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Economic Fluctuations in Central and Eastern Europe. The Facts

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Economic Fluctuations in Central and Eastern Europe. The Facts*

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Abstract

This paper provides a detailed empirical analysis of quarterly frequency dynamics in macroeconomic aggregates in twelve countries of Central and Eastern Europe. It shows that business fluctuations in CEE countries are in general more pronounced than in developed ones, and are of similar size as in other emerging market economies. Private consumption is particularly volatile. Relative to major developed economies government spending is dominantly procyclical, and net exports are strongly countercyclical. The most frequent country outliers are the high inflation countries of Bulgaria, Romania and Russia, especially in labor market, price and exchange rate variables. Excluding these countries from the sample makes many of the observed patterns in cyclical dynamics more homogenous, and broadly similar to ones established in developed economies.

Key words: Business Cycles, Central and Eastern Europe
JEL Classification: E32

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1 INTRODUCTION

The pure notion of the business cycle is a novelty for many observers, policymakers and citizens in the post-socialist countries of Central and Eastern Europe (CEE). Though economic fluctuations have been severely mixed with the transition bust and boom, by now it seems evident that these economies are also subject to ups and downs, regardless of the initial transition shock and the following catch-up process. While direct evidence on business fluctuations is becoming available from an increasing number of individual countries, although often using somewhat different measurements, statistics and time periods, no study has aimed at documenting business cycle facts in a major segment of emerging market countries, the economies of Central and Eastern Europe. In the current project, this is the task we pursue.

We seek to answer a number of specific questions. Is there a common pattern in CEE business cycle fluctuations? Can one treat certain variables as systematically leading or lagging the business cycle? Can one identify certain country characteristics, such as monetary policy regime, size, openness in goods and financial markets that are associated with these differences? Are there important similarities and differences in the behavior of macroeconomic aggregates *vis-à-vis* developed, or other emerging countries? The findings are also meant to provide input for economic policies in these countries. For instance, in the process of joining the EU and the EMU, can policy-makers treat CEE countries as a relatively homogeneous group, or do they need to be considered on an individual basis? Understanding the cyclical frequency dynamics of key macroeconomic aggregates can also assist policymakers to identify the most important short-term policy targets, instruments and mechanisms.

To address this set of issues, we analyze the cyclical behavior of quarterly frequency time series of twenty-two major macroeconomic variables in twelve emerging market economies in the CEE region. Despite their similarity in geographical position and basic economic structure, these economies show a significant amount of variation in the strength of trading ties to the EU, policy arrangements, and country size. By studying a large group of emerging market countries with similar, still somewhat diverse institutions, we are seeking to establish regularities that are more general than pure country-specific effects, and point to insights of potential interest for business cycle theory.[2]

While our exploration of facts is not driven by any specific model economy, the evidence we report on is motivated by and informs modern quantitative models of the business cycle. In particular, without taking a prior stand on the particular source of shocks (e.g.

[2] We discuss only briefly how cyclical regularities in CEE countries relate to those observed in other developed and emerging market economies. Providing a more comprehensive account of the international evidence is the subject of our ongoing research.

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technology, monetary policy, fiscal policy, consumer/producer sentiment, or price setting) or propagation mechanism (intra- or inter-temporal substitution, nominal or real rigidities, or some other frictions) transmitting shocks into the relevant macro variables (such as components of GDP, and various labor market, monetary and financial variables), we consider a large class of Dynamic Stochastic General Equilibrium (DSGE) models building on and extending early Real Business Cycle (RBC) theories as the starting point of our analysis.[3] Instead of testing one particular model, we document a menu of empirical regularities in a group of emerging market economies, against which one can better formulate and evaluate alternative DSGE theories of the business cycle.

Our empirical approach places no constraint on the joint determination of the variables of interest. Nonetheless, the choice and transformation of data, the selection of statistics and the interpretation of results are all guided by economic theory. As normal in modern business cycle analysis since the seminal work of Lucas (1977), we focus on deviation, as opposed to level or difference cycles. The unconditional statistics we report on include the variability and persistence in and the co-movement among the cyclical component of output and other aggregate variables.[4]

2 DATA

Completing the empirical program requires one to overcome a major hurdle, assembling the sample of quarterly frequency macroeconomic variables in CEE economies. Dictated mainly by the availability of suitable data, the countries we examine are Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia and Slovenia. The sample period spans over a period of more than a decade, starting in 1993:1, or one or two years later in certain countries, and ending in 2004:4. We focus on standard variables in real and monetary DSGE models, including constant price measures of output (GDP, industrial production), components of aggregate demand (private consumption, investment, government consumption, exports, imports), labor market variables (real wage, employment, productivity), and monetary and financial variables (credit and monetary aggregates, prices and inflation, capital flows, interest and exchange rates).[5]

[3] Serving as an impetus for much of the subsequent research in the RBC tradition, the classic studies examining the cyclical component of macroeconomic time series are Kydland and Prescott (1990) in the closed economy context, and Backus *et al* (1995) in an open economy one.

[4] Importantly, we do *not* study the degree of comovement of particular variables across different countries. For a study of cross-country patterns in comovement in CEE economies, see Darvas and Szapáry (2008).

[5] Private sector credit is added for comparison to Agénor *et al* (2000). Fiorito and Kollintzas (1994) also analyze the properties of real interest rates, defined as the difference between nominal rates and realized future inflation. Such a procedure of calculating the real interest rate would be problematic in our sample, due to high and volatile inflation

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Our sample ideally consists of 48 quarterly observations from 1993:01 to 2004:04. Excluding pre-1993 data from the sample is driven by a number of considerations. First, some of the countries we study simply did not exist before 1993, or did not systematically collect data at the quarterly frequency. Second, major data revisions having taken place in the early 1990s render the quality of these early data highly questionable. Third, as documented in Artis *et al* (2004), the big, pre-1993 'transition shock' manifesting itself as a structural break in output series would make the interpretation of the cycle as deviation from a smooth trend questionable. To ensure cross-country comparability in time periods, underlying shocks and data quality, we thus restrict our attention to post-1993 quarterly data.

While all variables are available in just about every country over the whole sample period, some of the countries have an imperfect record. In Hungary, Lithuania, Poland, Russia and Slovenia reliable figures for GDP and its components are available only from 1995:1, in Bulgaria, Croatia, the Czech Republic and Romania from 1994:1 onwards. Data on net capital flows in Poland is available only from 2000:1. Total employment in Latvia and industrial employment in Lithuania are missing, making the corresponding productivity variables unavailable too.

Our primary data sources are numerous, including local central banks, statistical offices and research institutes, the International Financial Statistics of the IMF, the OECD, ILO and the WIIW databases. When multiple sources exist, we always select the most credible variant. In the end, we employ a uniquely comprehensive dataset over a decade long period of economic transformation, the largest meaningful panel of such observations in terms of time frame and country coverage. We believe that the quality of the sample is as good as one can hope for in this context, even in comparison to developed economy samples.[6]

Prior to the empirical analysis, the raw data are transformed in several steps. First, all variables are de-seasonalized using the X11 procedure, with multiplicative adjustment; the exceptions being inflation and the interest rate, where the adjustment is additive. For computing ratios, and other generated variables, we use the seasonally adjusted series; i.e. the ratios are not adjusted any further. As no de-trending procedure is free of criticism, we employ three alternative filtering procedures popular in the literature, such as the Hodrick-Prescott (H-P) filter (with parameter 1600), log first differencing (potentially problematic with trending variables), and fitting a quadratic time polynomial. These choices coincide with the ones used in Christodoulakis *et al* (1993) and Fiorito and Kollintzas (1994).

rates. Other potentially relevant variables in DSGE models, for instance such as hours worked, terms of trade, FDI, or more detailed productivity figures are in general unavailable at the quarterly frequency.

[6] Our project website http://www.personal.ceu.hu/departs/personal/Attila_Ratfai/data/benczur-ratfai_webpage.htm gives a full description of data definition, construction and sources.

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In most cases filtering is applied to the natural logarithm of the variables. Exceptions include inflation and the nominal interest rate, which are already in log-difference form so these series are directly filtered. Other exceptions are net exports and net capital flows, which can take on both negative and positive values. Similarly to Kydland and Zarazaga (1997) and Agénor *et al* (2000), we employ the ratio of net exports to GDP in percentage terms.[7] Also, we compute the net capital flows to GDP ratio using dollar denominated data for both variables. In all other cases, taking logs and then de-trending delivers country-specific normalization. Finally, labor productivity is calculated both in economy-wide and industry-level data.

3 RESULTS

It is first useful to have a bird-eye view of the output data. As randomly selected examples, Figures 1 and 2 show the evolution of GDP and industrial output in Estonia and Poland. The graphs confirm that GDP, and especially industrial output show notable ups and downs around a strong upward trend. One can clearly see an initial transition bust, followed by a robust expansion, in some instances broken by the apparent effect of the Russian crisis. In some quarters, growth has picked up, with an unclear cyclical behavior through the global slowdown starting around 2000. Overall, the emerging picture points to some noticeable though not systematic cyclical patterns.

We now turn to basic summary statistics of output fluctuations in CEE countries, and compare them to ones documented in other country groups. Table I reports measures of volatility and persistence in H-P-filtered measures of output. Overall, output is somewhat more volatile in CEE countries than in developed economies, and is about as volatile as in other emerging ones.[8] Average GDP volatility in CEE countries is a bit lower than in the small number of emerging market countries with data available, and higher than in EU countries. Hungary appears to be a clear outlier here, and Slovakia also features relatively low GDP volatility. It is interesting to observe that the most volatile countries, Bulgaria, Romania and Russia are also countries with the highest annual inflation rates, with above 40 percent inflation on average over the sample period. The persistence in H-P filtered output is broadly similar in all countries listed in the table; the first two autocorrelations are typically significant, and the

[7] Kaminsky *et al* (2004) argue that the correlation between the levels of these variables, *not* normalized by output provides a superior measure of the cyclical stance. Using the cyclical component of the raw net export and capital flow data however makes the interpretation of the relevant volatility figures difficult as the scale is invariant within, but not across countries.

[8] As most other results in the literature are obtained using less recent, but longer, 15-30 years of quarterly time series, some of this pattern might be due to differences in sample period and size. For recent evidence in developed economies, see Agresti and Mojon (2001). The most detailed account of emerging market fluctuations are in Agenor *et al* (2000), Aguiar and Gopinath (2007) amd Neumeyer and Perri (2005).

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third one is sometimes so. Persistence is particularly high in G7 and some CEE economies, and low in Spain and Slovenia.

As industrial production is a popular proxy for output in the related literature, we also examine this variable in some more detail. The first panel of Table II displays the relevant volatility, cyclicality and persistence figures. Comparing these figures to the corresponding ones in Table I indicates that industrial output is highly volatile, about as volatile as in other emerging countries. Volatilities are reasonably similar across CEE countries. Industrial output is in general strongly procyclical and often synchronous.[9] With the generally low correlation coefficients and persistence measures, Slovakia and Slovenia are major outliers. Interestingly, while the H-P filtered series show high persistence, first differenced industrial production series (not reported) tend to be close to white noise.

Tables II through IV summarize the results for the three major groups of variables we examine, constant price output components (consumption, investment, government consumption, net exports, imports, exports), labor market variables (employment, real wages, productivity), and monetary and nominal variables (private sector credit, M1, M2, CPI, inflation, net capital flows, nominal interest rates, nominal and real effective exchange rates). For the cyclical component in all variables, the following four statistics are reported: *volatility* (standard deviation) in absolute terms and relative to output, *cyclicality* (the size and the lead/lag position of the highest correlation in absolute value between the variable itself, and lagged and leaded output) and *persistence* (first-order autocorrelation coefficient). We use constant price GDP as our measure of output.[10]

We derive results for three alternative filtering procedures: Hodrick-Prescott (H-P), time polynomial and first difference. In the sense that first differenced series tend to show little persistence and cyclicality, difference cycles in CEE economies are largely non-existent. To save space, we thus do not report these figures. At the same time, the H-P and the time polynomial filters tend to produce virtually identical cyclical outcomes. Consequently, we focus on results in H-P filtered data below.[11]

Expenditure variables

Private consumption. The absolute and relative volatility of private consumption is exceptionally high; indeed, it is higher in all CEE countries than in the US. Some of the CEE countries have even higher consumption volatility than other emerging countries, such as

[9] The 95% significance level benchmark we use throughout is approximated by $2/\sqrt{T} \approx 0.3$.
[10] The detailed results with industrial production serving as a proxy for output are available upon request.
[11] The full set of results is available in the non-for-publication appendix.

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Argentina, Mexico and Turkey.[12] The comparison with the EU and the G7 country group studied in Christodoulakis *et al* (1993) and Fiorito and Kollintzas (1994) also shows instructive patterns. For instance, the UK has the largest relative volatility of 1.15 in the G7 group, a figure being on the same order of magnitude as some of the smallest relative volatilities in the current sample with 1.05 in Lithuania and Poland, and 1.03 in Russia. The relative volatility figure of 0.71 in Slovenia is a clear outlier. While high consumption volatility contradicts the predictions of business cycle models with household preferences for consumption smoothing, potential explanations for this puzzle are manifold. First, one of the explanations could be the dominance of durable consumption, a particularly important and volatile component of private consumption, especially in CEE economies characterized by rapid income growth and fast drifting consumer behavior. A complementary argument is the presence of liquidity constraints in economies with underdeveloped financial systems. It might also be the case that consumers face particularly uncertain income prospects, resulting in strong precautionary motives to save and excess sensitivity in consumption. Finally, as argued in Aguiar and Gopinath (2007), high volatility in consumption may also stem from the dominance of permanent shocks to trend growth, a particularly pervasive feature of many emerging economies.

With the exceptions of Latvia being countercyclical and Lithuania acyclical, private consumption is also highly procyclical. The contemporaneous correlation between consumption and GDP is always positive, typically significantly so. The magnitude of the correlation coefficients appears to be similar to ones found in developed economies. Persistence in consumption is in general significant, though lower than in the US. The main outlier is Latvia, with a tiny autocorrelation coefficient.

Investment. Investment is strongly procyclical and is often coincidental. Latvia is an exception again. Investment is also the most volatile component of aggregate spending in all CEE countries. Though we measure investment as gross fixed capital formation, thereby excluding its most volatile component inventories, its absolute volatility is very high in international comparison, especially relative to developed countries. At the same time, the relative volatility figures are strikingly similar to ones found in many other samples.[13] Nonetheless, excessive volatilities might stem from measurement problems such as classification of certain capital items, or simply the privatization of a large portion of previously government owned physical assets. Countries show mixed patterns in persistence. Interestingly, in some countries such as Latvia, Romania, and to a smaller degree, Hungary and Slovenia, low persistence is coupled with low synchronization.

[12] See Alper (2002) for Mexico and Turkey and Kydland and Zarazaga (1997) for Argentina.
[13] See Basu and Taylor (1999).

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Government consumption. Governments still play a central role in many CEE economies. At the same time, prudential fiscal policy is one of the key criteria of EU and EMU accession. For these reasons, in these countries budget items are often moved across years or budget categories, creating extra volatility in spending, and transforming fiscal dynamics in artificial ways. Having said that, government consumption in CEE countries appears to be more volatile than in developed and about as volatile as in emerging market countries. In addition, government spending tends to be more volatile than private consumption, and less volatile than investment in the sample. While Croatia, the Czech Republic and Hungary are acyclical, and Estonia is countercyclical, government consumption in general is procyclical, somewhat more so than in developed economies. The fact that governments tend to boost spending in cyclical upturns and do the reverse in downturns suggests that fiscal policy magnifies rather than mitigates fluctuations in CEE economies.[14] The persistence in government consumption is moderate.

Net exports. With the exceptions of Hungary and Romania showing acyclical trade balance, all signs of the cyclicality statistics are negative, though sometimes only marginally so, as predicted by standard open economy models with technology shocks, and in line with the experience in other emerging and developed economies.[15] Russia, major exporter of raw materials shows a number of sizeable and positive lead coefficients as well. While they tend to be the least volatile component of GDP in absolute terms, net export volatilities in CEE economies are substantially higher than in developed ones. Finally, countries with the highest persistence in net exports, Russia and Slovakia show particularly high volatility as well.

Imports. The volatility of imports relative to GDP tends to be larger than the one for developed economies. In relative terms, imports are the most volatile in Slovakia, perhaps due to heavy re-exporting activities. Croatia, Lithuania and Russia show particularly high, while the Czech Republic and Slovenia particularly low absolute volatilities. Just like in G7 countries, imports are always markedly procyclical and close to being coincidental in all countries.

Exports. Again, relative export volatilities in CEE countries tend to exceed those in developed countries. Exports are least volatile in Russia and Slovenia, both in absolute and relative terms. Exports are much less procyclical than imports; indeed, they are sometimes acyclical, or even mildly countercyclical as in Bulgaria. Exports are especially procyclical and persistent in countries with the most open goods and capital markets, such as the Baltic countries and Hungary. Nonetheless, exports are also procyclical and moderately persistent in major commodity exporter countries, such as Romania and Russia.

[14] For similar international evidence in annual frequency data, see Kaminsky *et al* (2004).
[15] See Aguiar and Gopinath (2007), Backus *et al* (1995) and Neumeyer and Perri (2005).

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Labor market variables

Employment. We examine both total employment and employment in industry. In general, employment in CEE countries tends to be slightly more variable than in developed ones, both in absolute and relative terms. Bulgaria shows particularly high absolute volatility, while the Czech Republic and Slovenia a particularly low relative one. Cyclical patterns in employment in CEE countries are similar to G7 ones as documented in Fiorito and Kollintzas (1994); with the exception of Estonia (only industrial employment), the Czech Republic (only industrial employment, with a short time series), Slovenia and Croatia, employment is highly procyclical. Conforming again to the evidence in G7 economies, one can detect phase shifts, especially in total employment. In particular employment is often lagging the cycle in CEE economies, pointing to theories of the business cycle with labor hoarding considerations.[16] The cyclical component of employment is also highly persistent.

Real wage. The relative volatility of real wages is notably higher here than in G7 economies, particularly so in Hungary and Russia. In contrast to the acyclical or mildly procyclical pattern observed in developed economies, significant positive cyclical patterns dominate negative and zero ones, though phase shifts depict a mixed picture. Volatile and procyclical real wages, a key component of marginal costs, are consistent both with workers on their labor supply curve responding to technology shocks in RBC models, and with countercyclical markups when firms do not adjust prices to demand disturbances in monetary models. At the same time, in the presence of preference or government expenditure shocks, equilibrium models of the business cycle are more consistent with countercyclical real wages. The differential patterns observed in real wage cyclicality points to cross-country variation in the relative importance of supply and demand shocks. Lastly, we note that real wages tend to be persistent, with the exception of Estonia.

Productivity. We study both economy-wide (total) and industrial labor productivity. Absolute and relative volatilities in total productivity are in general fairly high in most countries, often exceeding similar statistics in developed economies. The absolute volatility of total productivity appears to be low in the 'Visegrad Group' of the Czech Republic, Hungary, Poland and Slovakia. At the same time, industrial productivity is exceptionally volatile in Bulgaria, Estonia and Romania. Productivity is strongly procyclical and typically coincidental. Exceptions include only marginally procyclical total productivity in Slovakia, countercyclical industrial productivity in Bulgaria and Slovakia, and acyclical industrial productivity in Poland. With the exception of Slovenia, the data also show medium to high persistence in cyclical productivity.

[16] See for example McKay and Reis (2006).

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Taken together, these findings are consistent with shocks to productivity playing an important role in driving economic fluctuations.

Monetary and financial variables

Private sector credit. Unlike Agénor *et al* (2000), we find some pronounced pattern in the current sample. The relative volatilities in many countries appear to be fairly high, especially in Latvia. Absolute volatilities in Bulgaria, Latvia and Romania are truly astronomic, likely to be explained by the financial crises in the mid- to late-1990s. Private sector credit is dominantly procyclical and strongly persistent. As pointed out by Agénor *et al* (2000), a strong positive coefficient could have important consequences for the cost of monetary tightening if credit leads the cycle. In the current sample however private credit is dominantly lagging the cycle. In Bulgaria, Latvia, Lithuania and Russia, significant negative lead correlation coefficients are followed by positive lag ones, again, potentially explained by the financial crisis episodes.

Money. Relative volatilities in the sample are only somewhat larger than the ones in the US or in the G7 economies. Absolute volatility in M1 is particularly high in Bulgaria, and to a lesser extent in Croatia, Russia and Slovakia. Given the high or moderate inflation history in most CEE countries, large volatility in money creation should come as no surprise. In absolute terms, M1 is least volatile in countries maintaining versions of managed float exchange rate policies, Hungary and Slovenia. Apart from Hungary and Slovakia, absolute volatilities in M2 are large, larger than for the G7 and the EU group, other than France, but never as high as say in Argentina. M2 is highly volatile in Bulgaria, Croatia, Latvia and Russia. M1 is in general persistent, procyclical, and rather leading or coincidental. At the same time, in Estonia and Latvia one can observe large cyclical coefficients in M1 of both signs at various leads and lags. The same applies to M2 in Latvia and Romania. M1 in Hungary shows a unique pattern with correlations being insignificant at all leads and lags. By exhibiting large negative but no sizeable positive correlation between money and output, Bulgaria also stands out. Kydland and Zarazaga (1997) also find M1 to be countercyclical using their “new version” of GDP in Argentina, a country plagued by a history of particularly deep financial crises. Money moving the opposite direction to output is however undocumented in other samples. Overall, M1 and M2 behave similarly; both variables tend to be procyclical or acyclical, in accordance with the evidence in G7 economies. Without imposing further structure of the data, these findings are consistent with alternative interpretations of the business cycle, including ones that posit monetary disturbances as the fundamental source of aggregate fluctuations, and ones supporting the endogenous determination of the money supply.

CPI. Since a large and changing fraction of prices is in the regulated category in CEE economies, one would not expect a very clear cyclical pattern of the CPI. Somewhat

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surprisingly, most of the countries still exhibit a countercyclical behavior of the price level. This behavior is similar to that of the G7, and is often interpreted as supporting the classical approach to economic fluctuations with shifting aggregate supply along a stable aggregate demand curve. Countercyclical prices are weakly leading or coincidental. The CPI is strongly procyclical in Poland and Russia, and marginally procyclical in Lithuania. Prices in Croatia, the Czech Republic, Hungary, Poland, Slovakia and Slovenia vary only moderately. Reflecting the large nominal shock associated with the financial crises periods in the second half of the 1990s, prices are particularly volatile in Bulgaria, Romania and Russia. The Baltic countries, holding close trading ties with Russia, appear to constitute another group with moderately high absolute volatility figures. Overall, the CPI in CEE economies exhibits much larger absolute volatility than in developed ones. The CPI is also in general highly persistent in most countries. Croatia and Slovenia have the least persistent *and* least volatile CPI.

Inflation. Chadha and Prasad (1994) argue that it is the behavior of inflation and output that reflects the relative importance of demand- versus supply-driven versus supply-driven disturbances. Though the relevant negative correlation coefficients outnumber the positive ones, the small size of the largest coefficients and the highly mixed pattern in leads and lags make inflation show no unambiguous cyclical properties. Inflation is not particularly volatile in most countries, the exceptions again being Bulgaria, Romania and Russia. Russia and Estonia also stand out by having inflation series that are quite persistent and highly negatively correlated with GDP. It is also notable that inflation is procyclical in countries with relatively more flexible exchange rate regimes, such as the Czech Republic, Hungary, Poland and Romania.

Net capital flows. Net capital flows in CEE economies are in general quite volatile, much more volatile than in developed ones, with Hungary and Slovakia exhibiting the highest volatilities.[17] The relatively large and closed economies of Poland, Romania and Russia exhibit the lowest volatilities. Also, net capital flows are universally more volatile than net exports. Although no particularly strong patterns appear to emerge, capital flows tend to be somewhat procyclical. They are marginally countercyclical only in Bulgaria and Slovenia. Possibly explained by the impact of the financial crisis in 1998, Russia shows significant positive coincident and lagged coefficients. Consistently with the presence of significant barriers to international capital flows in CEE countries, with the exception of Russia, net capital flows show very low persistence. Indeed, other than in Lithuania, they are much less persistent than net exports.

Nominal interest rate. Interest rates proxied by the nominal lending rate are extremely variable in Bulgaria, Russia, and somewhat in Romania. In other countries they exhibit very

[17] See Broner and Rigobon (2006).

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small volatilities. Though the figures are not always significant, nominal interest rates tend to show positive lagging, and negative leading correlation coefficients. With Croatia and Russia as notable exceptions, one may interpret this pattern as evidence for the interest channel in monetary transmission, at least in the sense of Granger-causality. Nominal interest rates are also markedly persistent, with the exceptions of Croatia and Slovenia.

Nominal effective exchange rate. Exchange rates in Bulgaria and Russia show exceptionally high absolute *and* relative volatilities. Absolute volatilities are also quite high in Estonia, Latvia, Lithuania and Romania. These observations are partly explained by the few large discrete jumps in the nominal exchange rate associated with policy regime changes, partly by high the high inflation episodes, especially in Bulgaria, Romania and Russia. On the other hand, Croatia, the Czech Republic and Slovenia show particularly low relative volatilities. Volatilities do not seem to be strongly related to country size, openness or monetary regime; they are rather associated with the impact of single exchange rate episodes in particular countries. Nonetheless, economies with more volatile nominal exchange rates seem to have more volatile price levels as well. While all series are highly persistent, the cyclical correlations and phase shifts show entirely mixed patterns.

Real effective exchange rate. Relative volatilities in real exchange rates are in general lower than the ones for nominal rates. The only country in which absolute volatility in real effective exchange rates exceeds the corresponding nominal figure is the Czech Republic. While real exchange rate volatility figures show more uniformity than nominal ones, again, in absolute terms they are particularly volatile in Bulgaria, Romania and Russia. Relative volatility is quite high in Poland and Russia, indicating that the exchange rate could be rather a source than an absorber of shocks in these countries. Comparing patterns in cyclicality in real with that in nominal exchange rates, we find sign switches in Romania and to some degree, Russia; otherwise signs, and often phase shifts remain unchanged. This is the sense in which purchasing power parity is at work in cyclical exchange rate data. The small number of positive lead coefficients in this and the previous table however seem to indicate that the exchange rate channel is not particularly strong in CEE economies, relative to the interest rate channel. Corsetti *et al* (2007) argue that in response to technological shocks, the real exchange rate is more likely to appreciate in larger and more closed economies. The results give some support to this prediction. In countries where the real wage is procyclical suggesting a dominant role for technological shocks, it is only the small and very open Lithuania exhibiting a negative correlation between output and the real exchange rate; while larger and more closed Bulgaria, Croatia, Russia, and partly Romania all show signs of appreciation (depreciation) associated with an output boom (bust). Finally, real rates are persistent, though the degree of persistence tends to be slightly lower than the one in nominal exchange rates.

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4 TAKING STOCK

The goal of the present work is to document facts of business cycle fluctuations in a major segment of emerging market economies, the countries of Central and Eastern Europe. The evidence in general suggests that real business cycle models with shocks to productivity can account for a number of fundamental features of the data. Indeed, many countries in the sample, including Croatia and the accession group (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) show broadly similar cyclical behavior to developed economies. The most frequent country outliers are the high inflation countries of Bulgaria, Romania and Russia, especially in labor market, price and exchange rate variables.

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Figure 1: Estonia

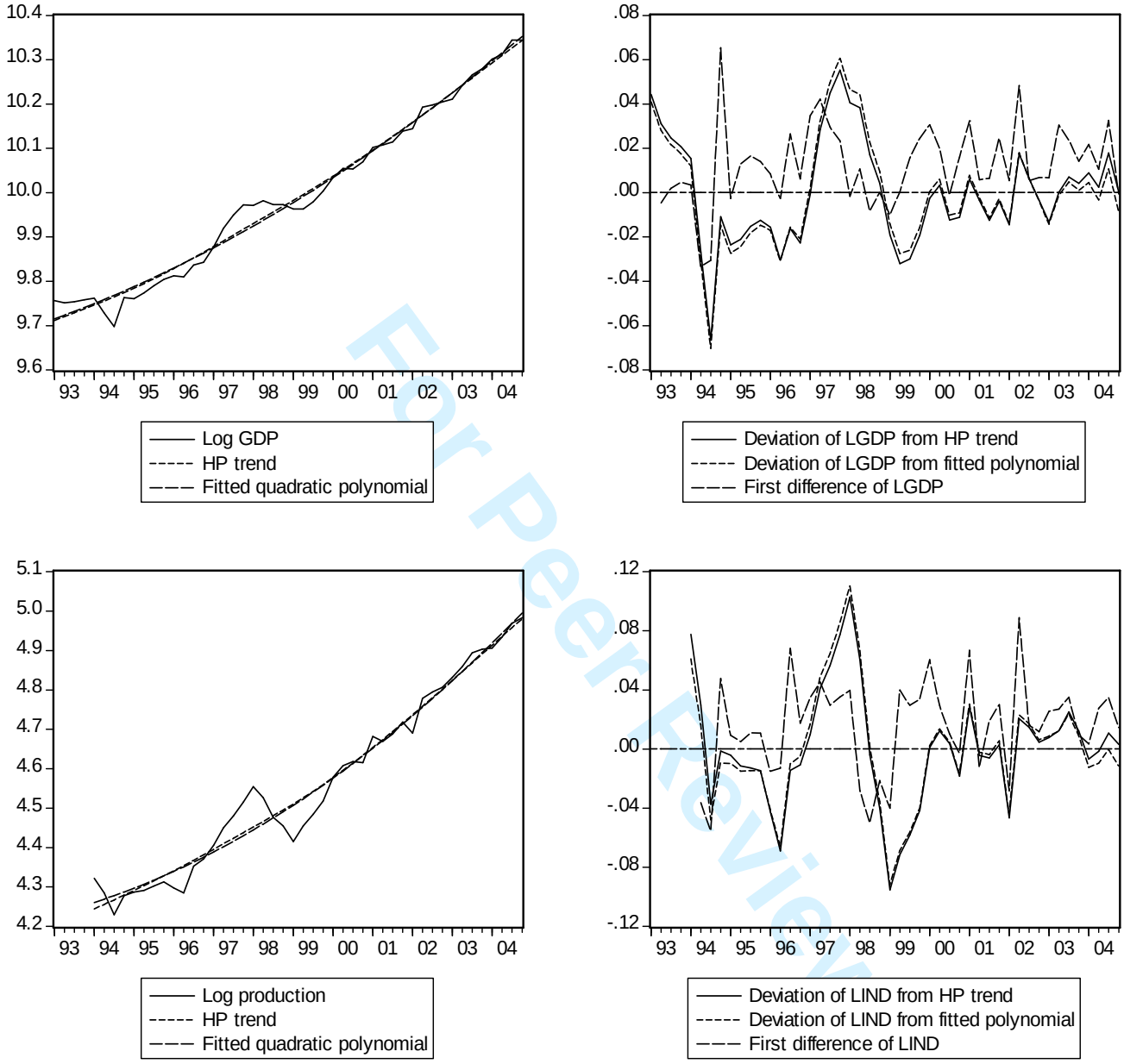

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Figure 2: Poland

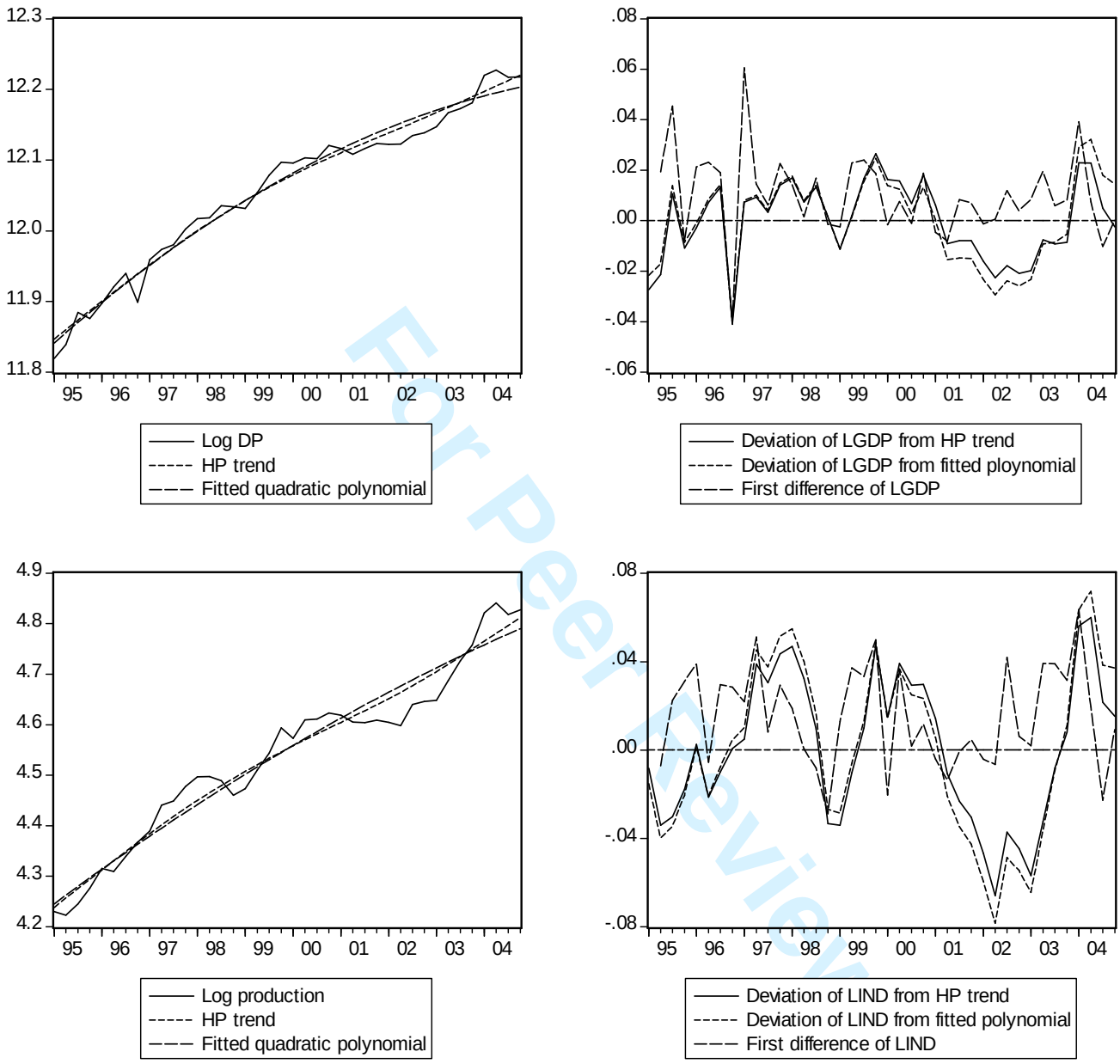

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TABLE I, SUMMARY STATISTICS FOR OUTPUT

Country	Sample Period	GDP Volatility	IP Volatility	Autocorrelation lag1	lag2	lag3	lag4
Argentina	1970:1 / 1980:1 – 1990:4	3.06 / 4.59	5.57				
Chile	1986:1 – 1998:4	2.00	4.53	0.68	0.51	0.27	0.00
Colombia	1978:1 – 1995:4		2.33	0.51	0.27	0.17	0.02
India	1978:1 – 1995:4		2.45	0.48	0.35	0.10	0.02
Korea	1978:1 – 1995:4		3.47	0.71	0.44	0.20	-0.14
Malaysia	1978:1 – 1995:4		4.06	0.69	0.30	0.07	-0.16
Mexico	1987:1 – 2000:2	2.34	3.31	0.72	0.40	0.14	-0.13
Morocco	1978:1 – 1995:4		2.77	0.06	0.25	0.08	-0.18
Nigeria	1978:1 – 1995:4		6.69	0.45	0.09	-0.06	-0.12
Philippines	1978:1 – 1995:4		7.45	0.63	0.42	0.10	-0.15
Tunisia	1978:1 – 1995:4		2.72	0.63	0.42	0.13	0.06
Turkey	1987:1 – 2000:2	3.48	3.62	0.38	0.14	0.06	-0.12
Uruguay	1978:1 – 1995:4		4.94	0.63	0.50	0.27	-0.01
Developing average		2.77 / 3.10	4.15	0.55	0.34	0.13	-0.08
Bulgaria	1994:1 – 2004:4	3.99	5.87	0.65	0.31	0.01	-0.18
Croatia	1994:1 – 2004:4	2.15	2.31	0.58	0.33	0.18	0.12
Czech Republic	1994:1 – 2004:4	1.63	2.67	0.89	0.74	0.48	0.24
Estonia	1993:1 – 2004:4	2.37	3.95	0.72	0.45	0.18	-0.08
Hungary	1995:1 – 2004:4	0.99	3.62	0.69	0.35	0.08	0.18
Latvia	1993:1 – 2004:4	1.81	4.27	0.63	0.33	0.09	0.06
Lithuania	1995:1 – 2004:4	2.42	5.60	0.59	0.42	0.42	0.25
Poland	1995:1 – 2004:4	1.57	3.30	0.44	0.22	0.29	0.15
Romania	1994:1 – 2004:4	3.45	7.09	0.67	0.43	0.35	0.29
Russia	1995:1 – 2004:4	2.87	3.92	0.81	0.53	0.24	0.01
Slovakia	1993:1 – 2004:4	1.22	3.85	0.63	0.55	0.50	0.51
Slovenia	1995:1 – 2004:4	2.19	2.04	0.20	0.36	0.16	-0.03
CEE average		2.22	4.04	0.62	0.42	0.25	0.13
US	1960:1 – 1989:3	1.74	3.70	0.85	0.65	0.41	0.21
Canada	1960:1 – 1989:3	1.39	3.79	0.78	0.51	0.27	0.04
Japan	1960:1 – 1989:3	1.53	4.07	0.78	0.59	0.38	0.19
Germany	1960:1 – 1989:2	1.69	3.06	0.67	0.46	0.35	0.23
France	1960:1 – 1989:3	0.90	2.70	0.77	0.54	0.30	0.10
UK	1960:1 – 1989:1	1.54	2.85	0.55	0.37	0.20	0.07
Italy	1960:1 – 1989:3	1.70	3.58	0.80	0.52	0.22	-0.04
G7 average		1.50	3.39	0.74	0.52	0.30	0.11
Belgium	1960:1 – 1989:4	2.68	2.75	0.72	0.49	0.22	-0.04
Denmark	1960:1 – 1989:4	2.30	2.24	0.26	0.05	0.00	0.13
Greece	1962:1 – 1990:4	2.85	3.04	0.64	0.36	0.17	-0.01
Ireland	1976:1 – 1989:4	2.31	3.11	0.35	0.03	0.10	0.05
Luxembourg	1960:1 – 1989:4	3.20	5.07	0.54	0.30	0.11	0.00
Netherlands	1960:1 – 1989:4	1.79	2.27	0.32	0.09	0.11	0.06
Portugal	1968:1 – 1989:4	3.05	3.52	0.52	0.37	0.19	0.16
Spain	1975:1 – 1989:4	1.47	1.80	0.13	0.17	0.18	0.03
EU average		2.12	3.07	0.52	0.31	0.18	0.06

Note: GDP and Industrial Production (IP) are all Hodrick-Prescott filtered. Autocorrelations are computed in IP in the developing group, and in real GDP otherwise. 'EU average' includes G7 members of EU as well.

Sources: Kydland and Zarazaga (1997) for GDP and IP in Argentina (old / new estimates); Agenor *et al* (2000) for IP in all other developing countries; Alper (2003) for GDP in Mexico and Turkey; Burgoeing and Soto (2000) for GDP in Chile; Fiorito and Kollintzas (1994) for GDP and IP in G7 countries; Christodoulakis *et al* (1995) for GDP and IP in EU countries; authors' calculation for GDP and IP in CEE countries.

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TABLE II, PRODUCTION AND EXPENDITURE VARIABLES[a]

	Bulgaria	Croatia	Czech Rep	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Russia	Slovakia	Slovenia
Industrial Output												
Absolute Volatility	5.87	2.31	2.67	3.95	3.62	4.27	5.60	3.30	7.09	3.92	3.85	2.04
Relative Volatility	1.47	1.08	1.64	1.74	3.66	2.52	2.31	2.10	2.06	1.37	3.16	0.93
Cyclicality/Phase Shift	-0.35 / -4	0.71 / 0	0.58 / +4	0.77 / 0	0.84 / 0	0.61 / 0	0.70 / 0	0.72 / 0	0.78 / 0	0.87 / +2	0.38 / -4[§]	0.38 / +4
Persistence	0.75	0.52	0.64	0.69	0.80	0.70	0.37	0.79	0.86	0.77	0.38	0.25
Private Consumption												
Absolute Volatility	5.22	5.03	2.05	3.30	1.97	2.28	2.54	1.64	4.78	2.95	2.38	1.56
Relative Volatility	1.31	2.34	1.26	1.39	2.00	1.39	1.05	1.05	1.38	1.03	1.95	0.71
Cyclicality/Phase Shift	0.78 / 0	0.59 / 0	0.73 / 0	0.71 / 0	0.39 / +3	-0.61 / +4	0.30 / +1	0.44 / +1	0.74 / 0	0.61 / +3	0.44 / +2	0.79 / 0
Persistence	0.56	0.81	0.65	0.71	0.72	0.20	0.40	0.43	0.56	0.75	0.47	0.36
Investment												
Absolute Volatility	13.74	8.16	4.55	7.16	3.29	12.43	9.65	6.36	8.08	8.55	9.78	6.05
Relative Volatility	3.44	3.80	2.80	3.02	3.32	7.60	3.98	4.05	2.34	2.98	8.01	2.77
Cyclicality/Phase Shift	0.48 / -3	0.71 / 0	0.86 / 0	0.61 / +1	0.51 / -1	0.32 / +2	0.67 / 0	0.67 / 0	0.38 / 0	0.71 / +1	0.48 / +3	0.90 / 0
Persistence	0.45	0.83	0.86	0.66	0.19	0.21	0.63	0.63	-0.09	0.38	0.71	0.18
Government Consumption												
Absolute Volatility	7.65	2.94	2.37	3.62	2.68	4.02	5.45	2.54	4.63	1.27	5.68	0.76
Relative Volatility	1.92	1.37	1.46	1.52	2.71	2.46	2.25	1.62	1.34	0.44	4.66	0.35
Cyclicality/Phase Shift	0.61 / -1	0.23 / +4[§]	-0.30 / 0	-0.39 / +2	-0.19 / -3	0.77 / +3[§]	0.51 / 0	0.36 / +2	0.44 / -1	0.43 / -4	0.30 / +2	0.37 / -3
Persistence	0.47	0.42	0.39	0.43	0.33	0.66	0.04	-0.08	0.25	0.44	0.34	0.44
Net Exports												
Absolute Volatility	4.61	3.79	1.66	2.48	2.16	2.58	2.11	1.17	2.30	3.86	4.52	1.67
Cyclicality/Phase Shift	-0.51 / 0	-0.59 / 0	-0.45 / -1	-0.32 / -1	-0.29 / -4	-0.36 / +2	-0.35 / +3	-0.57 / +2	0.17 / +2	-0.68 / +1§	-0.36 / +3	-0.90 / 0
Persistence	0.45	0.42	0.36	0.19	0.44	0.41	0.12	0.55	0.23	0.73	0.61	0.26
Real Imports												
Absolute Volatility	6.25	8.63	4.06	7.20	4.57	6.25	9.12	6.79	6.21	12.64	6.53	3.23
Relative Volatility	1.57	4.02	2.50	3.03	4.62	3.82	3.77	4.32	1.80	4.40	5.35	1.48
Cyclicality/Phase Shift	0.47 / 0	0.66 / 0	0.65 / +1	0.60 / +1	0.66 / -1	0.47 / +1	0.68 / -3	0.65 / 0	0.38 / -2	0.75 / +1	0.49 / +3	0.78 / 0
Persistence	0.15	0.70	0.51	0.75	0.72	0.56	0.72	0.32	0.46	0.75	0.48	0.05
Real Exports												
Absolute Volatility	7.23	7.05	4.23	7.24	4.40	5.09	9.32	6.45	6.63	3.25	4.70	3.03
Relative Volatility	1.81	3.29	2.61	3.05	4.45	3.11	3.85	4.10	1.92	1.13	3.85	1.39
Cyclicality/Phase Shift	-0.34 / +3	0.24 / -1	0.34 / 0	0.53 / 0	0.40 / -1	0.65 / 0	0.69 / -3	0.60 / 0	0.42 / -3	0.55 / -2	-0.14 / 0	-0.28 / -1
Persistence	0.39	0.30	0.63	0.73	0.67	0.81	0.75	0.03	0.41	0.41	0.62	0.43

[a] All data are at the quarterly frequency, de-seasonalized and de-trended by the Hodrick-Prescott filter. 'Absolute Volatility' is the standard deviation of the variable. 'Relative Volatility' is measured as the ratio of the standard deviation of the variable and that of real GDP. 'Cyclicality' is the highest correlation coefficient in absolute value between the variable and real GDP. Negative values for 'Phase shift' indicate lead, while positive ones lag to real GDP. 'Persistence' is the AR(1) coefficient.
[§] Unclear cyclical pattern.

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TABLE III, LABOR MARKET VARIABLES[a]

	Bulgaria	Croatia	Czech Rep	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Russia	Slovakia	Slovenia
Total Employment												
Absolute Volatility	4.29	1.79	0.82	1.26	0.87		2.28	1.58	1.98	0.76	1.36	0.81
Relative Volatility	1.08	0.84	0.51	0.53	0.88		0.94	1.01	0.57	0.26	1.14	0.37
Cyclicality/Phase Shift	0.70 / +4	-0.61 / -4	0.34 / +1	0.55 / +2	0.47 / -2		0.46 / +3	0.59 / +2	0.56 / 0	0.52 / 0	0.71 / -1	-0.36 / -4
Persistence	0.87	0.72	0.74	0.72	0.81		0.75	0.82	0.82	0.68	0.91	0.84
Industrial Employment												
Absolute Volatility	6.72	2.62	1.46	4.84	1.66	3.59		3.21	2.74	2.58	2.38	1.23
Relative Volatility	1.69	1.22	1.30	2.04	1.68	1.98		2.04	0.80	0.90	2.00	0.56
Cyclicality/Phase Shift	0.77 / +4	-0.60 / -4	-0.57 / -4[§]	-0.48 / +4	0.41 / +1	0.55 / 0		0.62 / +1	0.51 / +2	0.66 / +1	0.73 / 0	0.05 / +4
Persistence	0.83	0.77	0.71	0.53	0.76	0.84		0.87	0.82	0.94	0.89	0.85
Real Wage												
Absolute Volatility	10.28	3.83	2.28	2.34	3.46	3.35	5.93	4.41	7.34	10.57	2.80	0.99
Relative Volatility	2.58	1.78	1.40	0.98	3.50	1.85	2.45	2.81	2.13	3.68	2.30	0.45
Cyclicality/Phase Shift	0.80 / 0	0.37 / 0	0.73 / 0	-0.28 / -4	-0.32 / +3	-0.46 / -4	0.70 / +3	0.25 / -2	0.75 / -1	0.69 / +2	0.68 / +1	-0.22 / +3
Persistence	0.54	0.81	0.69	0.01	0.81	0.70	0.78	0.78	0.77	0.87	0.85	0.53
Productivity												
Absolute Volatility	6.43	3.12	1.59	2.09	1.02		3.03	1.82	2.86	2.56	1.01	2.24
Relative Volatility	1.61	1.45	0.98	0.88	1.04		1.25	1.16	0.83	0.89	0.85	1.02
Cyclicality/Phase Shift	0.76 / 0	0.83 / 0	0.87 / 0	0.85 / 0	0.63 / 0		0.67 / 0	0.57 / 0	0.82 / 0	0.97 / 0	0.30 / 0	0.93 / 0
Persistence	0.76	0.57	0.81	0.57	0.48		0.63	0.43	0.50	0.77	0.36	0.20
Industrial Productivity												
Absolute Volatility	7.46	3.62	2.61	6.33	3.77	3.45		2.80	6.56	2.74	3.24	2.11
Relative Volatility	1.87	1.69	2.33	2.79	3.81	2.03		1.78	1.90	0.95	2.72	0.97
Cyclicality/Phase Shift	-0.74 / +4	0.70 / 0	0.56 / +4	0.49 / 0	0.65 / 0	0.37 / 0		0.28 / -2	0.69 / 0	0.67 / +2	-0.53 / +4	0.33 / +4
Persistence	0.60	0.65	0.71	0.58	0.72	0.52		0.62	0.78	0.61	0.72	0.23

[a] See notes to Table II.
[§] Unclear cyclical pattern.

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TABLE IV, FINANCIAL AND MONETARY VARIABLES[a]

	Bulgaria	Croatia	Czech Rep	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Russia	Slovakia	Slovenia
Private Sector Credit												
Absolute Volatility	26.28	7.66	8.21	10.76	5.95	20.21	12.22	3.06	21.39	10.42	4.65	4.08
Relative Volatility	6.59	3.62	5.05	4.53	6.02	11.34	5.05	1.95	6.20	3.63	3.63	1.86
Cyclicality/Phase Shift	0.77 / +3	0.63 / +1	0.41 / 0	0.64 / +2	0.73 / 0	0.70 / +3	0.69 / +4	0.44 / -2	0.82 / +2	-0.45 / -4[§]	0.63 / +1	0.37 / 0
Persistence	0.78	0.83	0.87	0.88	0.81	0.87	0.90	0.77	0.88	0.73	0.91	0.66
M1												
Absolute Volatility	35.37	9.25	6.59	6.43	4.30	6.17	7.69	6.28	6.12	9.39	8.44	3.04
Relative Volatility	8.87	4.37	4.05	2.71	4.35	3.46	3.18	4.00	1.78	3.27	6.92	1.39
Correlation	-0.52	0.61	0.49	0.20	0.13	0.30	0.73	0.33	0.21	0.50	0.50	0.52
Cyclicality/Phase Shift	-0.81 / +2	0.61 / 0	0.57 / -2	-0.45 / +4[§]	0.29 / -2	0.50 / +2[§]	0.76 / +2	0.57 / -3	0.60 / +3	0.67 / +1	0.68 / -3	0.52 / 0
Persistence	0.88	0.86	0.84	0.77	0.63	0.70	0.87	0.85	0.71	0.72	0.73	0.79
M2												
Absolute Volatility	26.89	8.90	4.76	5.83	1.82	8.62	3.96	3.77	6.27	7.87	2.45	4.61
Relative Volatility	6.74	4.21	2.93	2.45	1.84	4.84	1.64	2.40	1.82	2.74	2.01	2.11
Cyclicality/Phase Shift	-0.83 / +2	0.62 / -1	0.76 / 0	-0.26 / +4	0.45 / -4	-0.58 / -4[§]	0.49 / +2	0.64 / +4	-0.53 / -4[§]	0.61 / -1	0.48 / -3	0.62 / -4
Persistence	0.88	0.90	0.85	0.77	0.58	0.81	0.73	0.88	0.79	0.81	0.64	0.90
CPI												
Absolute Volatility	43.31	0.92	1.46	5.03	2.37	4.38	3.95	2.35	12.61	11.23	2.12	1.29
Relative Volatility	10.86	0.43	0.90	2.12	2.40	2.42	1.63	1.49	3.65	3.91	1.74	0.59
Cyclicality/Phase Shift	-0.85 / +2	-0.35 / -4	-0.66 / -4	-0.37 / 0	-0.43 / +2	-0.47 / 0	0.32 / -2	0.57 / +4	-0.79 / -1	0.63 / -4	-0.63 / +3	-0.48 / -1
Persistence	0.86	0.73	0.86	0.95	0.93	0.94	0.93	0.94	0.88	0.84	0.84	0.76
Inflation												
Absolute Volatility	22.86	0.71	0.80	1.33	0.61	1.30	1.02	0.70	6.03	6.04	1.11	0.73
Relative Volatility	5.73	0.34	0.50	0.58	0.72	0.71	0.42	0.46	1.75	2.11	0.90	0.33
Cyclicality/Phase Shift	-0.74 / 0	-0.17 / +4	0.33 / +4	-0.41 / -2	0.36 / -1	-0.36 / -1	-0.24 / -1	0.47 / -1	0.54 / +2	-0.50 / +1	0.29 / +4	-0.38 / -2
Persistence	0.33	-0.19	0.20	0.51	0.29	0.22	0.52	0.31	0.44	0.66	0.04	0.00

[a] See notes to Table II.
[§] Unclear cyclical pattern.

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TABLE IV, CONTINUED, FINANCIAL AND MONETARY VARIABLES[a]

	Bulgaria	Croatia	Czech Rep	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Russia	Slovakia	Slovenia
Net Capital Flows												
Absolute Volatility	6.59	6.25	5.13	4.93	7.49	5.64	4.74	2.68	3.89	4.67	8.77	4.08
Cyclicality/Phase Shift	-0.33 / +2[§]	0.34 / 0	0.24 / -4	0.47 / -2	0.26 / +2	0.41 / +3	0.32 / 0	0.32 / 0	0.22 / +4	0.47 / +1[§]	0.18 / -1	-0.35 / -2
Persistence	-0.03	-0.10	0.22	0.14	0.07	-0.03	-0.32	0.09	0.03	0.42	-0.07	-0.17
Nominal Interest Rate												
Absolute Volatility	9.49	1.00	0.24	0.54	0.35	1.13	0.42	0.62	3.15	9.99	0.55	0.62
Relative Volatility	2.38	0.46	0.15	0.23	0.36	0.64	0.18	0.40	0.91	3.48	0.45	0.28
Cyclicality/Phase Shift	-0.71 / 0[§]	0.38 / +4	0.72 / +4	0.66 / +3	-0.44 / -4	0.43 / +4	-0.72 / -2	-0.49 / -4[§]	-0.52 / -2	0.49 / -4	0.62 / +4	-0.50 / -2
Persistence	0.75	0.25	0.86	0.72	0.77	0.83	0.85	0.83	0.62	0.87	0.83	0.38
Nominal Effective Exchange Rate												
Absolute Volatility	42.03	2.41	2.88	5.93	3.50	7.56	7.63	4.77	9.96	21.47	3.31	2.29
Relative Volatility	10.54	1.12	1.77	2.50	3.54	4.46	3.15	3.04	2.89	7.48	2.71	1.05
Cyclicality/Phase Shift	0.82 / +1	0.63 / +1	0.24 / +1	-0.71 / 0	-0.45 / -3	-0.51 / -2	-0.72 / -3	-0.63 / -2	0.63 / -1	-0.70 / -4[§]	0.39 / 0	0.57 / -3
Persistence	0.87	0.82	0.71	0.86	0.78	0.80	0.84	0.77	0.74	0.84	0.67	0.81
Real Effective Exchange Rate												
Absolute Volatility	7.83	1.90	3.04	4.10	2.39	4.02	4.14	5.00	8.20	14.25	3.07	1.90
Relative Volatility	1.96	0.89	1.87	1.73	2.42	2.35	1.71	3.18	2.38	4.96	2.52	0.87
Cyclicality/Phase Shift	0.73 / -1	0.43 / -3	-0.25 / -2	-0.38 / +1	-0.47 / +1	-0.31 / -4	-0.61 / -4	-0.55 / -2	-0.59 / +1[§]	0.70 / +2[§]	-0.30 / +3	0.59 / -3
Persistence	0.64	0.64	0.71	0.76	0.70	0.80	0.74	0.76	0.80	0.83	0.59	0.71

[a] See notes to Table II.
[§] Unclear cyclical pattern.

For Peer Review