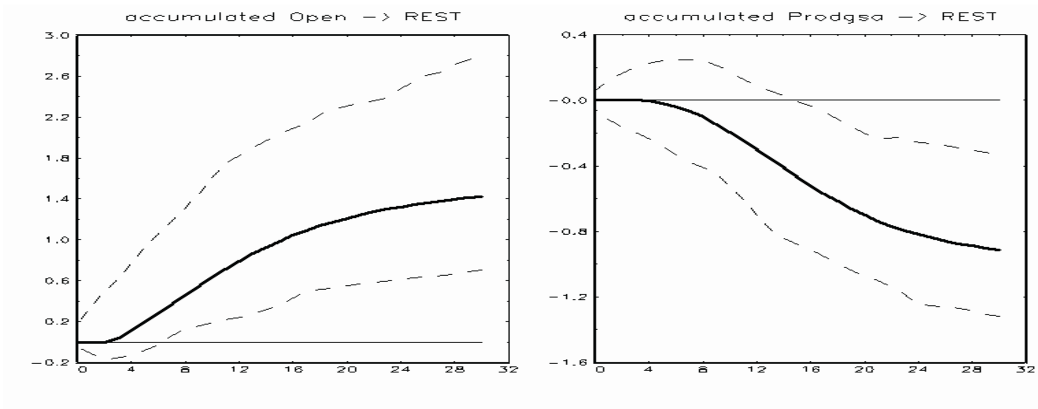
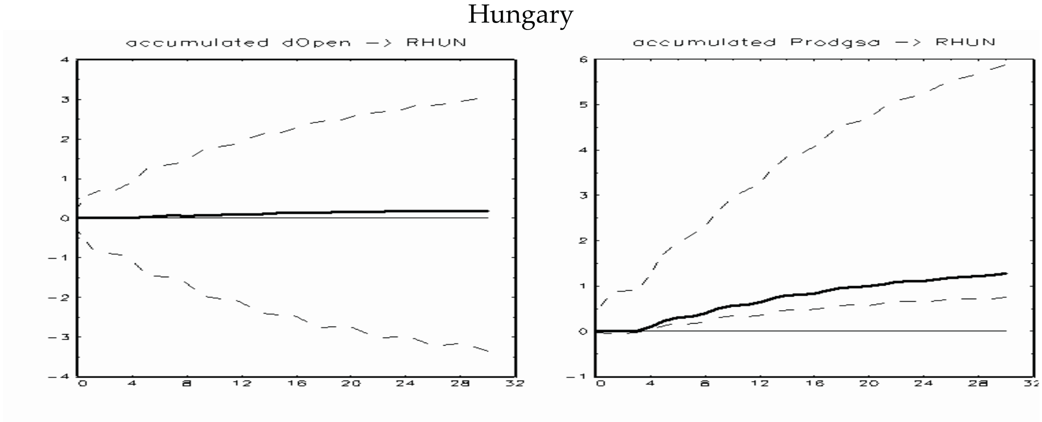
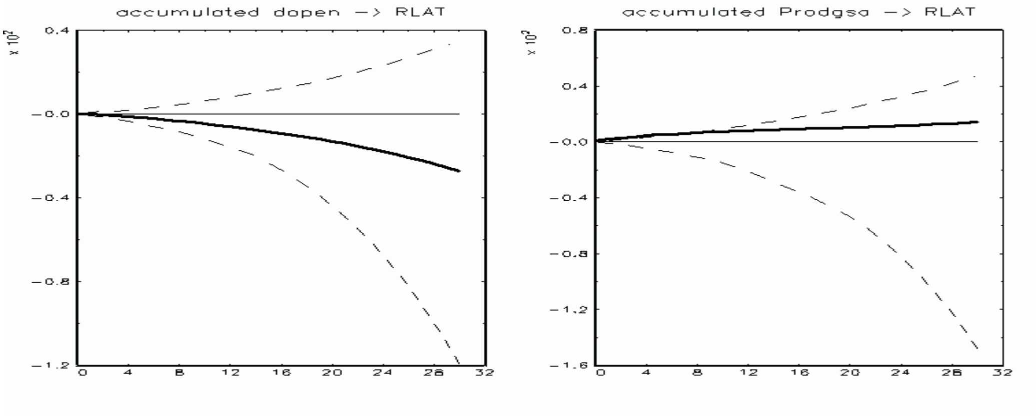


Hungary



Latvia



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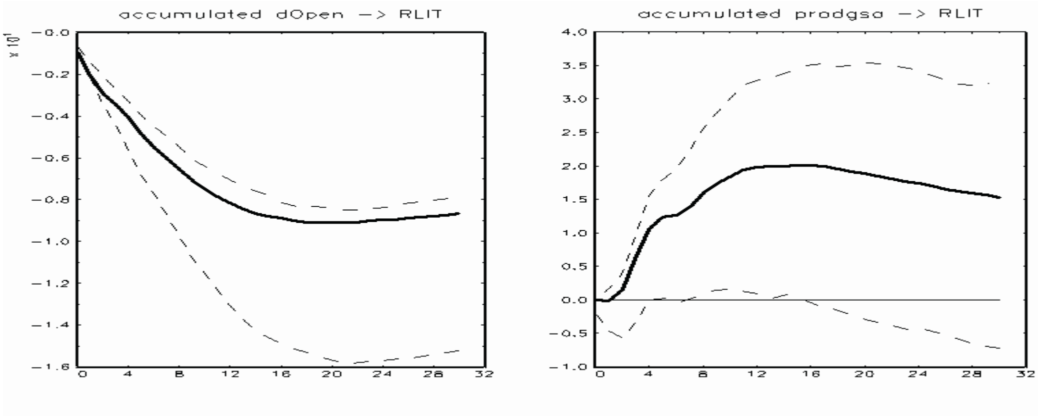

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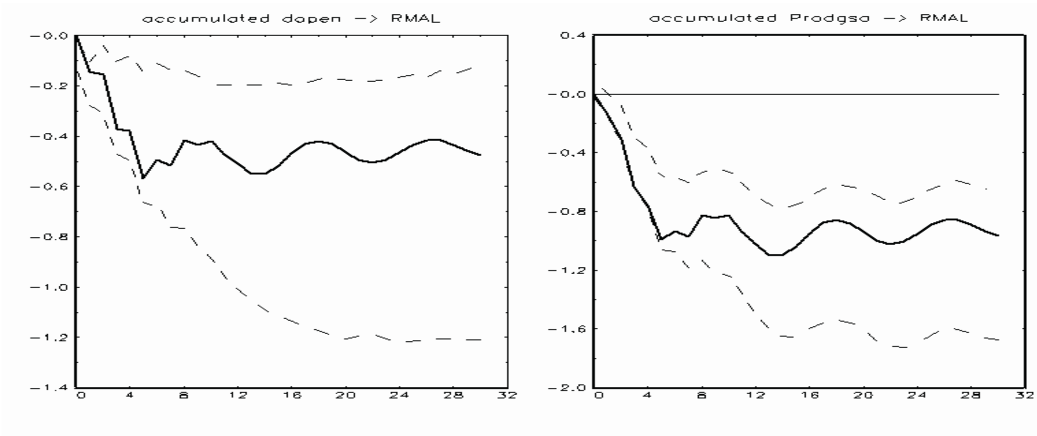
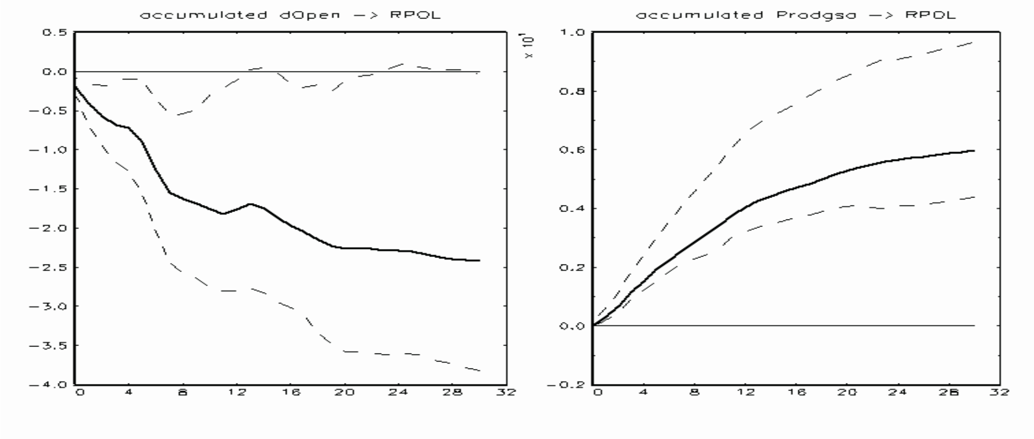
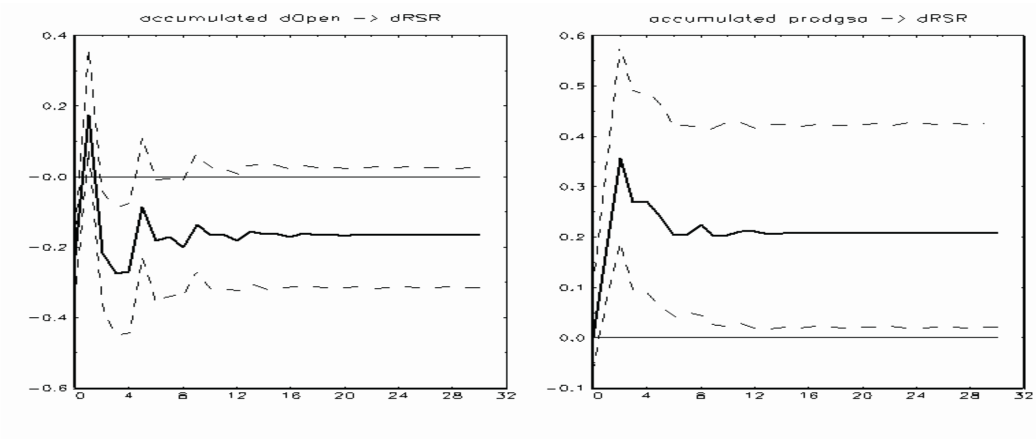


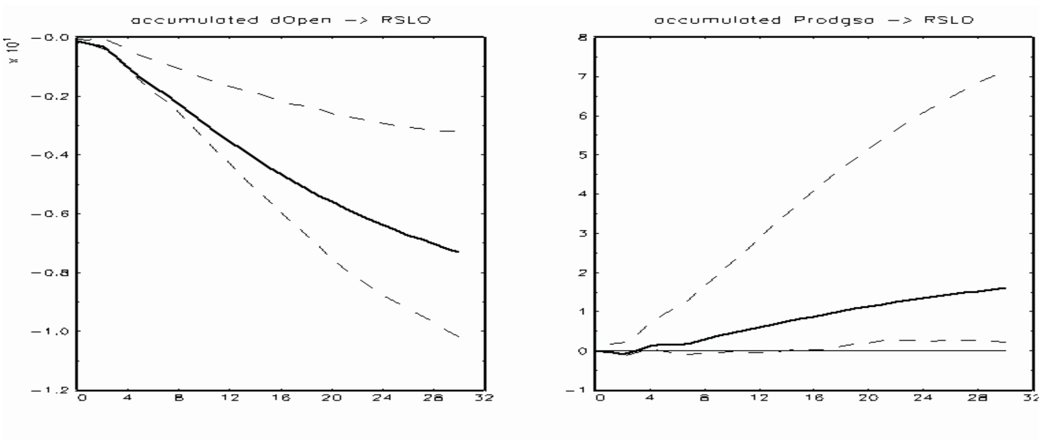
Poland



Slovakia



Slovenia



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