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Sectoral Productivity, Demand, and Terms of Trade: What Drives the Real Appreciation of East European Currencies?

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Sectoral Productivity, Demand, and Terms of Trade: What Drives the Real Appreciation of East European Currencies?

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Sectoral productivity, demand, and terms of trade

What drives the real appreciation of East European currencies?[1]

Vasily Astrov

INTRODUCTION

Since the start of transition in the early 1990s, the currencies of most East European countries have initially experienced an abrupt real depreciation against the U.S. dollar and the euro (ECU prior to 1999), followed by a trend real appreciation over the subsequent years. The latter observation generally holds true irrespective of the exchange rate regime chosen by a particular country. The widely adopted explanation relates this phenomenon to the rapid productivity growth in the manufacturing sector—in excess of that in the sector of services. This explanation is supply-side-based and essentially represents the well-known "Balassa-Samuelson effect." At the same time, economic theory suggests that in the long run, the real exchange rate is determined by the three groups of factors: technology (the supply side), tastes (the demand side), and the terms of trade. We aim to identify the relative contribution of each of these groups of factors to the real appreciation phenomenon in eight East European countries—Hungary, Czech Republic, Poland, Slovakia, Slovenia, Romania, Croatia, and Bulgaria—between 1990 and 2001.

The chapter is organized as follows. We start with an overview of economic developments in the East European countries in the course of transition, with a particular emphasis on inflation, exchange rates, and productivity. Then we present the theory of purchasing power parity (PPP), the various approaches explain-

[1] The author thanks Leon Podkaminer from the Vienna Institute for International Economic Studies (wiiw) for valuable comments on the first draft of this work.

ing the deviation of market exchange rates from PPPs, and the implications of above theoretical arguments for the particular situation of economies in transition. Subsequently, we provide a survey of previous empirical studies explaining real exchange rates, both in industrial countries and in transition economies. In the next step, we construct our own model of the real exchange rate, put it to an empirical test and discuss the main findings.

OVERVIEW OF ECONOMIC DEVELOPMENTS IN THE EAST EUROPEAN COUNTRIES

The dynamics of real exchange rates in the East European transition countries since 1990 is to be considered against the background of overall economic development (see 9.A.1). The price and foreign trade liberalization measures of the early 1990s typically triggered a high, and in a number of cases a hyper-inflation, fuelled by a lax monetary policy. For instance, in Poland producer prices in 2001 were 44 times higher than in 1989; they were 80 times higher in Slovenia, and over 4000 times higher in Croatia. The prices of services were rising particularly fast; in all countries involved, consumer price inflation has exceeded producer price inflation. The macroeconomic instability caused by inflation, coupled with the cuts in subsidies, led to a sharp fall in output which often lasted several years in a row, before the recovery driven by the newly emerging private sector finally set in.

The dynamics of *nominal* exchange rates was determined in the first line by the exchange rate regime. In the planned economy system, exchange rates were multiple, arbitrary and typically reflected neither the purchasing power of currency, nor its value in the foreign exchange market. After the planned economy had been dismantled, transition countries had experience with a surprising variety of exchange rate regimes, both across countries and in time, though with a tendency toward more flexible regimes in recent years. In our sample, Poland and the Czech Republic, floating their currencies on the one hand, and Bulgaria, which adopted the hardest version of a peg—a currency board—in 1997, on the other hand, appear to be the two extremes, with the remaining countries lying in between.

Table 9.A.1 reveals that, irrespective of the exchange rate regime chosen, all countries have experienced a real appreciation of their currencies against the euro, particularly when measured by consumer price index, and implying that the rates of nominal depreciation were generally lagging behind the inflation rates. This has translated into a substantial narrowing of the gap in price levels between respective countries and the eurozone (EU-12). This gap is statistically captured

by the so-called Exchange Rate Deviation Index (ERDI), which is calculated as a ratio of nominal exchange rate to purchasing power parity (both expressed as the price of 1 euro in terms of domestic currency). Between 1991 and 2001, ERDI fell, e.g., from 4.6 to 2.3 in the Czech Republic and from 5.9 to 3.7 in Bulgaria, but Slovenia has experienced only a slight real appreciation. A visual inspection of table 9.A.1 also suggests that there may be a negative correlation between ERDI and per capita GDP. Indeed, the richest country—Slovenia—had in 2001 one of the highest price levels (only 1.5 times lower than in EU-12), and in the poorest countries—Bulgaria and Romania—it was the lowest (the ERDIs of these countries were 3.7 and 3.3, respectively).

REAL EXCHANGE RATE DETERMINATION: THEORETICAL ARGUMENTS

Theory of Purchasing Power Parity

There is a strong belief among economists that exchange rates between currencies are not independent from their purchasing powers. In its absolute (and strictest) version, the PPP theory says that exchange rates are set in such a way that price levels in different countries, expressed in one currency, are equal. The theory has its origins in the intuitively appealing "law of one price" for each internationally traded commodity. Clearly, with the "law of one price" applicable to each individual good, a certain basket of such goods will cost the same in different countries as well.

It was David Ricardo who first recognized that if the price level in a given country were lower than abroad, the arbitrage would result in a growing demand for its goods, leading to an inflow of gold. The increase of gold in circulation would push the price level in this country upwards and restore the price level parity with other countries. Later on, Gustav Cassel reformulated the idea of Ricardo in application to the countries with paper currencies. In his model, a cross-country discrepancy in price levels leads to a growing demand for the currency of the country with the lower price level, pushing its exchange rate upwards—until the initial discrepancy is completely eroded.

The absolute version of purchasing power parity described above is seldom empirically tested because of the limited availability of direct cross-country price comparisons at a single point in time. Therefore, most empirical work on PPP has been focusing on its relative version, which only requires the constancy of real exchange rate. According to the relative version of PPP, any inflation differentials between countries are necessarily accompanied by a corresponding nominal exchange rate adjustment. Most time-series studies on a range of OECD countries over the post-Bretton Woods floating period found it extremely difficult to reject the non-stationarity of real exchange rate (i.e., to confirm the validity of the relative version of PPP), although the empirical evidence was more supportive for the interwar float (Taylor, 1995). It has been argued that this may be due to the low power of unit root tests applied to short time periods. Indeed, empirical estimations based on longer time series, e.g., spanning over a century or more, using panel data or systems estimations methods generally proved more favorable. At present, the overall consensus seems to suggest that real exchange rates converge toward PPPs in the very long run, with deviations damping out at a rate of roughly 15 percent per year.

However, there are a number of theoretical objections why the absolute or the relative versions of PPP may not necessarily hold.

First, the theory of PPP refers to the price level, which is a weighted average of prices of goods in a certain basket. However, since productive endowments and consumer tastes typically vary across countries, the composition of such a basket will not be the same in different countries either. In particular, each country will tend to consume commodities with lower relative prices in larger quantities. Therefore, it is not clear what basket should underlie the cross-country price comparisons. This is the so-called "index-number problem," which is further exacerbated in the dynamic setting, with the consumption weights shifting and new (previously non-existent) goods emerging.

Second, the price equalization even for individual internationally traded goods is not guaranteed in the presence of transport costs and trade barriers. For instance, Engel and Rogers find that transport costs, proxied by distance, are an important explaining factor of price discrepancies between different locations (Engel and Rogers, 1996). Such discrepancies, which might be substantial even within a particular country, become even larger in the case of cross-border comparisons. This "border" effect, which remains significant even in absence of any trade barriers and after controlling for transport costs, is somewhat of a puzzle although sticky nominal prices are one possible explanation. True, as demonstrated by Taylor, who applies a general equilibrium approach in a two-country two-commodity model with symmetric trade barriers and equal commodity weights, price discrepancies for individual goods do not violate the equalization of price levels (Taylor, 1996). However, the restrictive assumptions of Taylor's model make it largely of theoretical interest.

Third, while international arbitrage tends to equalize the prices of tradable goods, there is no immediate reason why the same should apply to the prices of non-tradables (mainly services). Normally, international arbitrage of non-tradables is either impossible, or severely limited due to the prohibitively high costs associated with such arbitrage. Strictly speaking, there is no a priori division into “tradables” and “non-tradables.” Instead, what matters is the cost of arbitrage. If the cross-country price differential for a particular good at prevailing exchange rate is large enough to compensate the costs of arbitrage, this good becomes a “tradable.” Therefore, the larger the price differential, the greater the number of goods becoming “tradable,” and the faster is convergence of prices toward PPP. This is often seen as a source of non-linearities in the mean-reversion of real exchange rates (Taylor and Sarno, 2001).

Also, potentially tradable goods may be “non-tradable” because of the differing tastes and technical and quality standards in different countries. To the extent that such goods cannot be arbitraged, producers can price discriminate between individual national markets. Besides, many goods, which are per se tradable, may contain a significant non-traded component, especially at the consumer price level. Kindleberger has argued that factor price equalization due to international trade in tradables, coupled with identical production functions of non-tradables, brings about price equalization of the latter (Neustadt, 1991). However, since in reality the assumptions of Kindleberger’s model are not fulfilled, it is little wonder that prices of non-tradables often differ by a wide margin.

Real Exchange Rate and Deviations from Purchasing Power Parity

The theory of purchasing power parity cannot account for the simple observation that price levels in different countries are often very different. Besides, it has long been observed that a low price level is typically associated with a low level of development, and vice versa. In other words, poor countries tend to have a low real exchange rate. For instance, in a sample of twelve industrial countries, Balassa found a strong positive correlation between the ratio of PPP to market exchange rate (this ratio is an inverse of ERDI defined earlier) and per capita GNP (Balassa, 1964). A more recent study based on the 1991 International Comparison Project of Summers and Heston related price level to per capita GDP and found a significant positive correlation as well (Rogoff, 1996). Noteworthy, the relationship is strong for the mixed group of rich and poor countries, but it is far less pronounced when rich and poor countries are considered as separate sub-samples.

The most influential explanation of the fact that poorer countries typically have lower price levels goes back to Balassa and Samuelson, and is therefore referred to as the “Balassa-Samuelson effect.” Their model is based on the observation that productivity differentials between poor and rich countries in the tradable sector usually by far exceed productivity differentials in the non-tradable sector. The big gap in tradable productivity may be the result of technological inferiority of poor countries, since the production of tradable goods is typically capital-intensive. In turn, the scope for productivity advances in the largely labor-intensive non-tradable sector is rather limited.

Since the prices of tradables are equalized across countries due to international arbitrage, lower tradable productivity in the poor country directly translates into lower wages in the tradable sector. However, cross-sector labor mobility brings about wage equalization, so that wages in the non-tradable sector in the poor country will typically be low as well. The low wages in the non-tradable sector, coupled with the relatively high productivity, explain the low price of non-tradables and hence the low overall price level observed in poor countries.

The Balassa-Samuelson effect has clear implications in the dynamic setting. Relatively fast economic growth of a poor country can normally be attributed to a rapid increase in tradable productivity. This brings about rising wages in both the tradable and the non-tradable sectors. Rising wages lead to the rising prices of non-tradables, since there is no corresponding productivity growth in this sector. Therefore, the relative price of non-tradables (in terms of tradables) goes up. The overall price level goes up as well, leading to real appreciation which accompanies economic growth.

The conventional Balassa-Samuelson model stipulates that the relative price of non-tradables is fully determined by sectoral productivity differentials, i.e., the supply side of economy. Demand shocks can only lead to changes of the quantities of tradable and non-tradable goods, but not of their relative prices. This result is due to a number of strong assumptions, such as the “law of one price” for tradables, perfect competition (or the same degree of competitiveness) in both sectors, and perfect labor mobility between sectors. However, as soon as we abandon one of these assumptions, there is no reason to assume that the demand side, i.e., consumer preferences, does not matter. In fact, as argued by De Broeck and Sloek, a wide range of variables affecting demand may be of importance in this respect (De Broeck and Sloek, 2001). First, the growth of incomes is likely to result in demand skewed toward non-tradables (services) due to the luxury-good nature of many of them. This may drive the relative price of non-tradables further upwards, in excess of the level predicted by the Balassa-Samuelson model. Second, the share of government in GDP also tends to raise the relative price of non-tradables, as government spending typically falls more heavily on such non-traded goods as defense, health care, and education.

Relaxing the assumption of validity of the “law of one price” for tradables brings us to the issue of terms-of-trade and the impact of their shifts on real exchange rate. Such shifts are likely to affect the price level and hence the real exchange rate, both directly (via the changing price of tradables) and indirectly (via the changing price of non-tradables). As shown by De Gregorio and Wolf, the indirect effect may operate through both supply- and demand-side channels (De Gregorio and Wolf, 1994). Within the framework of their approach, tradables fall into two groups: goods which are being produced but not consumed (exportables), and goods that are being consumed but not produced (importables). Demand-side effects may come from both exportables and importables. A rising price of exportables induces a positive income effect, thus creating an upward pressure on the relative price of non-tradables. However, a change in the price of importables has ambiguous effects, since income and substitution effects run in this case in opposite directions. Only if the former dominates, will the falling price of importables lead to a growing demand for non-tradables and drive its relative price upwards. In turn, supply-side effects may be generated only by exportables. The rising price of the latter creates an upward pressure on wages in the tradable and therefore also in the non-tradable sector, raising the relative price of non-tradables. Generally, improving terms-of-trade are expected to induce real appreciation.

The Balassa-Samuelson model implies essentially that real appreciation is induced by rising productivity in the tradable sector. Interestingly, Grafe and Wyplosz have suggested a model for the particular case of transition economies where the causality between the two above-mentioned variables actually runs in the opposite direction (Grafe and Wyplosz, 1999). They split the sector of tradables into an "old" one, comprising traditional state-owned and largely subsidized enterprises, and a "new" one consisting of market-oriented private companies. Initially, the "new" sector offers low real wages as it needs high profit margins to accumulate capital. However, it can only attract labor from the "old" sector offering higher real wages, i.e., exceeding those in the "old" sector. Reallocation of labor to the "new" sector means that the "old" sector has to close down inefficient production lines, thereby raising overall productivity in the economy. Thus, in the interpretation of Grafe and Wyplosz, productivity growth is a consequence rather than a cause of real appreciation.

It should be mentioned that apart from the Balassa-Samuelson effect, there is another though not unrelated theoretical explanation of the link between the level of development and the value of real exchange rate. It was offered by Kravis and Lipsey and Bhagwati, and is based on differences in relative factor endowments between countries (Kravis and Lipsey, 1983; Bhagwati, 1984). In particular, rich countries are relatively well endowed with capital (because of imperfect capital mobility) and relatively badly endowed with labor. Therefore, they have relatively high wages and consequently relatively high prices for typically labor-intensive non-tradables, as compared to poor countries.

To sum up, the theory of Balassa-Samuelson and its demand-side modifications suggest that in the long run, real exchange rates are completely determined by real variables: productivities and tastes. In the short run, real exchange rates may be influenced by financial factors as well, such as monetary shocks, changes in portfolio preferences, and asset bubbles. Such shocks directly affect the nominal and, in the presence of nominal rigidities, the real exchange rate. Indeed, a number of empirical studies suggest that real exchange rates tend to be more volatile under floating than under fixed regimes. A change in the rate of inflation, coupled with nominal rigidities, is one example of a monetary shock affecting the real exchange rate. Since non-tradables do not directly face international competition, their prices may exhibit in the short run a relatively higher degree of nominal rigidity than the prices of tradables. Therefore, disinflation attempts through the use of fixed exchange rates as a nominal anchor may result in the rising relative price of non-tradables (real appreciation). Similarly, acceleration of inflation is likely to result in their falling relative price (real depreciation).

However, it is generally believed that monetary shocks cannot prevent the ultimate mean-reversion of the real exchange rate.[2] Taylor argues that even in the case of real shocks it cannot be ruled out, as long as the shocks themselves are mean-reverting (Taylor, 1995). The latter may be the case, for instance, due to cross-border technology transfer, which eliminates the gap resulting from initial productivity shocks. The argument loses its attractiveness though when we consider real exchange rates between industrial and transition (or developing) countries. In this case, transfer of technology is mostly unidirectional and is itself a source of faster productivity growth in poorer countries, so that there is no reason to expect the mean-reversion of real exchange rate.

Theoretical Arguments in Application to Real Exchange Rates in Transition Economies

Against the background of the above theoretical arguments, the dynamics of real exchange rates in the East European transition countries could be accounted for as follows.

The initial abrupt real depreciation could represent a combined effect of shock-wise external opening and hyperinflation, triggered by price liberalization

[2] Still, it seems unlikely that nominal rigidities can explain the very low empirically observed speed of real exchange rate mean-reversion. Rogoff refers to this problem as "purchasing power parity puzzle" (Rogoff, 1996).

in the presence of the inherited large monetary overhang. Under these circumstances, foreign assets were widely seen as a safe haven, with rapid nominal depreciation as a consequence. While the prices of tradables were rising roughly in line with depreciation, nominal rigidities could account for the fact that price increases for non-tradables were lagging behind, thereby inducing real depreciation.

Since in our interpretation, the initial real depreciation was caused by monetary shocks which can only explain real exchange rate movements in the short run, the subsequent real appreciation can be partly understood as a correction of the initial under-valuation. Besides, there are reasons to expect that the equilibrium real exchange rate, i.e., real exchange rate determined by real factors, was appreciating as well. First, the industrial restructuring largely financed by foreign direct investment inflows, must have brought about an increase in tradable productivity, possibly inducing a Balassa-Samuelson type of relationship. The accompanying growth of incomes could, in turn, lead to the over-proportionally rising demand for non-tradables, driving their relative price further upwards. Finally, real appreciation could also be promoted by the improving terms of trade, with exporters raising the quality of their output and learning how to operate in foreign markets.

REAL EXCHANGE RATE DETERMINATION: EMPIRICAL STUDIES

A number of empirical studies, focusing on both advanced and transition countries, aimed at identifying the factors behind real exchange rate movements. Table 9.1 presents the findings of those of them, which are most directly relevant for our purposes.

Halpern and Wyplosz attempt to explain the movements in dollar wages (a proxy for the real exchange rate) over the years of transition (Halpern and Wyplosz, 1997). In particular, they ask whether there is any substantial deviation of actually observed dollar wages from their presumed equilibrium levels. The equilibrium levels themselves are calculated as fitted values from a regression run on a sample of 80 countries between 1970 and 1985, with observations taken 5 years apart. In their approach, equilibrium dollar wage depends on aggregate productivity, sectoral productivity differentials, and a number of indicators of "economic effectiveness," such as the quality of exported goods, the sectoral wage gap, and the degree of market competitiveness. Since most of these indicators are not available, they are proxied by general indicators of development, such as the shares of agriculture and government in GDP and the level of education. In addition, to capture the dynamics of dollar wages about their equilibrium levels, the authors formulate an error correction model. The results suggest that the real appreciation of the East European currencies corresponds to a combination of a return to equilibrium after an initial overshooting,

Table 9.1. Explaining Real Exchange Rates: Overview of Some Previous Panel Data Studies[1]

	De Gregorio et al. (1994)		**De Gregorio and Wolf (1994)**	**UNO (2001)[2]**	**De Broeck and Sloek (2001)[3]**	
Sample	OECD countries			Transition economies		
Dependent variable	Relative price of non-tradables, *log*		Real exchange rate, *log*	Service-to-non-food producer price ratio, *log*	Real effective exchange rate, *log*	
Time span	1970-1985			1991-1998	1993-1998	
	Short-run	Long-run			EU accession countries[4]	Other transition countries[5]
Estimation method	SUR on first diffe-rences	OLS on cross-section	SUR on first differences	GLS	LSDV	
Price of exports, *log*	-	-	0.59 (0.03)	-	-	-
Price of imports, *log*	-	-	-0.46 (0.03)	-	-	-
Terms of trade, *log*	-	-	-	-	-0.03 (0.17)	-0.15 (0.11)
Labor productivity in industry,[6] *log*	-	-	-	0.24***	0.87 (0.19)	0.88 (0.26)
Labor productivity in services,[6] *log*	-	-	-	-0.18*	-0.55 (0.24)	0.10 (0.28)
Labor productivity in agriculture,[6] *log*	-	-	-	-	0.22 (0.10)	0.12 (0.21)

Total factor productiv-ity differen-tial, *log*	0.23 (0.02)	0.74 (0.28)	0.26 (0.05)	-	-	-
Share of government expenditure in GDP	1.85 (0.02)	-0.002 (0.074)	2.90 (0.29)	-	-	-
Govern-ment bal-ance, *log*	-	-	-	-	0.04 (0.01)	-0.02 (0.02)
GDP per capita (PPP), *log*	0.27 (0.03)	0.03 (0.24)	-0.16 (0.09)	0.03**	-	-
Openness, *log*	-	-	-	-	-0.40 (0.01)	-0,12 (0.09)
First	-0.05	-	-	country-	-	-
difference of inflation rate	(0.01)			specific, all significant		
Broad money over GDP, *log*	-	-	-	-	-0.11 (0.09)	-0.31 (0.09)
Fuel prices, *log*	-	-	-	-	-0.02 (0.12)	-0.83 (0.32)
Non-fuel prices, *log*	-	-	-	-	0.01 (0.33)	2.43 (0.85)
Serice-to-non-food price ratio lagged, *log*	-	-	-	0.44***	-	-

Notes:

[1] The figures correspond to slope coefficients (with the standard error in brackets).

[2] *, * *, * * * indicate significance at 10%, 5% and 1% levels, respectively.

[3] All variables (except fuel and non-fuel prices) are relative to the average of OECD countries.

[4] Except Romania.

[5] Southeast Europe, CIS, and Mongolia.

[6] Labor productivity is calculated as gross output at constant prices divided by employment.

and of real equilibrium appreciation, which in turn is driven by the improving fundamentals. Despite that, as of 1997, real exchange rates of these countries were still far below the levels suggested by their development indicators.

A "classical" empirical study on real exchange rates goes back to De Gregorio et al. (1994), who use the data on 20 sectors in 14 OECD countries in the period between 1970 and 1985. The detailed sector-level data on employment, nominal and real output, and capital stock allow the authors to derive sectoral price deflators and estimate production functions. They define a good as "tradable" if its exports in the whole sample amount to at least 10 percent of production. According to this criterion, manufacturing, mining, agriculture and transportation fall into the category of tradables, while services turn out to be non-tradable. In the next step, the authors regress the relative price of non-tradables on total factor productivity differential between sectors (presumably capturing the Balassa-Samuelson effect) and a number of other variables, including per capita GDP, the share of government, and inflation acceleration term. All regressors turn out to be statistically significant. In particular, the short-run coefficient on productivity differential is estimated at 0.23. In addition, to explain the dynamics of relative price of non-tradables in the long run, the authors run a cross-section regression using the average growth rates of variables during the period 1970-85. The coefficient on productivity differential turns out to be much higher (0.74), whereas the share of government and per capita income become statistically insignificant. These results suggest that in the long run, it is the productivity differential which determines the relative price of non-tradables.

Halpern and Wyplosz apply the approach of De Gregorio et al. to the panel of 9 transition countries for the period of 1991-1999 (UNO, 2001). They start with an observation that in most countries of the region labor productivity in industry was rising faster than in services. Subsequently, they put to an empirical test each step of reasoning leading to the Balassa-Samuelson effect. They find the dynamics of sectoral labor productivity to be driven by supply-side factors: the sectoral investment ratio and the inflows of foreign direct investment, the latter being a proxy for technological innovation. Besides, their results confirm that wages tend to be equalized across sectors, reflecting presumably labor mobility and the pressure coming from trade unions. Also, the impact of productivity on the real wage is found to be statistically significant. In the last step, they check for the presence of the Balassa-Samuelson effect directly and find that a 10 percent rise in productivity in industry raises the relative price of non-tradables by 2.4 percent in the short run and 4.4 percent in the long run. Per capita GDP and inflation acceleration are found to be significant as well. The findings also suggest that a floating exchange rate regime reinforces the Balassa-Samuelson effect, which is probably due to the fact that nominal appreciation is likely to occur faster than real appreciation via a price adjustment.

De Gregorio and Wolf (1994) were the first to augment the model of real exchange rate with the terms-of-trade. Using the same data on OECD countries as De Gregorio et al. (1994), the authors confirm the presence of the Balassa-Samuelson effect. They find that a 10 percent rise in total factor productivity differential across sectors induces a 2.4 percent real appreciation. The terms-of-trade shifts are found to be a significant determinant of real exchange rate movements, making GDP per capita statistically insignificant. This suggests that terms-of-trade operate mostly via the income effect. In absolute terms, export prices have a greater coefficient than import prices—a finding consistent with the underlying theoretical model, since the former affect both the supply and the demand side, whereas the latter the demand side only. In addition, the coefficient on import prices turns out to be negative, suggesting that the income effect dominates the substitution effect.

The results obtained by De Gregorio and Wolf suggest, among other things, the importance of terms-of-trade shifts in explaining the real exchange rate dynamics. However, as demonstrated by Chinn and Johnston, this may be due to the short-run focus applied (Chinn and Johnston, 1997). The latter authors attempt to identify a long-run relationship by applying cointegration techniques on the same panel of 14 OECD countries. They find that in the long run, the terms-of-trade cease to be an important determinant of real exchange rate, which is completely driven by tradable productivity (interestingly, non-tradable productivity and government spending become insignificant as well). The authors find it extremely difficult to find cointegration for individual time series, but the results of panel data estimations are more favorable. The authors conclude that the cointegrating relationship definitely includes relative sectoral productivity levels and government spending ratios, while the evidence regarding other variables is somewhat more ambiguous. In particular, they find that a 1 percent innovation in tradable sector productivity induces a 0.2 to 0.5 percent real appreciation.

A further sophistication of empirical work on real exchange rates in transition countries goes back to De Broeck and Sloek, who relate real effective exchange rate to a wide range of variables (De Broeck and Sloek, 2001). Each variable is expressed in relative terms to the “rest of the world,” which is proxied by OECD weighted average. The variables include productivity in industry, services and agriculture, money-to-GDP-ratio, government balance, degree of openness, terms-of-trade, and fuels and non-fuels prices. Two separate regressions are run on the two sub-samples—the EU accession countries (now the new EU members) and the remaining transition economies—which show diverging patterns of real exchange rate dynamics. The findings suggest that real exchange rate is positively associated with tradable productivity in both sub-samples. However, the authors argue that the same statistical relationship reflects opposite developments. While in the accession countries the real appreciation accompanies the growing tradable productivity, in the remaining countries real depreciation is associated with the falling tradable productivity. In another regression, the authors regress real exchange rate on the ratio of tradable to non-tradable productivity and find that the Balassa-Samuelson effect is statistically significant in the accession countries, but not in the second sub-sample. Interestingly, the terms-of-trade were found to be insignificant in both sub-samples.[3]

EMPIRICAL ESTIMATION

Theoretical Model: Real Exchange Rate Decomposition

As can be seen from above, the productivity-based explanation of real exchange rates has become a standard result of a large number of empirical studies, whereas the evidence has been generally more mixed with respect to both the terms-of-trade and the demand-side variables. In order to identify the relative contribution of each of these factors in the particular case of our countries, we first construct a model decomposing real exchange rate movements in two components: the shifts in terms-of-trade and the changing relative price of non-tradables.

We start from the standard definition of real exchange rate:

$$q = s + p - p^* \tag{1}$$

where q is log real exchange rate,

s is log nominal exchange rate (defined as the price of a unit of domestic currency in terms of foreign currency),

p is log domestic price level, and

p* is log foreign price level.

Given our definition, rising q means real appreciation, and declining q real depreciation.

[3] The same model, estimated on the sample of OECD countries, suggests that the terms-of-trade are statistically significant. As pointed out by the authors, this may be due to a more stable economic environment in OECD countries, which diminishes the relative importance of other shocks.

Now, log price levels both "at home" and "abroad" represent the weighted averages of log prices of tradables and non-tradables:

$$p = \alpha p_T + (1-\alpha)p_N \tag{2}$$

$$p^* = \alpha^* p_T^* + (1-\alpha^*)p_N^* \tag{3}$$

where p_T and p_T^* are log prices of tradables "at home" and "abroad,"

p_N and p_N^* are log prices of non-tradables "at home" and "abroad," and

α and α^* are the weights of tradables in consumption basket "at home" and "abroad."

Plugging (2) and (3) into (1) yields:

$$\begin{aligned} q &= s + \alpha p_T + (1-\alpha)p_N - \alpha^* p_T^* - (1-\alpha^*)p_N^* = \\ &= s + [\alpha p_T + (1-\alpha)p_T] + [(1-\alpha)p_N - (1-\alpha)p_T] - \\ &- [\alpha^* p_T^* + (1-\alpha^*)p_T^*] - [(1-\alpha^*)p_N^* - (1-\alpha^*)p_T^* \end{aligned}$$

$$q = s + p_T - p_T^* + (1-\alpha)(p_N - p_T) - (1-\alpha^*)(p_N^* - p_T^*) \tag{4}$$

Thus, real exchange rate can be decomposed into three components:

(1) (the terms-of-trade (the first three terms on the right-hand side of equation (4)),

(2) (the relative price of non-tradables in terms of tradables "at home," adjusted for the share of non-tradables in consumption basket (the fourth term), and

(3) (the relative price of non-tradables in terms of tradables "abroad," adjusted for the share of non-tradables in consumption basket (the last term).

From now on, we will concentrate on the first two components. We assume that the change in the relative price of non-tradables "abroad," i.e., in industrial countries, is negligibly small as compared to the East European transition countries. In this interpretation, real appreciation may be driven by two factors: by the improving terms-of-trade and/or by the rising relative price of non-tradables.[4]

The rising relative price of non-tradables itself can be driven by the Balassa-Samuelson effect, but may also reflect the shifts in demand. As demonstrated by De Gregorio et al. (1994), the relative price of non-tradables can be expressed as follows:

[4] $(1-\alpha)$ is the weight of non-tradables in the domestic consumption basket and is therefore positive.

$$p_N - p_T = \frac{\lambda_N}{\lambda_T}\pi_T - \pi_N + \mu \quad (5)$$

where λ_N and λ_T are the shares of labor in the non-traded and traded goods sectors, respectively,

π_N and π_T are log total factor productivities in the non-traded and traded goods sectors, respectively, and

μ captures the demand-side variables.

Substituting (5) into (4) without the last term on the right-hand side, we obtain:

$$q = s + p_T - p_T * + (1-\alpha)\left[\frac{\lambda_N}{\lambda_T}\pi_T - \pi_N + \mu\right] \quad (6)$$

It is this latter equation, which we test empirically. The dependent variable is *log* real exchange rate, and regressors include:

- log price of domestic tradables (exported goods), converted into foreign currency, with an expected positive sign;
- log price of foreign tradables (imported goods), with an expected negative sign;
- log labor productivity in the tradable sector, with an expected positive sign;
- log labor productivity in the non-tradable sector, with an expected negative sign;
- demand-side factors (such as the per capita GDP and the share of government expenditures), with expected positive signs (for reasoning, please refer to section 2.2.).

Besides, since the non-tradable sector is typically more labor-intensive than the tradable sector, and therefore $\lambda_N > \lambda_T$, we expect the coefficient on tradable productivity to be greater in absolute terms than the coefficient on non-tradable productivity.

Data and Methodology

Given the annual frequency of observations and the relatively short time period available for estimation, we use a panel data technique. In particular, we use an unbalanced panel of 8 countries—Hungary, Czech Republic, Poland, Slovakia, Slovenia, Romania, Croatia, and Bulgaria—over the period of maximum 12 years (from 1990 to 2001). The data presented in table 9.A.2 are taken from the wiiw database and thus ensure consistency both across countries and in time. All variables (except the share of government in GDP) are estimated in logs. The dependent variable is real exchange rate, which we calculate as the inverse of ERDI from 9.A.1. In all cases, we calculate the real exchange rate against the euro, given the fact that the European Union is by far the most important trading partner for all countries in question.

Due to the unavailability of reliable capital stock data and the short time span, we are unable to derive total factor productivity and therefore use labor productivity as a proxy. The latter is calculated as gross output (at constant prices) divided by employment. Although a correct measure of labor productivity would be the ratio of gross value added at constant prices and employment, the computation of value added at constant prices is hardly possible, given the unavailability of an appropriate deflator. Both productivity variables for each country are in index form, which enables us to analyze the impact of productivity differential on real exchange rate in the time-series context for a particular country, but makes it impossible to compare productivities in different countries. This would require conversion factors, similar to the International Comparison Project-based purchasing power parity, but enabling the comparison of price levels in individual sectors. The unavailability of such conversion factors and the resulting incomparability of sectoral productivities between countries make us use the within-group estimation technique.

The prices of exports and imports and the terms-of-trade (the ratio of export to import prices) are index variables as well. The original time series of export and import prices are typically based either on prices in domestic currency or on dollar prices, so that we had to convert them into euro-based prices to make them operational for our purposes. Again, as in the case of sectoral productivities, cross-country comparisons are impossible given the absence of appropriate conversion factors.

To capture the possible role of demand factors, we use two variables: GDP per capita (in euro, converted at PPP) and the share of government expenditures in GDP. Both variables are expected to have positive coefficients in line with the theory.

To estimate our model, we use the within-group estimation technique, which is based on deviations of variables from their individual, i.e., in our case, country-specific, means. Formally, an econometric model using such technique and applied to our special case of real exchange rate looks as follows:

$$q_{it} - \overline{q_i} = (x_{it} - \overline{x_i})'\beta + (\varepsilon_{it} - \overline{\varepsilon_i}) \quad (7)$$

where q_{it} is real exchange rate of country i in year t,

$\overline{q_i}$ is real exchange rate of country i, averaged over time,

x_{it} is a vector of explanatory variables in country i in year t,

$\overline{x_i}$ is a vector of explanatory variables in country i, averaged over time,

ε_{it} is the error term in a regression of q_{it} on the vector of explanatory variables x_{it}',

$\overline{\varepsilon_i}$ is the error term in a regression of $\overline{q_i}$ on the vector of explanatory variables $\overline{x_i'}$, and

β' is the vector of coefficients on explanatory variables.

Essentially, within-group estimation reveals to what extent deviations of the dependent variable (in our case, real exchange rate) from its country-specific mean can be explained by deviations of explanatory variables from their country-specific means. The vector of slope coefficients β' is assumed to be the same for all countries, whereas the country-specific intercepts (the so-called “fixed effects”) are eliminated due to the mean-subtraction. Within this approach, the variation of real exchange rates between countries remains unexplained, which suits our case, given the above-mentioned incomparability of sectoral labor productivity and export and import price indices across countries.

Results

Table 9.2 presents the main findings of our estimations, as well as the accompanying diagnostic statistics. Both the number of available indicators and the time-series length vary across countries, leading to an unbalanced panel. Therefore, the number of countries and observations underlying our six separate regressions is not the same.

The diagnostic statistics presented in Table 9.2 are generally favorable toward our model specifications. The Wald test for the joint significance of coefficients, which has a χ^2 -distribution, with the number of degrees of freedom corresponding to the number of regressors, is significant at 1 percent level in most tried specifications. The only exception is the baseline model (regression (1)), which contains the largest number of regressors, but even there it is significant at 10 percent level. This prompts us to reject the null hypothesis of non-significance of coefficients in all cases.

Table 9.2. Empirical Modeling of Real Exchange Rate

	(1)	(2)	(3)	(4)	(5)	(6)
Tradable productivity	0.55 (0.18)	0.56 (0.18)	0.64 (0.19)	-	0.53 (0.19)	0.47 (0.12)
Non-tradable productivity	-0.08 (0.28)	-0.08 (0.27)	0.06 (0.30)	-	0.22 (0.20)	-0.22 (0.20)
Export prices	0.64 (0.22)	-	-	1.18 (0.45)	0.55 (0.32)	0.68 (0.23)
Import prices	-0.57 (0.18)	-	-	-0.69 (0.32)	0.03 (0.10)	-0.66 (0.27)
Terms-of trade	-	0.60 (0.18)	-	-	-	-
Per capita GDP	-0.15 (0.25)	-0.13 (0.24)	-0.21 (0.23)	0.24 (0.11)	-0.47 (0.27)	-
Share of government in GDP	0.76 (0.25)	0.78 (0.26)	0.76 (0.27)	0.12 (0.27)	-	0.76 (0.26)
R-squared	0.710	0.709	0.647	0.599	0.616	0.705
Number of countries	6	6	8	7	6	6
Number of observations	47	47	56	58	58	47
Wald test for the joint significance of coefficients,	12.2* [0.057]	273*** [0.000]	370*** [0.000]	39.9*** [0.000]	862*** [0.000]	262*** [0.000]
$\chi^2_{no.ofregressors}$						
Test for autocorrelation with 1 lag, *N(0, 1)*	0.87 [0.38]	0.71 [0.48]	0.73 [0.46]	0.29 [0.78]	0.61 [0.54]	0.74 [0.46]
Test for autocorrelation with 2 lags, *N(0, 1)*	-0.57 [0.57]	-0.66 [0.51]	-0.68 [0.49]	-0.33 [0.74]	-0.36 [0.72]	-0.78 [0.43]

Notes:

The figures in the rows of explanatory variables correspond to slope coefficients (with standard error in round brackets).

The figures in the rows of diagnostic tests correspond to test statistics [with p-value in square brackets].

All variables, except for the share of government in GDP, are in logs.

***, **, *** indicate significance at 10%, 5% and 1% levels, respectively.**

We also performed two tests for autocorrelation, with one and two lags, respectively. The null hypothesis underlying the tests suggests zero coefficients in the regression of residuals on their lagged values and thus corresponds to no autocorrelation. The test statistics asymptotically have a standard normal distribution and turn out to be insignificant in all cases (see the two bottom rows of Table 9.2), implying a non-rejection of the null hypothesis of no autocorrelation.

In terms of contents, our results can be briefly summarized as follows.

First, in line with the earlier studies, our results seem to support the importance of the Balassa-Samuelson connection in explaining the dynamics of real exchange rates in Eastern Europe. In the baseline specification of our model, i.e., regression (1), tradable productivity has a positive and significant coefficient of 0.55 and non-tradable productivity a negative, though insignificant, coefficient of -0.07. As expected, the absolute value of the latter is smaller than the tradable productivity coefficient, suggesting that the labor-intensity of non-tradables is greater than that of tradables. The various modifications, which we undertook to our baseline model, see regressions (2) to (6); allow no qualitative changes to the above conclusions. Omission of productivity variables—see regression (4)—results in a considerable decline in fit, as measured by R-squared, which falls from 0.71 to 0.60.

Second, unlike some previous findings (e.g., De Broeck and Sloek, 2001), our results suggest the significance of export and import prices (or, alternatively, the terms-of-trade) in affecting the real exchange rate. Both export and import prices have the "right" coefficients and are significant in the baseline model, as well as in most other specifications. Omission of export and import prices—see regression (3)—also leads to a worse fit, albeit not as much as omission of productivity variables (R-squared falls to 0.65).

Third, in the baseline model, as well as in most other specifications, not only does the coefficient on GDP per capita turn out to be insignificant, but it is even negative contrary to what we could expect. Its omission from the model—see regression (6)—leads to almost no change of fit. However, with omitted productivity variables (regression (4)), it becomes positive and significant. We suggest the following interpretation of this finding. If both productivity variables and GDP per capita are included as regressors, the former capture the supply-side of economy, while the latter only picks up the demand effects associated with growing income. It is these demand effects, which are found to be statistically insignificant. However, in the absence of productivity variables, GDP per capita also incorporates the supply side and becomes significant.

CONCLUSIONS

We attempted to explain the real exchange rate movements in the East European countries in the process of transition. The currencies of these countries—Hungary, Czech Republic, Poland, Slovakia, Slovenia, Romania, Croatia, and Bulgaria—have undergone a substantial real appreciation vis-ŕ-vis the euro, resulting in a considerable narrowing of the gap in price levels between the eurozone and the countries involved. Economic theory suggests that in the long run, real exchange rate movements can only be explained by real shocks, such as the shifts in tastes (demand), technology (supply), and the terms-of-trade. Monetary factors can influence the real exchange rate only in the short run and only in conjunction with sticky prices and wages.

Using the above-mentioned theoretical results, we constructed a model decomposing real exchange rate movements into two components: the shifts in terms-of-trade and the changing relative price of non-tradables, whereby the latter is affected by both demand- and supply-side variables. In the next step, we put our model to an empirical test, using an unbalanced panel of 8 countries over a maximum of 12 years and applying within-group estimation technique.

Some of the results obtained are in line with previous findings. For instance, our findings support the conventional explanation of real appreciation in these countries—the rapidly growing productivity in the sector of tradables. The latter is the engine of the "catching-up" process and reflects the profound restructuring of inefficient industrial enterprises inherited from the planned economy. Also, the share of government in GDP has been found to be positively associated with the real exchange rate, probably due to the relatively high demand for non-tradable goods on the part of the state.

At the same time in a number of ways, our results differ from the earlier findings. In particular, we found improvements in terms-of-trade to be another important factor behind the real appreciation. Export prices were generally rising faster than prices of imports, most probably reflecting the rising quality of East European products and the increased ability of East European producers to operate in foreign markets. At the same time, we found no positive correlation between the real exchange rate and GDP per capita with included productivity variables on the right-hand side of the model, suggesting the relative unimportance of demand effects associated with rising income.

What would be the implications of our findings for the new EU countries wishing to join the European Monetary Union, thereby adopting the euro as the sole legal tender? It has already been argued that the productivity-driven real appreciation of the East European currencies may create problems for irrevocable exchange rate fixing. In particular, transition countries with a fixed nominal exchange rate will be likely to have inflation rates well above those in the "old" eurozone countries, thus jeopardizing the Maastricht inflation criterion. Our results suggest that this effect can be further exacerbated by the "terms-of-trade effect," provided past developments can be extrapolated into the future. Also, while so far there seems to be no evidence of rising incomes *per se* leading to real appreciation via the skewed demand for non-tradables, the situation may change, as living standards and consumption patterns in transition economies will converge to those currently observed in the "old" EU countries. This is a factor which may fuel the real appreciation of East European currencies still further.

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APPENDIX

Table 9.A.1. Inflation, Exchange Rates, Purchasing Power Parity, and GDP Per Capita in East European Countries in 1990-2001.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Czech Republic												
Producer price index, 1989=100	104.3	177.7	195.3	213.3	224.5	241.6	253.0	265.4	278.4	281.2	295.0	303.6
Consumer price index, 1989=100	109.7	171.8	190.8	230.5	253.5	276.7	301.0	326.6	361.6	369.2	383.6	401.6
Exchange rate (ER), CZK/EUR	22.89	36.60	36.62	34.10	34.06	34.31	34.01	35.80	36.16	36.88	35.61	34.08
Real ER (CPI-based), 1989=100	133.1	143.0	134.6	107.5	100.7	95.8	89.5	88.6	82.2	83.2	79.3	74.3
Real ER (PPI-based), 1989=100	135.6	130.0	120.0	103.7	100.4	98.3	93.6	94.8	90.9	91.9	88.6	83.4
PPP, CZK/EUR	6.02	7.89	8.44	10.08	11.19	11.85	12.68	13.36	14.62	14.75	14.57	15.03
ERDI (EUR based)	3.80	4.64	4.34	3.38	3.04	2.90	2.68	2.68	2.47	2.50	2.44	2.27
GDP per capita, EUR (PPP-based)	10040	9270	9680	9800	10230	11280	11980	12180	12220	12540	13260	13950
Hungary												
Producer price index, 1989=100	122.0	161.8	180.3	199.8	222.4	286.7	349.2	420.4	467.9	491.8	549.3	577.8
Consumer price index, 1989=100	128.9	174.0	214.0	262.1	311.4	399.3	493.5	583.8	667.3	734.0	805.9	880.1

Exchange rate (ER), HUF/EUR	80.48	92.70	102.10	107.50	124.78	162.65	191.15	210.93	240.98	252.80	260.04	256.68
Real ER (CPI-based), 1989=100	101.6	91.2	85.3	76.0	76.6	80.3	78.2	74.5	75.8	73.2	70.3	65.1
Real ER (PPI-based), 1989=100	104.0	92.3	92.4	89.0	94.8	100.2	97.3	90.0	92.0	91.9	88.6	84.2
PPP, HUF/EUR	27.96	33.78	39.04	46.80	54.74	65.99	78.67	90.73	100.85	107.17	115.03	122.92
ERDI (EUR based)	2.88	2.74	2.62	2.30	2.28	2.46	2.43	2.32	2.39	2.36	2.26	2.09
GDP per capita, EUR (PPP-based)	7210	7150	7300	7370	7770	8320	8600	9270	9890	10560	11410	11880
Poland												
Producer price index, 1989=100	722.4	1017.9	1368.9	1806.0	2262.6	2837.2	3189.0	3578.0	3839.6	4058.4	4375.0	4445.0
Consumer price index, 1989=100	685.8	1168.0	1670.0	2259.9	2987.6	3818.1	4577.9	5260.0	5880.7	6309.9	6947.2	7329.3
Exchange rate (ER), PLN/EUR	1.209	1.313	1.768	2.119	2.696	3.135	3.377	3.706	3.923	4.227	4.011	3.669
Real ER (CPI-based), 1989=100	117.1	78.5	77.3	70.9	70.4	66.0	60.8	59.3	57.1	58.1	51.3	45.6
Real ER (PPI-based), 1989=100	107.7	84.8	86.0	79.2	82.1	79.6	76.8	75.8	74.5	76.0	70.0	63.8
PPP, PLN/EUR	0.321223	0.48060	0.63275	0.81623	1.0253	1.2669	1.4797	1.6659	1.8389	1.9245	2.0163	2.0618
ERDI (EUR based)	3.76	2.73	2.79	2.60	2.63	2.47	2.28	2.22	2.13	2.20	1.99	1.78
GDP per capita, EUR (PPP-based)	4580	4400	4740	4960	5320	6300	6790	7340	7790	8270	8790	9060

Slovak Republic												
Producer price index, 1989=100	104.8	177.0	186.4	218.4	240.9	262.6	273.5	285.8	295.3	306.5	336.6	358.8
Consumer price index, 1989=100	110.4	177.9	195.7	241.1	273.4	300.5	317.8	337.2	359.8	397.9	445.6	478.1
Exchange rate (ER), SKK/EUR	22.98	36.48	36.63	35.98	37.93	38.45	38.40	38.01	39.60	44.12	42.59	43.31
Real ER (CPI-based), 1989=100	132.9	137.7	131.3	108.4	104.0	98.8	95.7	91.1	90.5	92.3	81.6	79.3
Real ER (PPI-based), 1989=100	135.5	130.1	125.8	106.8	104.2	101.4	97.8	93.5	93.9	100.9	92.9	89.7
PPP, SKK/EUR	7.01	9.09	9.61	10.96	12.21	12.86	13.22	13.63	14.16	14.77	15.38	15.89
ERDI (EUR based)	3.28	4.01	3.81	3.28	3.11	2.99	2.90	2.79	2.80	2.99	2.77	2.73
Slovenia												
Producer price index, 1989=100	490.4	1099.0	3469.6	4218.9	4965.8	5601.3	5982.4	6347.2	6727.8	6869.0	7391.3	8048.9
Consumer price index, 1989=100	651.6	1400.9	4305.1	5721.7	6923.3	7857.9	8635.7	9360.9	10100.5	10716.2	11670.2	12650.2
Exchange rate (ER), SIT/EUR	14.39	34.02	105.02	132.28	152.36	153.12	169.51	180.40	186.27	193.63	205.03	217.19
Real ER (CPI-based), 1989=100	72.5	83.8	88.0	86.4	84.8	77.4	79.9	80.1	78.0	77.4	77.2	77.3
Real ER (PPI-based), 1989=100	93.3	100.5	99.6	104.6	104.5	97.3	101.5	102.8	99.7	101.6	104.7	103.1
PPP, SIT/EUR	9.74	18.29	53.58	72.57	87.05	96.30	105.26	113.81	121.15	126.58	130.96	141.05

ERDI (EUR based)	1.48	1.86	1.96	1.82	1.75	1.59	1.61	1.59	1.54	1.53	1.57	1.54
GDP per capita, EUR (PPP-based)	10110	9540	9520	9930	10700	11610	12190	12860	13550	14520	15480	16250
Bulgaria												
Producer price index, 1989=100	114.7	454.7	709.8	910.6	1600.0	2454.4	5645.0	60462.0	70468.5	72723.6	85159.3	91376.0
Consumer price index, 1989=100	123.8	543.0	1038.5	1794.7	3518.1	5702.9	12637.6	146393	173733	178204	196584	211132
Exchange rate (ER), BGN/EUR	0.001	0.021	0.030	0.032	0.065	0.087	0.192	1.896	1.972	1.956	1.956	1.956
Real ER (CPI-based), 1989=100	92.0	456.5	364.8	234.2	245.6	209.9	214.3	186.8	166.7	163.1	151.6	144.8
Real ER (PPI-based), 1989=100	96.2	512.9	487.1	411.9	477.2	437.2	422.1	393.5	349.8	336.4	300.9	283.8
PPP, BGN/EUR	0.001071	0.00349	0.00530	0.00791	0.01338	0.02092	0.04546	0.3887	0.4746	0.4825	0.5037	0.5255
ERDI (EUR based)	0.93	5.92	5.71	4.10	4.83	4.15	4.22	4.88	4.16	4.05	3.88	3.72
GDP per capita, EUR (PPP-based)	4860	4500	4440	4460	4650	5010	4630	5400	5720	6010	6500	7010
Romania												
Producer price index, 1989=100	126.9	406.2	1156.8	3065.5	7372.6	9961.1	14928.8	37725.0	50235.3	72589.7	111354	157009
Consumer price index, 1989=100	105.1	283.9	881.5	3138.9	7431.5	9829.0	13643.6	34758.8	55300.0	80629.4	117450	157971
Exchange rate (ER), ROL/EUR	31.10	94.76	399.35	884.60	1967.56	2629.51	3862.90	8090.92	9989.25	16295.6	19955.8	26026.9

Real ER (CPI-based), 1989=100	190.5	226.0	320.6	206.6	200.2	208.5	226.2	189.8	149.9	169.8	146.4	145.5
Real ER (PPI-based), 1989=100	152.9	148.6	222.9	188.8	178.3	184.4	181.8	152.2	140.5	158.7	132.7	124.2
PPP, ROL/EUR	6.92	19.67	56.10	181.46	424.35	551.44	788.18	2181.1	3319.0	4808.2	6777.7	9099.7
ERDI (EUR based)	4.49	4.82	7.12	4.87	4.64	4.77	4.90	4.27	3.41	3.89	3.38	3.28
GDP per capita, EUR (PPP-based)	5340	4830	4720	4850	5160	5770	6110	5140	4970	5050	5260	5660
Croatia												
Producer price index, 1989=100	555.6	1368.3	12660.0	204130	362535	365073	370184	378698	374154	383882	421118	436278
Consumer price index, 1989=100	709.5	1582.2	12111.9	195909	387117	394859	408679	423391	447531	466327	495239	519506
Exchange rate (ER), HRK/EUR	0.01	0.02	0.34	4.13	7.09	6.76	6.80	6.96	7.14	7.58	7.63	7.47
Real ER (CPI-based), 1989=100	66.6	53.2	101.3	78.9	70.6	68.0	67.8	68.3	67.5	69.6	67.7	64.7
Real ER (PPI-based), 1989=100	82.4	57.8	88.4	67.5	66.6	65.9	65.9	66.5	68.7	71.2	68.4	65.4
PPP, HRK/EUR	0.009817	0.01885	0.1245	1.928	3.995	4.04	4.119	3.788	4.055	4.139	4.311	4.355
ERDI (EUR based)	1.47	1.29	2.73	2.14	1.77	1.67	1.65	1.62	1.53	1.61	1.56	1.51
GDP per capita, EUR (PPP-based)	5980	5190	4860	4360	4710	5210	5830	7150	7540	7560	8340	8860

Source: The Vienna Institute for International Economic Studies (wiiw).

Table 9.A.2. Export and Import Prices, Terms-of-Trade, Sectoral Productivity, and Share of Government in GDP in East European Countries in 1990-2001.

Hungary

	Export prices (EUR-based)	Import prices (EUR-based)	Terms-of-trade	Labor productivity in industry	Labor productivity in services	Government expenditures
	1995=100	1995=100	1995=100	1995=100	1995=100	% of GDP
1990	80.0	75.4	105.9	-	-	61.3
1991	90.7	95.6	94.9	-	-	65.7
1992	90.0	95.4	94.4	69.2	98.7	70.4
1993	95.6	99.1	96.5	79.7	98.4	73.2
1994	97.4	98.7	98.7	88.5	100.9	60.9
1995	100.0	100.0	100.0	100.0	100.0	53.4
1996	100.4	102.8	97.7	104.1	101.7	49.3
1997	104.5	105.6	98.8	114.0	104.8	49.7
1998	103.3	103.0	100.1	118.1	108.3	49.9
1999	102.2	103.6	98.5	125.4	106.9	47.0
2000	109.1	113.7	95.9	139.1	108.7	46.0
2001	113.0	118.1	95.6	138.4	113.4	-

Czech Republic

	Export prices (EUR-based)	Import prices (EUR-based)	Terms-of-trade	Labor productivity in industry	Labor productivity in services	Government expenditures
	1992=100	1992=100	1992=100	1995=100	1995=100	% of GDP
1990	-	-	-	-	-	-
1991	-	-	-	-	-	-
1992	100.0	100.0	100.0	-	-	-
1993	110.8	106.2	104.3	83.3	99.3	41.2
1994	116.0	107.4	108.0	92.7	96.0	39.1
1995	123.6	112.8	109.6	100.0	100.0	38.5
1996	125.5	115.4	108.8	117.9	96.7	38.0
1997	125.7	114.7	109.6	121.2	94.8	38.2
1998	130.4	112.0	116.4	112.9	97.9	37.6

1999	127.3	111.2	114.4	114.4	99.5	38.5
2000	137.3	123.4	111.2	128.5	99.7	39.3
2001	143.1	126.4	113.3	127.2	104.7	-

Poland

	Export prices (EUR-based)	**Import prices (EUR-based)**	**Terms-of-trade**	**Labor productivity in industry**	**Labor productivity in services**	**Government expenditures**
	1990=100	**1990=100**	**1990=100**	**1995=100**	**1995=100**	**% of GDP**
1990	100.0	100.0	100.0	-	-	34.6
1991	109.3	119.9	91.2	-	-	29.9
1992	103.6	103.8	99.9	75.0	91.2	33.2
1993	108.6	100.8	107.7	84.0	94.0	32.3
1994	109.9	100.8	109.0	93.4	98.4	32.7
1995	114.6	103.4	110.9	100.0	100.0	29.6
1996	115.0	106.6	107.9	108.3	103.3	28.1
1997	118.3	110.3	107.3	119.2	102.4	26.6
1998	119.4	106.7	111.9	125.6	102.0	25.2
1999	119.8	106.2	112.8	139.6	109.2	22.5
2000	127.7	117.9	108.3	158.2	114.6	22.1
2001	134.0	120.9	110.8	-	-	24.0

Slovakia

	Export prices (EUR-based)	**Import prices (EUR-based)**	**Terms-of-trade**	**Labor productivity in industry**	**Labor productivity in services**	**Government expenditures**
	1995=100	**1995=100**	**1995=100**	**1997=100**	**1997=100**	**% of GDP**
1990	-	-	-	-	-	46.6
1991	-	-	-	-	-	41.7
1992	-	-	-	-	-	42.5
1993	85.5	85.5	100.0	-	-	51.8
1994	91.2	91.2	100.0	93.2	86.4	37.0
1995	100.0	100.0	100.0	103.1	87.1	33.2
1996	100.1	110.1	90.9	102.1	90.5	44.9

1997	101.2	111.3	90.9	100.0	100.0	43.6
1998	106.8	106.8	100.0	103.8	102.8	41.5
1999	95.9	104.6	91.7	114.6	103.5	42.2
2000	117.4	117.4	100.0	111.0	109.1	44.1
2001	115.4	124.3	92.9	112.5	111.8	-

Slovenia

	Export prices (EUR-based)	Import prices (EUR-based)	Terms-of-trade	Labor productivity in industry	Labor productivity in services	Government expenditures
	1990=100	**1990=100**	**1990=100**	**1995=100**	**1995=100**	**% of GDP**
1990	100.0	100.0	100.0	93.5	83.0	-
1991	103.6	97.5	106.3	89.4	83.8	-
1992	101.1	92.3	109.5	83.1	87.9	42.1
1993	107.4	92.0	116.8	86.8	93.7	43.8
1994	114.4	92.4	123.7	96.8	95.8	43.4
1995	125.7	98.3	127.9	100.0	100.0	43.1
1996	131.0	100.4	130.5	106.9	100.1	42.4
1997	131.9	101.0	130.5	119.2	100.3	43.2
1998	133.5	99.2	134.6	127.0	102.1	43.7
1999	127.6	95.8	133.2	132.8	104.3	44.2
2000	148.9	116.7	127.8	144.1	104.9	44.1
2001	-	-	-	150.2	104.4	44.5

Romania

	Export prices (EUR-based)	Import prices (EUR-based)	Terms-of-trade	Labor productivity in industry	Labor productivity in services	Government expenditures
	1995=100	**1995=100**	**1995=100**	**1995=100**	**1995=100**	**% of GDP**
1990	126.7	56.6	223.8	79.5	103.2	-
1991	104.4	53.7	194.7	75.0	84.8	-
1992	88.3	71.6	123.2	74.6	85.2	-
1993	101.8	84.7	120.1	82.1	88.6	-
1994	100.4	88.3	113.8	89.2	91.5	-

1995	100.0	100.0	100.0	100.0	100.0	-
1996	104.8	107.7	97.3	105.8	111.9	33.8
1997	109.0	110.7	98.4	108.9	108.6	33.9
1998	102.7	99.3	103.4	109.1	108.6	35.3
1999	100.1	93.3	107.4	121.1	114.2	34.7
2000	113.8	102.5	111.1	132.0	117.5	35.4
2001	-	-	-	-	-	33.8

Croatia

	Export prices (EUR-based)	Import prices (EUR-based)	Terms-of-trade	Labor productivity in industry	Labor productivity in services	Government expenditures
	1995=100	**1995=100**	**1995=100**	**1998=100**	**1998=100**	**% of GDP**
1990	-	-	-	-	-	-
1991	-	-	-	-	-	-
1992	-	-	-	-	-	-
1993	-	-	-	-	-	-
1994	-	-	-	-	-	44.1
1995	-	-	-	-	-	48.9
1996	-	-	-	-	-	50.7
1997	-	-	-	-	-	49.8
1998	-	-	-	100.0	100.0	52.4
1999	-	-	-	104.9	98.1	54.8
2000	-	-	-	110.4	102.0	-
2001	-	-	-	116.2	104.5	-

Bulgaria

	Export prices (EUR-based)	Import prices (EUR-based)	Terms-of-trade	Labor productivity in industry	Labor productivity in services	Government expenditures
	1992=100	**1992=100**	**1992=100**	**1998=100**	**1998=100**	**% of GDP**
1990	-	-	-	-	-	59.3
1991	-	-	-	-	-	44.9
1992	100.0	100.0	100.0	-	-	45.7

1993	98.0	90.1	108.8	-	-	50.3
1994	81.5	74.4	109.7	-	-	47.5
1995	88.3	82.4	107.1	-	-	42.9
1996	105.4	104.9	100.6	99.2	103.5	43.3
1997	-	-	-	91.2	96.2	34.8
1998	-	-	-	100.0	100.0	38.8
1999	-	-	-	101.3	102.7	41.6
2000	-	-	-	120.9	115.0	42.4
2001	-	-	-	132.1	120.8	40.8

Source: The Vienna Institute for International Economic Studies (wiiw), own calculations.

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