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Abstract: This paper uses a simple VAR analysis to examine 5 CEE countries (the Czech Republic, Hungary, Poland, Romania and Slovakia) in order to understand whether their business cycles are synchronized with each other and/or with the major economies that they are supposed to be linked with, namely the US, Germany and Russia. We find that there are differences across the CEE countries themselves and that there is no common CEE business cycle. Comparing the individual CEE business cycles with those of the dominant economies, we find that Hungary and Poland are related to the US business cycle, reflecting the fact that they are more integrated with the global economy, whereas Slovakia is closer to the Russian cycle. Finally, splitting the sample into the late 1990s and 2000s due to the transition nature of these economies in the former period shows that the influence of Russia on the CEE economies has declined over time. However, in contrast to the expectations that CEE countries are likely to be affected by Germany in the second half of the sample due to EU negotiations followed by full membership, among the CEE countries only the business cycle of Slovakia is synchronized with that of Germany. On the other hand the Czech Republic, Hungary and Poland are synchronized with the US business cycle, showing that globalization has decreased the importance of distance.

Key Words: Business cycle synchronization, CEE countries, EMU

JEL: E32, F15, F41

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1. Introduction and Literature Review

The synchronization of business cycles among developed countries, both within a monetary union and between a candidate country and a monetary union, has been studied extensively. These studies attempt to answer questions such as whether there exists a common business cycle within a group of countries or whether a candidate country should be a member of a monetary union since business cycle synchronization is accepted as a necessary condition for an optimum currency area (OCA). According to Mundell (1961), prerequisites for an OCA are highly correlated economic shocks, a high level of trade integration and labor mobility among member countries, and the existence of a federal fiscal transfer system compensating for adverse shocks (Frankel, 2000). However, there has been no study to our knowledge that analyzes the synchronization of a specific country's business cycle with those of the major economies of the world to show which one is more influential. This type of analysis also has implications for political science as economic dominance brings about political dominance.

The early studies on the subject point out that the business cycles of major economies seem to be synchronized until the Second World War (Haberler, 1937). During the post-war reconstruction phase, however, it appeared that business contractions in Europe until the 1970s (Zarnowitz, 1985) and in Japan until the 1980s (Helbling and Bayoumi, 2003) were being replaced by mere retardations in economic activity.[1] There was a revival of interest in business cycle synchronization in the context of advanced economies, especially for the Group of Seven (G-7) countries, after the oil price shocks of 1970s. With the exception of Japan and Canada that did not experience a classical recession in this period, the remaining 5 countries' recessions in 1974-75 were synchronized, not only in terms of peaks and troughs but also in terms of the duration of recovery. The recessions for these countries in the early 1980s were also closely synchronized, except for those in the United Kingdom (Helbling and Bayoumi, 2003).

Unlike the 1970s and 1980s, the timing of classical recessions among G-7 seemed to disperse in the 1990s, so did the interest on business cycle synchronization in the literature. However, the interest was renewed in the new millennium after the growth slowdown in the United States in 2000-2001 unexpectedly spilled over to the rest of the world. The questions raised in the studies include whether the synchronized slowdown in this period is unusual or the result

[1] The business cycle is defined as expansions and contractions in the general economic activity, whereas the alternations of above-trend and below-trend growth phases, i.e., deviations from long run trends rather than levels of economic aggregates are termed as growth cycles.

of the diversification of the 1990s; whether it is a consequence of globalization, i.e., rising international trade and financial integration of the world economy; and whether it is caused by a global shock or by increasing spillovers of country-specific shocks.[2] The answer for the first question by Helbling and Bayoumi (2003) is that when analyzed from the perspective of quantitative aspects of international business cycle linkages among G-7 countries since 1973, the synchronized business cycles are the norm rather than the exception.

Regarding the second question, Kose, Prasad, Terrones (2003) provide at best limited support for the conventional wisdom that globalization leads to an increase in the degree of synchronization of business cycles worldwide. Examining some summary statistics on the correlations of output growth rates in each country with the growth rate of the composite measure of world output, they find that on average, industrial countries have stronger correlations with world output than developing economies. For industrial countries, these correlations on average increase sharply in the 1970s (the oil-shock period) and rise further in the 1990s. For developing countries, on the other hand, these correlations are in general much lower compared to industrial countries and, if anything, decline in the 1990s.

For the last question, i.e., whether business cycles synchronization is caused by a global shock or by increasing spillovers of country-specific shocks, dynamic factor models, which allow the decomposition of fluctuations in each macroeconomic aggregate into a common factor (common across all countries) and a country-specific factor, are used. Kose, Prasad, Terrones (2003) examine the changes in the relative importance of the common factor by estimating their model over two periods: 1960-1980 and 1981-1999. If globalization has a positive impact on the degree of business-cycle synchronization over time, the contribution of the common factor to the variation of output growth is expected to rise in the second period. However, the importance of the common factor for output fluctuations is found to be almost the same across the two sub periods, suggesting that the increased international economic interdependence has not significantly changed the extent of business-cycle co-movement. Furthermore, their results indicate that the common factor explains a much larger fraction of output fluctuations in industrial countries than it does in the developing countries. A similar result is reached in a recent paper by Altug and Bildirici (2010), who find that not only are the characteristics of developing economies significantly different from those of the developed ones, but they also tend to exhibit quite disparate behavior relative to each other, using a

[2] The recent global recession of 2008–09 is likely to increase the interest in business cycle synchronization even more.

univariate Markov regime switching approach. Yet their study documents episodes when business cycle activity appears highly synchronized, implying the importance of large global shocks in inducing major recessions, such as the oil shocks of the 1970s and 1980s as well as the financial shock of 2008.

The second wave of studies on business cycle synchronization has been motivated with the formation of Economic and Monetary Union (EMU) of the European Union, because when countries are considering forming a monetary union, the question of whether their business cycles are coordinated arises (Harding and Pagan, 2006).[3] In line with this view, EMU was established in three phases: coordinating economic policy, achieving economic convergence such that their business cycles are synchronized, and finally, culminating in the adoption of the euro. As a first step, the European Exchange Rate Mechanism (ERM) was introduced in March 1979, to reduce exchange rate variability and achieve monetary stability in Europe. Therefore, the studies on business cycle synchronization among EU countries started as early as 1992. For example, by extracting information on underlying aggregate supply and demand disturbances using a VAR decomposition, Bayoumi and Eichengreen (1992) find that the underlying shocks are significantly more idiosyncratic across EU members in comparison to shocks across the regions in the US. However, a core of EU countries, made up of Germany and its immediate neighbors, is found to experience shocks of similar magnitude and cohesion to the US regions, which may indicate that a monetary union in the EU operates better among the core members of the EU. In fact, the 1980s and 1990s saw a proliferation of studies comparing the degree of economic integration between European countries to that between the US or Canadian states. As Basten (2006) points out not all methodologies used were uncontroversial, and yet some consensus emerged in the early 1990s, which implied that a core of European countries comprising of Germany, France, the Benelux area and to a lesser extent Austria probably has business cycle coordination, whereas a larger group including the countries at the periphery of Europe, such as Greece, did not. Next, there were many studies on the endogeneity of the optimum currency areas. The most prominent proponents of this argument are Frankel and Rose (1998), who stated that a monetary union will lead to an intensification of bilateral trade by eliminating exchange rate risk and bringing about greater economic and financial stability, which in turn will lead to a more equal spread of demand

[3] Full economic and monetary union has been in effect since 1 January 2002 for twelve countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain) with additional members joining since then, namely Cyprus, Malta, Slovakia, and Slovenia.

shocks, as well as a greater correlation of policy shocks through more similar policies, resulting in greater synchronization of business cycles. Since, a priori considerations alone cannot tell us how strong the drive towards synchronization is, an empirical answer is needed whether monetary union leads to greater synchronization of business cycles as a consequence of more correlated monetary policy under the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS). One such paper, which examines the effect of European Monetary System on the business cycles of participating economies in the post-ERM period, is Artis and Zhang (1997). They address the question of whether the functioning of the ERM has strengthened the linkages between the participating economies, resulting in a dilution of the effect of the US business cycle on these economies in favor of a stronger effect from the business cycle of Germany. They use monthly industrial production for the US, Japan, Canada, the UK, Finland, Norway, Sweden as control countries and Germany, France, Italy, Netherlands, Belgium, Spain, Portugal and Ireland as ERM members and divide the data sample into two parts, corresponding to the periods before and after the formation of the ERM on March 1979. Contemporaneous correlations show that before the ERM was formed, most countries' business cycles were linked to that of the US and that, afterwards, the group of ERM countries moves clearly into the German business cycle orbit. Furthermore, this shift is specific to the ERM group and occurs neither for Canada nor for the non-ERM European countries.

The latest wave of interest in business cycle synchronization has been generated with the prospect of the participation of the new EU members from CEE in the EMU. These studies date back as early as 1998, long before CEE countries became members of the EU, and address directly the degree of correlation between business cycles in the EU and the accession countries. One of the first results on CEE obtained by Boone and Maurel (1998) basically calculate correlation coefficients between the cyclical components of industrial production and unemployment rates for the accession countries and the EU, or other reference countries, such as Germany, Greece, France and Portugal. Their results point towards a deeper integration of the CEE countries with Germany than with the EU, reflecting the old ties Germany had and still has with Eastern countries. It must be noted that due to the availability of monthly data for all EMU countries, many studies look at industrial production data, rather than at GDP data. The use of industrial production as a proxy for GDP is justified by a historically strong correlation between the two, yet industrial production does not cover all of GDP (Basten, 2006). Synchronization is expected to occur more quickly in industry than in

the economy as a whole, as the former accounts for the majority of international trade, and ultimately our concern in the context of monetary union is GDP as a whole. Furthermore, although business cycles are defined as co-movements of many aggregates, GDP is the most inclusive measure of economic activity and is therefore a useful proxy for the overall business cycle. Thus, among the numerous studies on the correlation between business cycles in the EU and in the CEE countries, we only survey the ones in which GDP is used.

An early example by Błaszkiewicz and Wozniak (2003), using annual as well as quarterly GDP data, argues that the correlation of the real growth rates seems to be smaller for the then-candidate countries than for the EU members. Using annual GDP data, they find that while these coefficients are all well above 0.5 for the EU members (except for Greece), the respective figures for the acceding countries are extremely dispersed and often take on negative values. Real growth rates in the Czech Republic, Slovakia, Latvia, and Lithuania exhibit consistently negative correlations with the Euro-zone growth rates. While those for Estonia are close to zero, high positive correlations were detected for Poland, Hungary, Slovenia, Malta and Cyprus. For these countries, the correlation gets stronger as the starting date of the sample moves forward, indicating that the process of convergence is taking place. For the correlations of real growth rates using quarterly data, Hungary and Slovenia score higher with respect to the other CEE countries, as they do for the annual data. Poland and Slovakia exhibit high correlations for quarterly industrial production, but rather chaotic and negative correlations in the case of GDP. Coefficients for Latvia and Lithuania are very unstable and often negative and finally, in contrast to its annual correlations, quarterly Czech correlations are positive and high.

Another study of interest is Traistaru (2004), which investigates the bilateral correlations of business cycles between the CE-EU-8 countries and the current euro area members over the period 1990-2003, using cyclical components extracted from quarterly real GDP. The results indicate that the asymmetries of the business cycles between the CE-EU-8 and the euro area members are significant. Among these countries, average correlations of business cycles with the euro area are the highest for Poland, Slovenia, and Hungary. For the 1993-2001 period, Fidrmuc (2004) confirms the previous finding that business cycles in Hungary, Slovenia, and to a lesser extent, Poland, are strongly correlated with the business cycle in Germany, while those of Czech Republic and Slovakia are not, indicating that country-specific shocks may still have significant effects on the latter two countries.

Darvas and Szapáry (2005) examine the business cycle synchronization in the new EU members of CEE and the euro zone countries, as well as in a control group comprising of non-EMU EU members (Denmark, Sweden and the United Kingdom), two other European countries (Switzerland and Norway), the United States, and Japan to represent the other two main economic areas, and Russia. In order to reach more robust findings, they use five measures of synchronization, two filtering techniques and two measures of euro area economic activity. Their results on whether the correlation of economic activity in the CEE countries with the euro area has increased over time, indicate that Hungary, Poland and Slovenia show strong improvement in cyclical correlation from the 1993-1997 period to the 1998-2002 period. The values of their correlation coefficients are comparable to that of several current EMU member states. However, their findings show that the Czech Republic and Slovakia are less synchronized than the aforementioned three CEE countries and the Baltic States are not synchronized at all

Eickmeier and Breitung (2006) study the economic linkages between ten new members of EU as of 2004 and the euro area by using dynamic correlation and cohesion measures. After identifying the main structural common euro-area shocks, they investigate their transmission to new members by using a large-scale factor model. Finally, they compare the transmission of these shocks to new EMU members to their propagation to old members and find mixed results. For the quarterly series, ranging from 1993 to 2003, business cycle correlations are lower on average for the new members than for EMU countries, though they are larger than in some smaller peripheral countries, e.g., Greece and Portugal.

Darvas and Vadas (2005), basing the weights on revisions of the output gap for all dates by recursively estimating the model, use various univariate techniques for calculating the cyclical component of GDP and study the dependency of the cyclical correlation with the euro area on the method selected, for quarterly GDP data in 1993-2004. Their results on the level and the change in business cycle correlation coefficients of the new EU Member States with the euro area differ substantially according to the specific filter adopted, which prevents them from drawing firm conclusions.

In this paper, we attempt to establish which dominant economy of the world influences each CEE country's business cycle, using business cycle literature tools. The CEE countries have historically been under the dominance of the former Soviet Union, so its successor, i.e. Russia, is one of these possible dominant economies. Taking into account that the major CEE countries, namely Czech Republic, Hungary, Poland, Romania, and Slovakia, have become

EU members, Germany is selected as a proxy for the EU.[4] Finally, the United States should be considered as another candidate for the dominance on the CEE countries as the world's greatest economy. Thus, we consider the business cycles in Russia, Germany and the US as three anchors and try to find with which the CEE economies' individual business cycles coincide. This resembles the technique used in Artis and Zhang (1997) to answer the question of whether the ERM has created a degree of business cycle conformity among the participating economies by positing that the business cycles in the US and in Germany form two poles of attraction which other countries' cycles will gravitate towards.

2. Data and Empirical Methodology

In order to answer the question of which of the three anchor economies' business cycles the CEE economies' individual business cycles gravitate towards, this paper employs a panel data set. Panel data, by providing a large number of observations, increases the degrees of freedom, reduces collinearity among explanatory variables and increases the probability of producing more reliable parameter estimates (Baltagi, 1995).

The estimated empirical model is a vector autoregression (VAR), which is a non-structural approach to modeling the relationship among several variables and is commonly used for analyzing systems of interrelated time series. The VAR is an alternative to the structural approach to time series modeling, which is often plagued with inadequate economic theory in providing a dynamic relationship between involved parameters as well as with the complications that arise from the possibility that endogenous variables appear on either side of the equation.

The VAR econometric framework makes it possible to ignore the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of the endogenous variables in the system, in this case the GDP per capita of the six countries. Since GDP per capita is a non-stationary series, growth rate of GDP per capita (y) is used in the empirical analysis. Essentially, the model expresses the quarter-on-quarter growth rate of the variable y of country i as a function of the past of that variable and of the other countries--all represented by $y_{(i,t-L)}$ and an error term, $e_{i,t}$. The use of quarter-on-quarter growth rate eliminates the seasonality in the variable. For each of the pooled data set

[4] GDP (PPP) of more than 100 billion dollars as of 2008 according to World Bank.

comprised of an anchor country and the major CEE countries, the estimated equation is as follows:

$$y_{i,t} = A_{i,t-L} y_{i,t-L} + e_{i,t},$$

where, $y_{i,t}$ is the quarter-on-quarter growth rate of GDP per capita of country i at time t, L is the number of lags, which is taken as 1, and i is the number of countries in each pool, i.e., 6.[5] This model is particularly suited to responding to the question raised in this paper, since it allows for the specification of the dynamics for the GDP series, interdependencies among countries and changes over time in these interdependencies.

However, correlations including more advanced techniques of detecting co-movements in the real sphere such as VARs, should be examined with the highest caution in the case of transition economies. As stated in Błaszkiewicz and Wozniak (2003), there is a risk of interpreting real GDP movements in post-socialist economies as business cycles. The transition to a market economy in the first half of the 1990s brought a lot of structural changes to these countries, but the data becomes more reliable by the end of the 1990s. Hence, in this study, we use the data from 1996 onwards. Our data are quarterly GDP at constant prices measured in units of the national currency. Letting $Y_{i,t}$ denote real GDP per capita of country i in quarter t, we take the annual quarter-to-quarter growth rate of GDP for country i as

$$y_{i,t} = \ln(Y_{i,t}) - \ln(Y_{i,t-4})$$

Table 1 provides the data sources and the sample period associated with them for the countries used in our study.

3. Results

3.1 Summary Statistics

We begin our analysis by looking at the characteristics of the data. Table 2 presents the summary statistics for our main variable, GDP per capita growth. Looking at the whole sample, we observe that the growth of GDP per capita is on average higher for Poland, Romania and Slovakia compared to the Czech Republic and Hungary. It is also apparent that among our three dominant economies, only Russia's GDP per capita growth is similar to those of the CEE countries, which is not surprising considering that these economies together

[5] We consider Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC) lag-order selection statistics to choose this lag structure.

with Russia went through a transition process in this period. Given this fact, we also split the sample into two and compare the mean and standard deviations of the growth rates for two periods: 1994-2001 and 2002-2009. Except for Hungary, on average the growth rate of per capita GDP is higher in the post-2001 period for the CEE countries. This is reasonable given that the 1990s were a period of structural change and crisis for them.

Next, we look at the correlation coefficients between the growth rates of GDP per capita for the CEE and the candidate-dominant economies in our sample. Table 3 shows that the CEE countries display significant differences among themselves. Poland is the most different country, exhibiting low positive correlations with Hungary, Czech Republic and Slovakia and a negative correlation with Romania.

In order to answer our main question of whether the CEE countries are more in the sphere of the US, Germany or Russia, we can look at the last three rows of Table 3. The Czech Republic is the country which has the highest correlation with Russia among the three dominant countries. Hungary and Poland are equally correlated with Germany and the US, whereas Romania and Slovakia are mostly correlated with Germany. Finally, we observe that Hungary is the country with the highest correlation with its dominant economy, suggesting that its cycle is synchronized with that of the US and Germany.

An alternative way to visually see which dominant economy each of the CEE countries are most influenced by is to graph the GDP growth rates over time. Figure 1 shows that among the dominant economies, the growth rates of GDP per capita move together for the US and Germany, whereas that of Russia is more volatile and fluctuates over a longer range. After a big collapse in output in the late 1990s, growth resumed in Russia at a higher rate than the US and Germany as well as most of the CEE countries. The visual analysis supports the finding that Hungary's cycle is highly correlated with those of the US and Germany and not with Russia, as it is the only CEE country which is affected neither by the big output collapse in 1998 nor the resumed growth in Russia afterwards.

3.2 Regression Results

Summary statistics by themselves are not enough to understand the linkages between the business cycles of the CEE countries and the 3 dominant economies that we consider to be influential on these economies. Thus, we turn to a simple VAR framework as discussed in Section 2. Previous studies on the business cycle synchronization of the CEE economies did not generally use this type of framework since the range of the data was not long enough, but

having quarterly data from 1995 to 2009 gives us enough observations to be able to use a VAR in order to answer our main question.

First, we run regressions for the five CEE countries to understand whether their business cycles are synchronized within themselves, followed by 3 set of regressions in which Germany, the US and Russia are added to the set comprising of the five CEE countries one by one. In Table 4, each column represents a VAR with the dependent variable as the GDP per capita growth rate of one of the CEE countries and the regressors as the first lags of the GDP per capita growth rate of the 5 CEE countries in the sample.

As expected, each country's growth rate is highly correlated with the first lag of its own growth rate. There is a positive effect from Hungary to Romania and from the Czech Republic to Slovakia, indicating that the economies of the region that have performed better immediately after the fall of the Eastern Bloc have some effect on the neighboring latecomer economies. Surprisingly, Romania has a negative effect on the GDP growth rates of Hungary and Poland. Apart from that, there is not much interaction across the countries, suggesting that CEE countries do not share a business cycle of their own. Thus, we go on to explore what effect the larger economies of the world have on the CEE countries.

As a starting point, Germany is added to the CEE countries in the sample. Germany is the largest economy in Europe and has played the anchor role in the ERM, making it the obvious standard for comparison as mentioned in many studies including Bayoumi and Eichengreen (1992). In Table 5, the results from Table 4 do not change significantly, with the most dominant effect across CEE economies being that from the Czech Republic to Slovakia. Surprisingly, there is no effect from Germany to any of the CEE countries, whereas German GDP per capita growth is affected by that of Hungary and Poland. This can also be seen from the impulse response functions in Figure 2. One reason for this might be the large exposure of German banks in these two countries compared to the other three economies. Figure 3 shows that the investments of German banks in Hungary and Poland have also increased over time, especially in the last few years. This suggests that due to its close proximity and close economic ties, the German economy is exposed to shocks in some of the CEE countries, although it is the larger economy. In fact, the German economy has historically been closely linked to those of its eastern neighbors and despite Germany being the larger economy, this has been a two way relationship. For example, during the Great Depression, there was contagion from Austria to Germany as a result of similarities in their banking system as well as German investments in Austria.

Next, a VAR is run with the CEE countries and the US. The US is an obvious candidate as the world's largest economy and the last global crisis proved that developments in the US economy have worldwide repercussions. Table 6 shows that the interactions across the CEE countries themselves continue to hold. Furthermore, the US business cycle has an effect on that of Hungary and Poland, which is in line with the results on correlation coefficients shown in Table 3. This might be due to the fact that these two economies are linked more to the global economy as larger recipients of capital flows. It should also be noted that none of the CEE countries affect the US business cycle, in contrast to the results for Germany. Since the US is the largest economy of the world, there is a one way linkage where the US is the source of shocks affecting the rest of the world, including the CEE economies (Figure 4). On the other hand, the US economy does not share the close links that Germany has with the CEE countries as its investments are more dispersed.

Finally, a VAR is run with Russia as the last candidate country to affect the business cycles of the CEE countries. The results in Table 7 indicate that Slovakia is the only country to be affected by the growth of GDP per capita of Russia, though inversely. Russia, on the other hand, is affected positively by the business cycle of Hungary. Looking at the impulse response functions in Figure 5, we observe that a shock to the Russian GDP per capita growth has a small effect on that of the CEE countries, but it disappears after a few quarters, thus not very influential.

The four sets of VARs that are run to address the question of which dominant economy affects the business cycles of the CEE countries show that Hungary and Poland are influenced by the US cycle, whereas Slovakia is negatively affected by Russia. Surprisingly, no country is affected directly by the German business cycle. It should be noted that since the CEE countries are transition economies during the sample period, they have gone through a lot of structural changes, including changes in their trade and capital flow patterns. So, next we consider splitting the sample to see if there was a change in the transmission of business cycles across the CEE economies and the set of 3 dominant economies over time.

The upper parts of Table 8-10 present the first period from 1996 to 2001 and the lower part represents the sample from 2002 to 2010 for Russia, the US and Germany respectively. According to Table 8, in the beginning of the sample, Russia influences the Czech Republic positively and Romania and Slovakia negatively. These countercyclical effects are reversed when further lags are included, suggesting that there is a delay in the transmission of shocks

across countries.[6] In the latter period, on the other hand, Russian business cycle is synchronized with none of the CEE economies. This is an indication that the CEE countries have become more connected with the rest of the world as a result of the transition period. Another difference across the two samples is that there is more of a business cycle synchronization among the CEE countries in the latter period, although it is far from perfect. This might be due to the fact that they have been going through similar changes and used policies aimed at entering the EU and the EMU.

Table 9 shows that the US is the most influential economy on the business cycle of the CEE countries in the latter period. In the first half of the sample, only Poland is positively affected by the US, whereas Slovakia is negatively correlated. This result is not surprising since Poland was the first country to open up to the rest of the world and start integrating with the global economy. In the latter period, the Czech Republic, Hungary and Poland are in synchronization with movements in the GDP per capita of the US. This is consistent with results from other studies that show that the US economy is the source of shocks to other countries but is not affected from local crises in the rest of the world. The latest crisis of 2008-2009 proved this once more, as the financial turmoil in the US led to a worldwide economic crisis.

Though no effect from Germany to any of the CEE countries has been found for the whole period, Table 10 shows that German business cycle is effective on Slovakia in the latter period. Contrary to expectations, Germany is more influenced by the CEE economies than vice versa, possibly due to the concentration of investments in these countries, as mentioned before. Poland affects German GDP growth positively in the beginning of the sample, while Hungary besides Poland starts to be effective on Germany in the second half of the sample as German investments in Hungary, especially in the financial sector, increase (Figure 3).

4. Conclusion

We use a simple VAR analysis to examine 5 largest CEE economies (the Czech Republic, Hungary, Poland, Romania and Slovakia) in order to understand whether their business cycles are synchronized with each other and/or with one of the major economies that they are linked with, namely the US, Germany and Russia. This is important given that these CEE countries have become members of the EU after the fall of the Eastern Bloc and are candidates for

[6] These results are not reported here and are available upon request.

EMU membership. Since adopting the euro implies giving up monetary policy, it is essential to see what drives the business cycles of the CEE countries. Through our analysis, we reach a few stylized facts, though we should add the caveat that the sample size is still small for these economies and that our results will be further enhanced as time goes on.

First, we find that there are differences across the CEE countries themselves and that there is no common CEE business cycle. This finding supports our idea that the business cycle of each CEEC is synchronized with a different dominant economy. There are some effects from the larger economies of the region, Hungary and the Czech Republic, to the smaller ones, Romania and Slovakia, respectively, but it is not enough to talk about a common cycle. Looking at the dominant economies, we see that the German and the US cycles are more closely correlated with each other than that of Russia. This is due to the fact that the Russian economy went through a lot of changes in the 1990s and experienced a drastic crisis in 1998.

Second, comparing the individual CEE business cycles with those of the dominant economies, we find that Hungary and Poland are related to the US business cycle, reflecting the fact that they are more integrated with the global economy, whereas the other two candidate dominant economies have no effect on the CEE countries for the whole period. Slovakia is negatively synchronized with Russia due to the fact that it experienced a currency crisis a few quarters later than the Russian crisis of 1998 as a result of inadequate reforms and macroeconomic imbalances at the beginning of the 1990s. These results are in line with Darvas and Szapáry (2005), who find that CEE countries can be split into three groups according to their synchronization with the EU countries: most correlated (Hungary, Poland and Slovenia), not correlated (Baltic states) and somewhat correlated (the Czech Republic and Slovakia). They suggest that with the resuming of growth due to reforms in the countries in the last group, they will become more synchronized with the European cycle as well. This is supported by our finding that Slovakia started to be affected by the German cycle in the latter period.

Finally, splitting the sample into the late 1990s and 2000s due to the transition nature of these economies shows that the influence of Russia on the CEE economies have declined over time as their trade with Russia collapsed and they restructured their trade towards the EU. However, in the second half of the sample, among the CEE countries only Slovakia is synchronized with the business cycle of Germany, whereas the Czech Republic, Hungary and Poland are synchronized with the US business cycle. This suggests that despite their EU membership and close trade links with the rest of Europe, the CEE countries do not share a business cycle with the German business cycle, which we use as a proxy for that of the EU.

The business cycles of the CEE countries are more synchronized with that of the US, especially after 2002, showing that the globalization has decreased the importance of distance. Furthermore, we find that Germany is more influenced by the CEE economies than vice versa. This finding supports the view that countries are mutually interdependent in modern times unlike the old vision of economic hegemony of a handful of leading economies on the rest of the world.

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Table 1: Sample of Countries

Country	Source	Sample Period
Czech Republic	OECD	1994:1-2009:4
Hungary	OECD	1995:1-2009:4
Poland	OECD	1995:1-2009:4
Romania	OECD	1994:1-2009:4
Slovakia	OECD	1993:1-2009:4
Germany	OECD	1994:1-2009:4
Russia	OECD	1994:1-2009:4
USA	FRED	1994:1-2009:4

Table 2: GDP per capita growth

	Whole Sample		Pre 2002 Sample		Post 2002 Sample	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
CZR	0.030	0.032	0.026	0.027	0.033	0.036
HUN	0.029	0.035	0.042	0.016	0.019	0.043
POL	0.045	0.023	0.046	0.026	0.046	0.019
ROM	0.043	0.073	0.038	0.094	0.047	0.050
SLK	0.044	0.041	0.038	0.037	0.050	0.045
RUS	0.041	0.058	0.024	0.061	0.054	0.053
USA	0.015	0.018	0.022	0.013	0.009	0.019
DEU	0.010	0.022	0.017	0.012	0.003	0.027

Source: See text.

Table 3: Correlation coefficients between growth rates of GDP per capita, 1994-2009

	CZR	HUN	POL	ROM	SLK	RUS	USA	DEU
CZR	1.000							
HUN	0.468	1.000						
POL	0.156	0.047	1.000					
ROM	0.401	0.325	-0.099	1.000				
SLK	0.658	0.309	0.117	0.415	1.000			
RUS	0.615	0.577	0.099	0.037	0.271	1.000		
USA	0.398	0.764	0.344	0.195	0.316	0.312	1.000	
DEU	0.554	0.781	0.347	0.231	0.419	0.572	0.744	1.000

Source: See text.

Table 4: VAR Regression for CEE countries

	CZR	HUN	POL	ROM	SLK
	(1)	(2)	(3)	(4)	(5)
CZR	0.845***	-0.0551	0.0665	-0.00928	0.383**
	(0.0972)	(0.0822)	(0.115)	(0.358)	(0.154)
HUN	0.1000	1.020***	0.0105	0.445*	0.0273
	(0.0713)	(0.0603)	(0.0844)	(0.262)	(0.113)
POL	0.0717	-0.0214	0.483***	0.272	0.173
	(0.0929)	(0.0785)	(0.110)	(0.342)	(0.147)
ROM	0.0153	-0.0569**	-0.0734*	0.579***	0.0770
	(0.0323)	(0.0273)	(0.0383)	(0.119)	(0.0512)
SLK	-0.0241	0.0484	0.0682	0.0257	0.518***
	(0.0687)	(0.0581)	(0.0813)	(0.253)	(0.109)
Constant	-0.00279	0.00112	0.0206***	-0.0109	-0.00345
	(0.00510)	(0.00431)	(0.00604)	(0.0188)	(0.00808)
Observations	55	55	55	55	55

Source: Dependent variable is the growth rate of GDP per capita. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses,* significant at 10%; **significant at 5%; *** significant at 1%.

Table 5: VAR Regression for CEE countries and Germany

	CZR	HUN	POL	ROM	SLK	GER
	(1)	(2)	(3)	(4)	(5)	(6)
CZR	0.839***	-0.0481	0.0599	-0.000398	0.364**	0.0348
	(0.0991)	(0.0837)	(0.117)	(0.365)	(0.157)	(0.0854)
HUN	0.0755	1.050***	-0.0177	0.483	-0.0516	0.238**
	(0.110)	(0.0932)	(0.131)	(0.406)	(0.174)	(0.0951)
POL	0.0576	-0.00404	0.467***	0.294	0.128	0.257***
	(0.105)	(0.0884)	(0.124)	(0.385)	(0.165)	(0.0903)
ROM	0.0164	-0.0582**	-0.0722*	0.578***	0.0805	-0.0101
	(0.0325)	(0.0275)	(0.0385)	(0.120)	(0.0514)	(0.0280)
SLK	-0.0271	0.0521	0.0648	0.0304	0.508***	-0.0335
	(0.0695)	(0.0587)	(0.0822)	(0.256)	(0.110)	(0.0599)
GER	0.0519	-0.0637	0.0597	-0.0809	0.167	0.432***
	(0.178)	(0.151)	(0.211)	(0.656)	(0.282)	(0.154)
Constant	-0.00165	-0.000284	0.0219***	-0.0127	0.000230	-0.0129**
	(0.00643)	(0.00544)	(0.00762)	(0.0237)	(0.0102)	(0.00555)
Observations	55	55	55	55	55	55

Source: Dependent variable is the growth rate of GDP per capita. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses,* significant at 10%; **significant at 5%; *** significant at 1%.

Table 6: VAR Regression for CEE countries and USA

	CZR	HUN	POL	ROM	SLK	USA
	(1)	(2)	(3)	(4)	(5)	(6)
CZR	0.845***	-0.0439	0.0845	-0.0391	0.374**	-0.0460
	(0.0974)	(0.0788)	(0.108)	(0.352)	(0.153)	(0.0548)
HUN	0.102	0.867***	-0.237*	0.856**	0.149	-0.00238
	(0.110)	(0.0889)	(0.122)	(0.398)	(0.173)	(0.0618)
POL	0.0726	-0.109	0.341***	0.508	0.243	0.0557
	(0.105)	(0.0846)	(0.117)	(0.379)	(0.164)	(0.0588)
ROM	0.0153	-0.0532**	-0.0674*	0.569***	0.0740	0.0169
	(0.0324)	(0.0262)	(0.0361)	(0.117)	(0.0509)	(0.0182)
SLK	-0.0239	0.0325	0.0424	0.0686	0.531***	-0.0126
	(0.0693)	(0.0560)	(0.0772)	(0.251)	(0.109)	(0.0390)
USA	-0.00363	0.365**	0.592***	-0.982	-0.291	0.895***
	(0.200)	(0.162)	(0.223)	(0.724)	(0.314)	(0.112)
Constant	-0.00283	0.00447	0.0260***	-0.0199	-0.00612	3.71e-05
	(0.00542)	(0.00438)	(0.00604)	(0.0196)	(0.00852)	(0.00305)
Observations	55	55	55	55	55	55

Source: Dependent variable is the growth rate of GDP per capita. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses,* significant at 10%; **significant at 5%; *** significant at 1%.

Table 7: VAR Regression for CEE countries and Russia

	CZR	HUN	POL	ROM	SLK	RUS
	(1)	(2)	(3)	(4)	(5)	(6)
CZR	0.803***	0.0582	0.0706	0.146	0.595***	0.156
	(0.112)	(0.0921)	(0.141)	(0.441)	(0.181)	(0.209)
HUN	0.128	1.143***	0.0357	0.585*	0.218	0.273*
	(0.0829)	(0.0682)	(0.105)	(0.326)	(0.134)	(0.155)
POL	0.112	0.00918	0.499***	0.293	0.202	-0.220
	(0.0883)	(0.0726)	(0.112)	(0.347)	(0.143)	(0.165)
ROM	0.0295	-0.0724***	-0.0716*	0.555***	0.0432	-0.00954
	(0.0327)	(0.0269)	(0.0413)	(0.129)	(0.0528)	(0.0611)
SLK	0.000555	0.0450	0.0747	0.0116	0.499***	0.0490
	(0.0656)	(0.0540)	(0.0829)	(0.258)	(0.106)	(0.123)
RUS	0.0577	-0.0705	0.00632	-0.110	-0.150*	0.777***
	(0.0523)	(0.0430)	(0.0661)	(0.206)	(0.0846)	(0.0978)
Constant	-0.00913*	-0.00448	0.0180***	-0.0152	-0.00929	0.00291
	(0.00532)	(0.00437)	(0.00672)	(0.0209)	(0.00859)	(0.00994)
Observations	55	55	55	55	55	55

Source: Dependent variable is the growth rate of GDP per capita. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses,* significant at 10%; **significant at 5%; *** significant at 1%.

Table 8: VAR Regression for CEE countries and Russia: Split Sample

	CZR	HUN	POL	ROM	SLK	RUS
	(1)	(2)	(3)	(4)	(5)	(6)
CZR	0.352**	-0.158*	-0.0381	0.447	0.750***	-0.0556
	(0.151)	(0.0827)	(0.245)	(0.899)	(0.285)	(0.342)
HUN	-1.171***	0.454***	-0.0217	0.574	0.713	-0.444
	(0.307)	(0.168)	(0.498)	(1.825)	(0.578)	(0.694)
POL	0.0236	-0.0581	0.338	-0.978	0.219	-0.860**
	(0.150)	(0.0821)	(0.244)	(0.893)	(0.283)	(0.340)
ROM	0.0873**	-0.0294	-0.101	0.232	-0.00383	-0.0373
	(0.0404)	(0.0221)	(0.0656)	(0.240)	(0.0762)	(0.0914)
SLK	-0.207	-0.0472	-0.0926	-1.456*	0.376	-0.377
	(0.138)	(0.0752)	(0.223)	(0.817)	(0.259)	(0.311)
RUS	0.190**	0.0286	-0.0918	-1.107**	-0.334*	0.687***
	(0.0925)	(0.0505)	(0.150)	(0.549)	(0.174)	(0.209)
Const.	0.0601***	0.0320***	0.0383	0.110	-0.0285	0.0843*
	(0.0210)	(0.0115)	(0.0341)	(0.125)	(0.0396)	(0.0476)
Obs.	23	23	23	23	23	23
CZR	0.828***	0.000800	0.485**	-0.190	0.684**	0.186
	(0.168)	(0.199)	(0.223)	(0.264)	(0.328)	(0.285)
HUN	0.357**	1.426***	-0.312	0.977***	0.281	1.227***
	(0.166)	(0.196)	(0.221)	(0.261)	(0.323)	(0.281)
POL	0.160	0.143	0.309*	0.625***	0.119	0.522**
	(0.126)	(0.150)	(0.168)	(0.199)	(0.247)	(0.215)
ROM	-0.249*	-0.293*	-0.232	0.207	-0.259	-0.280
	(0.129)	(0.153)	(0.172)	(0.203)	(0.252)	(0.219)
SLK	-0.0533	0.148	-0.105	0.251	0.542**	0.463**
	(0.129)	(0.153)	(0.172)	(0.203)	(0.252)	(0.219)
RUS	0.165	-0.143	0.310	-0.0784	-0.0292	-0.0906
	(0.218)	(0.258)	(0.290)	(0.343)	(0.425)	(0.370)
Const.	-0.00572	-0.00550	0.0218***	-0.0164**	-0.000397	-0.0139
	(0.00502)	(0.00594)	(0.00668)	(0.00790)	(0.00979)	(0.00852)
Obs.	32	32	32	32	32	32

Source: Dependent variable is the growth rate of GDP per capita. The upper part of the table represents the sample from 1996 to 2001 and the lower part is from 2002 to 2010. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses, * significant at 10%; **significant at 5%; *** significant at 1%.

Table 9: VAR Regression for CEE countries and USA: Split Sample

	CZR	HUN	POL	ROM	SLK	USA
	(1)	(2)	(3)	(4)	(5)	(6)
CZR	0.501***	-0.125*	-0.0818	-0.568	0.423*	-0.0817
	(0.137)	(0.0677)	(0.194)	(0.814)	(0.240)	(0.0503)
HUN	-0.901***	0.444***	-0.282	-0.310	0.539	-0.297***
	(0.311)	(0.153)	(0.439)	(1.844)	(0.544)	(0.114)
POL	-0.0489	-0.124	0.231	0.202	0.677**	0.114**
	(0.153)	(0.0756)	(0.217)	(0.910)	(0.268)	(0.0562)
ROM	0.0267	-0.0376**	-0.0695*	0.574***	0.0977*	0.0322***
	(0.0298)	(0.0147)	(0.0421)	(0.177)	(0.0522)	(0.0109)
SLK	-0.347***	-0.0854	-0.0683	-0.403	0.725***	-0.0607
	(0.121)	(0.0596)	(0.171)	(0.718)	(0.212)	(0.0443)
USA	-0.293	0.204	0.777**	-1.684	-0.963**	0.887***
	(0.257)	(0.127)	(0.362)	(1.523)	(0.449)	(0.0941)
Constant	0.0670***	0.0320***	0.0323	0.0831	-0.0347	0.0116
	(0.0221)	(0.0109)	(0.0312)	(0.131)	(0.0387)	(0.00810)
Observations	23	23	23	23	23	23
CZR	0.662***	-0.198	0.349	-0.355	0.502	-0.0775
	(0.196)	(0.219)	(0.218)	(0.272)	(0.339)	(0.145)
HUN	0.183	1.094***	-0.417**	0.713***	0.0120	0.242**
	(0.165)	(0.184)	(0.183)	(0.229)	(0.285)	(0.121)
POL	0.0266	-0.0483	0.213	0.470**	-0.0459	0.0864
	(0.144)	(0.161)	(0.160)	(0.200)	(0.249)	(0.106)
ROM	-0.196	-0.335**	-0.137	0.184	-0.267	-0.180*
	(0.126)	(0.141)	(0.140)	(0.175)	(0.218)	(0.0928)
SLK	0.0637	0.149	0.0605	0.267*	0.584***	0.0212
	(0.115)	(0.129)	(0.128)	(0.160)	(0.199)	(0.0850)
USA	0.559*	0.573*	0.719**	0.519	0.571	0.819***
	(0.286)	(0.318)	(0.317)	(0.396)	(0.493)	(0.210)
Constant	0.00648	0.00833	0.0304***	-0.00511	0.0123	0.00315
	(0.00585)	(0.00652)	(0.00649)	(0.00812)	(0.0101)	(0.00431)
Observations	32	32	32	32	32	32

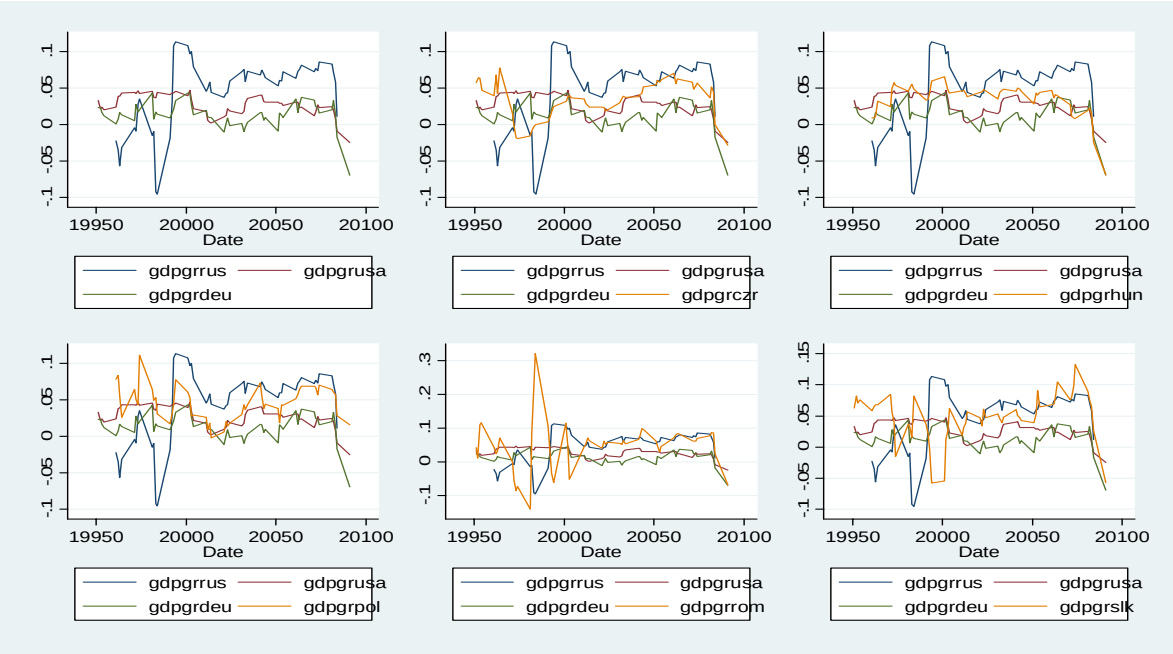
Source: Dependent variable is the growth rate of GDP per capita. The upper part of the table represents the sample from 1996 to 2001 and the lower part is from 2002 to 2010. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses,* significant at 10%; **significant at 5%; *** significant at 1%.

Table 10: VAR Regression for CEE countries and Germany: Split Sample

	CZR	HUN	POL	ROM	SLK	GER
	(1)	(2)	(3)	(4)	(5)	(6)
CZR	0.446***	-0.146**	-0.0226	-0.479	0.427	0.0287
	(0.140)	(0.0743)	(0.213)	(0.875)	(0.274)	(0.0693)
HUN	-1.268***	0.431**	0.301	-0.585	0.167	0.236
	(0.358)	(0.189)	(0.543)	(2.230)	(0.699)	(0.176)
POL	-0.162	-0.0875	0.471**	-0.163	0.435	0.193***
	(0.142)	(0.0753)	(0.216)	(0.888)	(0.278)	(0.0702)
ROM	0.0430	-0.0356**	-0.0933**	0.576***	0.110*	-0.0104
	(0.0307)	(0.0162)	(0.0466)	(0.191)	(0.0600)	(0.0151)
SLK	-0.348***	-0.0678	-0.0424	-0.523	0.670***	-0.168***
	(0.118)	(0.0622)	(0.178)	(0.733)	(0.230)	(0.0580)
GER	0.551	0.0987	-0.760	-0.122	0.313	-0.155
	(0.351)	(0.186)	(0.532)	(2.187)	(0.685)	(0.173)
Constant	0.0715***	0.0339***	0.0277	0.0749	-0.0354	0.00693
	(0.0219)	(0.0116)	(0.0331)	(0.136)	(0.0427)	(0.0108)
Observations	23	23	23	23	23	23
CZR	0.694***	-0.107	0.421*	-0.300	0.430	0.0930
	(0.200)	(0.228)	(0.228)	(0.276)	(0.320)	(0.229)
HUN	0.347**	1.274***	-0.200	0.870***	0.158	0.377**
	(0.141)	(0.161)	(0.161)	(0.195)	(0.226)	(0.162)
POL	0.0950	0.0454	0.314**	0.544***	-0.0180	0.291*
	(0.140)	(0.159)	(0.160)	(0.193)	(0.224)	(0.160)
ROM	-0.247*	-0.347**	-0.180	0.155	-0.389*	-0.372**
	(0.134)	(0.152)	(0.153)	(0.185)	(0.214)	(0.153)
SLK	-0.0691	0.0921	-0.0681	0.179	0.307	0.00673
	(0.136)	(0.155)	(0.156)	(0.188)	(0.218)	(0.156)
GER	0.375	0.0936	0.328	0.221	0.901**	0.699**
	(0.253)	(0.288)	(0.289)	(0.349)	(0.405)	(0.290)
Constant	0.0116	0.00515	0.0325***	-0.00406	0.0325**	-0.00538
	(0.00897)	(0.0102)	(0.0103)	(0.0124)	(0.0144)	(0.0103)
Observations	32	32	32	32	32	32

Source: Dependent variable is the growth rate of GDP per capita. The upper part of the table represents the sample from 1996 to 2001 and the lower part is from 2002 to 2010. The columns represent the regression for each of the countries in the sample. Standard errors in parentheses,* significant at 10%; **significant at 5%; *** significant at 1%.

Figure 1: Growth rates of GDP per capita over time



Source: See text.

Figure 2: Orthogonalized Impulse Response Functions: Germany

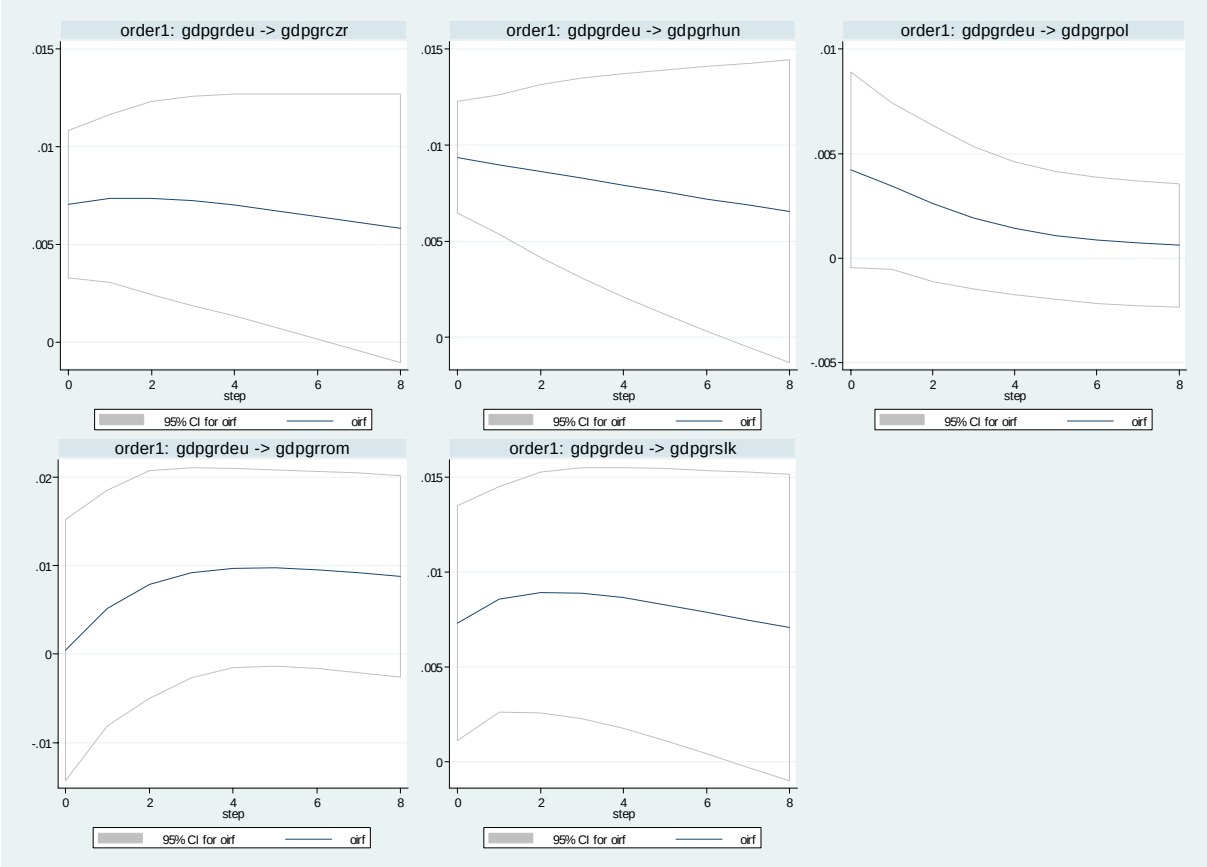
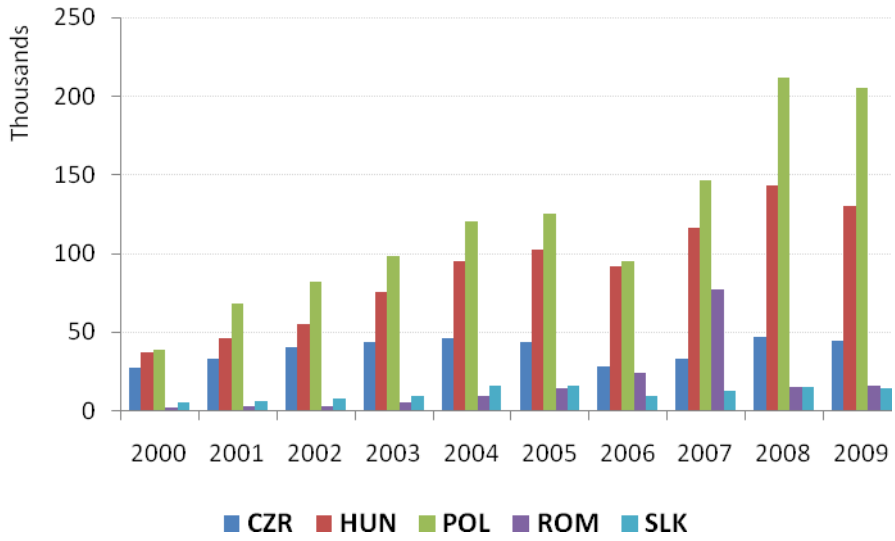


Figure 3: Investment of German Banks (in US dollars)



Source: Bank of International Settlements

Figure 4: Orthogonalized Impulse Response Functions: USA

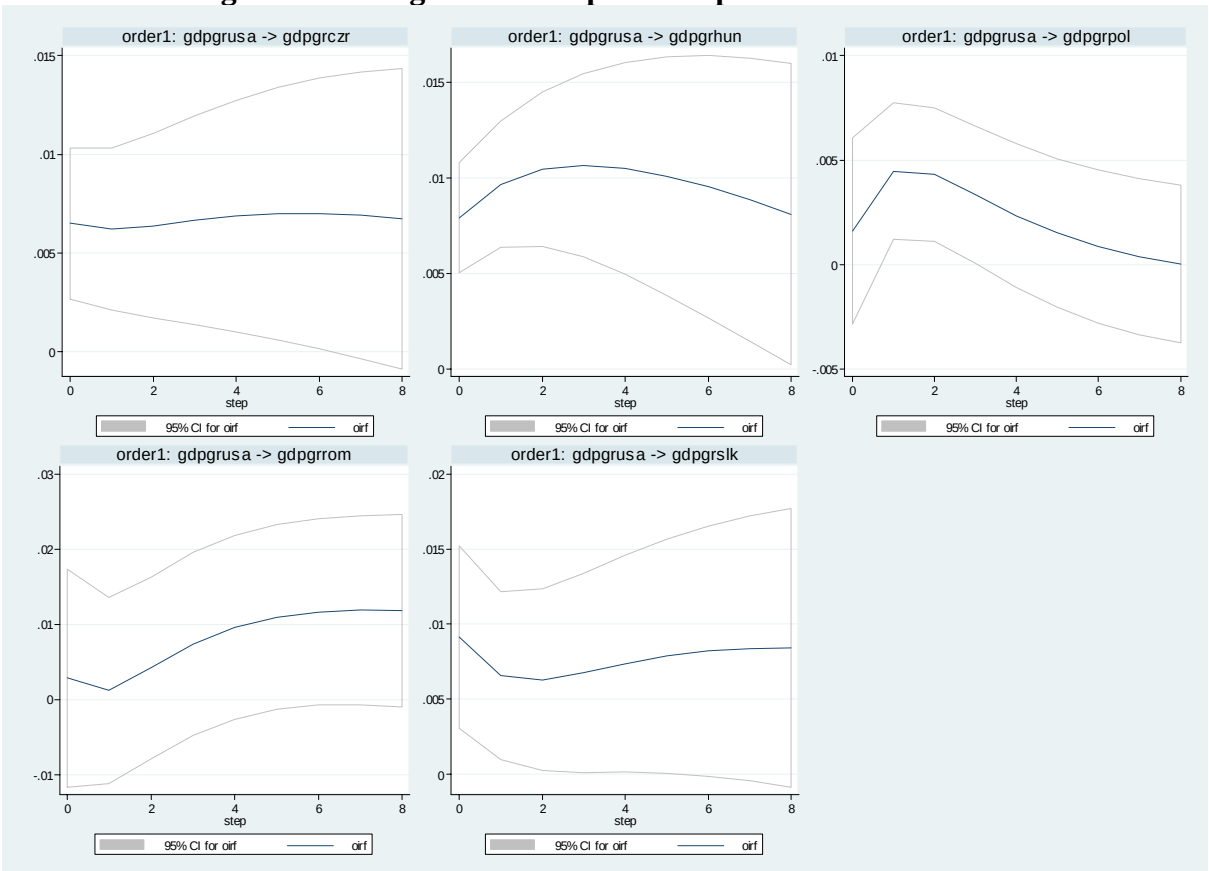
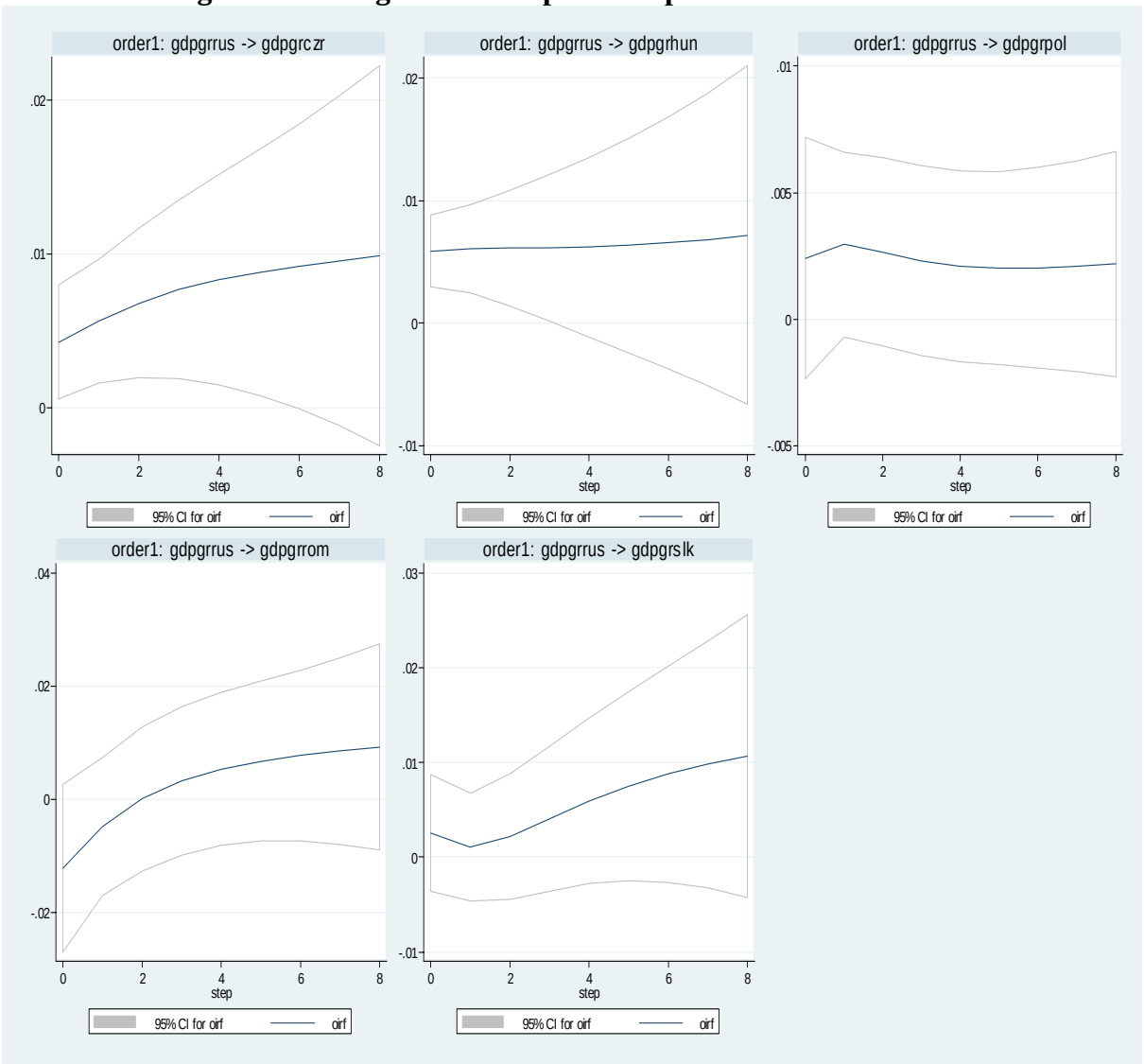


Figure 5: Orthogonalized Impulse Response Functions: Russia



Appendix:

Figure A1: Impulse Response Functions: Germany

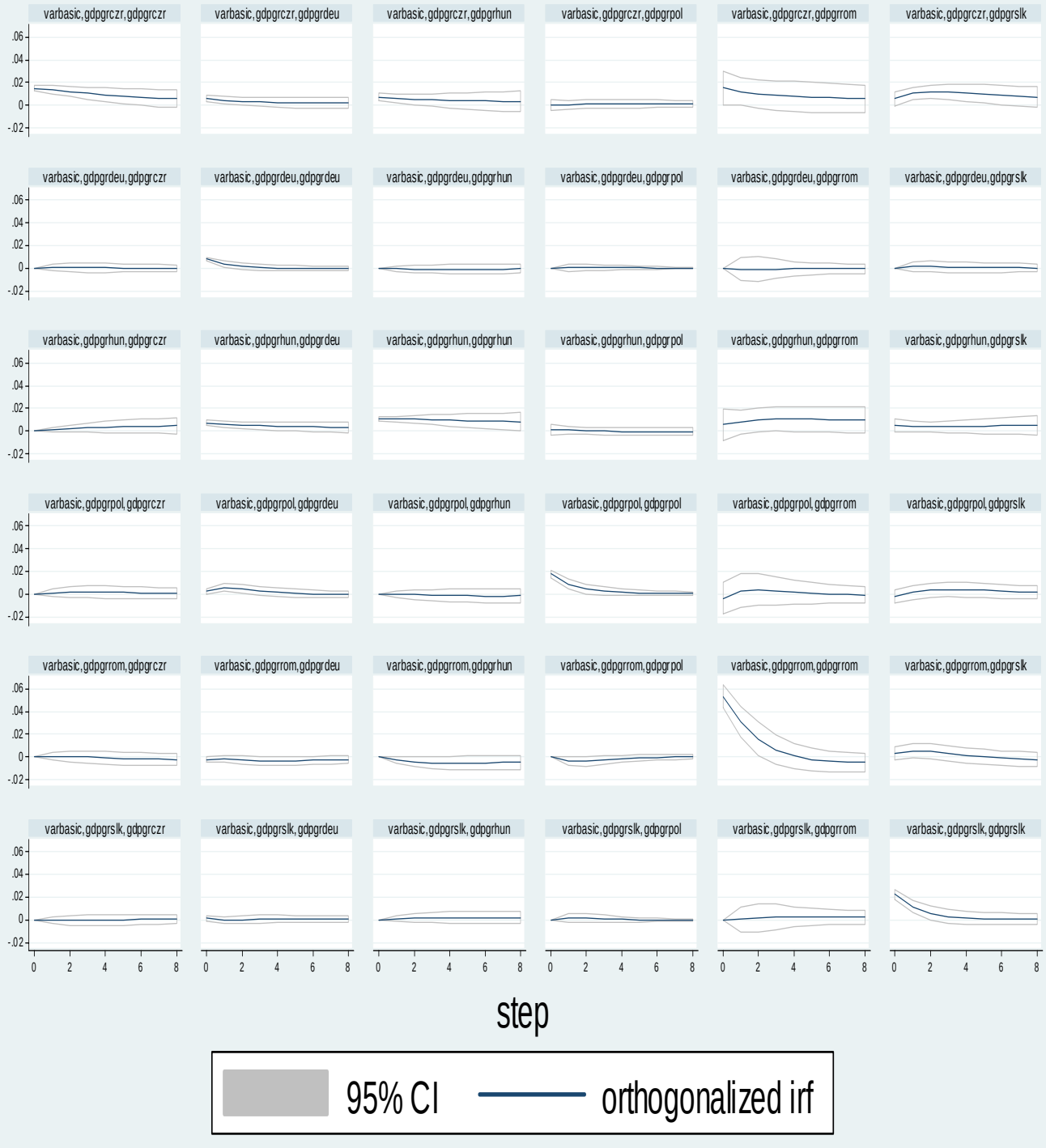


Figure A2: Impulse Response Functions:
USA

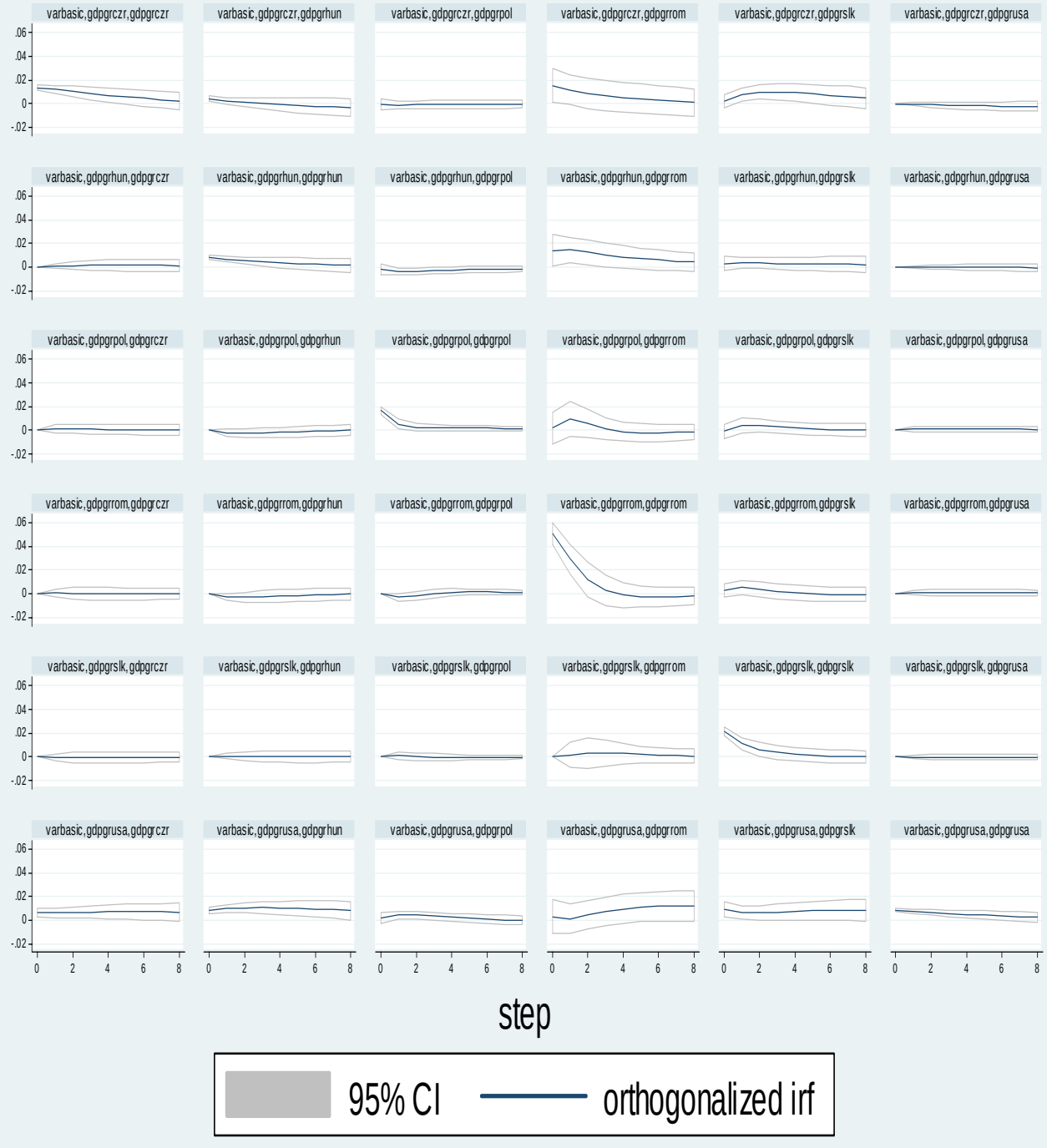


Figure A3: Impulse Response Functions: Russia