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in Tradables in Transition Countries**

Martin Cincibuch
Jiří Podpiera

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Martin Cincibuch, Jiří Podpiera

Beyond Balassa - Samuelson: Real Appreciation in Tradables in Transition Countries

Martin Cincibuch*, Jiří Podpiera†

Abstract

Using the simple arbitrage model, we decompose real appreciation in tradables in three Central European countries between the pricing-to-market component (disparity) and the local relative price component (substitution ratio). Appreciation is only partially explained by local relative prices. The rest is absorbed by disparity, depending on the size of the no-arbitrage band. The observed disparity fluctuates in a wider band for differentiated products than for a commodity like goods.

JEL Codes: F12, F15.

Keywords: Purchasing power parity, pricing-to-market, transition, real appreciation, exchange rates.

*Czech National Bank, e-mail: martin.cincibuch@cnb.cz.

†Czech National Bank, e-mail: jiri.podpiera@cnb.cz.

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Nontechnical Summary

The trend of real appreciation of currencies for European economies in transition is a well-documented phenomenon, which has attracted economists' attention for some time now (Halpern and Wyplosz, 1997, Krajnyak and Zettelmeyer, 1998, Cincibuch and Vvra, 2001). Nevertheless, ambiguity still exists regarding its nature. However, the proper judgement about the 'equilibrium' pace of real appreciation became a major policy issue for monetary authorities and governments in small, open economies of several Central and Eastern European countries. In other words, the major question is to what extent do the actual real exchange rate movements reflect equilibrium appreciation processes that can be explained by structural changes in a transition economy's production and its newly gained access to markets and to what extent are they driven by cyclical forces and reactions of the economy to shocks in the presence of various imperfections and rigidities. The answer to this question will then greatly affect monetary policy decision-making.

The often cited explanation for the real appreciation trend is the Balassa-Samuelson effect (Balassa, 1964, Samuelson, 1964). However, empirically this explanation is weakly supported. The real appreciation of currencies for the CEE transition countries relative to developed Europe appears to be faster than can be explained by productivity differentials between traded and non-traded goods in the respective countries. It is documented in Begg et al. (2001), Flek et al. (2002), or Egert (2003).

By its nature, the Balassa-Samuelson model explains only the differential between the real exchange rate based on the prices of all goods and the real exchange rate based on the prices of internationally tradable goods. However, for tradables like manufactured products, real appreciation is also observed, and it often accounts for the bulk of the overall appreciation.

We focus on explaining the trend and changes of the tradable part of the real exchange rate. We approximate prices of the tradable component by producer prices, export prices, and import prices. These prices, which represent wholesale trade, should be less influenced by non-tradable component than price of any tradable good on the final consumer level, which include the price of retailing services.

The empirical literature suggests that, although the deviations from the purchasing power parity for tradable goods tend to die out, convergence is extremely slow. Taking insight from the extensive PPP, pass-through and pricing-to-market literature, we propose an extremely simple, arbitrage-based model, that leads to decomposition of the real exchange rate between the substitution and pricing-to-market components, the latter we call disparity.

Using this model, we decompose real appreciation in tradables in three Central European countries between the pricing-to-market component (disparity) and the local relative price component (substitution ratio). We find that because border, substitution and measurement factors, the real exchange rate is too approximative to have great relevance as a measure of the relative price of the home and foreign goods. Appreciation is only partially explained by local relative prices.

The rest is absorbed by disparity, depending on the size of the no-arbitrage band. The observed disparity fluctuates in a wider band for differentiated products than for a commodity like goods.

Also we document that, almost by rule, the relative prices of the goods produced by the transition economy and sold on either market segment drifted upwards. Most likely, it is attributable to the quality adjustment bias. It remains to be seen whether such a process may continue. Indeed, the continued integration of manufacturing production into the globalised economy will lead to saturation of the process. This is a major source of trend real appreciation in tradables. Yet, this structural appreciation is slower than overall real exchange rate appreciation. Depending on the size of the no-arbitrage band, the pricing-to-market component absorbs the rest of the process. Indeed, the pricing-to-market component exhibits no trend but adds to medium-term volatility of the exchange rate.

With regard to the example of disaggregated data for manufactured products from selected transition economies and Germany, we show that disparity fluctuates less for more homogenous and arbitrage-friendly goods and that there is a potential for large deviations from the law of one price for differentiated products like cars, perhaps, because the differentiation allows producers to elevate more barriers to cross-border trade.

An additional theoretical structure imposed on the data is useful in several respects. First, it allows the formation of testable hypotheses that take into consideration the exchange rate pass-through. Empirical tests may validate the underlying structure. It may then be useful for inflation forecasts. Second, it might be helpful in judgements about the cyclical position of a particular economy. It stems from the fact that components extracted from decomposition have naturally different trending and cyclical behaviour. Thus, the door is open to enhancing filtering methods for estimating various economy gaps in monetary policy models.

In the next section, we discuss the possible reasons that may cause the tradable-based real exchange rate to fluctuate or even exhibit a trend. Our further aim is to rely on the results of the literature and to set up an operational framework that would allow a robust interpretation of the exchange rate dynamics. To this end, we present a simple decomposition, which allows us to separate real exchange rate changes allowed by border barriers from changes stemming from imperfect substitution between home and foreign goods. Next, we argue that both of these components might have a structural part responsible for a trend and a cyclical part. Testable hypotheses stemming from the intuitive interpretation of the decomposition are that there should be no trend or a very weak trend in the pricing-to-market component. Further, the variability of this component should be smaller for industries dealing with less differentiated products where less barriers to cross-border arbitrage might be expected. We perform a bilateral trade analysis for three CEE countries and Germany using disaggregated data on the prices of manufactured products and find that the results are consistent with our basic intuition.

1. Introduction

We focus on explaining the trend and changes of the tradable part ¹ of the real exchange rate. The real exchange rate index in tradables Z_T is defined by

$$Z_T = sP_T^*/P_T, \quad (1)$$

where P_T and P_T^* represent price indexes of internationally tradable goods produced at home and in a foreign country respectively.

The literature dealing with the hypothesis of purchasing power parity is very extensive, even though the concept itself is simple. This follows from a long list of possibly interacting complications that may be behind the observed PPP failures. These factors may be sorted according to how they relate to the preconditions of the hypothesis. Indeed, the parity is a paraphrase of the arbitrage-based law of one price saying that if there are *no frictions* then prices of *perfect substitutes* are equal. Let us use these two abstract provisions as a filter and classify potential economic and measurement reasons for why the real exchange rate index Z_T changes over time.

First consider a hypothetical situation without any special barriers to cross-border arbitrage. If consumers are homogenous in tastes and wealth, then within a classical model, it is difficult to explain any dynamics in the real exchange rate. For example, in the benchmark Ricardian model of Obstfeld and Rogoff (1996) there is a continuum of imperfect substitutes. Each country produces those goods in which it has a comparative advantage and imports other goods. Arbitrage arranges so that each good has the same price on each side of the border, and the homogeneity of consumers implies the same aggregation rule so the exchange rate index remains at unity².

On a practical level, the application of the abstract concept of continuum of goods is complicated by a limited observability of what a particular good is. In a Lancasterian sense, goods might be viewed as different and unbreakable bundles of elementary characteristics that cluster in groups of close substitutes. This clustering leads to a fuzzy notion of market and industry. However, within a given industry group, goods are still differentiated by e.g. location, time and availability, quality and design, services, warranty, consumers' information and beliefs about goods existence, and characteristics or brand image. Quite disaggregated price and trade data as well are collected on the industry level, which gives rise to the *problem of imperfect accounting for quality*.

¹The real exchange rate Z derived from overall home and price indexes P and P^* might be formally decomposed between tradable and non-tradable parts. When we denote weights of the tradable goods in the home and foreign price index by α and β , we may write

$$Z = s \frac{P^*}{P} = s \frac{P_T^{*\beta} P_N^{*(1-\beta)}}{P_T^\alpha P_N^{(1-\alpha)}} = s \frac{P_T^* (P_N^*/P_T^*)^{(1-\beta)}}{P_T (P_N/P_T)^{(1-\alpha)}}.$$

Obviously, the real exchange rate decomposes between the exchange rate in tradables $Z_T = sP_T^*/P_T$ and a 'Balassa factor' $B = (P_N^*/P_T^*)^{(1-\beta)} / (P_N/P_T)^{(1-\alpha)}$.

²That notwithstanding, the terms of trade may change in time if the relative structure of production in the two countries evolves, for example, because of a comparative advantage shift.

For the abstract continuum of goods model, this is a measurement problem: a bundle of characteristics changes over time. In fact, it becomes a different good³ with a naturally different price. Yet in data, it still represents a particular group of goods, and consequently the measured sectorial real exchange rate changes. This problem is difficult to solve wholesale, because the characteristics involve not only physically measurable features, but it also reflects how the good is perceived by potential buyers. The statistical agencies use expert judgement to make adjustments due to quality changes, but the adjustments are likely to be incomplete and the approach might differ across countries.

In the context of transition economies, the quality induced CPI bias has been addressed by Filer and Hanousek (2001a,b) or Mikulcová and Stavrev (2001) who conclude that it is an important phenomenon that leads to overstatement of average CPI inflation and understatement of economic growth. They argue that this source of bias is especially important for transition economies where the initial quality (match with consumer preferences) was very low⁴.

When agents are heterogeneous and unevenly distributed across countries, then other factors may cause changes in the measured real exchange rate. The heterogeneity of tastes and wealth implies differences in consumption patterns, so price indexes are weighted differently. As regards the relative importance of the two factors, Helpman (1999) argues that most of the heterogeneity is generated by wealth differences and that genuine differences in preferences are less important. Consequently, the real exchange rate index may drift with changes in the index components' relative prices. However, contrary to Lancasterian characteristics, components of the index basket are not consumed as a bundle, and therefore, such changes in the real exchange rate index do not pose a severe measurement problem. This *index composition problem* may be easily circumvented by analysing the law of one price for the prices of single index constituents, which is a common practice in the literature (e.g. Engel and Rogers, 1995; Engel et al., 2003).

Heterogeneity of consumers might compound with product differentiation and create yet another channel of measured real exchange rate changes. In this situation, a producer may engage in second degree price discrimination when it offers its product in more qualities and makes use of self-selecting devices to differentiate consumers according to how they value quality. If the proportion of high value consumers differs across countries, perhaps due to a wealth gap, then the trade-weighted price index of the particular industry would be different. The sectorial real exchange rate would then change with the relative wealth of the two nations.

Hitherto, we assumed no barriers to cross-border arbitrage, and the discussed potential changes of the real exchange rate index were related to some sort of measurement error or aggregation bias. In reality, border barriers are very important. As Rogoff (1996) puts it, the international goods markets, though becoming more integrated all the time, remain quite segmented, with

³Models of Obstfeld and Rogoff (1996) assume that all goods of the continuum are produced in either of the countries, but it would be an easy extension to allow only a subset of the good to be produced.

⁴Argument of Stiglitz (1994) is invoked that the command economy created incentives to underprovision of quality. It stems from the notion that personal rewards in the command economy were based on the fulfilment of well controllable quantitative production targets of imprecisely defined goods.

large trading frictions across a broad range of goods. These frictions may be due to the international goods markets, though, are becoming more integrated all the time and remain quite segmented with large trading frictions across a broad range of goods. These frictions may be due to transportation costs, information costs, threatened or actual tariffs or non-tariff barriers. Non-tariff barriers include, for instance, differing national standards (different voltage, sockets, consumer protection norms, etc).

When cross-border transaction costs are introduced, then the real exchange rate index may change even in the abstract Ricardian perfect competition model (Obstfeld and Rogoff, 1996). In particular, transportation costs make it feasible for some goods to be produced in both countries and not to enter international trade. These goods are sold for different prices, depending on the relative costs of production. For the other goods, for which international specialisation prevails, prices differ across countries, too. As in the case of marginal cost pricing, at least consumers in the importing country pay transportation costs in addition to what consumers pay in the country of origin. To sum up, in this model the real exchange rate changes with varying relative production costs as well as due to fluctuating transportation costs.

Significantly, border barriers make feasible third degree discrimination⁵, so the producers also attempt to create additional barriers to enhance their market power. For example, they may refuse warranty or service provisions in one country for goods purchased in another, or they may attempt to directly control the distribution channels in the two markets⁶. The possibility of pricing-to-market (Krugman 1987) greatly complicates the situation, and it generated a large theoretical and empirical literature surveyed e.g. by Goldberg and Knetter (1997). Pricing-to-market is always *allowed* by market segmentation, but realisation of this possibility may stem

⁵There is only a fine distinction between second degree price discrimination combined with the heterogeneity of preferences across countries and border barriers to arbitrage that are usually associated with third degree price discrimination. According to Tirole (2000, chapter 3), the major difference between discrimination of the second and third degree is that the latter one uses a direct signal about demand, whereas the former relies on the self-selection of consumers. As an example of local differences in perceived quality across countries, consider tractors with and without a roof window. In Finland, where winter roads often lead across frozen lakes, the roof window is a very important feature. It may provide the only way out of the cabin if the ice breaks and the tractor starts to sink. Elsewhere, say in Poland, where this situation does not occur, the value of the roof window is negligible. If Finland allows for higher markups than Poland, then the producer could discriminate. He would ask a higher premium for the roof window than would be justifiable by the difference in marginal costs. Although it is a third-degree price discrimination according to Tirole (2000), it is also a marginal case of second-degree price discrimination: there are two quality-price bundles which heterogeneous consumers select according to their tastes.

⁶Consider a real-world example. There is a large German producer of plastic window frame profiles. In the Czech Republic, it set up a distribution network of small regional producers who make windows using their profiles and technology and who are subcontracted by local construction firms or install windows directly for building owners. But they are not authorised to resell the profiles. This arrangement effectively allows the German monopolist to discriminate between Czech and German consumers. Indeed, local partners have invested sunk costs in setting up the business with their supplier, and unless this enterprise is unprofitable, they have little incentive to spoil the relationships. The supplier presumably knows the approximate production capacity of any single regional partner and may stem attempts to resell a significant quantity of the material. Moreover, the windows are usually tailor-made for each building, and it would be costly for window producers to serve the German market. In this context, it is interesting that more than one half of the regional partners are located in Moravia and only very few are within a comfortable distance from German borders.

from various, conceivably complementary, economic stories that are, in general, difficult to distinguish. Different prices charged for the same product on distinct markets may be an optimal reaction of the oligopolist to a shock to the nominal exchange rate when wages are sticky and when residual demand, at least on one of the markets, is less convex than demand with constant elasticity⁷ (Marston, 1990; Bergin and Feenstra, 2001). Another possible source of pricing-to-market is costly price adjustment in the currency of the destination market. Therefore, prices are sticky, and the exchange rate variability is absorbed in producers' markups (Betts and Devereux, 2000; Chari et. al., 2000). An additional mechanism is complementary. Kasa (1992) shows that costly adjustment in quantities lead to sticky prices under exchange rate uncertainty. Yet, we considered only comparative advantage and product differentiation to be incentives for international trade. Indeed, there is also a possibility of strategic two-way trade in identical commodities as in Brander (1981) or Anam and Chiang (2003).

Importantly, the pricing-to-market literature stems largely from the analysis of export prices from one country to several locations (Kasa, 1992; Knetter, 1993) or specifically the relative price of exports and goods sold on the local market (Marston, 1990). To a great extent, this approach helps filter out some of the complicating factors of the relative price changes. In particular, issues of imperfect substitutability are presumably less urgent: even if exported and locally sold goods are not outright identical then it is likely that they are produced by the same technology and under similar quality controls. In other words, they share the same 'nationality' and brand. Significantly, the marginal costs of producing variations of the goods will be quite similar. Indeed, the wages of designers and workers producing left- and right-hand steering Škodas are very much correlated, input materials for clothes designated for home and foreign markets are from similar suppliers and the cost of capital is identical for both the local and export variation of any good.

Some issues remain. The cost of transport may influence the relative prices. Import prices are reported *cif*, so that fluctuating transportation costs may add to changes of the relative price of imported and local goods. However, the influence is likely to be relatively small⁸. Contrary to import prices, export prices are usually reported exclusive of freight and insurance, *fob*, and therefore the relative price of exported goods and home produced and sold goods should not be affected by transportation costs.

Also, the index composition bias may still be present. For example, it might be due to a combination of second order quality-based discrimination and unevenly distributed preference over quality across countries, as was already discussed. Thus, data indexes may be heterogeneous, even on the low level, if some component prevails in the export index and the other good has more weight in the local index. Then the evolution of the relative price of these two goods may

⁷Indeed, the relative price of the product sold at different market segments would not vary if all demands were of the constant elasticity type and the marginal costs were constant (Obstfeld and Rogoff, 1996; Betts and Devereux, 1996).

⁸According to Hummels (1999), on the trade-weighted average, freight and insurance make between 2%-6% of import prices depending on the industry. So the increase in transportation costs by 10% causes an increase in import prices by just about 0.5%.

introduce some noise. These problems may be alleviated by focusing on the most disaggregated data as possible. Moreover, the international comparisons of the national income suggest that factors like relative wealth or preferences change only very slowly when compared with a normal business cycle time span. To sum up, although there may be some mild trend in the relative price of exports due to the catching up process in wealth, we believe that fluctuations of the relative prices of exports well reflect pricing-to-market behaviour.

Overall, we learn from the literature, as Goldberg and Knetter (1997) put it, that deviations from the law of one price are not just artefacts of non-identical goods, and incomplete pass-through is not just the result of changes in world prices. Rather, they appear to be the results of price discrimination stemming from border barriers. Moreover, border barriers are quantitatively quite important. The prices of similar goods are much more different across countries than within countries (Engel and Rogers, 1995; Rogers and Smith, 2000; Engel et.al., 2003). Using disaggregated data it has been found, in particular, that although the relative price of the same good across two cities in one country is a function of the distance between them, the effect of the border and a different currency is dramatic. The border effect on relative price volatility is equivalent to adding between 4,000 to 36,000 kilometres of additional distance.

The finding that cross-border friction is much more important than internal market frictions motivates our model. We assume that buyers' arbitrage works in each national market. This competition forces the law of one price per unit of marginal utility of a representative buyer to hold. In other words, it means that the relative price of imported and locally sold goods fully reflects the relative marginal utility. In contrast to perfect arbitrage taking place on local markets, we assume that the relation between the domestic and foreign market is weak. These markets may be independent to a certain degree. For instance, the exchange rate might be more influenced by other factors than arbitrage over the border. Therefore, we suppose that disparity between these markets can exist measured by the cyclical component of the relative price of exports to home-sold goods.

2. Decomposition of the Real Exchange Rate in Tradables

We assume that for the market of the i – th good is divided between the home and foreign segment and that there are four tradable *sub*-goods to consider: home-produced and home-sold (in quantity x_i), home-produced and exported (in quantity \tilde{x}_i), foreign-produced and imported (in quantity x_i^*), and foreign-produced and sold (in quantity \tilde{x}_i^*). All four goods carry different prices p_i , p_i^{ex} , p_i^{im} and sp_i^* respectively. Here we are following a treatment typically adopted by statistical and customs offices and assume that goods can be categorised in groups of distinct substitutes and the following analysis is relevant for prices within such a single industry; e.g. passenger cars.

As regards the notation, the lower case denotes prices of individual goods in contrast to capital letters indicating indexes. For example, if i tags a tradable category then p_i denotes a component of the home price index of tradable goods P_T . Yet, to avoid notation cluttering we drop the subscript i where it is not necessary.

As discussed, the *major* reasons for price differences within and between segments may differ. For example, the price difference between Škodas sold on Czech and Swedish markets is caused by factors other than the differences in prices between Volvo and Škoda offered on either market segment. In our model, the inter-market price difference between Škodas is *allowed* mainly by spatial differentiation, i.e. by barriers to arbitrage prices of close physical substitutes. On the other hand, the intra-market differences between the price tags of Škoda and Volvo result from differences in product substance and their consequential imperfect substitutability on home and foreign markets.

To capture this intuition, we assume that home buyers perceive the foreign-produced goods as perfect substitutes up to some convenience multiplicative premium a^* ($a^* > 1$) carried by the imported good. Similarly, the home-produced and sold good carries a premium a over exported goods. This assumption implies that the utility is linear in these pairs of goods. On the contrary, home- and foreign-produced goods are only distinct substitutes (Dixit and Stiglitz, 1977; Shaked and Sutton, 1982).

Formally, let U is the utility function of the representative home buyer and let u_i is its restriction on the i - *th* good. Then we assume that it (subscripts dropped) can be written as⁹

$$u(x, \tilde{x}, x^*, \tilde{x}^*) = v(ax + \tilde{x}, a^*x^* + \tilde{x}^*).$$

From analogous assumptions about premia and utility of the foreign representative buyer it follows that

$$\tilde{u}(x, \tilde{x}, x^*, \tilde{x}^*) = \tilde{v}(x + \tilde{a}\tilde{x}, x^* + \tilde{a}^*\tilde{x}^*).$$

Such specification of utilities allows modelling of the market segmentation. It follows from the linearity of subutilities that, in the typical situation, either buyer consumes only two of the four goods. It is easy to show that home agents buy only locally offered goods if the following conditions are satisfied

$$\frac{p}{p^{ex}} < a, \tag{2}$$

$$\frac{p^{im}}{sp^*} < a^*. \tag{3}$$

Similar conditions for the foreign buyer to only buy goods offered for the foreign market are

$$\frac{p^{ex}}{p} < \tilde{a}, \tag{4}$$

$$\frac{sp^*}{p^{im}} < \tilde{a}^*. \tag{5}$$

⁹We assume that v is differentiable, strictly quasiconcave function.

Combining (2) with (4) and (3) with (5) produces the necessary conditions for market segmentation

$$1/\tilde{a} < \frac{p}{p^{ex}} < a \quad (6)$$

$$1/\tilde{a}^* < \frac{p^{im}}{sp^*} < a^*. \quad (7)$$

Let's denote the relative price of the two goods produced in one country by the term (good-specific) disparity d and d^* . This term is motivated by the fact that convenience premia may be viewed as a positive function of transportation costs (e.g. when the two goods are only spatially differentiated) and of other barriers to arbitrage that otherwise would drive prices close to each other¹⁰. Formally,

$$d \equiv p^{im}/sp^* \text{ and } d^* \equiv p/p^{ex}. \quad (8)$$

The conditions (6) and (7) thus determine bands within which the disparities may fluctuate.

Contrary to cross-border trade, where we allow for corner solutions of the optimal consumer choice, for each national market, we assume that the usual relation between prices and marginal utilities holds. In particular, prices per marginal utility have to be equal. For the home market, it must be that

$$\frac{\partial u}{\partial x} \frac{1}{p} = \frac{\partial u}{\partial x^*} \frac{1}{p^{im}}. \quad (9)$$

Analogically for the foreign market we have

$$\frac{\partial \tilde{u}}{\partial \tilde{x}} \frac{1}{p^{ex}} = \frac{\partial \tilde{u}}{\partial \tilde{x}^*} \frac{1}{sp^*}. \quad (10)$$

Denote the good-specific terms of trade p^{ex}/p^{im} by tot and the good-specific real exchange sp^*/p rate by z . Then from equations (9) and (10) we may express the relationship between terms of trade and the real exchange rate to define the average 'substitution ratio' q :

$$q^2 \equiv \left(\frac{\partial u}{\partial x} \frac{\partial \tilde{u}}{\partial \tilde{x}} \right) / \left(\frac{\partial u}{\partial x^*} \frac{\partial \tilde{u}}{\partial \tilde{x}^*} \right) = \frac{p^{ex}p}{sp^*p^{im}} = \frac{tot}{z} \quad (11)$$

The ratio of terms of trade to the real exchange rate equals the ratio of marginal utilities derived from the consumption of home and foreign goods, where the 'total marginal utility' derived from the country's production is measured by the squared geometric average of marginal utilities on the local and foreign markets. In a sense, terms of trade to the real exchange rate ratio is a more general gauge of local production's real value than just the real exchange rate since it combines information from both markets.

This notation provides us with an illustrative decomposition of the real exchange rate in tradables. From (8) it follows that $dd^* = 1/(z \text{ tot})$; therefore one may easily derive that

$$1/z = q\sqrt{dd^*}, \quad (12)$$

¹⁰More precisely, detrended values should be used. The trend then represents a change in the *market premium*.

or in percentage changes

$$-\hat{z} = \hat{q} + 1/2 (\hat{d} + \hat{d}^*). \quad (13)$$

Equation (13) shows that real appreciation may be decomposed between a quality improvement and an average increase in disparity.

Since disparity measures the border effect, we may expect some empirical regularities related to this concept. First, the observed disparity should not exhibit a long trend, and it should vary no more than is consistent with the band caused by reasonable transaction costs. Second, we expect that the border effect is stronger for differentiated goods than for commodities.

3. Real Appreciation in Three CE Countries

We evaluate the breakdown of the real exchange rate against Germany for tradable goods into disparity and the substitution ratio for three countries: the Czech Republic, Slovakia and Slovenia. The choice of Germany as the reference country is motivated by the position of Germany as the major and dominant trading partner in the case of all three transition countries.

In order to apply our model, we need to consider distinct, substitute goods in order to permit extraction of information from local market arbitrages within each product group. Therefore, we focused on product groups within which effective trade in both directions of trade takes place¹¹. Such product groups are mainly manufacturing goods. In the case of Czech foreign trade, trade in manufacturing product groups accounts for 65 % of total trade. According to the respective customs office statistics in relation to Germany, Czech-German trade in manufacturing that goes in both directions i.e., a positive export and import of distinct, substitute goods has attained 80%.

Similarly, the Slovak and Slovenian share of the manufacturing industries in total trade exceeds 60 %. In the case of Slovakian manufacturing, the share of Slovak-German trade and Slovak-Czech trade in both directions accounts for more than 70 % of trade. Slovenia's largest trading partners are Germany (29 % of total trade) and Italy (14 %). In the Slovenian case, the two-way trade between Slovenia and Germany, and Slovenia and Italy is dominant in the manufacturing industries.

The evaluation of all bilateral rates between Germany, the Czech Republic and Slovakia allows cross-checking of the sensibility of the theoretical concept. If there is positive disparity in the real CZK/EUR exchange rate and no disparity in the SKK/EUR, then we should verify a similar magnitude of disparity in the SKK/CZK real exchange rate. This seemingly trivial conclusion hinges on the validity of the relationships (9) and (10) that rely on the buyers' arbitrage on the two local markets and similarity of preferences across markets.

¹¹One may argue that we can even use goods that are traded only in one direction. However, in such a case, cross-checking for the structural differences would not be possible, see Section 5.

4. Data Description

In order to pursue decomposition along the lines it was necessary to prepare a disaggregated price dataset of two-way trade in distinct substitutes. We analysed bilateral trade among the Czech Republic, Slovakia and Germany and also bilateral trade between Slovenia and Germany.

The task involved working with several goods classification standards that have only partial overlaps. To overcome this problem, we have inspected in detail and matched the corresponding items across all five classifications and derived comparable groups of distinct substitutes. With the series by series procedure, we at least partially alleviated the problem that only two-digit SITC data were available¹². In this way, we have constructed several product groups for the manufacturing industries: chemicals, paper, textiles, metals and fabric metal products, machines and tools, and cars.

The sample period was determined by the availability of data from the respective statistical offices, i.e. the Czech Statistical Office, the Slovak Statistical Office, the Slovenian Statistical Office, and the German Statistical Office. In the Czech Republic and Germany, the quarterly time series starts in 1Q1997 and ends in 1Q2004. In the case of Slovakia, the sample period extends over 1Q1997-4Q2002 and for Slovenia we collected data for 1Q1997-2Q2003.

These classification standards involved double-digit SITC, OKEČ (classification of economic activities by products), DESTATIS (product classification by the German Statistical Office), NACE Rev.1 (Eurostat classification) and HS (national classification system of products in international trade). Czech export and import prices are in SITC, whereas the Czech PPI is in OKEČ. The Slovak PPI is reported in OKEČ and import and export prices of Slovakia are in HS. Slovenian data for export and import prices and the PPI are in NACE Rev.1. The German PPI was obtained in the DESTATIS classification (Segment 4162). Table 1 summarizes the relations among classifications used for reporting in all four countries¹³.

5. Measured Disparity and Structural Differences among Markets

What can we learn from the relative developments of the price of home goods on the two markets over the longer term? Typically, there are upward trends in the relative prices of the home-produced (transition country) goods on the two markets, i.e. p/p^{im} and p^{ex}/sp^* , but do the trends take place at the same speed? They should in the benchmark case. If the relative quality of home production steadily improves then, on average, it should have approximately the same impact on both markets and both ratios should be increasing at the same rate. Or, if there is a steady increase in the relative wealth of the home country vis-à-vis the foreign country,

¹²For instance, we found from the description of chemicals in SITC that SITC 59 corresponds to the OKEČ DG, DEST 24, NACE Rev. 1 DG(24) and HS VI.

¹³SITC may be expanded for standard international trade classification. See www.mfcr.cz. OKEČ - classification of economic activities by products by the Czech and Slovak Statistical Offices, see also www.czso.cz or www.statistics.sk. DEST, denotes here the German Statistical Office classification standards; Segment 4162 (www.destatis.de). NACE is the Eurostat classification (revision 1). See <http://europa.eu.int/comm/eurostat/>. HS stands for the national system of products in international trade in Slovakia. See www.statistics.sk.

Table 1: Overview of product classification

Product group	SITC ¹⁾	OKEČ ²⁾	DEST ³⁾	NACE Rev.1 ⁴⁾	HS ⁵⁾
Chemicals	59	DG	24	DG(24)	VI
Paper, paper products	64	DE	21	DE(21,22)	X
Textile, textile products	65	DB	17-18	DB(17,18)	XI
Metals and metal products	67-69	DJ	27-28	DJ(27,28)	XV
Machines, equipment, tools	71-77;87-88	DK	29-33	DK(29)	XVI
Cars	78-79	DM	34-35	DM(34,35)	XVII

then elasticity of demand may decline and markups increase, as well as the relative price level. However, by this process, both p and p^{im} would be affected, and therefore the ratio should not change.

What might be a reason for the different dynamics of p/p^{im} and p^{ex}/sp^* ? A likely factor can be the insufficient similarity of exports and products sold on the local market. For example, in the legacy of the command economy, the home firms had produced basic goods designated for the local market and premium goods for export markets. On the other hand, the imported foreign goods had about the same quality as the foreign goods sold on the foreign market. When the home firms begin to serve both markets with the same quality goods then the ratio p/p^{im} increases, but p^{ex}/sp^* remains unchanged. In the model sense, it is again a measurement problem of too little disaggregation.

Another possible factor is that the analysis is designed for bilateral trade, but the country usually trades with more partners, and the export and import price indexes are not country specific. Again, if there is too much aggregation the bias may occur. For example, assume that trade in machines and tools is analysed for countries A and B, and B is the largest trading partner of A. Further, there is a country C, which is a the second largest trading partner for country A. Different machinery is produced in each of the countries. We then compare p_A/p_{BC}^{im} with p_A^{ex}/sp_B^* , where p_{BC}^{im} is the import price index that blends machines imported both from B and C. Now it is obvious that if the relative world price of p_B/p_C changes, then the two relative prices of interest evolve differently.

If it turns out that the two relative prices differentiate too much then it is a warning that the measured disparity p^{ex}/p might include not only pricing-to-market, but it also might be noised by index composition effects.

We check whether there is a difference in the average speed of change between the two relative prices across countries and industries. We test the structural stability assumption using a simple t-test of the equality of the two mean values.

In Table 2, t-statistics and p-values of equality of two means are presented. The results are

Table 2: Test of structural homogeneity

Product group	CZ - G	CZ - SK	SK - G	SLO - G
Chemicals	0.117 _(0.908)	-0.086 _(0.932)	-0.218 _(0.829)	0.137 _(0.892)
Paper, paper products	0.233 _(0.818)	-0.122 _(0.904)	-0.235 _(0.816)	0.164 _(0.871)
Textile, textile products	-0.051 _(0.961)	-0.023 _(0.982)	-0.259 _(0.979)	0.209 _(0.836)
Metals, metal products	-0.013 _(0.989)	-0.021 _(0.983)	-0.123 _(0.903)	0.228 _(0.822)
Machines, equipment, tools	0.159 _(0.875)	0.064 _(0.949)	0.031 _(0.975)	0.231 _(0.819)
Cars	-0.099 _(0.921)	0.016 _(0.988)	-0.036 _(0.971)	0.165 _(0.871)

Note: presented are t-statistics, in parenthesis are given p-values for equality of the two means.

mixed. For the former Czechoslovakia constituents, the results suggest a very standard situation. The null hypothesis of no bias is not rejected for all industries at a 10 % significance level. And for several, it is not rejected even at a much higher significance. It may be explained by the great integration in the past of the two economies and the missing bilateral ‘market premium’. Also by historical reasons the methodology of the two national statistical agencies is likely to be more similar than might be the case for the other countries; better reliability of the results follows.

On the other hand, for bilateral trade between Slovenia and Germany, it seems that the situation is more complicated. We believe that the fact that Germany accounts for a far smaller share of the overall trade of Slovenia than is the case for the Czech Republic and Slovakia may cause the problems.

We conclude that the double-digit classification is a satisfactory detail for application of the model for the Czech Republic, Slovakia and Germany, but that the results for Slovenia would have to be taken with more caution.

6. Sectorial Decomposition by Country

The evaluation of sectorial disparities follows the decomposition of z derived earlier. By declaring the average of 1997 as the parity year, we derive the basis indices of disparities and substitution ratios. The assumption about the base year is, however, arbitrary and hence this reservation should be taken into account, especially when the disparity is interpreted.

Czech Koruna vs. German Mark

Based on our arbitrage model, we partitioned the Czech koruna sectorial tradable real exchange rates with the German mark for each group of considered manufacturing products. In particular, we evaluated indices of sectorial disparities and the sectorial substitution ratios with the base year of 1997.

Figure 1: Czech koruna vs. German mark (1997a=100)

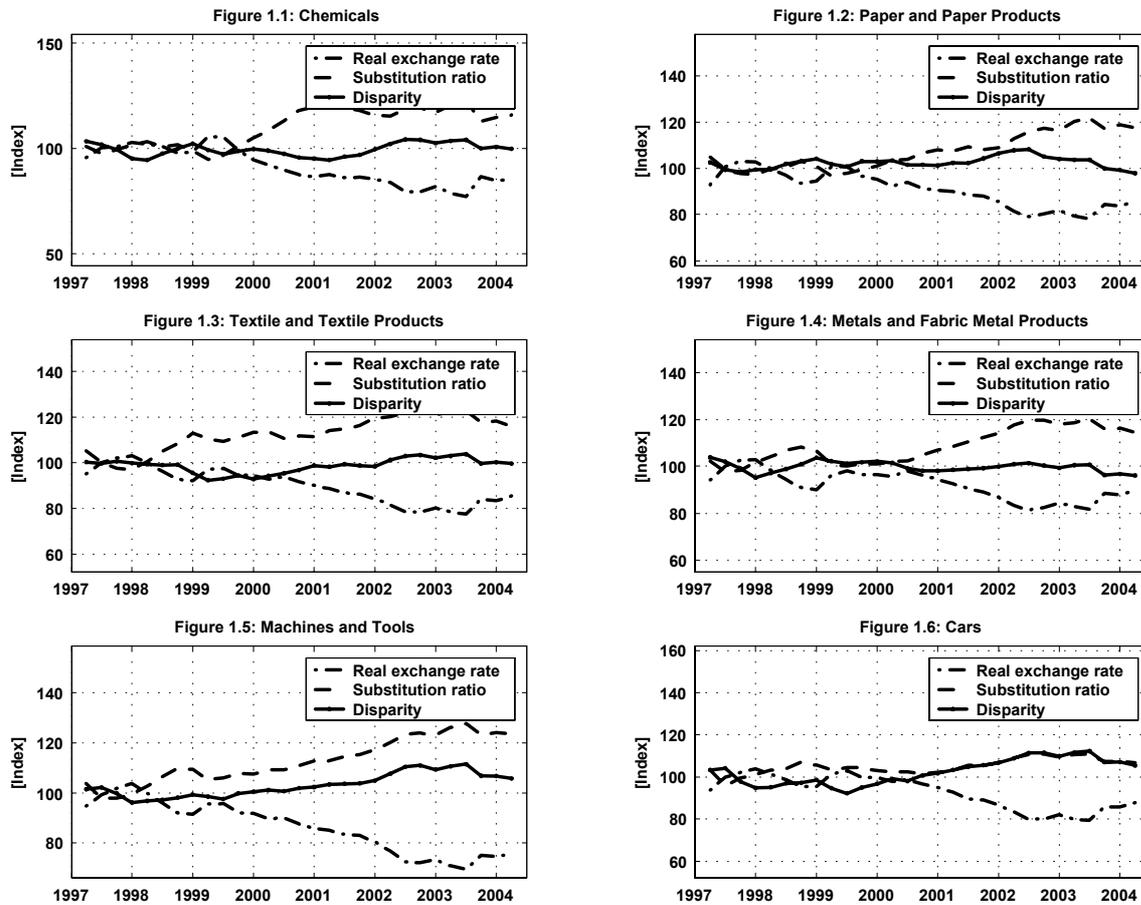


Figure 1 graphs the development of the sectorial real exchange rate, the sectorial disparities and substitution ratios. A move of the index of disparity above the threshold of 100 indicates an overvaluation of the Czech currency relative to the base year of 1997, and similarly, a move deeper into the region under the threshold means undervaluation. Real exchange rate appreciation appears to be the most significant in the product group of machines, equipment and tools, amounting up to 30% compared to 1997 (appreciation for the RER is in downward direction). It amounts to an average annual appreciation rate of about 5.4%. In other product groups real appreciation was slower, between 2.5% for metals and about 4% for chemicals (see Table 3). Quality improvements and other longer-term factors affecting the real exchange rate added about 3.5% p.a. for machines, but only 1.2% p.a. for cars. The rest is due to pricing-to-market measured by disparity. It fluctuates in a band of 20% for cars and 15% for machines and tools, where more pricing-to-market can be expected, and only between 9% and 10% for metal products, chemicals and paper.

Slovak Koruna vs. German Mark

The development of the sectorial real exchange rate and its components since 1997 can be divided into two periods: before and after the sharp devaluation of the Slovak koruna in 1999.

Table 3: Average trends in sectorial exchange rates (Confidence intervals in parentheses)

Industry	Czechia - Germany	Slovakia - Germany	Slovakia - Czechia	Slovenia - Germany
Chemicals	-3.91 (-4.77,-3.04)	0.91 (-0.47,2.29)	3.76 (2.78,4.75)	1.87 (0.79,2.94)
Paper	-3.57 (-4.32,-2.82)	-0.33 (-1.33,0.66)	4.59 (3.45,5.74)	-1.74 (-2.50,-0.97)
Textile	-3.60 (-4.31,-2.89)	0.76 (-0.14,1.65)	3.63 (2.32,4.95)	0.31 (-0.16,0.78)
Metals	-2.54 (-3.34,-1.75)	0.85 (-0.47,2.17)	2.24 (0.92,3.56)	-0.94 (-1.61,-0.27)
Machines	-5.39 (-6.13,-4.65)	3.08 (1.67,4.49)	2.61 (1.11,4.11)	-0.88 (-1.45,-0.31)
Cars	-3.44 (-4.33,-2.55)	-0.77 (-1.84,0.30)	4.85 (3.24,6.47)	0.27 (-0.36,0.91)

This variation in the nominal exchange rate provides with interesting insight into the width of the band where disparity may fluctuate. The disparity band for cars, machines and tools is huge; the relative price level between Slovakia and its partners changed by more than 50% over the sample period. This is a large number, but it agrees with the German - Japan - US disparities reported by Marston (e.g. 1990); Kasa (e.g. 1992).

On the contrary, for other goods groups, the observed disparity bands are quite close to the Czech case. It is important that disparity is formed more or less equally from disparities in local and imported products. In this case, the local market conditions drive price dispersion between the markets. A detail look at the structure of disparity shows that disparity is constructed rather equally from disparity in local and foreign goods, respectively. The domestic goods part of the disparity accounts for 86 % in the case of chemicals, 64 % for paper, and 62 % in the case of cars. In the machines industry, domestic products' disparity accounts for 33 %.

One should emphasise that the sectors with large disparity coincide with those found in the case of the Czech koruna vs. the German mark. It is consistent with the intuition that disparity could be more significant for less homogenous goods.

Slovak Koruna vs. Czech Koruna

From the point of view of the RER between the Slovak and Czech koruna, Figure 3 shows the gradual deepening of disparity in the direction of undervaluation, especially for the cars, machines, paper and paper products and chemicals since 1997. It seems that the Czech market has become a premium market vis-à-vis Slovakia. Indeed, many Czech visitors to Slovakia experience the feeling of being 'richer'.

Table 4: Average trends in substitution ratio (Confidence intervals in parentheses)

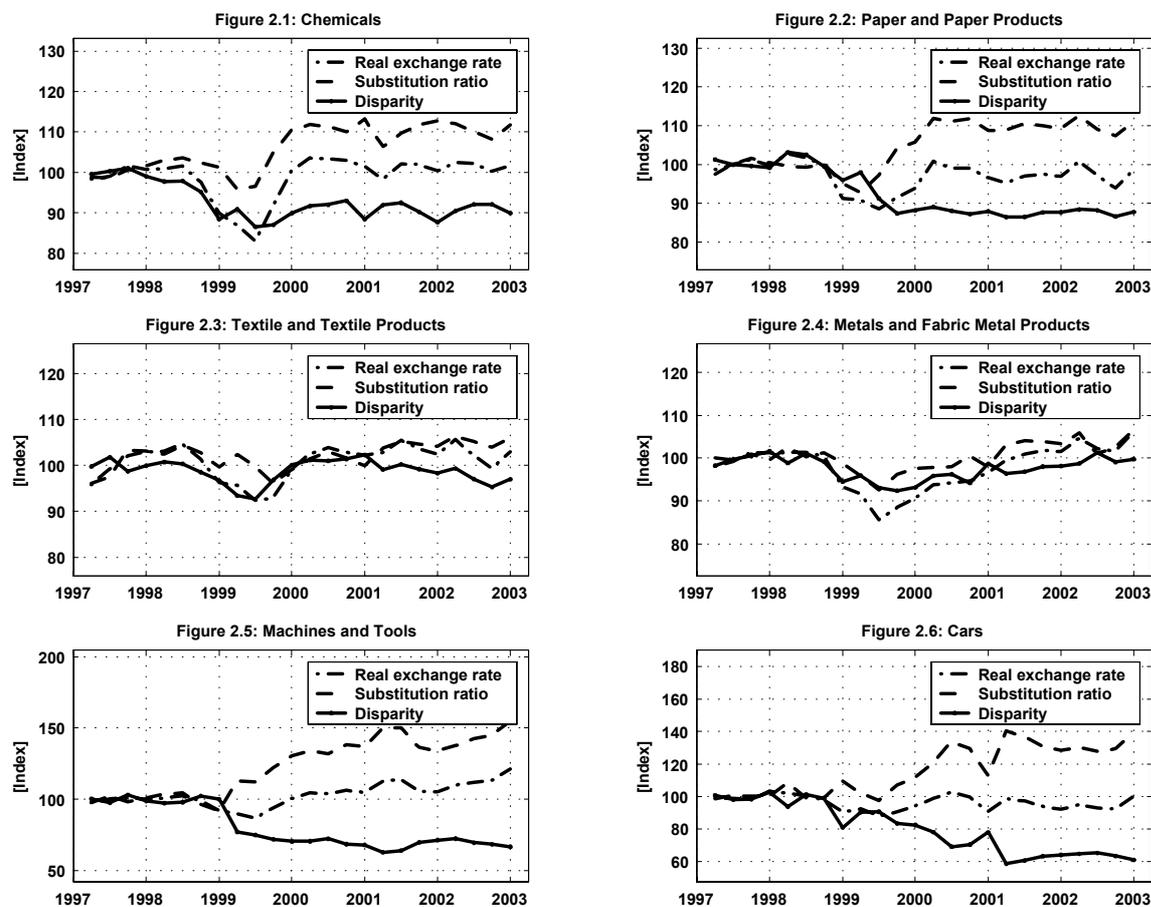
Industry	Czechia - Germany	Slovakia - Germany	Slovakia - Czechia	Slovenia - Germany
Chemicals	3.23 (2.37,4.09)	2.37 (1.54,3.20)	0.18 (-0.59,0.96)	1.35 (0.51,2.19)
Paper	3.12 (2.58,3.67)	2.57 (1.64,3.50)	0.63 (-0.42,1.68)	0.19 (-0.62,1.00)
Textile	2.84 (2.24,3.44)	0.97 (0.38,1.57)	-1.16 (-1.89,-0.44)	0.81 (0.45,1.17)
Metals	2.75 (2.11,3.39)	0.88 (0.15,1.62)	-0.59 (-1.30,0.12)	-0.33 (-0.72,0.07)
Machines	3.53 (3.11,3.96)	8.56 (6.85,10.27)	5.68 (3.75,7.61)	-0.11 (-0.48,0.26)
Cars	1.22 (0.80,1.65)	6.44 (4.86,8.02)	4.63 (2.90,6.37)	1.95 (1.18,2.72)

Table 5: Bands of observed disparity

Industry	Czechia - Germany	Slovakia - Germany	Slovakia - Czechia	Slovenia - Germany
Chemicals	(-0.05,0.05)	(-0.07,0.09)	(-0.09,0.14)	(-0.06,0.05)
Paper	(-0.04,0.06)	(-0.07,0.12)	(-0.13,0.16)	(-0.08,0.06)
Textile	(-0.06,0.05)	(-0.06,0.04)	(-0.11,0.08)	(-0.04,0.03)
Metals	(-0.05,0.04)	(-0.05,0.04)	(-0.05,0.10)	(-0.03,0.05)
Machines	(-0.07,0.08)	(-0.21,0.29)	(-0.24,0.37)	(-0.03,0.05)
Cars	(-0.10,0.10)	(-0.27,0.29)	(-0.30,0.35)	(-0.08,0.08)

The magnitudes of sectorial RER depreciation are greater than those found in the Slovak-German case. As we can see in Figure 3, this translates into higher disparities for the RER of the Slovak-Czech koruna than was found in the case of Slovak-German disparity. It corresponds to common sense, since Czech-German disparity was positive and hence we would expect Slovak-Czech disparity to exceed the Slovak-German disparity.

Figure 2: Slovak koruna vs. German mark (1997a=100)



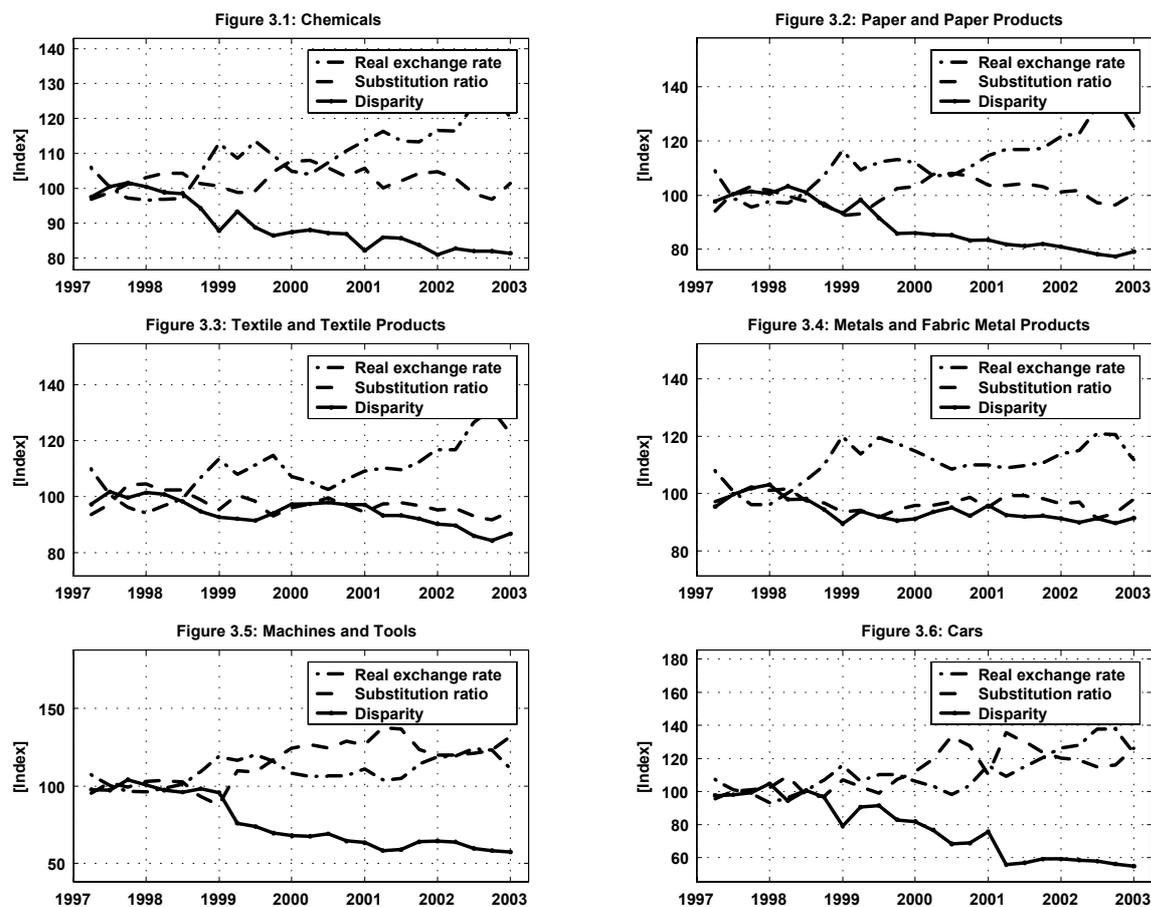
Slovenian Tolar vs. German Mark

The developments on the partitioned sectorial RER of the Slovenian tolar vs. the German mark are presented in Figure 4 and show diverse patterns. For some sectors such as cars, machines and tools, paper and paper products, disparity is relatively significant and is located in the region of undervaluation. For other sectors such as textiles and metals, the disparity is minor. A reverse development can be found in the chemical sector, where disparity exhibits a slight overvaluation. Similarly to the results for other currencies, the more differentiated goods' sectors (machines, cars, etc.) are characterised by higher disparity (effective market power leading to pricing-to-market practice) and markets for less differentiated goods exhibit a minor magnitude of disparity.

7. Conclusions

Being affected by all border, substitution and measurement factors, the real exchange rate is too approximative to have great relevance as a measure of the relative price of the home and foreign goods. The empirical literature suggests that, although the deviations from the purchasing power parity for tradable goods tend to die out, convergence is extremely slow. Taking insight from the extensive PPP, pass-through and pricing-to-market literature, we propose an extremely

Figure 3: Slovak koruna vs. Czech koruna (1997a=100)

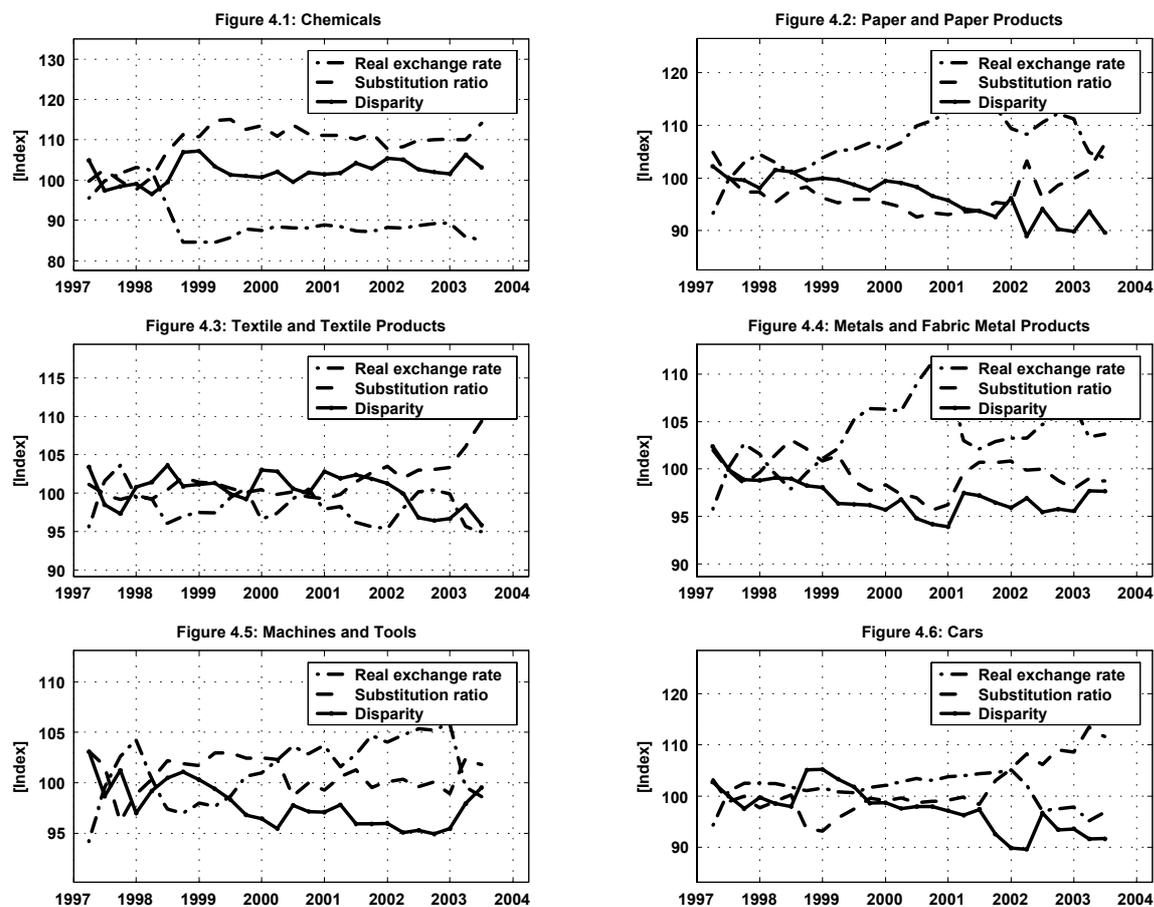


simple, arbitrage-based model, that leads to decomposition of the real exchange rate between the substitution and pricing-to-market components, the latter we call disparity.

We document that, almost by rule, the relative prices of the goods produced by the transition economy and sold on either market segment drifted upwards. Most likely, it is attributable to the quality adjustment bias. It remains to be seen whether such a process may continue. Indeed, the continued integration of manufacturing production into the globalised economy will lead to saturation of the process. This is a major source of trend real appreciation in tradables. Yet, this structural appreciation is slower than overall real exchange rate appreciation. Depending on the size of the no-arbitrage band, the pricing-to-market component absorbs the rest of the process. Indeed, the pricing-to-market component exhibits no trend but adds to medium-term volatility of the exchange rate.

With regard to the example of disaggregated data for manufactured products from selected transition economies and Germany, we show that disparity fluctuates less for more homogenous and arbitrage-friendly goods and that there is a potential for large deviations from the law of one price for differentiated products like cars, perhaps, because the differentiation allows producers to elevate more barriers to cross-border trade.

Figure 4: Slovenian tolar vs. German mark (1997a=100)



An additional theoretical structure imposed on the data is useful in several respects. First, it allows the formation of testable hypotheses that take into consideration the exchange rate pass-through. Empirical tests may validate the underlying structure. It may then be useful for inflation forecasts. Second, it might be helpful in judgements about the cyclical position of a particular economy. It stems from the fact that components extracted from decomposition have naturally different trending and cyclical behaviour. Thus, the door is open to enhancing filtering methods for estimating various economy gaps in monetary policy models.

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Czech National Bank
Economic Research Department
Na Příkopě 28, 115 03 Praha 1
Czech Republic

phone: +420 2 244 12 321

fax: +420 2 244 14 278

e-mail: research@cnb.cz