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Convergence of Relative Prices and Inflation in Central and Eastern Europe

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Convergence of Relative Prices and Inflation in Central and Eastern Europe

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Abstract

The paper assesses inflation risks resulting from the convergence of structures of relative prices in Central and Eastern European (CEE) countries toward the European Union (EU). The basic idea of the paper is that under low downward flexibility of domestic nominal prices, the adjustment of relative price structures is likely to lead to higher inflation. The authors find that the degree of differences in the structures of relative prices in transition economies vis-à-vis EU economies has a strong negative relationship to price levels in the transition economies. Based on their calculations, the authors assess the likely future inflationary pressures that can stem from the remaining differences between the structures of relative prices in the CEE economies and the EU. The authors argue that their approach can be thought of as an extension of the standard Balassa-Samuelson explanation of international variability in price levels.

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I. Introduction

The process of price adjustment in transition economies vis-à-vis the developed ones is usually interpreted as convergence of average price levels. There is much less debate about the adjustment of structures of relative prices. This paper focuses on the adjustment of relative price structures and its implications for inflation. The basic idea is that if nominal prices are "sticky" (if their downward flexibility is low), then the adjustment of relative prices may be facilitated by non-zero inflation. The key question we try to answer is how large inflation pressures can result from the adjustment of structures of relative prices.

An extensive literature already exists on the relationship between relative prices and inflation (see, for instance, Parks, 1978; Lach and Tsiddon, 1992; Debelle and Lamont, 1997; or Fielding and Mizen, 2000). However, the literature focuses exclusively on the relationship between relative price *variability*[2] and inflation, while neglecting the important information contained in the *structure* of relative prices itself.

The focus on relative price variability can be appropriate in the case of developed countries, where the structure of relative prices has already "settled down," and most of the movements in relative prices are reactions to small deviations from the equilibrium set of prices. As a result, most of these studies have concentrated on the United States or other developed economies. The focus on volatility is most likely inappropriate in the case of emerging markets, where most of the movements in relative prices still reflect an adjustment process toward a new equilibrium set of relative prices. Our paper tries to fill this gap by shifting the focus from a time-series analysis of price variability vs. inflation in individual countries to the cross-sectional analysis of structures of relative prices vs. price levels in a sample of European countries.[3]

The cross-country analysis of relative price structures, presented in this paper, can also be thought of as a generalization of the standard Balassa-Samuelson framework (see Balassa, 1964; Samuelson, 1964) for a case of more than two types of commodities. While the usual Balassa-Samuelson analysis assumes the existence of two groups of commodities ("tradables"

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[2] Following Parks (1978), the literature defines relative price variability as

$RVP_t = \sum_{i=1}^{n} w_{it}^{*}(Dp_{it} - DP_t)^2$, where w_{it}^{*} is the expenditure share of commodity *i*,

$Dp_{it} = \ln p_{it} - \ln p_{it-1}$ is the growth rate of the price of commodity *i*, and $DP_t = \sum_{i=1}^{n} w_{it}^{*} Dp_{it}$ is a measure of inflation, using a standard Divisia price-index formulation. We have to define the key variable differently, however, since we do not focus on relative price volatility over time, but rather on cross-country differences in relative prices.

[3] The advantage of shifting from the time-series approach to cross-country analysis is also the fact that we do not have to address the tricky issue of simultaneity of the relative price volatility and inflation.

and "nontradables"), in this paper we work with about thirty commodity groups with different degrees of tradability.

The paper is organized as follows. After this introduction, the second part briefly discusses the traditional Balassa-Samuelson framework for explaining relative price levels. The third part defines a measure of differences in structures of relative prices, discusses the properties of such an indicator, and calculates it for various EU and CEE countries. The fourth part analyzes past adjustments in relative prices and assesses what would happen if relative prices adjusted the same way in the future. The fifth part discusses implications for monetary policy. The sixth part concludes.

II. THE TRADITIONAL APPROACH: PRICE LEVELS VS. GDP

The main source of international data on relative prices and price levels is the International Comparison Program (ICP), organized worldwide by the United Nations (see Kravis and others, 1982; Kurabayashi and Sakuma, 1990; Heston and Lipsey, 1999), and in Europe by OECD/Eurostat, in cooperation with the individual statistical offices (see, for instance, Czech Statistical Office, 1999; Statistical Office of Macedonia, 1999). One of the key results of the comparison program is data on prices in individual countries, on both a highly aggregated level (GDP and its components) and also a detailed breakdown into commodity groups. The price data have the form of "comparable prices." The comparable price of a commodity i, denoted as P_{ij}, is a price of the commodity i in the economy j in terms of commodity i in a reference economy (for instance, the price of bread in the Czech Republic in terms of bread in Germany). The ICP calculates the P_{ij}s for various commodity groups. Private consumption, for instance, consists of thirty items (Czech Statistical Office, 1999).[4]

[4] The basic methodology of the ICP can be explained using the following system of $(m+n)$ equations. The first subset defines the international price of commodity i (Π_i) as the quantity-weighted average of purchasing-power-adjusted prices of commodity i in the n countries:

$$\Pi_i = \sum_{j=1}^{n} \left(p_{ij} / PPP_j\right) \left(q_{ij} / \sum_{i=1}^{n} q_{ij}\right) \qquad i = 1, ..., m ,$$

where p_{ij} and q_{ij} is the price and quantity, respectively, of commodity i in country j. The second subset of equations defines the overall purchasing power parity for country j (PPP_j) as a ratio of the cost of its total bill of goods at national prices to the cost at international prices:

$$PPP_j = \left(\sum_{i=1}^{m} p_{ij} q_{ij}\right) \Bigg/ \left(\sum_{i=1}^{m} \Pi_i q_{ij}\right) \qquad j = 1, ..., n$$

This is known as the Geary-Khamis system of equations, after Geary (1958) and Khamis (1972). In the ICP, price input for each category is 1 for the numéraire country (the United States), and it is the category purchasing power parity vis-à-vis the numéraire country for other countries. For more details on ICP methodology, see Kravis and others (1982), Kurabayashi and Sakuma (1990), or Heston and Lipsey (1999).

The existing literature focused on the strikingly positive relationship between the average price level and per capita GDP. Figure 1a and equation (1) show, for a pooled sample of European OECD countries[5] and selected CEE transition countries in 1999, that in the cross-country comparison, a very significant positive relationship exists between the price level and GDP per capita (standard errors are in parentheses):

$$\mu = \underset{(0.06)}{-0.04} + \underset{(0.07)}{1.00}\ GDP, \qquad (1)$$

$$R^2{=}0.91,\ N{=}22,\ F{=}209.3,$$

where μ is the average price level and GDP is the gross domestic product (in both cases, Germany=1). The regression accounts for almost 90 percent of the cross-country variability in price levels, and the null hypothesis of no correlation between the two variables can be easily rejected at the 1 percent significance level. At the same significance level, we cannot reject the hypothesis that the slope coefficient equals 1. Our estimate therefore suggests that for the given sample, an increase in GDP per capita in purchasing power parity (PPP) units relative to Germany by 1 percent tends to be accompanied by an increase in the price level relative to Germany by 1 percent.

Is the finding that the slope coefficient is equal to 1 robust? Empirically, the question can be addressed by including other, less developed, transition countries (see Figure 1b). The slope coefficient in this regression remains positive, but becomes less than 1 (roughly 0.9). It therefore seems that the slope coefficient may partly depend on the exact selection of countries. Appendix I explains in greater detail that both Figure 1a and Figure 1b are consistent with the Balassa-Samuelson model's quantitative predictions regarding the slope coefficient.

The significantly positive relationship between price levels and GDP contradicts the simple ("absolute") version of the purchasing power parity hypothesis, which states that price levels in different countries should be equal.[6] It is, however, consistent with the Balassa-Samuelson model (see Balassa, 1964; Samuelson, 1964).

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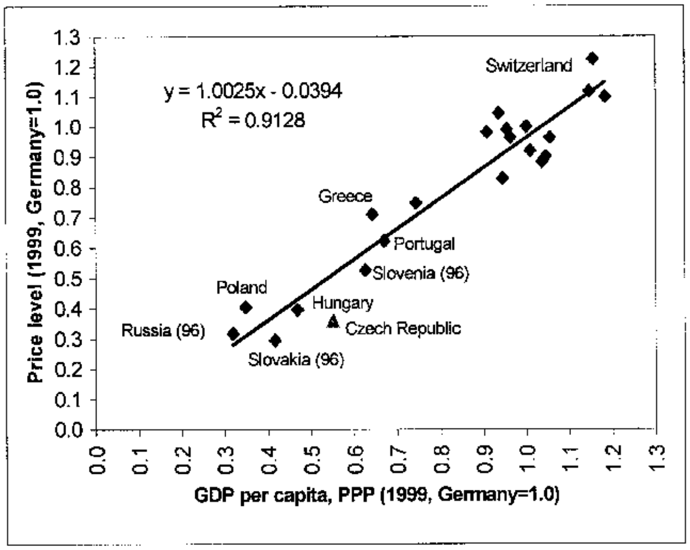
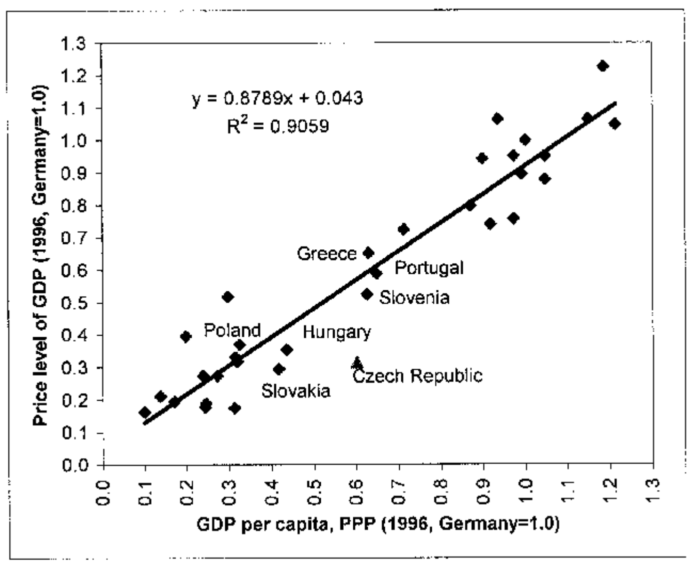
[5] Luxembourg was excluded as an outlier.

[6] This can be reconciled with the dynamic ("relative") version of purchasing power parity theory, though. For an excellent overview of the purchasing power parity literature, see Officer (1976) or Froot and Rogoff (1995).

Figure 1. The Traditional Approach—Price Level vs. GDP
(a) 22 Countries[7]



(b) 33 Countries[8]



Sources: ICP and authors' calculations.

[7] Countries included: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Poland, Portugal, Russia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom (*N*=22).

[8] Countries included: Those in Figure 1a, plus Albania, Belarus, Bulgaria, Croatia, Estonia, Latvia, Lithuania, FYR Macedonia, Moldova, and Romania (*N*=33).

The key element of the Balassa-Samuelson approach is the distinction between tradable and nontradable commodities. For tradables, the law of one price is assumed to hold. Nontradable commodities are characterized by the absence of arbitrage, so that no direct mechanism of elimination of price differences among countries is in place. The price of nontradable commodities is therefore fully determined by domestic demand and supply. Demand and supply in the domestic market are in turn closely related to real wages, because they influence both production costs and the purchasing power of the workforce. Since the main factor determining real wages in the long run is labor productivity in the tradable sector, less developed countries with low labor productivity in the tradable sector have lower price levels than more developed countries. This is the basic Balassa-Samuelson explanation for the strong positive correlation between price level and GDP per capita, shown in Figures 1a and 1b. For more detailed accounts of the Balassa-Samuelson theory, see Mussa (1984), Frenkel and Mussa (1986), Asea and Corden (1994), or Samuelson (1994). For empirical estimates, see for instance De Gregorio and others (1994), or De Broeck and Sløk (2001).

One of the main problems of the standard Balassa-Samuelson approach is that the distinction between tradable and nontradable commodities seems to be artificial. It is very difficult to distinguish, in available data, which commodity groups are tradable and which are not.[10] One possibility to distinguish between tradability and nontradability is to run regressions between prices and GDP, similar to those shown in Figures 1a and 1b and in the estimate (1), but separately for each individual commodity group. The explanatory variable is still GDP, but the dependent variable P is not the general price level, but the price of a specific commodity group. For a tradable commodity, one can expect that the slope coefficient will not be significantly different from zero, while for a nontradable commodity, it will.[11]

The results of these regressions for 29 commodity groups in 22 European countries are summarized in Table 1. The relationship between the price and GDP was not statistically significant in only one group (cars). In all the other groups, the slope coefficient was significantly positive, and with the exception of only two groups, the estimated slope was higher than 0.5. Clearly, the standard data sets suggest that there are many different degrees of

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[9] This can be reconciled with the dynamic ("relative") version of purchasing power parity theory, though. For an excellent overview of the purchasing power parity literature, see Officer (1976) or Froot and Rogoff (1995).

[10] Moreover, especially in the period of transition from a planned economy to a market economy, the distinction between the two categories shifts over time, since as a result of foreign investment and improved competitiveness, many originally nontradable commodities become tradable.

[11] At least in theory, one can imagine that tradability can be analyzed more directly, by investigating whether foreign competition participates in a particular market. In practice, such an analysis is impaired by data constraints and by the difficulty of defining precisely "foreign competition in a particular market." This leads us to the indirect method described above.

tradability rather than two clearly distinguished and separated groups of goods. We find that even for several commodities traditionally described as "tradable," such as footwear or garments, the prices have significantly differed, depending on GDP. One explanation for the differences in prices of "tradables" can be the fact that their retail prices include also nontradable elements, such as transportation costs, wholesale margins and retail margins.

The cross-country regression of price levels vs. GDP does not account for all of the differences in price levels, suggesting that there might be additional explanations and that the regression analysis might be extended. In Appendix II we try to explain the most significant negative residual in our sample, the Czech Republic, and we show an extended form of the cross-country regression (1).

All these detailed explanations suggest that a need exists to go beyond the standard cross-country comparison of average price levels and beyond the standard analysis of tradable vs. nontradable prices. In the next part of the paper, we therefore start studying detailed price data.

III. Price Levels vs. Differences in Structures of Relative Prices

The differences in structures of relative prices are so large that it can be very deceptive to rely on average price level data. Appendix III shows the distribution of comparable prices in the Czech Republic, and also in the Netherlands and Portugal. In the Czech Republic, rents, schooling, and health care are at less than 15 percent of the German level, while cars and shoes have virtually the same price as in Germany. It would be an oversimplification, however, to state that the lower prices are only those of "nontradables;" it would also not be true to claim that all "tradable" prices are equalized. A significant part of the traditional "tradable" commodities (such as most foodstuffs, nonalcoholic beverages, clothing, floor coverings, home appliances, etc.) are at 45–75 percent of the German level, and the distribution of relative prices is very uneven and dispersed (see Appendix III for more details).

The wide dispersion of the comparable prices means that relative prices (such as the price of shoes in terms of rents, or the price of cars in terms of food) are significantly different in the Czech Republic and other CEE countries from prices in developed countries. Comparable prices, P_i, do not allow for a direct computation of relative prices. However, we can choose a reference country (such as Germany), and compare to what extent the structure of relative prices of a given country is similar to the system of relative prices in the reference country.

In order to measure the extent of relative price differences more exactly, we suggest defining the *coefficient of relative price differences*, which captures the degree of deviations of relative prices in a given country vis-à-vis the system of relative prices in the reference country. This coefficient is calculated as a weighted standard deviation of comparable price levels of individual goods in the given country relative to the average comparable price level, that is,

$$\rho = \frac{1}{\mu} * \sqrt{\sum_i w_i (P_i - \mu)^2} , \qquad (2)$$

where w_i are weights of the individual commodities in the consumption basket and μ is the average price level of consumption. Note that this definition does not measure relative prices (such as price of cars in terms of food in the Czech Republic) directly. It measures only the differences in structures of relative prices, by measuring the dispersion in comparable prices (such as price of cars in the Czech Republic vis-à-vis cars in Germany). If, for instance, the structures of relative prices in the given country and the reference country are completely identical, then all comparable prices will be the same (that is, equal to μ), meaning that the coefficient of relative price differences will reach its minimum value of zero. The higher the differences in individual relative prices, that is, the higher the dispersion of the comparable prices around their average, the higher the value of ρ. Theoretically, the coefficient of relative price differences is not limited from above, but, as shown in Tables 3 and 4, empirical values for European countries tend to be well below 1.

The coefficient of relative price differences, as defined in (2), is only one of potentially many ways of expressing the degree of differences in structures of relative prices. There might also be other significant features of the distribution of relative prices, which are not captured by this coefficient (such as the skewness or the kurtosis of the distribution). The definition in (2), however, has several advantages. First, it compresses the information about the price structures into a single coefficient. Second, it is intuitively easy to explain and to interpret as a "weighted standard deviation" of the relative prices. Third, as we will show below, it is useful for further analysis, since it has meaningful relationships to other variables.

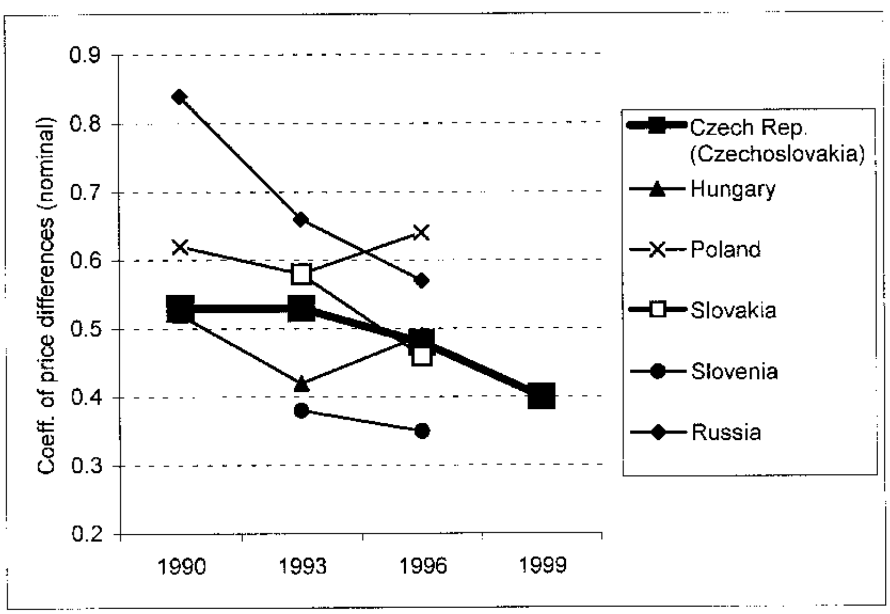
There are several practical problems related to the calculation of ρ. The most important one is the choice of suitable weights. There are two basic ways of calculating the weights of individual commodities in the consumption basket. First, we can use the actual structure of nominal consumption expenditures by households (below, we will refer to these weights as "nominal"). The problem with nominal weights is that they tend to underestimate the importance of items with artificially low (regulated) prices, such as rents, thereby biasing downward the coefficient of relative price differences in transition economies. Second, we can calculate "real weights" of the respective commodities by imputing internationally comparable prices of individual commodities. The calculation of "real weights" is somewhat artificial, since it implicitly assumes that the real structure of consumption in transition countries will not change as relative prices will change. It is, however, likely that if the relative price of a commodity increases, people will try to substitute its consumption with other commodities, so that the structure of consumption will tend to shift towards those commodities whose prices grow the least.[12] The "nominal weights" and "real weights" are lower and upper bounds of the "true" distribution; the most likely scenario probably lies somewhere in between. In this paper, we calculate the results for both real weights and for nominal weights, which allows us to estimate the range of likely scenarios.

[12] At the same time, though, there will be also income effects: the growth of wealth is likely to increase the share of consumption of luxurious items.

Tables 3 and 4 summarize our calculations of coefficients of relative price differences for a sample of 22 European countries in 1980 through 1999. The calculations are based on the standard breakdown to 29 commodity groups of private consumption used in the ICP. We can see that the results for real weights are not qualitatively different from those for nominal weights.

In general, coefficients of relative price differences in the most developed EU countries are well below 0.20, and even in the least developed EU countries they are not higher than 0.35. The coefficients in transition countries are generally much higher. In the Czech Republic and several other transition countries, they have been declining toward the EU levels. Nevertheless, significant gaps still exist vis-à-vis even the least developed EU countries. Moreover, Figure 2 shows that the decline is not a rigid rule and that some countries may temporarily experience an increase in the coefficient of relative price differences.

Figure 2. Coefficients of Relative Price Differences in Selected CEE Countries, 1990–99



Sources: ICP and authors' calculations.

Note that the coefficient of relative price distortions is not equal to zero in any of the countries. It just confirms that even in the closely intertwined European countries, some differences in relative prices remain. These differences are mainly due to differences in consumer preferences, in government regulation (for example, indirect taxes), and other factors (for example, transportation costs). We do not claim that these differences are likely to disappear. We do think, however, that the differences in structures of prices between the CEE countries and the

EU countries are large and that during the convergence process, they are likely to decline to the values usual in EU countries.[13]

Figure 3 plots the price levels in the individual countries against the coefficient of relative price differences. The data in Figure 3 can be fitted by a standard linear regression. For Figure 3a (real weights), we obtain the following result:

$$\begin{aligned} \mu &= \underset{(0.06)}{1.19} - \underset{(0.16)}{1.17}\rho\,, \\ R^2&=0.73,\ N=22,\ F=54.83\ . \end{aligned} \tag{3a}$$

For Figure 3b (nominal weights), we get:

$$\begin{aligned} \mu &= \underset{(0.09)}{1.26} - \underset{(0.26)}{1.57}\rho\,, \\ R^2&=0.64,\ N=22,\ F=35.79\ . \end{aligned} \tag{3b}$$

where μ is the average price level of consumption and ρ is the coefficient of relative price differences, defined in (2). All the coefficients and both regressions are significant at the 1 percent significance level.

How stable is the slope coefficient in these regressions? Table 5 summarizes results of regressions of price levels vs. coefficients of price differences for earlier periods than those covered in equations (3a) and (3b). In general, the regressions are more significant for real weights than for nominal weights. The determination coefficients were significantly higher for 1993 and 1996, when the regressions covered more transition economies (influential points). The slope coefficients in 1993 and 1996 are similar; they do not seem to be very stable in the previous periods, but the average slope coefficient for real weights in 1980, 1985 and 1990 was 1.18, which is very close to the coefficient for 1993 and 1996. For the purposes of our study, more important observations are indeed those for the 1990s, because they include the transition countries.[14]

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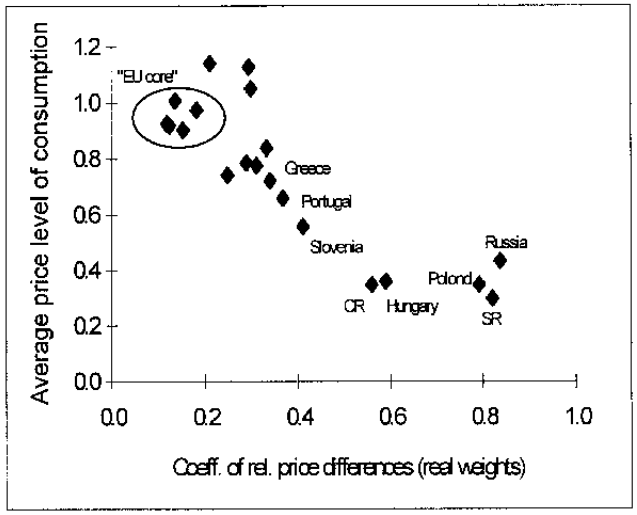
[13] For the same reason, the results of our analysis would not change dramatically if we used France, for instance, as the reference country instead of Germany, because the differences in relative prices between France and Germany are much lower than between Germany on one hand and the CEE countries on the other hand (see Tables 3 and 4).

[14] In order to test the stability of the slope coefficient formally, we tested for the presence of structural breaks in the pooled regression. For the coefficient with nominal weights, the Chow test detected a structural break in 1993 (p-value=0.07), which can be seen already directly from

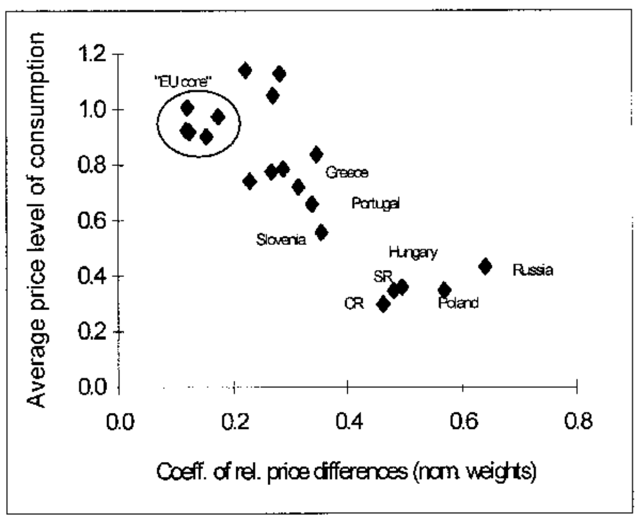
(continued...)

Figure 3. Price Levels and Relative Price Differences in 1996; 22 Countries[15]

(a) Real Weights



(b) Nominal Weights



Sources: ICP and authors' calculations.

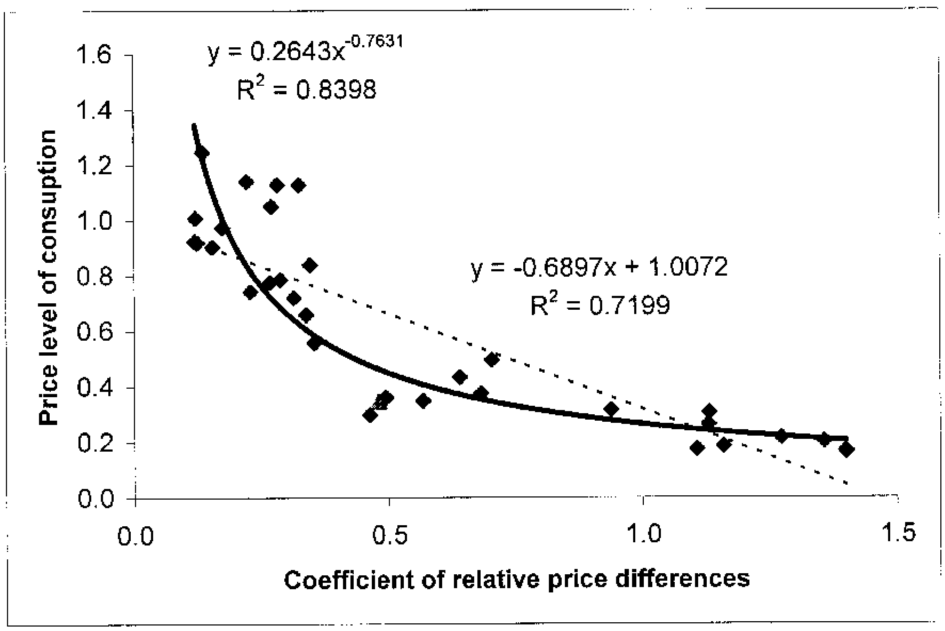
Table 5. For real weights, we were not able to detect any structural break at the 10 percent significance level (p-value=0.12). We are aware of the methodological weaknesses of the pooled-data approach; we would like to switch to a panel-data approach in the future.

[15] The reference country is Germany (=1 on the vertical axis). For a list of the countries included, see Figure 1a.

The negative relationship between price levels and coefficients of relative price differences can be found also for a broader sample of 32 European countries, which includes other, less developed Eastern European countries (see Figure 4). We can see that in this sample, the coefficient of relative price differences is higher than 1 in some countries. The relationship between the price level and the coefficient of relative price differences is still strongly negative, but it seems to be hyperbolic rather than linear, suggesting that the lower the differences in the structure of prices, the higher the impact of relative price adjustments on the price level.

We also estimated the relationship between price levels and relative price differences for a worldwide sample of 104 countries. As expected, the relationship was much weaker, but it was still slightly negative. The results are summarized in Appendix IV, together with the results of regression (1) of price levels vs. GDP for a worldwide sample of 106 countries.

Figure 4. Price Levels and Relative Price Differences in 1996; 32 Countries[17]



Sources: ICP and authors' calculations.

[16] In order to test the stability of the slope coefficient formally, we tested for the presence of structural breaks in the pooled regression. For the coefficient with nominal weights, the Chow test detected a structural break in 1993 (p-value=0.07), which can be seen already directly from Table 5. For real weights, we were not able to detect any structural break at the 10 percent significance level (p-value=0.12). We are aware of the methodological weaknesses of the pooled-data approach; we would like to switch to a panel-data approach in the future.

[17] The reference country is Germany (=1 on the vertical axis). For a list of the countries included, see Figure 1b.

The negative relationship between relative price differences and price levels is consistent with the idea that our framework is a generalization of the standard Balassa-Samuelson approach to explaining international differences in price levels. One of the key features of the Balassa-Samuelson framework is the distinction between tradable and nontradable commodities. Let us assume that the consumer price index in a country is a geometric weighted average of traded and nontraded goods prices,[18]

$$P = P_T^{1-\alpha} P_N^{\alpha} \;, \tag{4}$$

where P is the price index, P_T is the traded goods price index, P_N is the nontraded goods price index, and α is the share that nontraded goods take in the price index. Similarly, the consumer price index abroad is defined as:

$$P* = P_{T*}^{1-\alpha^*} P_{N*}^{\alpha^*} , \tag{5}$$

where the meaning of the variables is the same, with the star denoting the foreign country. The real exchange rate can then be denoted as:

$$Q = \frac{P}{E\,P^*} = \frac{P_T}{E\,P_{T*}} \left(\frac{P_{T*}}{P_{N*}} \right)^{\alpha^*} \left(\frac{P_T}{P_N} \right)^{-\alpha} , \tag{6}$$

where E is the nominal exchange rate. The standard Balassa-Samuelson approach assumes that the first fraction is equal to 1, because prices of tradables equalize. Therefore, equation (6) relates the real exchange rate (the comparable price level) to the structures of relative prices in the two countries. In the Balassa-Samuelson model, the structures of the prices are simplified into the ratio of tradable and nontradable prices, while in our approach they are represented by the coefficient of price differences.

The basic hypothesis behind our following calculations is that with the economic convergence of CEE countries toward the EU, the coefficient of relative price differences will decline. Will that really be the case, though? Let us look at whether the convergence of relative price structures was the case in EU economies, especially in the less developed ones that entered the EU at a later stage. The data in Tables 3 and 4 indicate that the coefficients of relative price differences do not always decline. For instance, in several EU countries (Austria, Denmark, Greece, Ireland, Italy, Spain, Sweden, United Kingdom), coefficients of relative price differences increased between 1993 and 1996. The Box below discusses the various reasons that the coefficient could increase in certain periods.

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[18] The geometric average is an optimal price index, provided that we assume a utility function with constant elasticity of substitution between tradable and nontradable commodities. The traditional arithmetic average can be thought of as a log-linear approximation of this optimal price index (see, for instance, Obstfeld and Rogoff, 1998).

In spite of these reservations, it is possible to conclude that a long-term tendency exists toward a decline in the coefficients of relative price differences. In Portugal, for instance, the coefficient with real weights declined between 1980 and 1996 from 0.40 (and 0.67 in 1985) to 0.37, and the coefficient with nominal weights decreased from 0.49 to 0.34. Similarly, in Greece, the coefficient declined in the same period from 0.49 to 0.37 for real weights and from 0.42 to 0.31 for nominal weights. The convergence of price structures, although discontinued by the atypical year 1996, can also be observed in the more developed EU countries. We should not be surprised if the process of EU accession leads to a temporary increase in the coefficient of relative price differences, but it is reasonable to assume that in a horizon of about a decade, the tendency toward a decline in this coefficient will prevail in the CEE countries as well. The decline in the coefficient is likely to be more pronounced in the CEE countries, because the extent of relative price distortions is still higher than it was in the EU-accession countries in the past.

Box: Explaining Increases in the Coefficient of Relative Price Differences

Why did the coefficients of relative price differences in Austria, Denmark, Greece, Ireland, Italy, Spain, Sweden, and the United Kingdom increase between 1993 and 1996? There are several factors that may have caused this increase in coefficients of price differences. First, all the countries are being compared with Germany, which was in the beginning of 1993 subject to a significant shock, namely the unification with Eastern Germany, which partially influenced the structure of relative prices in Germany as a whole. Second, there were also partial changes in the methodology of data calculation, which make comparisons across time complicated. Third, in 1996, prices in the EU countries were influenced by the impact of the crisis of the EMS and the forced devaluation of several currencies (Italy, the United Kingdom). Fourth, if the downward flexibility of prices in individual countries is different, the economic slowdown in 1996 might have led to an increase in the coefficient of relative price differences relative to Germany. Finally, the price system in the new EU member countries (Austria, Sweden) might have been temporarily disturbed by the preparation for EU accession and by the accession itself. A similar development was observed before EU accession in Spain and Portugal, too, where the coefficient of relative price differences temporarily increased in 1985 (in Portugal, it was true only for the real-weights-based coefficient). This development—somewhat paradoxical at first sight—can be easily explained: the acceptance of common EU policies (such as the common agricultural policy) or tax harmonization can increase some groups of prices in poorer countries, thereby distorting the system of relative prices temporarily; it is only afterwards that the relative prices begin to "settle down" again, and that the coefficient of relative price differences starts to decrease again.

IV. Inflation and The Mechanism of Relative Price Adjustment

We have illustrated that the extent of relative price differences in Central and Eastern European countries is relatively large, and that it can play a much more important role in inflation developments than usual in standard EU economies. It is therefore crucial to understand the relationship between relative price differences and future inflation.

In general, there are many possible scenarios for the development of nominal prices. However, it is possible to restrict the number of reasonable scenarios. The key assumption is that nominal prices (and wages) are not very flexible downward. Therefore, most adjustments of relative prices are likely to take the form of increases in individual nominal prices.

Is this a reasonable assumption, though? Figure 5 shows cumulative growth indices of domestic prices of individual consumption items in the Czech Republic in the period 1993–99 as a function of their level in 1993 (the reference country being Germany). None of the prices declined in this period. Moreover, we can see that those prices, which were already relatively close to the developed countries in 1993, tended to grow at a slower rate in the consequent period, while prices of undervalued commodities experienced a faster growth rate. This negative relationship between the original price level and the growth rate of the domestic prices was estimated by a hyperbolic-shaped curve (standard errors in parentheses):

$$P_i[99]/P_i[93] = \underset{(0.11)}{1.11} + \underset{(0.05)}{0.11}\,[1/P_i[93]]\,, \qquad (7)$$

$$N = 29;\ R^2 = 0.45;\ p(F\text{-statistics}) = 0.00\,.$$

The estimated hyperbola is also depicted in Figure 5.[19] Both the coefficient of the explanatory variable and the coefficient of determination are statistically significant at the 1 percent significance level, which confirms that there was a decline in relative price differences. The estimated curve is a hyperbola, not a straight line: when a linear term ($P_i[93]$) was included in the estimate, the respective slope coefficient was insignificant. The finding that the most underpriced items were growing at the fastest rate seems somewhat surprising, given the regulation of prices of most of these items. The data indicate that in spite of the price regulation,

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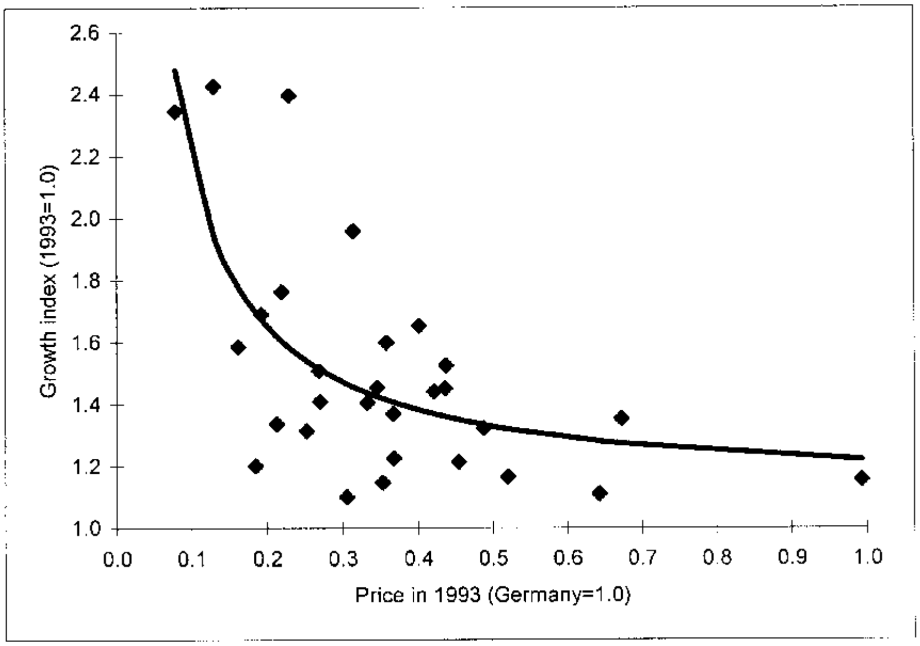
[19] Note that the growth rates shown on the vertical axis of Figure 5 are calculated from official consumer price data published by the Czech Statistical Office. We use the domestic data because we want to derive policy conclusions expressed in terms of variables used by the domestic authorities. Nevertheless, a similar negative relationship between the price gaps and the growth rates of prices can also be found in the ICP data (which is consistent with the observation that the coefficient of relative price differences in the Czech Republic declined over time).

the prices of the most under-priced commodities were growing fast enough to decrease the coefficient of relative price differences.

Figure 5. Czech Republic: Adjustments in Relative Prices in 1993–99



Sources: Czech Statistical Office and authors' calculations.

How general is the finding, illustrated in Figure 5, that growth rates of individual prices are negatively correlated with initial comparable prices? It can be expected that the negative correlation will be present for other transition countries as well, especially for those that are still in the initial period of rapid relative price adjustments. But even for Slovenia, the country with the highest GDP per capita among the CEE countries, we still find a significantly negative relationship between growth rates of individual prices and the initial comparable prices:

$$P_i[00]/P_i[96] = 2.12 - 0.85\, P_i[96] - 0.13\, [1/P_i[96]]\,,$$

$$(0.40)\quad (0.36)\qquad (0.10)$$

$$N = 29;\ R^2 = 0.27;\ \text{p}(F\text{-statistics}) = 0.01\,.$$

The only difference compared with the Czech Republic is the fact that the hyperbolic term is insignificant. However, the slope coefficient of the linear term is highly significant and negative, so that we still observe a negative relationship between the two variables.

How will prices adjust in the future? We noted that the estimated cross-sectional slope coefficients seem to be relatively stable over time. An easy approach therefore is to assume that the slope coefficients estimated in the cross-country regressions are useful guides for estimating future price adjustments. This approach is adopted in Table 6, which shows, for the sample of CEE countries, what increase in the price level would correspond to a decrease in the coefficient of price differences to the level of 0.30, which is roughly the level of the least developed EU countries. We can see that the nominal weights-based index always leads to a lower estimate of the pressure on the price level. The price level pressures resulting from the "necessary" relative price adjustment is the lowest in Slovenia, and the highest in Poland.

An alternative approach to the problem is to assume that the price of an individual commodity will adjust proportionally to the gap vis-à-vis the respective price in the reference country. This assumption can be expressed as follows:

$$P_i^* = P_i^0 + s(1 - P_i^0) \ , \tag{8}$$

where s is the "shrinkage" parameter, which captures the rate at which price gaps are being closed. Zeros denote initial period, while stars denote end period, so that P_i^0 and P_i^* denote the starting and the end values, respectively, of the comparable price of commodity i. An intuitive justification of this assumption can be drawn both from the "conditional convergence" theory, and from models of state-contingent pricing, known as "*Ss* pricing."[20] Let us call this adjustment mechanism "linear shrinkage," because the extent of the price shrinkage is a linear function of the price gap.

If, for a moment, we adopt the assumption of "linear shrinkage," the task of estimating price-level pressures transforms to the task of finding s, such that the coefficient of relative price differences for the P_i^*s (σ^*) reaches some "target value." This approach is not as artificial as it might appear at first sight, since the choice of the target value is quite natural. In the Czech Republic, as well as other Central and Eastern European countries, the sensible "target value" would be that of a country like Austria or Germany, which are both a part of the Central European region and have many historical and economic ties with the Czech Republic and other CEE countries.[21]

Such a target would be too high to provide a reasonable estimate for the horizon of roughly a decade, though. It is not likely that Czech relative prices could reach Austrian (or German) relative prices in a few years. We can, however, use the fact that for the EU countries in general, the coefficient of relative price differences is below 0.30–0.35, which is still significantly less than in transition economies. A natural way of posing the question therefore is to ask what adjustment of prices is necessary for the coefficient of price differences to reach 0.30–0.35, that

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[20] For an introduction to the theory of *Ss* pricing under staggered price adjustment, see Romer (1996). For the motivation of this "shrinkage formula" in the theory of conditional convergence, see, for instance, Barro and Sala-i-Martin (1995).

[21] Austrian relative prices are very similar to German ones: the coefficient of relative price differences for Austria relative to Germany is lower than 20 percent (see Tables 3 and 4).

is the value of the least developed EU economies, such as Greece and Portugal. It is, in fact, a mild requirement: the transition countries of Central and Eastern Europe have close economic ties to Germany, usually closer than those of Greece or Portugal. Compared with Greece or Portugal, these economies are more likely to face shocks similar to those faced by Germany; moreover, the similarity of consumer preferences between in these countries and Germany is likely to be higher than between Greece and Germany or Portugal and Germany. It would therefore be possible to expect that the coefficient of relative price differences would eventually become even lower in Central and Eastern Europe than in Greece or Portugal.

If we divide both sides of (8) by P_i^0, the equation can be rewritten as follows:

$$\frac{P_i^*}{P_i^0} = (1-s) + s / P_i^0 \ . \tag{9}$$

In other words, the assumed mechanism of future adjustments in relative prices corresponds to the hyperbola, so that it is consistent with the past data for the Czech Republic (see Figure 5 and equation (7)). The only significant difference is the fact that the shift coefficient is $(1\text{-}s)$, which ensures that the hyperbola goes through the point $P_i = 1$ on the horizontal axis. The reason is that we want to separate the effect of adjustment of price levels from the adjustment of price levels *per se*. The direct effect of price levels can be approximately estimated by the vertical shift of the hyperbola. From equation (7), we find that for $P_i = 1$, the estimate based on past data is about 0.22 ($1.11 + 0.11 \times 1 = 1.22$) above the "optimum" hyperbola in equation (9). In other words, 22 percentage points from the total headline inflation in 1993–99 (roughly 3.4 percentage points a year) were "excessive" in the sense that they cannot be associated with the adjustment of relative prices.

Let us now compute what the pressure would be on the price level in the Czech Republic in the future, if differences in structures of relative prices were to decrease so that the coefficient of relative price differences declined to 0.30. We assume that relative prices develop according to equation (8),[22] and that the weights in the consumer basket are "real weights," as explained above. The calculation proceeds in two steps, the first being to find (by numerical methods) the value of the shrinkage coefficient s corresponding to the target value of the coefficient of relative price differences, and the second step being the calculation of the change in price level, based on the calculated shrinkage coefficient. Using this approach, the OECD data set, and the above-noted assumptions, we calculated that the decline of relative price deviations to the level

[22] It is possible to adopt different assumptions on the price adjustment mechanism, but this one was simple enough and provided a useful first approximation. Moreover, past data in Figure 5 were consistent with this assumption: the fastest price growth was seen in the relatively "cheapest" groups, like rents, health care or education, while the relatively "most expensive" groups, like cars or shoes, experienced only a very slight price increases, basically in line with inflation in the EU.

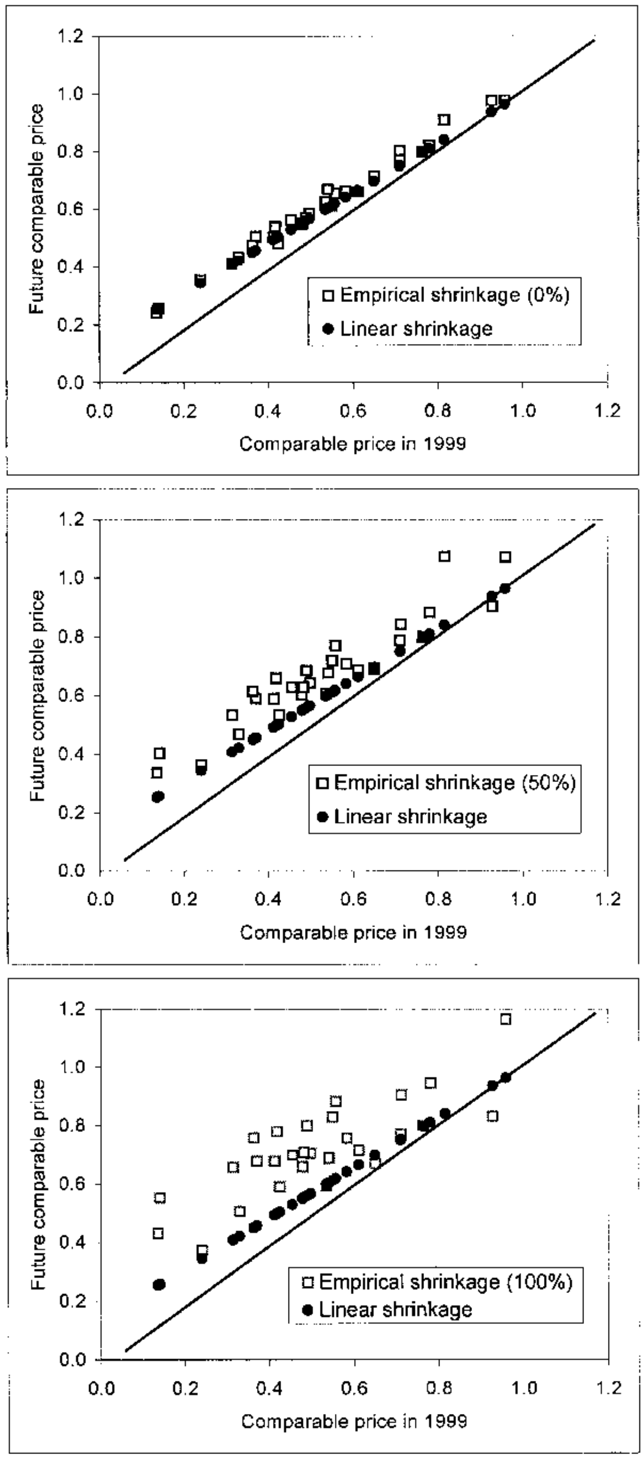
of the least developed EU countries would be connected to the increase in the price level by 30 percent.

How sensitive is this result to changes in assumptions? It is not very sensitive to slight alterations to the mechanism of adjustment of relative prices, provided that a significant majority of adjustments in relative prices has the form of growth in nominal prices. Far more important is whether we use "real" or "nominal" weights. For instance, if we use nominal weights instead of real ones, the estimate of the resulting increase in the price level becomes roughly 20 percent. The estimated increase is even smaller for the weights of the 1994 official consumer basket, used by the Czech Statistical Office for CPI calculations until 2000. These weights, however, do not reflect the adjusted structure of household consumption. For 1999 weights, which started to be used in the beginning of 2001, the difference between the version called "nominal weights" and that called "official weights" virtually vanished. It is both helpful (we decreased the number of scenarios) and logical, since the official weights should now be closer to the actual structure of household consumption. The results of the calculations are summarized in Table 10.

The actual impact of relative price convergence on inflation is likely to lie between these two extreme estimates, because nominal weights underestimate the weight of commodities with the most rapid price growth, while real weights ignore the adjustments in the structure of consumption in response to the changing relative prices, thereby most likely overestimating the actual impact of growing prices. We can therefore conclude that if the Czech price structure is to reach at least the same degree of similarity to the German price structure as currently reached by the least developed EU countries, the associated price adjustments are likely to press for an increase in the price level by 20–35 percent.

An alternative approach to estimating the likely inflation pressures is to use the empirical relationships between the various individual prices and GDP, summarized in Table 1. The slope coefficients in Table 1 allow us to calculate the impact of a given change in GDP on each relative price, and therefore also on the coefficient of relative price differences. Let us focus again on the case of the Czech Republic and calculate the changes in the individual prices, corresponding to the increase in relative GDP from the current 55 percent vis-à-vis Germany to 65 percent. This assumes that the regression relationship is stable and that the prices of all commodity groups will move along the estimated regression lines. We should not, though, overlook the fact that the Czech Republic has a significantly negative residual in most of the regression, and that it is reasonable to assume that the residual in the individual regressions can "shrink" during the adjustment process. Tables 7 and 8 summarize the various results, depending on the size of the "shrinkage" from 0 to 100 percent. The table indicates that the key factor for the changes in the coefficient of price differences is GDP, not the shrinkage. The extent of "shrinkage," however, has an important effect on the price level. For real weights, the estimated increase in the price level ranges from 50 percent (for zero shrinkage) to 62 percent (for full shrinkage); for nominal weights; it ranges from 59 to 72 percent. It means that the extent of the shrinkage influences the implied inflation pressures. However, for the "realistic" shrinkage of roughly 30–50 percent, the results are similar to our previous calculations (even though they are slightly higher). Figure 6 compares growth rates of prices according to this "empirical shrinkage" and the original assumption of "linear shrinkage."

Figure 6. Czech Republic: Empirical vs. Linear Shrinkage



Sources: ICP and authors' calculations.

Note: The reference country is Germany (=1 on all axes).

V. Monetary Policy Implications

The standard Balassa-Samuelson model provides a useful basic approach to the issue of price adjustments, but it should not mislead us to an oversimplified conclusion that the solution to the problem of price level adjustment can be found in the macroeconomic domain, that is, in higher inflation or in nominal appreciation of the domestic currency. We argue that, on the contrary, important differences remain in the structures of relative prices, and that the necessary adjustments are likely to be associated with non-zero inflation. The advantage of this approach—compared with approaches deriving inflation from the adjustment of price levels to the EU—is the fact that we do not need any assumption concerning the exchange rate (for instance, no change in the nominal exchange rate).

What do our estimates of inflation pressures mean for medium-term monetary policy targets in the CEE countries? Let us again look closely at the example of the Czech Republic. We calculated in Table 10 that the adjustment of relative price differences to the level of the least developed European Union countries would push the price level up by 20–35 percent. In order to convert the estimated price level pressures into estimates of inflation, we need first to know the time horizon during which these adjustments take place. It is very difficult, but it is not a distinctive problem of our approach: the Balassa-Samuelson model does not predict anything about the actual timing of the adjustment process either. Fortunately, a useful benchmark can be found in the medium-term monetary policy strategy document, published by the Czech National Bank. The document formulates the long-term inflation target as "net inflation" in the interval 2±1 percent by the end of 2005,[23] and it states that net and headline inflation should be virtually equal by 2005, since the majority of adjustments in regulated prices and indirect taxes will be completed by that time. This scenario can be compared with our estimate of price level pressures. The growth in price levels related to the price adjustments will most likely continue even after the Czech Republic's entrance into the EU. If the price adjustments to at least the levels of the least developed EU countries are to take place until 2010, the yearly inflation rate will have to be 1.7–2.7 percentage points higher than if there were no adjustments in the relative price deviations. For the officially published inflation data since 2001, however, it is more realistic to assume a number slightly above the scenario of the 1996 nominal weights (the basket has been changed into 1999 weights), which estimates the contribution of relative price adjustment at around 1.7 percentage points a year.

The advantage of our approach is the fact that it allows for forecasting growth of the individual commodity groups in the consumption basket (see Table 9). It allows us to compute which part of the total increase in the price level can be attributed to regulated prices, and which part "remains" for net inflation. We have found that regulated prices account for one-half to two-thirds of the overall increase in price levels due to relative price adjustments (see Table 10).

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[23] "Net inflation" is the year-on-year CPI growth, net of changes in regulated prices and indirect taxes. After undershooting the first 1998 target (6.0±0.5 percent), net inflation also undershot its 1999 target (4.5±0.5 percent) and the 2000 target (4.5±1.0 percent).

This means that the impact on net inflation is 12–20 percentage points, that is, roughly 1.0–1.8 percentage points a year on average until 2010.

This estimate, however, includes only the natural inflationary pressures in addition to those that are also in place in developed economies enjoying price stability. Most economists seem to agree that price stability in developed countries means inflation in the order of 1–2 percent, which mostly reflects the inability of the existing price indices to account for the continuous increase in the quality of goods. We can find no reason to believe that the Czech Republic significantly differs from those countries. Therefore, we should add these 1–2 percentage points to our calculations.[24] As a result, we can say that in the Czech Republic, the sum of the natural inflationary factors will push towards the net inflation of 2.0–3.8 percent and headline inflation of 2.7–4.7 percent a year in the next decade.

If net inflation in the following years falls linearly to the level announced in the CNB's long-term monetary strategy for 2005 (2 percent) and remains steady afterwards, it would mean average yearly net inflation until 2010 of 2.3 percent. We can therefore say that the CNB's targets are within our interval of estimates, but they are close to the lower end, so that they are relatively ambitious. However, if we assume that the nominal weights scenario is the most realistic one, our estimate of net inflation pressures is at 2.2–3.2 percent, so that the ambitiousness of the CNB's targets becomes somewhat smaller.

Our calculations lead to the conclusion that it is feasible to decrease (net) inflation to 2±1 percent, but there seems to be a trade-off between the chosen inflation target and the speed of relative price adjustment. Our calculations are consistent with the hypothesis that in transition countries like the Czech Republic, there is a one-digit "natural" rate of inflation, significantly different from zero. The determination of such a natural inflation rate must always be a result of comparison of welfare costs and benefits of inflation. A vast literature exists on the costs of inflation.[25] Yet inflation has its benefits as well, and they can be even more important than costs for one-digit rates of inflation. One of the benefits has been demonstrated in this paper: under the conditions of downward inelastic nominal prices and wages, inflation can be the most acceptable way to adjust the distorted relative price structure.[26] The existence of a non-zero

[24] See Filer and Hanousek (2000) for a calculation of the upward bias in the official inflation data for the Czech Republic.

[25] See, for instance, Driffil, Mizon, Ulph (1990); and Feldstein (1996).

[26] In the transition countries, the distortion is mainly due to historical reasons, but important distortions can also be introduced institutionally. A typical example can be the ratio of the minimum (or average) wage to social payments. This ratio can be called the relative price of work compared with leisure. In the Czech Republic, this price is distorted by excessively high social payments. It is not realistic to assume that the adjustment of this relative price could take the form of nominal decrease in social payments. It seems to be politically more feasible that inflation will be accompanied by growth in nominal wages, which will enable the authorities to sustain or even slightly increase nominal level of social payments, and at the same time to erode their real value.

natural rate of inflation is not a result of a "need to narrow the price level gap between the Czech Republic and the European Union." No such an abstract need exists, since without a corresponding convergence in productivity, political pressure to converge in price levels would only increase the risk of external imbalance. The pressure toward higher inflation stems from the gradual adjustment of relative prices under conditions of low downward flexibility of nominal prices and wages, rather than from the adjustment of the price level as such. Moreover, this type of price adjustment cannot be substituted by an alternative approach, such as the nominal adjustment of the exchange rate.

VI. Conclusion

We have found that differences in structures of relative prices play an important role in movements of price levels in transition countries. Our calculations show a strong negative relationship between price levels and the degree of difference in structures of relative prices in individual countries. Using this relationship, and the remaining relative price differences vis-à-vis EU countries, we argued that the future pressures on the price level in the converging countries could be quite substantial, if the mechanism of the adjustment in the relative prices will be similar to the past, that is, will mostly mean increases in nominal prices. Based on the calculations, we assessed the existing inflation target in the Czech Republic, as feasible, but relatively ambitious.

We have argued that the approach in this paper can be thought of as an alternative to the existing studies that link relative price volatility and inflation, using time-series data (and around-the-steady-state analysis) from a single country. We were looking instead at the structures of relative prices themselves in a cross-section of countries, and were discussing the future convergence toward the "steady state" represented by the advanced EU countries. Unlike most of the existing literature on relative price setting, we explain relative price adjustment as an equilibrium phenomenon, rather than as an adjustment toward equilibrium.

The approach in this paper can also be thought of as a generalization of the Balassa-Samuelson approach. Similar to the approach of the Balassa-Samuelson model, our approach relates the price level to the structure of domestic prices. Yet while the Balassa-Samuelson model looks only at the ratio of tradable and nontradable prices, we consider a more general measure of deviations in the structure of relative prices. Unlike the Balassa-Samuelson framework, we do not rely on the artificial distinction between tradable and nontradable commodities; instead, we use a detailed breakdown of the price levels into individual commodity groups. We find that virtually no good belongs purely to one of these two groups; there is instead a continuum of goods according to their tradability. Moreover, in the period of economic transition, the distinction between the two categories tends to shift quickly over time.

While the predictions of the standard Balassa-Samuelson model for inflation depend on assumptions regarding the nominal exchange rate, our predictions for inflation depend on the assumption of price stickiness. The assumption of sticky prices seems to be a more realistic starting point for forecasting inflation than assuming that we can predict future nominal exchange rate movements. Moreover, as we have shown, the assumption of sticky prices seems to be consistent with the past experience of the CEE countries.

Table 1. Commodity Prices vs. GDP in 1996; 22 Countries

Commodity group	Intercept	Slope	t-stat.	R2	F-stat.	CR*
Equipment for passenger traffic	1.03	0.21	1.05	0.05	0.31	-0.20
Furniture and floor coverings, including repairs	0.56	0.37	4.23	0.47	0.00	-0.03
Recreation equipment, incl. repairs	0.68	0.41	3.66	0.40	0.00	*-0.18*
Housing equipment, including repairs	0.39	0.50	5.59	0.61	0.00	*-0.13*
Footwear, including repairs	0.50	0.51	5.83	0.63	0.00	0.00
Communication links	0.22	0.57	4.09	0.46	0.00	*-0.30*
Other vegetables	0.42	0.63	4.48	0.50	0.00	*-0.31*
Textile for housing, including repairs	0.24	0.66	6.26	0.66	0.00	-0.05
Fish	0.21	0.69	7.28	0.73	0.00	*-0.20*
Oils and fats	0.45	0.70	4.60	0.51	0.00	*-0.18*
Garments, including repairs	0.24	0.72	5.30	0.58	0.00	*-0.25*
Other products and services for households	0.23	0.81	7.47	0.74	0.00	*-0.21*
Non-alcoholic beverages	0.26	0.83	4.16	0.46	0.00	*-0.27*
Fruits, vegetables, incl. potatoes	0.14	0.87	8.08	0.77	0.00	*-0.15*
Fuel and energy	0.01	0.90	5.86	0.63	0.00	*-0.25*
Other products and services	0.08	0.92	8.13	0.77	0.00	*-0.27*
Operation of traffic equipment	0.16	0.94	10.54	0.85	0.00	*-0.12*
Alcoholic beverages	0.62	0.95	2.13	0.18	0.04	-0.45
Bread and cereals	0.02	0.98	7.65	0.75	0.00	*-0.31*
Milk, cheese, and eggs	0.24	0.99	8.65	0.79	0.00	*-0.28*
Transportation services	-0.17	1.04	9.95	0.83	0.00	*-0.18*
Education	-0.27	1.08	9.21	0.81	0.00	*-0.26*
Meat	-0.01	1.09	10.12	0.84	0.00	*-0.18*
Restaurant, cafes and hotels	0.03	1.12	6.62	1.74	0.00	*-0.39*
Rents and water	-0.38	1.16	8.19	0.77	0.00	*-0.17*
Health and medical care	-0.22	1.19	8.32	0.78	0.00	*-0.34*
Books, journals, and newspapers	-0.02	1.23	6.70	0.69	0.00	*-0.33*
Tobacco	-0.15	1.29	6.72	0.69	0.00	-0.16
Recreation services	-0.20	1.35	10.12	0.84	0.00	*-0.30*
TOTAL CONSUMPTION	-0.04	0.98	10.88	0.88	0.00	*0.23*

* CR means the Czech residual in the regression; numbers in italics exceed one SD of the regression

Table 2. Differences in Prices; the Czech Republic vs. Germany (Germany=100)

	1993	1996	1999*
HOUSEHOLD CONSUMPTION	25.8	34.7	41.4
of which: Foodstuffs, beverages, tobacco	37.6	48.9	51.3
Garments and shoes	36.0	48.3	55.3
Rent, fuel, energy	11.4	18.8	32.4
Housing equipment and maintenance	38.5	58.5	64.3
Health and medical care	18.5	14.0	13.9
Transportation and communications	41.9	51.9	59.9
Education, recreation, culture	20.1	38.9	44.4
Restaurants, cafes, hotels	26.9	31.1	36.3
Other goods and services	27.0	36.2	42.6
GDP TOTAL	25.6	31.7	36.0

Sources: Czech Statistical Office, OECD; *) authors‘ extrapolation (except GDP).

Table 3. Coefficients of Relative Price Differences (Real Weights); 22 Countries

	1980	1985	1990	1993	1996	1999*
Austria	0.23	0.16	0.16	0.13	0.19	NA
Belgium	0.18	0.21	0.16	0.13	0.12	NA
Czech Rep. (Czechoslovakia)	NA	NA	0.51	0.59	0.55	0.45
Denmark	0.25	0.22	0.22	0.17	0.29	NA
Finland	NA	0.34	0.31	0.24	0.25	NA
France	0.17	0.16	0.19	0.16	0.13	NA
Greece	0.49	0.35	0.37	0.31	0.34	NA
Hungary	0.63	0.63	0.56	0.45	0.57	NA
Ireland	0.34	0.40	0.29	0.26	0.31	NA
Italy	0.33	0.30	0.27	0.23	0.31	NA
Luxembourg	0.31	0.20	0.18	0.17	0.16	NA
Netherlands	0.20	0.15	0.15	0.12	0.12	NA
Norway	0.37	0.33	0.29	0.26	0.30	NA
Poland	0.63	0.77	0.60	0.68	0.77	NA
Portugal	0.40	0.67	0.46	0.39	0.37	NA
Russia	NA	NA	0.69	0.89	0.75	NA
Slovakia	NA	NA	NA	0.73	0.80	NA
Slovenia	NA	NA	NA	0.38	0.41	NA
Spain	0.15	0.44	0.29	0.21	0.25	NA
Sweden	NA	0.29	0.25	0.15	0.19	NA
Switzerland	NA	NA	0.19	0.14	0.14	NA
United Kingdom	0.23	0.24	0.22	0.18	0.27	NA

Sources: Czech Statistical Office, OECD; *) authors‘ extrapolation (except GDP).

Table 4. Coefficients of Relative Price Differences (Nominal Weights); 22 Countries

	1980	1985	1990	1993	1996	1999*
Austria	0.22	0.16	0.16	0.13	0.17	NA
Belgium	0.18	0.20	0.15	0.13	0.12	NA
Czech Rep. (Czechoslovakia)	NA	NA	0.53	0.53	0.48	0.40
Denmark	0.24	0.23	0.23	0.18	0.28	NA
Finland	NA	0.39	0.40	0.27	0.27	NA
France	0.17	0.16	0.18	0.16	0.12	NA
Greece	0.42	0.34	0.40	0.31	0.31	NA
Hungary	0.48	0.48	0.52	0.42	0.49	NA
Ireland	0.30	0.36	0.28	0.25	0.35	NA
Italy	0.30	0.25	0.23	0.20	0.27	NA
Luxembourg	0.38	0.18	0.17	0.15	0.15	NA
Netherlands	0.21	0.15	0.14	0.12	0.12	NA
Norway	0.32	0.38	0.34	0.28	0.32	NA
Poland	0.51	0.64	0.62	0.58	0.64	NA
Portugal	0.49	0.41	0.44	0.35	0.34	NA
Russia	NA	NA	0.84	0.66	0.57	NA
Slovakia	NA	NA	NA	0.58	0.46	NA
Slovenia	NA	NA	NA	0.38	0.35	NA
Spain	0.14	0.35	0.27	0.20	0.23	NA
Sweden	NA	0.34	0.29	0.15	0.22	NA
Switzerland	NA	NA	0.20	0.14	0.13	NA
United Kingdom	0.24	0.24	0.23	0.18	0.29	NA

Sources: Czech Statistical Office, OECD; *) authors‘ extrapolation (except GDP).

Table 5. Regression of the Price Level on the Coefficient of Relative Price Differences

	Intercept	Slope	St. error	R^2	p-value
1980, nominal weights	1.17	-1.35	0.34	0.56	0.001
1985, nominal weights	1.08	-0.75	0.43	0.17	0.099
1990, nominal weights	1.22	-1.12	0.34	0.37	0.004
1993, nominal weights	1.21	-1.61	0.17	0.81	0.000
1996, nominal weights	1.26	-1.57	0.26	0.64	0.000
1980, real weights	1.13	-1.13	0.25	0.62	0.001
1985, real weights	1.15	-0.88	0.25	0.45	0.003
1990, real weights	1.34	-1.54	0.34	0.54	0.000
1993, real weights	1.13	-1.23	0.13	0.81	0.000
1996, real weights	1.19	-1.17	0.16	0.73	0.000

Table 6. Increase in Price Level Corresponding to Decline in Coefficient of Relative Price Differences to 0.30

	Real Weights	Nominal Weights
Czech Republic	30.3%	28.3%
Hungary	33.8%	30.5%
Poland	62.8%	53.5%
Russia	57.5%	42.2%
Slovakia	60.8%	25.5%
Slovenia	13.0%	8.4%

Note: "Real weights" calculations based on equation (3a), "nominal weights" on equation (3b).

Table 7. Shrinkage of Relative Price Differences Along and Towards the Regression Lines; The Czech Republic

	ρ	μ
Real weights		
Shrinkage = 100 %	32.3 %	61.8 %
Shrinkage = 70 %	31.3 %	58.3 %
Shrinkage = 50 %	31.1 %	55.9 %
Shrinkage = 30 %	31.3 %	53.6 %
Shrinkage = 0 %	32.7 %	50.1 %
Nominal weights		
Shrinkage = 100 %	28.8 %	72.0 %
Shrinkage = 70 %	28.3 %	68.1 %
Shrinkage = 50 %	28.3 %	65.4 %
Shrinkage = 30 %	28.8 %	62.8 %
Shrinkage = 0 %	30.4 %	58.9 %

Note: The Czech GDP assumed to increase from 55 percent to 65 percent of German GDP. Different results shown for different shrinkage speeds of residuals from the regressions.

Table 8. Czech Republic: Inflationary Pressure Resulting from Relative Price Adjustment

	Increase in CPI (in percent)
Real weights	
Shrinkage = 100 %	89.3
Shrinkage = 70 %	68.2
Shrinkage = 50 %	55.2
Shrinkage = 30 %	43.1
Shrinkage = 0 %	26.2
Nominal weights	
Shrinkage = 100 %	74.3
Shrinkage = 70 %	55.3
Shrinkage = 50 %	43.7
Shrinkage = 30 %	32.9
Shrinkage = 0 %	17.8

Note: The Czech GDP is assumed to increase from 55 percent to 65 percent of German GDP. Different results are shown for different shrinkage speeds of residuals from the regressions.

Table 9. Czech Republic: "Adjustment Growth of Prices" by Commodity Groups (in percent)

Commodity group *)	Scenario (weights)		
	Real	Nominal	Official
Equipment for passenger traffic	1	0	0
Furniture and floor coverings, incl. repairs	5	4	4
Recreation equipment, including repairs	5	4	3
Housing equipment, including repairs	11	9	8
Footwear, including repairs	1	1	1
Communication links	23	19	16
Other vegetables	14	11	10
Textile for housing, including repairs	9	7	6
Fish	18	15	13
Oils and fats	7	6	5
Garments, including repairs	18	15	13
Other products and services for households	12	10	9
Non-alcoholic beverages	18	15	13
Fruits, vegetables, including potatoes	17	14	12
Fuel and energy	15	12	10
Other products and services	24	20	17
Operation of traffic equipment	7	6	5
Alcoholic beverages	4	3	3
Bread and cereals	37	31	26
Milk, cheese, and eggs	13	11	9
Transportation services	35	28	24
Education	110	91	78
Meat	20	17	14
Restaurant, cafes and hotels	30	25	21
Rents and water	54	44	38
Health and medical care	106	87	75
Books, journals and newspapers	24	20	17
Tobacco	14	12	10
Recreation services	29	24	20

*) The commodity groups are ordered according to the slope coefficient reported in Table 1.

Table 10. Czech Republic: "Adjustment Growth of Prices" (Total estimates)

Weights	Shrinkage parameter ("s")	Total increase in prices by (percent)	Of which (in percentage points):	
			Regulated prices	"Net inflation"
Real	0.173	34.3	21.9	20.2
Nominal	0.142	19.8	8.7	14.2
Official (1993)	0.122	17.4	8.2	11.7
Official (1999)	0.138	19.3	9.5	9.8

Table 11. Price Level vs. GDP: Regression Residuals (Worldwide Sample of 106 Countries), 1998

# Country	GDP	Price level				# Country	GDP	Price level			
		actual	predict.	resid.	% act.			actual	predict.	Resid.	% act.
1 Syrian Arab Rep.	9	131	45	86	66	41 Bahamas, The	48	87	83	4	5
2 Congo, Rep.	3	90	39	51	57	42 Hong Kong, China	71	110	106	4	4
3 Yemen, Rep.	2	63	38	25	40	43 Norway	90	128	124	4	3
4 Lebanon	14	80	50	30	38	44 Korea, Rep.	45	83	81	2	3
5 Gabon	19	82	55	28	34	45 Portugal	50	87	85	2	2
6 Dominica	16	75	52	24	31	46 St. Kitts and Nevis	33	70	69	1	2
7 St. Lucia	17	75	52	23	31	47 Netherlands	76	113	111	2	2
8 Jamaica	11	67	47	20	30	48 Argentina	40	76	75	1	1
9 Belize	15	69	50	18	27	49 Madagascar	3	39	38	0	1
10 Antigua and B.	30	89	66	23	26	50 Bolivia	8	44	43	0	1
11 Japan	81	151	116	36	24	51 Botswana	20	56	55	0	1
12 Sweden	68	135	103	32	24	52 Belgium	81	113	116	-3	-3
13 Croatia	*23*	*76*	*58*	*18*	*23*	53 Venezuela, RB	20	53	55	-2	-3
14 Zambia	2	50	38	12	23	54 United Kingdom	69	101	105	-4	-4
15 St. Vincent	15	65	51	14	22	55 Bahrain	40	72	75	-3	-4
16 Grenada	19	70	55	15	22	56 Iceland	85	115	120	-5	-4
17 Brazil	22	73	58	15	21	57 Singapore	87	114	121	-7	-6
18 Côte d'Ivoire	5	52	41	11	21	58 Ireland	62	91	97	-6	-7
19 Switzerland	92	159	127	32	20	59 Chile	29	60	65	-4	-7
20 Benin	3	47	39	8	18	60 Trinidad and Tob.	25	56	60	-4	-7
21 Germany	75	133	110	23	17	61 Jordan	9	41	45	-3	-8
22 Israel	58	112	93	19	17	62 Italy	70	97	105	-8	-8
23 Peru	14	60	50	10	16	63 Australia	75	100	110	-9	-9
24 Macedonia, FYR	*14*	*59*	*50*	*9*	*15*	64 Thailand	19	49	54	-6	-12
25 Denmark	82	136	117	20	15	65 Morocco	11	41	46	-5	-12
26 Ecuador	10	54	46	8	15	66 Indonesia	8	39	44	-5	-13
27 Greece	48	96	83	13	14	67 Turkey	23	51	58	-7	-13
28 France	73	124	108	17	13	68 Kenya	3	34	39	-5	-15
29 Cameroon	5	47	40	6	13	69 Sierra Leone	2	32	37	-5	-16
30 Fiji	14	57	50	8	13	*70 Poland*	*26*	*52*	*61*	*-9*	*-18*
31 Panama	17	60	52	8	13	*71 Slovenia*	*49*	*71*	*85*	*-13*	*-18*
32 Uruguay	29	73	65	9	12	72 Egypt, Arab Rep.	11	39	46	-7	-19
33 Austria	79	128	114	14	11	*73 Mongolia*	*5*	*33*	*41*	*-7*	*-22*
34 New Zealand	55	101	90	10	10	*74 Estonia*	*26*	*50*	*61*	*-11*	*-23*
35 Finland	71	118	106	12	10	75 Iran, Islamic Rep.	18	43	53	-10	-23
36 Malawi	2	42	38	4	10	76 Tunisia	18	43	53	-10	-24
37 Senegal	4	44	40	3	8	77 Guinea	6	33	42	-8	-25
38 Spain	55	96	90	6	7	78 Mexico	25	49	61	-12	-25
39 Tanzania	2	40	37	3	7	*79 Latvia*	*20*	*44*	*55*	*-11*	*-26*
40 Mali	2	40	38	2	6	*80 Albania*	*10*	*36*	*45*	*-10*	*-27*

Table 11. (cont'd) Price Level vs. GDP: Regression Residuals
(Worldwide Sample of 106 Countries), 1998

# Country	GDP	Price level				# Country	GDP	Price level			
		actual	predict.	resid.	% act.			actual	predict.	resid.	% act.
81 Mauritius	28	48	64	-16	-32	*94 Slovak Republic*	*33*	*44*	*68*	*-25*	*-57*
82 United States	100	100	135	-35	-35	*95 Azerbaijan*	*7*	*27*	*43*	*-16*	*-59*
83 Canada	78	84	113	-29	-35	96 Bangladesh	5	25	40	-15	-59
84 Russian Fed.	*21*	*42*	*57*	*-15*	*-36*	*97 Moldova*	*7*	*26*	*42*	*-16*	*-63*
85 Luxembourg	126	115	160	-45	-39	*98 Czech Republic*	*42*	*45*	*77*	*-32*	*-70*
86 Lithuania	*21*	*40*	*57*	*-17*	*-43*	*99 Georgia*	*12*	*28*	*47*	*-20*	*-71*
87 Hungary	*34*	*48*	*69*	*-21*	*-44*	*100 Ukraine*	*11*	*27*	*46*	*-19*	*-72*
88 Philippines	13	33	48	-15	-45	*101 Kazakhstan*	*15*	*28*	*50*	*-22*	*-79*
89 Zimbabwe	9	30	44	-14	-48	*102 Kyrgyz Republic*	*8*	*23*	*43*	*-20*	*-85*
90 Pakistan	6	28	41	-13	-48	103 Vietnam	6	21	41	-20	-98
91 Swaziland	14	33	50	-17	-51	104 Nepal	4	19	40	-20	-104
92 Armenia	*7*	*28*	*43*	*-15*	*-53*	*105 Romania*	*19*	*25*	*55*	*-29*	*-117*
93 Sri Lanka	10	29	46	-16	-55	*106 Tajikistan*	*4*	*17*	*39*	*-22*	*-130*

Sources: World Bank (ICP) and authors' calculations.

Notes: The countries are sorted in a descending order according to the residual in the regression of price level vs. GDP (the last column)—see equation (D1) in Appendix IV. "GDP" is GDP per capita in PPP terms (United States=100); "price level" is the international price level (United States=100); "resid." is a residual in the regression of price level and GDP in individual countries (in percentage points of the U.S. price level); and "% act." is residual expressed as percentage of the actual international price level of the country. For instance, for Switzerland (ranked 19th), this variable has the value of +20, meaning that the regression (D1) predicts for Switzerland a price level that is 20 percent lower than the actual one; for the Czech Republic (ranked 98th), this variable is –70, meaning that the predicted price level is 70 percent higher than the actual one. Italics denote transition economies of Central and Eastern Europe and the former Soviet Union countries.

Quantitative Predictions of the Balassa-Samuelson Model

From the viewpoint of the standard Balassa-Samuelson model, what is the most realistic slope coefficient in the regression between price level and GDP? To answer this question, we must derive the quantitative predictions of the model. Let us start with the simple assumption that the production functions of tradable (T) and nontradable (N) goods have the following form:

$$Y_T = A_T L_T , \tag{A1}$$

$$Y_N = A_N L_N , \tag{A2}$$

where Y is production, A is a constant describing the technology, and L is employment. The foreign countries (denoted by an asterisk) employ the same technology. Let us assume that the law of one price holds for tradable commodities and let us set the world price of tradable commodities equal to 1. Finally, let us assume perfect labor force mobility among sectors within an individual economy, but zero mobility of labor among the economies.

From equation (A1) it follows that wages in domestic economy, expressed in terms of tradable commodities, must satisfy the following conditions:

$$w = A_T \ . \tag{A3}$$

Due to perfect mobility of labor within individual economies, the same wages must also be set in the sector of nontradable commodities. The price of nontradable commodities (again in terms of the world price of tradables) must thus satisfy:

$$p_N = \frac{w}{A_N} = \frac{A_T}{A_N} \ . \tag{A4}$$

If we write the price index in the form of a geometric average,[27] we obtain

$$P \equiv (p_T)^{\gamma} (p_N)^{1-\gamma} = 1^{\gamma} \left(\frac{A_T}{A_N} \right)^{1-\gamma} , \tag{A5}$$

where γ is the share of tradable goods in private consumption. The relative price level vis-à-vis the outside world therefore is:

$$\frac{P}{P^*} = \left(\frac{A_T / A_N}{A_T^* / A_N^*} \right)^{1-\gamma} \ . \tag{A6}$$

[27] The geometric average is an optimal price index, provided that we assume a utility function with constant elasticity of substitution between tradable and nontradable commodities. The traditional arithmetic average can be thought of as a log-linear approximation of this optimal price index (see, for instance, Obstfeld and Rogoff, 1998).

If, for the time being, we suppose that productivity in the nontradable sector is the same in all economies, then the relative price level depends only on the ratio of productivities in the tradable sector at home and abroad, with the elasticity being equal to $1-\gamma$, that is, the ratio of nontradable commodities in the consumption basket.

We can derive the equation for nominal GDP per employee as

$$GDP_{nom} = \gamma A_T + (1-\gamma) p_N A_N = A_T \ , \qquad \text{(A7)}$$

which indicates that the nominal GDP expressed in terms of international prices of tradable commodities exactly reflects productivities in the production of tradable commodities. Equation (A6) can then be transformed into the following

$$\frac{P}{P^*} = \left(\frac{HDP_{nom}}{HDP^*_{nom}}\right)^{1-\gamma} \left(\frac{A^*_N}{A_N}\right)^{1-\gamma} , \qquad \text{(A8)}$$

that is, the relative price level depends directly on the ratio of nominal GDP at home and abroad, the elasticity being $(1-\gamma)$. In practice, the share of services (the main group including mostly nontradable commodities) in employment is usually in the range of 50–75 percent, and their share in GDP is usually between 50 percent and 70 percent. If we take the lower bound as a realistic estimate of the share of nontradable commodities (since not all services are nontradable),[28] we arrive at the conclusion that an increase in nominal relative GDP of 1 percent should be accompanied by an increase in the relative price level of about 0.5 percent.[29]

In the regression estimates in Figures 1a and 1b, however, we used GDP in PPP units instead of nominal GDP. If we use the definition of GDP in PPP units,

$$GDP_{PPP} \equiv GDP_{nom} \frac{P^*}{P} \ , \qquad \text{(A9)}$$

then equation (A8) can be rewritten as

$$\frac{P}{P^*} = \left(\frac{GDP_{PPP}}{GDP^*_{PPP}}\right)^{\frac{1-\gamma}{\gamma}} \left(\frac{A^*_N}{A_N}\right)^{\frac{1-\gamma}{\gamma}} , \qquad \text{(A10)}$$

which means that the elasticity of the relative price level with respect to GDP in PPP units is $(1-\gamma)/\gamma$. If $(1-\gamma)$ equals 50 percent, we obtain unitary elasticity, as estimated in Figure 1a, or in the

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[28] On the other hand, it is true that also some branches of the secondary sector, such as some parts of construction or supply network industries, can be examples of nontradable goods.

[29] Recall that it is a relative GDP divided by the number of employees, not by the whole population. This distinction can be important if the ratio of the employed population differs significantly from country to country.

last row of Table 1.[30] To obtain the elasticity of 0.87 of Figure 1b, it would be necessary for $(1-\gamma) = 47$ percent, which cannot be excluded either as a reasonable value.[31] Both estimates are therefore consistent with the B-S model not only qualitatively, but also quantitatively.

This conclusion remains unchanged even when we switch from the simple production function of equations (A1) and (A2) to a more general production function, using not only labor, but also capital, if we assume perfect mobility of capital between economies. Under these circumstances, equation (A6) changes into[32]

$$\frac{P}{P^*} = \left(\frac{A_T}{A_T^*}\right)^{\frac{(1-\gamma)(1-\beta)}{(1-\alpha)}} \left(\frac{A_N^*}{A_N}\right)^{(1-\gamma)} , \tag{A11}$$

where α is the equilibrium share of capital in the production of tradable commodities and β is the share of the capital in the production of nontradable goods.[33] Equation (A10) changes into

$$\frac{P}{P^*} = \left(\frac{GDP_{PPP}}{GDP_{PPP}^*}\right)^{\frac{(1-\gamma)(1-\beta)}{1-(1-\gamma)(1-\beta)}} \left(\frac{A_N^*}{A_N}\right)^{\frac{1-\gamma}{1-(1-\gamma)(1-\beta)}} . \tag{A12}$$

If we assume, for instance, $\beta=0.2$,[34] then to obtain unitary elasticity, it must hold that the share of nontraded goods $(1-\gamma)$ is 63 percent. In order to obtain elasticity equal to 0.75, it must hold that $(1-\gamma) = 58$ percent. In both cases, the values are reasonable and can be supported by empirical evidence.

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[30] If $(1-\gamma)$ equals 0.5, the non-linear relationship between price level and real GDP also becomes linear (see Figure 1a), even though the price index is geometric. It is interesting to note that in a cross-country regression of the price level and the nominal GDP the relationship seems to be "exponential" rather than linear, which is consistent with equation (A8). The estimated relationship is close to the square root, which is consistent with the fact that for GDP in PPP terms we obtain a linear relationship with a coefficient close to 1 (see equation A10).

[31] For the extended sample of 32 countries, the relationship between price level and nominal GDP seemed again to be non-linear, which is consistent with equation (A8), and the estimate of $(1-\gamma)$ was 0.47, which is close to the value of 45 percent mentioned in the text.

[32] See Obstfeld and Rogoff (1998).

[33] Note that for $\alpha=\beta=0$, equation (A11) becomes (A6); the same is true for equations (A12) and (A10), respectively.

[34] The standard neoclassical assumption is that the capital share in output is roughly one-third for the whole economy. In the sector of nontradable commodities, however, it is more realistic to assume lower than average capital intensity, because services usually have higher labor content.

WHY IS THE CZECH PRICE LEVEL SO LOW?

The Czech Republic had the largest negative residual of the 22 countries included in the regression of GDP vs. the average price level in Table 1. The Czech Republic was 23 percentage points (more than 2.0 standard errors of the regression) below the regression line in 1996. In 1999, the residual declined to 15 percentage points (1.7 of the standard error), but it remained the largest among the compared countries. The Czech residual is very large even in a world-wide comparison: when we estimate the regression of price levels vs. GDP per capita in PPP for a sample of 106 countries from all continents, and sort the countries according to the relative size of the residual in the regression, the Czech Republic ranks among the 10 percent of countries with the largest negative residual (it is 98th out of 106 – see Appendix IV and Table 11 for details).[35]

In domestic policy discussions, this negative residual was interpreted either as a sign that the increase in domestic price level after the EU accession can be very dramatic or as an indirect measure of structural and institutional weaknesses of the Czech economy (see Vintrová and others, 2001). What is the most reasonable explanation?

Perhaps the simplest explanation is the hypothesis that regulation of certain "socially sensitive" prices in the Czech Republic was more meticulous than it other countries. Table 1 confirms that there were large negative residuals for rents, fuels and energy, health care, education, communication, and other items with regulated prices in 1996. The residuals for rents, fuels and energy, and communications declined in absolute value between 1996 and 1999, so that unusually low prices now remain mainly in the area of state-financed social services (health care, education, etc.).

The significant negative residual can be found not only in regulated prices, though, but also in other commodities, which are traditionally thought of as being "tradable." In order to explain these residuals, we also have to include in our analysis other factors suggested by economic theory. One possibility is to reject the Balassa-Samuelson assumption of perfect competition in tradables and to assume that competition is monopolistic, so that prices of tradables can differ according to the monopolistic markup. The low price level in the Czech Republic can then be explained by a large share of high value-added products in Czech exports. For these products, perceived quality usually plays a more important role than price. If the Czech exports were in 1996 perceived as "low-quality goods from the East," the Czech producers had to compensate for the lower perceived quality by lower prices, and the lower the price elasticity, the bigger the compensation had to be. In order to estimate the impact of this factor, we included in the regression the share of exports of machinery and transportation equipment (SITC group 7) on total exports of the individual economies (we denote this variable *exp7*). The relationship

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[35] It would rank 104th out of 106 if we ranked the countries according to the absolute size of the residual. It is, however, more natural to think of the residual relative to the domestic price level rather than thinking of the absolute residual in terms of the U.S. price level.

between this variable and the price level cannot be expected to be monotonic, though, since underdeveloped economies must undercut, while "luxury" products from developed countries can have a monopolistic premium. We therefore also included in the regression the product of these exports and GDP (*exp7*GDP_96)* of individual countries.

The failure of the law of one price of tradable commodities can be also due to government interference in the economy, for instance, in the form of taxes or tariffs. These influences can be approximated by the share of general government revenues on GDP (*gov*).[36] The higher this variable, the lower the price level that can be expected in the respective country.

A part of the residuals in the regression of the price level and GDP can be explained as well within the Balassa-Samuelson model, though. First, the productivity in the tradable sector does not have to be reflected in GDP *per capita*, but rather in GDP *per worker.* If the share of workers in the total population differs substantially among countries, GDP per capita is only a very crude measure of productivity. In the Czech Republic, the participation rate is, despite a declining trend, traditionally very high, so that GDP per capita distorts productivity in the tradable sector upward, which might contribute to the large negative residual of the Czech economy. We therefore included in the regression the share of labor force on the total population (denoted *activ*). The larger this variable, the lower the price level that can be expected.

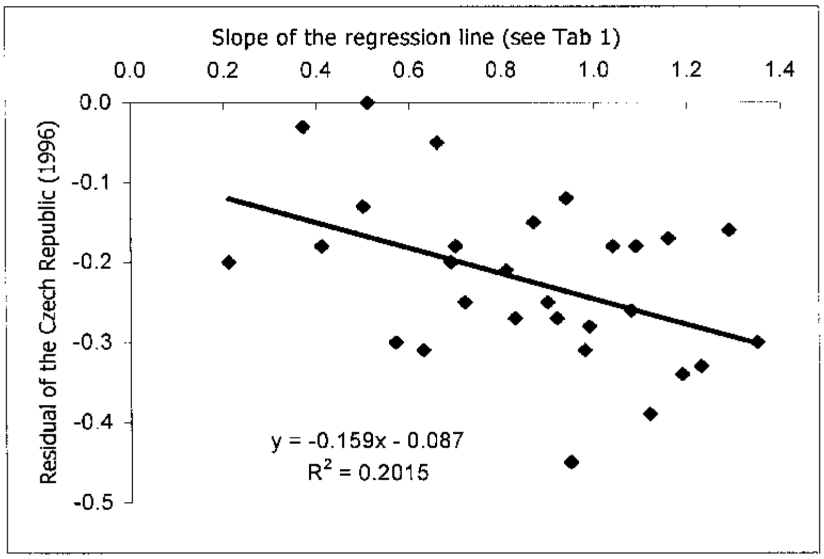
Second, the relative price level in the Balassa-Samuelson model is influenced not only by productivity in the tradable sector, but also by relative productivity in the nontradable sector—see equations (A10) and (A12). The differences in productivity in nontradable sectors are usually ignored in simple applications of the Balassa-Samuelson model, but they can be important for practical applications. Consistent with the Balassa-Samuelson model, a low price level (such as that in the Czech Republic) can be a sign of relatively high productivity in nontradable sector, which decreases unit labor costs and thereby prices in this sector as well. If this hypothesis were correct, it would contradict the prevailing view that the low price level in the Czech Republic is a sign of something objectionable, such as unfinished deregulation of prices, structural and institutional problems, or low non-price competitiveness (see, for instance, Vintrová and others, 2001).

If this hypothesis were correct, we would expect that the negative residuals of the Czech Republic in the regressions in Table 1 would be larger for commodities with a larger share of the nontradable elements, i.e., for commodities with a large slope coefficient in the regressions in Table 1. Figure B1 illustrates that this relationship exists. It is not very strong, but it is significant at the 5 percent significance level. Moreover, if we use generalized least squares instead of ordinary least squares and attribute a higher weight to residuals from the regressions

[36] We also tried to use the ratio of indirect tax revenues on GDP as an explanatory variable, but the estimated slope coefficient was against economic theory and intuition, so that we did not use it in the final regression.

with the largest R^2, the regression becomes statistically significant at the 1 percent significance level.

Figure B1. Czech Republic: Regression Residuals vs. the Nontradable Element in the Commodity

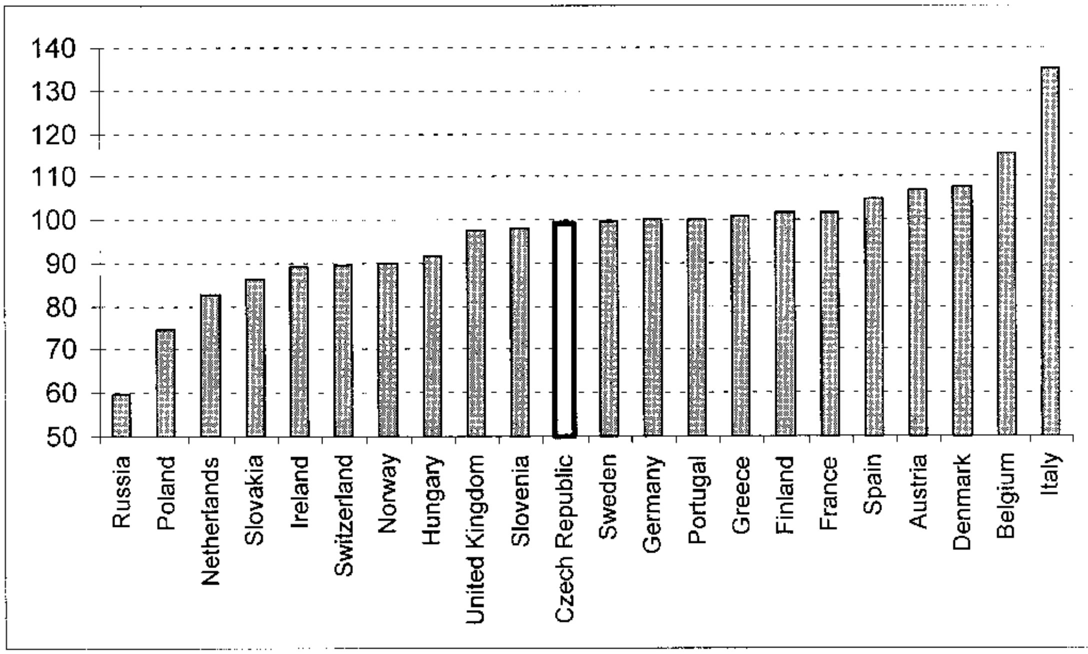


Source: authors' calculations.

In order to test this hypothesis more formally, we also included in the regression of "GDP vs. price level"a proxy for productivity in the nontradable sector (*prodN*), defined as the ratio of nominal value added in individual subgroups of services and the price levels of these subgroups in individual countries (see OECD, 1999).[37] We divided these amounts by the numbers of employees in services in individual countries, and we normalized the results so that productivity in services in Germany was equal to 100. The resulting values are illustrated in Figure B2. We can see that productivity in services in the Czech Republic is at about the level of several developed countries, such as the United Kingdom, Germany, or Switzerland, and that it is above the level of productivity in services in other CEE countries. This result suggests that the relatively low price level in the Czech Republic could be partly explained by relatively high productivity in the nontradable sector.

[37] By adopting the crude breakdown of consumption into goods and services, and by using services as a proxy for all nontradable commodities, we somewhat neglect our previous conclusion that the distinction between the tradable and nontradable sectors is very arbitrary. Yet there was no other way to proceed. Moreover, we used this approach only in the "aggregate" regression of GDP vs. average price level, for which we confirmed that the basic Balassa-Samuelson model yields reasonable predictions (see above).

Figure B2. Labor Productivity in Services (1996, Germany=100)



Sources: OECD, ILO, and authors' calculations.

The following table summarizes the results of the extended regression, including all the variables discussed above.

Dependent variable: Average price level, 1996				
Number of countries included: 22				
Variable	Coefficient	SE	t-statistics	Prob.
constant	0.66	0.30	2.21	0.04
GDP_96	0.58	0.24	2.44	0.03
activ	-0.72	0.46	-1.56	0.14
prodN	-0.34	0.19	-1.83	0.09
exp7	-1.09	0.55	-1.99	0.06
*exp7*GDP_96*	1.44	0.61	2.36	0.03
gov	0.50	0.38	1.32	0.21
R2	0.93	F-statistics		32.79
R2 adjusted	0.90	Prob(F-statistics)		0.00

Overall, the explanatory power of this regression is slightly higher than in the case of the simple regression (see the bottom row in Table 1). The additional explanatory variables are significant at least at the 10 percent significance level, with the exception of the share of public revenues on GDP (*gov*) and the participation rate (*activ*) – but standard econometric tests for these two variables indicated that it is sensible to leave them in the regression.[38] All coefficients have the expected signs. Moreover, we found that relationship between *exp7* and the price level is probably non-monotonic, as expected: for economies with GDP below 75 percent of Germany's GDP, a larger share of machinery exports leads to a lower average price level, and vice versa.

The residual of the Czech Republic in this extended regression for 1996 is still negative, but it declined in absolute value to 11 percentage points (from 23 percentage points), that is, to 1.2 times the standard error of the regression. Moreover, we have already shown that between 1996 and 1999, the adjustment of regulated prices (and the decline of relative GDP) led to a decline of the residual in the basic regression by 8 percentage points; this suggests that the price level is now not far from the value predicted by economic theory.[39]

The remaining unexplained residual can be attributed mostly to food prices (see the significant residual for 1999 in Table 1), which reflects especially the lower regulation of the Czech agricultural market compared with both the Common Agricultural Policy in the EU and with most other transition countries, where the agricultural sector is more significant than in the Czech Republic. The only price shock, which would therefore result from the negative residual of the Czech Republic in cross-country comparisons, is the shock resulting from accession to the common agricultural policy (see also Vintrová and others, 2001). From the viewpoint of monetary policy, this shock would be covered by the institution of exceptions in inflation targeting, which means that the central bank would not have to fight against the primary effect of the shock, but only against its secondary impact on other prices.

The extended regression, summarized in Table B1, has a few shortcomings, which are mostly related to the proxy variable for labor productivity in the nontradable sector. First, if the price levels in services are not properly measured—which cannot be excluded even in these international comparisons—both the average price level (i.e., the dependent variable) and the proxy variable for productivity in services (i.e., one of the explanatory variables) are biased. This might lead to spurious correlations. Second, it is not clear why the slope coefficient for labor productivity in services is significantly lower than that for GDP. According to (A10), they should be roughly the same, and according to (A12) the slope for productivity should be less than that for the GDP. This only suggests that the regression summarized in Table B1 is an illustration rather than a full-fledged explanation of price levels in all countries. An improvement of the extended regression would go beyond the scope of this paper, in which the focus is on the relationship between the detailed structure of relative prices and the price level.

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[38] We performed the F-test and the log-likelihood test for redundant variables. The latter indicated a statistical significance of the two variables at the 10 percent significance level (the former only at the 20 percent level).

[39] When we introduced into the regression data for the Czech Republic for 1999 instead of 1996, the residual declined to less than 5 percentage points (less than 1 standard error of the regression).

DISPERSION OF RELATIVE PRICES

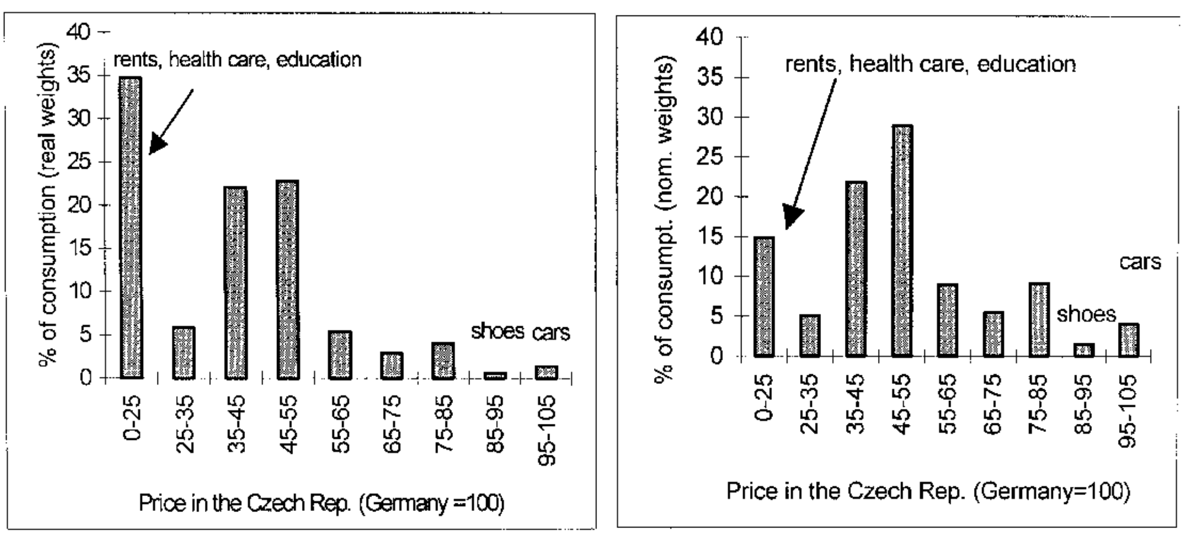
The distribution of relative prices in transition countries is very uneven and dispersed. Figure C1 illustrates that for the case of the Czech Republic. On the one extreme, there are rents, schooling, and health care, which are at less than 15 percent of the German level. On the other end, there are cars and shoes, which have basically the same price in the Czech Republic and in Germany. However, one cannot say that the lower prices are only those of "nontradables" and that all "tradable" prices are equalized. Cars and shoes are rather an exception than a typical example. A significant part of the traditional "tradable" commodities (such as most foodstuffs, non-alcoholic beverages, clothing, floor coverings, home appliances, etc.) are at 45–75 percent of the German level.

The uneven and dispersed nature of the distribution of Czech relative prices is especially apparent when compared with Figure C2, showing a similar histogram for the case of the Netherlands, which is an example of small open economy from the "EU core," where most comparable prices are clustered around the average price level (in the range of 80–120 percent). The difference is significant also in comparison with Portugal, a small open economy outside the "EU core" and both geographically and economically more distant from Germany than is the Czech Republic (see Figure C3).

The histograms in all three figures are shown both for "real weights" and for "nominal weights." As explained in the main text, nominal weights mean that we weigh prices using the actual structure of nominal expenditures by households. "Real weights" mean that we "imput" internationally comparable prices of the individual commodities, from which we calculate "real" weights of the respective commodities. "Nominal weights" underestimate the weight of low-priced items such as rents, while "real weights" overestimate it; the actual weights are most likely to lie between the two extremes.

Figure C1. Relative Prices: The Czech Republic vs. Germany, 1999

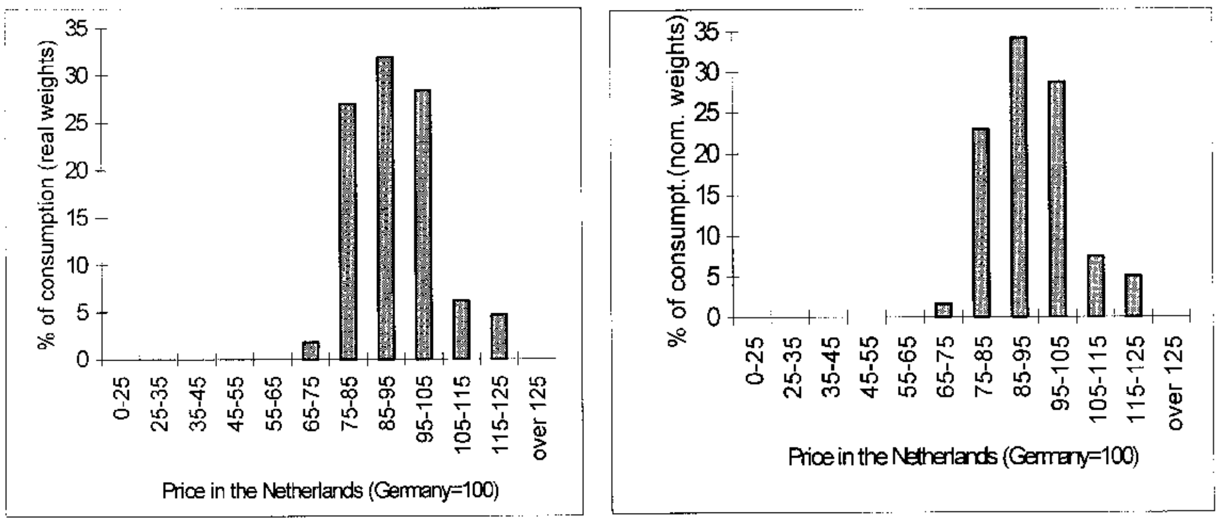
a) Real weights b) Nominal weights



Sources: OECD and authors' calculations.

Figure C2. Relative Prices: the Netherlands vs. Germany, 1999

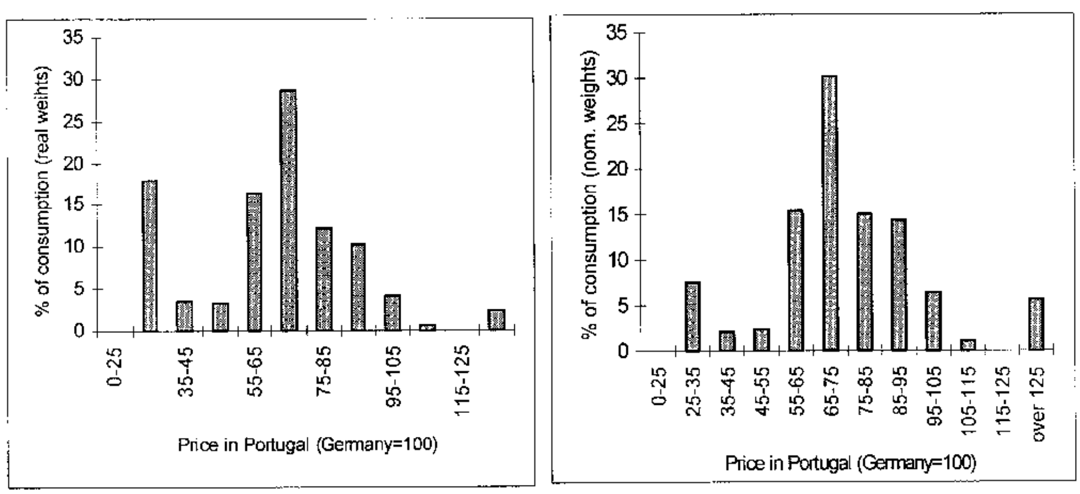
a) Real weights   b) Nominal weights



Sources: OECD and authors' calculations.

Figure C3. Relative Prices: Portugal vs. Germany, 1999

a) Real weights   b) Nominal weights



Sources: OECD and authors' calculations.

PRICE LEVELS AND PRICE STRUCTURES IN A WIDER SAMPLE OF COUNTRIES

Using World Bank (2000) data for a worldwide set of over one hundred countries from all continents, we estimated first the relationship between price levels and GDP, and second the relationship between price levels and the coefficient of relative price differences. For this sample, we chose the United States as the reference country instead of Germany.

First, we re-estimated equation (1) for a sample of 106 countries in 1998. The estimated equation was the following:

$$\mu = -35.68 + 0.99\, GDP, \qquad \text{(D1)}$$
$$(2.67)\ \ (0.07)$$
$$R^2 = 0.70,\ N = 106,\ F = 240.58,$$

where μ is again the average price level and GDP is the gross domestic product (in both cases, USA= 100). The regression is again very significant and at the 1 percent significance level, and thus we cannot reject the hypothesis that the slope coefficient equals 1. Our estimate therefore suggests that an increase in GDP per capita in PPP units relative to the United States of 1 percentage point tends to be accompanied by an increase in the price level relative to the United States of 1 percentage point. Table 11 shows the individual countries in a descending order according to the residual in the regression (D1). Most of the CEE countries are in the lower parts of the table, suggesting that there might be a need for additional explanations of the price levels in these countries (see Appendix II for the explanation in the case of the Czech Republic, which ranks 98th among the 106 countries in Table 11).

Second, we estimated the relationship between price levels and the coefficient of relative price differences in this wide sample of countries in 1998. The number of commodity groups was substantially smaller than in our calculations for Europe (6 instead of 29), but the number of countries was more than three times bigger. The resulting equation was:

$$\mu = -32.89 + 0.28\ \rho + 8424.07\ (1/\rho), \qquad \text{(D2)}$$
$$(61.67)\ (0.19) \qquad (4682.93)$$
$$R^2 = 0.04,\ N = 104,\ p(F\text{-stat}) = 0.18,$$

where μ is the average price level and ρ is the coefficient of relative price differences, defined in (2). We did not have data on weights, so that we had to calculate an unweighted version of the coefficient of relative price differences (that is, we calculated the coefficient as if the weights of all commodity groups were equal)

Compared with the case of East European countries and the EU, it is much more difficult to argue that price structures in countries as distant (both geographically and economically) as, for instance, the United States and Botswana, tend to equalize over time. Nevertheless, the regression was not inconsistent with our findings for Central and Eastern European countries. The coefficient of ρ was insignificant, but the coefficient of $(1/\rho)$ was significantly different from zero at the 7.5 percent significance level, suggesting that there might be a hyperbolical relationship similar to that found in the sample of 32 European countries. However, the regression as a whole was not very statistically significant, so that one should be very cautious about drawing strong conclusions from these findings.

References

Asea, P. K. and Corden, W. Max (ed.), 1994, "The Balassa-Samuelson Model: An Overview" (Special issue: Thirty years of the Balassa-Samuelson model), *Review of International Economics*; 2 (October): 191–325.

Balassa, B., 1964, "The Purchasing Power Parity Doctrine: A Reappraisal,." *Journal of Political Economy*, 72: 584–96.

Barro, R.J. and Sala-i-Martin, X., 1995, *Economic Growth*. New York: McGraw-Hill.

Blinder, A., 1991, "Why are prices sticky? Preliminary Results from an Interview Survey," *American Economic Review (Papers and Proceedings),* Vol. 81, No. 2: 89–96.

Čihák, M. and Holub, T., 2001, "Cenová konvergence k EU—pár nezodpovězených otázek," ("Price Convergence Towards the EU—A Few Open Questions,") *Finance a úvěr*, 5/2001.

Czech Statistical Office, 1999, "Srovnání hrubého domácího produktu a cenové úrovně ČR za rok 1996" ("Comparison of the Gross Domestic Product and Price Levels for 1996"), Publication No. 0117–99, Prague: Czech Statistical Office.

Debelle, G. and Lamont, O., 1997, "Relative Price Variability and Inflation: Evidence from U.S. Cities," *Journal of Political Economy*, Vol. 105, No. 1 (February): 132–152.

De Broeck, M. and Sløk, T., 2001, "Interpreting Real Exchange Rate Movements in Transition Countries," Working Paper No. 01/xx, Washington: International Monetary Fund.

De Gregorio, J., Giovannini, A., and T. Kruger, 1994, "The Behavior of Nontradable Goods Prices in Europe: Evidence and Interpretation," *Review of International Economics*, 2 (October): 284–305.

Driffil, J., Mizon, G. E., and Ulph, A., 1990, "Costs of Inflation," in B.M. Friedman and F.H. Hanh (eds.), *Handbook of Monetary Economics*, Vol. II, Elsevier Science Publishers.

Feldstein, M., 1996, "The costs and benefits of going from low inflation to price stability," NBER Working Paper No. 5469.

Fielding, D. and Mizen, P., 2000, "Relative Price Variability and Inflation in Europe," *Economica*, Vol. 67, pp. 57–78.

Filer, R.K. and Hanousek, J. 2000, "Output Changes and Inflationary Bias in Transition," Working Paper No. 167, CERGE-EI, Prague, December 2000.

Frenkel, J. and Mussa, M., 1986, "Asset Markets, Exchange Rates, and the Balance of Payments," Chapter 14 in E. Grossman and K. Rogoff (eds), *Handbook of International Economics*, Vol. 3, Amsterdam: North Holland.

Froot, K.A. and Rogoff, K., 1995, "Perspectives on PPP and long-run real exchange rates," In Grossman, G.M. and Rogoff, K. (eds.), *Handbook of International Economics*, Vol. 3, Amsterdam: North Holland.

Geary, R.G., 1958, "A note on comparisons of exchange rates and purchasing power between countries," *Journal of the Royal Statistical Society,* A121, pp. 97–99.

Goodfriend, M. and King, R. G., 1997, "The New Neoclassical Synthesis and the Role of Monetary Policy," NBER Macroeconomic Annual, 1997.

Heston, A and Lipsey, R.E. (eds.), 1999, *International and Interarea Comparisons of Income, Output, and Prices*, Studies in Income and Wealth, Vol. 61, NBER. Chicago: The University of Chicago Press.

Isard, P., 1977, "How far can we push the law of one price?" *American Economic Review* 67 (December): 942–48.

Janáček, K., Čihák, M., Frýdmanová, M., Holub, T., and Zamrazilová, E., 1999, "Czech Economy in 1999: An Uneasy Way to Recovery," *Economic Trends No. 19.* Prague: Komerční Banka. Reprinted in *Politická ekonomie* 2/1999 and in *Prague Economic Papers*, 2/1999.

Khamis, S.H., 1972, "A new system of index numbers for national incomes and prices," *Journal of the Royal Statistical Society*, A135, pp. 96–121.

Kočenda, E., 2001, "Convergence of Nominal Prices," *Journal of Comparative Economics*, February 2001.

Kravis, I.B., Heston, A., Summers, R., 1982, "World Product and Income: International Comparisons of Real Gross Product," Baltimore: The Johns Hopkins University Press and the World Bank.

Kurabayashi, Y. and Sakuma, I., 1990, "Studies in International Comparisons of Real Product and Prices." Economic Research Series, No. 28. Tokyo, Japan: Kinokuniya Company, Ltd.

Lach, S. and Tsiddon, D., 1992, "The Behavior of Prices and Inflation: An Empirical Analysis of Disaggregated Price Data," *Journal of Political Economy*, Vol. 100, No. 2 (April): 349–389.

Lucas, R.J., 1972, "Expectations and the Neutrality of Money," *Journal of Economic Theory* 4 (April).

Lucas, R.J., 1973, "Some International Evidence on Output-Inflation Trade-offs," *American Economic Review* 63 (June).

Mussa, M., 1984, "The Theory of Exchange Rate Determination," in J.F.O. Bilson and R.C. Marston (eds), *Exchange Rate Theory and Practice*, NBER Conference Report, Chicago: Chicago University Press.

Obstfeld, M., Rogoff, K., 1998, *Foundations of International Macroeconomics*, Cambridge, MA: MIT Press.

Officer, L., 1976, "The Purchasing Power Parity Theory of Exchange Rate: A Review Article," *International Monetary Fund Staff Papers*, 23: 1–60.

Parks, R.W., 1978, "Inflation and Relative Price Volatility," *Journal of Political Economy*, Vol. 86, No. 1 (February): 79–98.

Romer, D., 1996, *Advanced Macroeconomics*. New York: McGraw-Hill.

Samuelson, P.A., 1964, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, 46 (May): 145–154.

Samuelson, P.A., 1994, "Facets of Balassa-Samuelson Thirty Years Later" (Special issue: Thirty years of the Balassa-Samuelson model.) *Review of International Economics*; 2 (October): 191–325.

Statistical Office of Macedonia, 1999, "Gross Domestic Product in 1996," Skopje: Statistical Office of Macedonia.

Vintrová, R., et. al. 2001, "Studie o sociálních a ekonomických dopadech vstupu do EU," ("A Study of Social and Economic Impacts of the Entry to the EU,") Office of the Government, The Czech Republic (see also http://www.vlada.cz/1250/eng/vrk/rady/rady.htm).

World Bank, 2000, "World Development Indicators," Washington, D.C.: World Bank.