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

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Abstract

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

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1 Introduction and summary

The trend of real appreciation of currencies of European economies in transition is a well documented phenomenon, which attracts economists' attention already for some time (Halpern and Wyplosz,1997, Krajnyak and Zettelmeyer, 1998, Cincibuch and Vávra, 2001), but still ambiguity 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 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 they are driven by cyclical forces and reactions of the economy to shocks in the presence of various imperfections and rigidities. The answer to this question then greatly affects the 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 of 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 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 real exchange rate based on prices of all goods and the real exchange rate based on the prices of internationally tradable goods. However, for tradables like manufactured products, the real appreciation is observed too and it often accounts for the bulk of the overall appreciation.

We focus on explaining trend and changes of the tradable part[1] of the real exchange rate Z_T

[1] The 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

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

defined by

$$Z_T = SP_T^*/P_T,$$

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

As for example Obstfeld and Rogoff (2000) note, on the final consumer level, the price of any tradable good incorporates a significant non-tradable component, mostly price of retailing services. To avoid this complication, we approximate the tradable component by producer, export and import prices. Because these prices represent wholesale trade such effects are presumably less important.

In the next section, we discuss possible reasons that may cause the tradable based real exchange rate to fluctuate or even trend. Our further aim is to rely on the results of the literature and set up an operational framework that would allow 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 or 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 the analysis for bilateral trade of three CEE countries and Germany using disaggregated data on prices manufactured products and find that results are consistent with the basic intuition.

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

2 Deviations from PPP

The literature dealing with hypothesis of purchasing power parity is very large, even though the concept itself is simple. This follows from a long list of possibly interacting complications that may be behind observed PPP failures. These factors may be sorted according to how they relate to 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 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 causes 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 unity[2].

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 a different and unbreakable bundles of elementary characteristics (Lancaster, 1966) 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. And, even quite disaggregated price and trade data are collected on the industry level, which gives a rise to the *problem of imperfect accounting for quality.*

For the abstract model of continuum of goods, it is a measurement problem: A bundle of

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

characteristics changes over time, in fact it becomes a different good[3], 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 low[4].

When agents are heterogeneous and unevenly distributed across countries then other factors may cause changes in measured real exchange rate. The heterogeneity of tastes and wealth implies differences in consumption patterns so price indexes are differently weighted. As regards 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 of 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 of the real exchange rate index do not pose a severe measurement problem. This *index composition problem* may be easily circumvented by analysing law of one price for 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 an-

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

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

other channel of measured real exchange rate changes. In this situation, a producer may engage in the second degree price discrimination, when it offers its product in more qualities and make use of self-selecting devices to discriminate consumers according how they value the quality. If proportion of high value consumers differ across countries, perhaps due to wealth gap, then trade weighted price index of the particular industry would be different. Then the sectorial real exchange rate would 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 was 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 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 the 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, the transportation costs make feasible that some goods are produced in both countries and do not enter international trade. These goods are sold for different prices, depending on the relative costs of production. And for the other goods for which international specialization prevails prices differ across countries too. At least, as it is in the case of marginal cost pricing, consumers in the importing country pay transportation costs in addition to what pay consumers 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 discrimination[5], so the producers also

[5] There is only a fine distinction between the second degree price discrimination combined with heterogeneity of preferences across countries and border barriers to arbitrage that are usually associated with the third degree price discrimination. According 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 roof-window. In Finland, where winter roads often lead across frozen lakes, the roof window is a very important feature. It may provide with only way out of the cabin, when the ice breaks and the tractor sinks. Elsewhere, say in Poland, where this situation does not occur, the value of the roof window is negligible. If Finland

attempt to create an additional barriers to enhance their market power. For example, they may refuse warranty or service provisions in one country for goods purchased in another, they may attempt to control directly the distribution channels in the two markets [6]. Possibility of pricing to market (Krugman 1987) greatly complicates the situation[7], 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 realization of this possibility may stem from various, conceivably complementary, economic stories that are in general difficult to distinguish. Different prices charged for the same product at distinct markets may be an optimal reaction of the oligopolist to the shock to the nominal exchange rate when wages are sticky and when the residual demand at least on one of the markets is less convex then demand with constant elasticity[8] (Marston, 1990; Bergin and Feenstra, 2001). Another possible source of the 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). Further mechanism is complementary, Kasa (1992) shows that costly adjustment in quantities lead to sticky prices under exchange rate uncertainty.

Importantly, the pricing to market literature stems largely from the analysis of the export prices from one country to several locations (Kasa, 1992; Knetter, 1993) or specifically the relative price of exports and goods sold at the local market (Marston, 1990). To a great extent, this approach helps

allows for higher markups than Poland then the producer could discriminate. He would ask 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 Tirole (2000), it is also a marginal case of the second-degree price discrimination: There are two quality-price bundles which heterogeneous consumers select according their tastes.

[6] Consider the real world example. There is a large German producer of plastic window frame profiles. In Czechia 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 authorized to resell the profiles. This arrangement effectively allows the German monopolist to discriminate between Czech and German. Indeed, local partners have invested sunk costs in setting up the business with their supplier and unless this enterprise is unprofitable they have a 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 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 German market. In this context it is interesting that more that one half of the regional partners are located in Moravia and only very few are in a comfortable distance from German borders.

[7] Yet, we consider only comparative advantage and product differentiation to be incentives for international trade. For simplicity, we do not discuss strategic two-way trade in identical commodities as in Brander (1981) or Anam and Chiang (2003).

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

to filter out some of the complicating factors of the relative price changes. In particular, issues of the 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, they share the same 'nationality' and brand. And significantly, the marginal costs of producing the two variants 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 local and export variant 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 small[9]. Contrary to import prices, export ones 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 combination of the second order quality based discrimination and unevenly distributed preference over quality across countries, as it was already discussed. Thus, even on the low level data indexes may be heterogeneous if some components may prevail in the export index and other good may have more weight in the local index. Then the evolution of the relative price of these two goods may introduce some noise. These problems may be alleviated by focusing on most disaggregated data as is possible. Moreover, the international comparisons of the national income suggest that the 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 catching up process in wealth, we deem that fluctuations of the relative prices of exports well reflects pricing to market behaviour.

[9] According Hummels (1999), on the trade weighted average freight and insurance makes between 2-6 percent of import prices depending on the industry. So the increase of transportation cost by 10% causes increase of the import prices by just about 0.5 percent.

Overall, we learn from the literature, as Goldberg and Knetter (1997) put it, that deviations from the law of one price are not just artifacts of nonidentical goods, and incomplete pass-through is not just a result of changes in world prices. Rather, they appear to be results of the price discrimination stemming from border barriers. Moreover, the border barriers are quantitatively quite important. Prices of similar goods are much more different across countries then within countries (Engel and Rogers, 1995; Rogers and Smith, 2000; Engel et.al., 2003). In particular, using disaggregated data it is found 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 – 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 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 domestic and foreign market is weak. These markets may be to a certain degree independent, for instance, exchange rate might be more influenced by other factors than arbitrage over the border. Therefore, we suppose that between these markets can exist a disparity measured by the cyclical component of the relative price of exports to home sold goods.

3 The real exchange rate decomposition

We assume that market for tradable goods is divided between home and foreign segment and that there are four tradable goods to consider: home produced and home sold (in quantity x), home produced and exported (in quantity $\tilde{x}$), foreign produced and imported (in quantity x^*), and foreign produced and sold (in quantity $\tilde{x}^*$). All four goods carry different prices p, p^{ex}, p^{im} and Sp^* respectively. Here we are following a treatment typically adopted by statistical and customs offices and assume that tradable goods can be categorized in groups of distinct substitutes and the following analysis is relevant for prices within such a single industry; for example passenger cars.

As discussed, the *major* reasons for price differences within and between segments may differ. For example, the price difference between Škodas sold at Czech and Swedish markets is caused by other factors than the price differences between Volvo and Škoda offered at 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 price tags of Škoda and Volvo result from differences in substance of products and their consequential imperfect substitutability at 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).

Therefore, if U is the utility function of the representative home buyer then we assume that it can be written as[10]

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

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

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

Such specification of utilities allows to model 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 easy to show that home agents buy only locally offered goods if the following conditions

[10] We assume that V is differentiable, strictly quasiconcave function.

are satisfied

$$\begin{aligned}\frac{p}{p^{ex}} &< a, \qquad (1)\\ \frac{p^{im}}{Sp^{*}} &< a^{*}. \qquad (2)\end{aligned}$$

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

$$\begin{aligned}\frac{p^{ex}}{p} &< \tilde{a}, \qquad (3)\\ \frac{Sp^{*}}{p^{im}} &< \tilde{a}^{*}. \qquad (4)\end{aligned}$$

Combining (1) with (3) and (2) with (4) gives necessary conditions for market segmentation

$$\begin{aligned}1/\tilde{a} &< \frac{p}{p^{ex}} < a \qquad (5)\\ 1/\tilde{a}^{*} &< \frac{p^{im}}{Sp^{*}} < a^{*}. \qquad (6)\end{aligned}$$

Let denote the relative price of the two goods produced in one country by the term 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. in case when the two goods are only spatially differentiated) and of other barriers to arbitrage that otherwise would drive prices close one to each other[11]. Formally,

$$d \equiv p^{im}/Sp^{*} \text{and } d^{*} \equiv p/p^{ex}. \qquad (7)$$

The conditions (5) and (6) thus determine bands within which the disparities may fluctuate.

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

$$\frac{\partial u}{\partial x}\frac{1}{p} = \frac{\partial u}{\partial x^{*}}\frac{1}{p^{im}}. \qquad (8)$$

Analogically for the foreign market we have

$$\frac{\partial \tilde{u}}{\partial \tilde{x}}\frac{1}{p^{ex}} = \frac{\partial \tilde{u}}{\partial \tilde{x}^{*}}\frac{1}{Sp^{*}}. \qquad (9)$$

[11]More precisely, detrended values should be used. The trend then represents change in the *market premium.*

Denote the terms of trade p^{ex}/p^{im} by tot and the real exchange rate by z. Then from equations (8) and (9) we may express the relationship between terms of trade and real exchange rate to define the average 'substitution ratio' q:

$$q^2 \equiv \left(\frac{\partial u}{\partial x}\frac{\partial \tilde{u}}{\partial \tilde{x}}\right) / \left(\frac{\partial u}{\partial x^*}\frac{\partial \tilde{u}}{\partial \tilde{x}^*}\right) = \frac{p^{ex}p}{Sp^*p^{im}} = \frac{tot}{z} \tag{10}$$

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

This notation provides with an illustrative decomposition of the real exchange rate in tradables. From (7) it follows that $dd^* = z\ tot$; therefore one may easily derive that

$$1/z = q\sqrt{dd^*}, \tag{11}$$

or in percentage changes

$$-\hat{z} = \hat{q} + 1/2\left(\hat{d} + \hat{d}^*\right). \tag{12}$$

The equation (12) shows that the real appreciation decomposes between quality improvement and average increase of disparity.

Since the disparity measures the border effect we may expect some empirical regularities related to this concept. First, the observed disparity should not exhibit 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.

4 The real appreciation in three CE countries

We empirically 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 being the major and dominant trading partner in the case of all three countries in transition.

In order to apply the our model, we need to consider distinct, substitute goods in order to permit for 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 take place[12]. Such product groups are mainly manufacturing goods. In the case of the Czech foreign trade, the trade in manufacturing product groups accounts for 65 % of total trade. According to the respective customs office statistics, in relation to Germany being the major trading partner, the Czech-German trade in manufacturing that goes in both directions i.e., there is a positive export and import of distinct, substitute goods, reaches 80 percent.

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

The evaluation of all bilateral rates between Germany, Czechia and Slovakia allows for cross-checking the sensibility of the theoretical concept. If there is a positive disparity in real CZK/EUR exchange rate and no disparity in SKK/EUR, then we should verify similar magnitude of disparity in the SKK/CZK real exchange rate. This seemingly trivial conclusion hinges on the validity of the relationships (8) and (9) that rely on the buyers' arbitrage on the two local markets and similarity of the preferences across markets.

4.1 Data description

In order to pursue the decomposition along the lines it was necessary to prepare disaggregated dataset of two way trade in distinct substitutes. We analysed bilateral trade among Czech Republic,

[12] One may argue, that we can use even goods that are traded only in one direction. However, in such a case the cross checking for the structural differences would not be possible, see the Section 4.2.

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. By the series by series procedure we at least partially alleviated the problem that only two digit SITC data were available[13]. In this way we have constructed the several product groups of manufacturing industries: chemicals and its products, paper and its products, textile and textile products, metals and fabric metals products, machines and tools, and cars.

The sample period was determined by availability of data from respective statistical offices, i.e., the Czech Statistical Office, Slovak Statistical Office, Slovenian Statistical Office, and 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.

That classification standards involved double-digit SITC, OKEČ (classification of economic activities by products), DESTATIS (product classification by 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 are in OKEČ. The Slovak PPI is reported in OKEČ and import and export prices of Slovakia are in HS. Slovenian data for export, import prices and PPI are in NACE Rev.1. German PPI was obtained in DESTATIS classification (Segment 4162).

The Table 1 summarizes the relations among classifications used for reporting in all four considered countries.

[1)] SITC expands for standard international trade classification, see www.mfcr.cz. [2)] OKEČ (odvětvová klasifikace ekonomických činností - classification of economic activities by products) Czech and Slovak Statistical Offices, see www.czso.cz or www.statistics.sk. [3)] DEST, here denotes the German Statistical

[13]For 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.

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

Table 1: Overview of product classification

Office Classification standards; Segment 4162 (www.destatis.de). [4)] NACE Rev.1, the Eurostat classification,.http://europa.eu.int/comm/eurostat/). [5)] HS stands for the national system of products in international trade in Slovakia, see www.statistics.sk.

4.2 Measured disparity and structural differences among markets.

What can we learn from the relative developments of the price of home good in the two markets over a longer term? Typically, there are upward trends in the relative prices of the home (transition country) produced goods on the two markets, i.e p/p^{im} and p^{ex}/Sp^{*}, but do they trend at the same speed ? At the benchmark case they should. If the relative quality of the 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 relative wealth of the home country vis-a-vis the foreign country then elasticity of demand may decline and markups increase, so the relative price level. However, by this process both p and p^{im} would be affected, and therefore the ratio should not change.

What may 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 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 foreign goods sold at 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 the 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 the bilateral trade, but usually the country 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, B is the largest trading partner of A. Further, there is a country C, which is a the second largest trading partner for the country A. Different machinery is produced in each of the countries. Then we 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 relative the world prices of p_B/p_C changes then the two relative prices of interest evolve differently.

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

We check whether there is a difference in 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.

Product group	CZ - D	CZ - SK	SK - D	SLO - D
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.

Table 2: Test of structural homogeneity

In the Table 2 t-statistics and p-values of equality of two means are presented. The results are mixed. For the former Czechoslovakia constituents, results suggest the very standard situation. The null hypothesis of no bias is not rejected for all industries at 10% significance level. And for several it is not rejected even at much higher significance. It may be explained by the great past integration of the two economies and missing bilateral 'market premium'. Also, by historical reasons, methodology of the two national statistical agencies is likely to be more similar than might be the case of the other countries; the better reliability of results follows.

On the other hand, for bilateral trade between Slovenia and Germany, it seems that the situation is more complicated. We deem the fact that Germany account for far smaller proportion of the overall trade of Slovenia than it is the case for the Czech Republic and Slovakia is the main suspect.

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

4.3 Sectorial Decomposition by Country

The evaluation of sectorial disparities follows the decomposition of the RER derived earlier. By declaring the average of the 1997 as 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 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.

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)

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

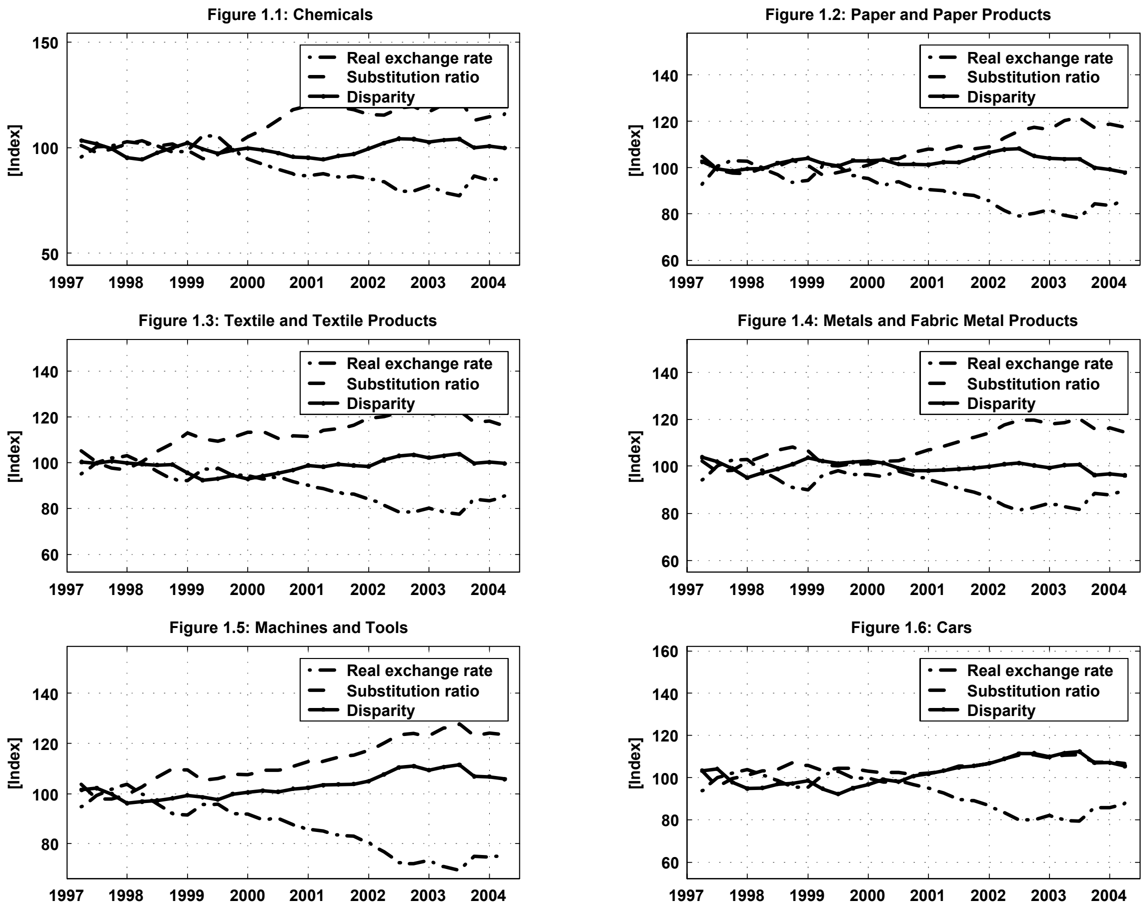

Figure 1: Czech Koruna vs. German Mark (1997a=100)

The Figure 1 graphs 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 relatively to the base year of 1997 and similarly a move deeper into the region under the threshold means undervaluation. The 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 in RER is in downward direction). It amounts to average annual appreciation rate by about 5.4%. In other product groups the real appreciation was slower between 2.5% for metals and about 4% for chemicals (see 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 the disparity. It

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

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)

Table 5: Bands of observed diparity

fluctuates in the band of 20% for cars and 15% for machines and tools, where more pricing to market can be expected. And, only of 9% and 10% for metal products, chemicals and paper.

`Slovak Koruna vs. German Mark`

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

On the contrary, for other good groups, the observed disparity bands are quite close to the Czech case. It is important that the disparity is formed more or less equally from disparities in local and imported products. In this case, the local market conditions drive the price dispersion between

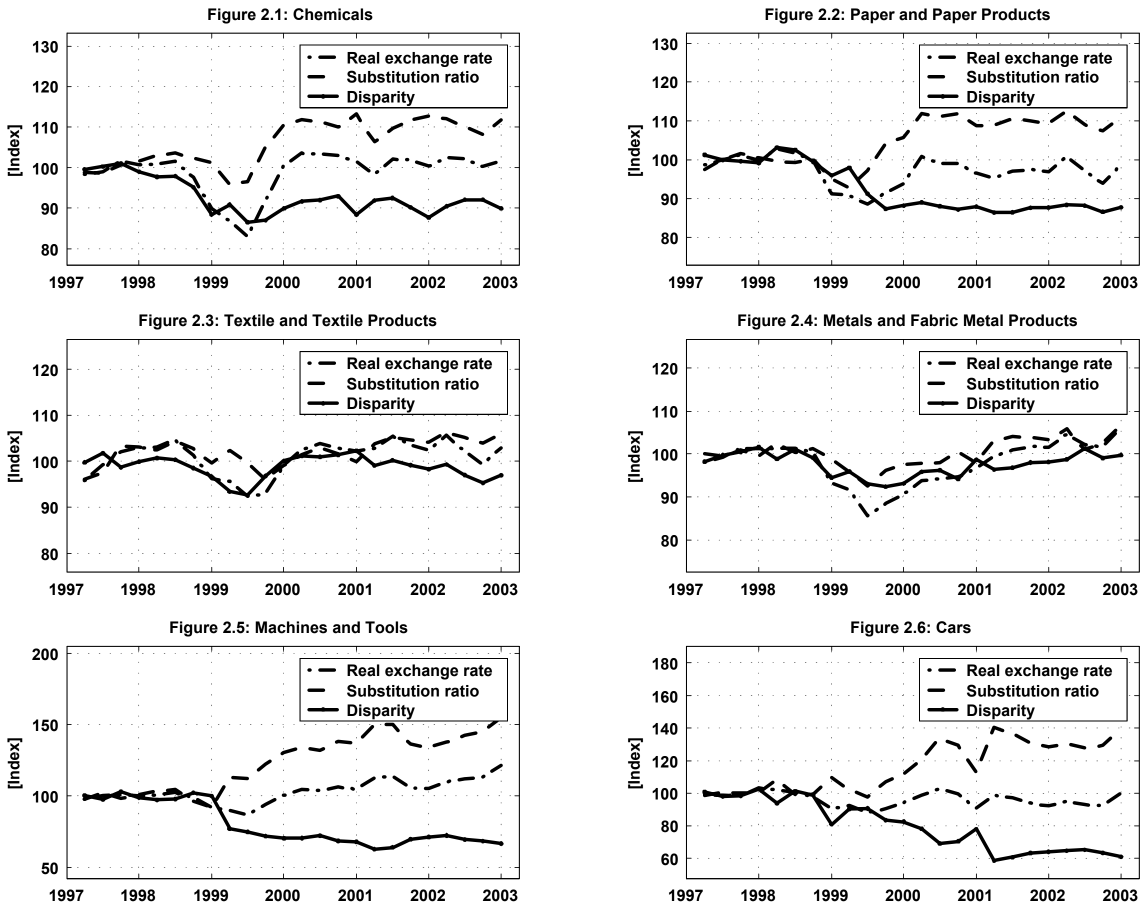

Figure 2: Slovak Koruna vs. German Mark (1997a=100)

markets. A detail look at the structure of the disparity shows that the 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% and 62% in the case of Paper and Cars, respectively. In the machines industry, domestic products' disparity accounts for 33%.

One should emphasize that the sectors with large disparity coincide with those found in the case of the Czech Koruna vs. German Mark. It is consistent with the intuition that the 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, the Figure 3 shows the gradual deepening of disparity in the direction of undervaluation; especially for the Cars, Machines, Paper an paper products and Chemicals since 1997. It seems that the Czech market has become a premium one vis-a-vis Slovakia. Indeed, it is a experience of many the Czech visitors to Slovakia that they there feel richer.

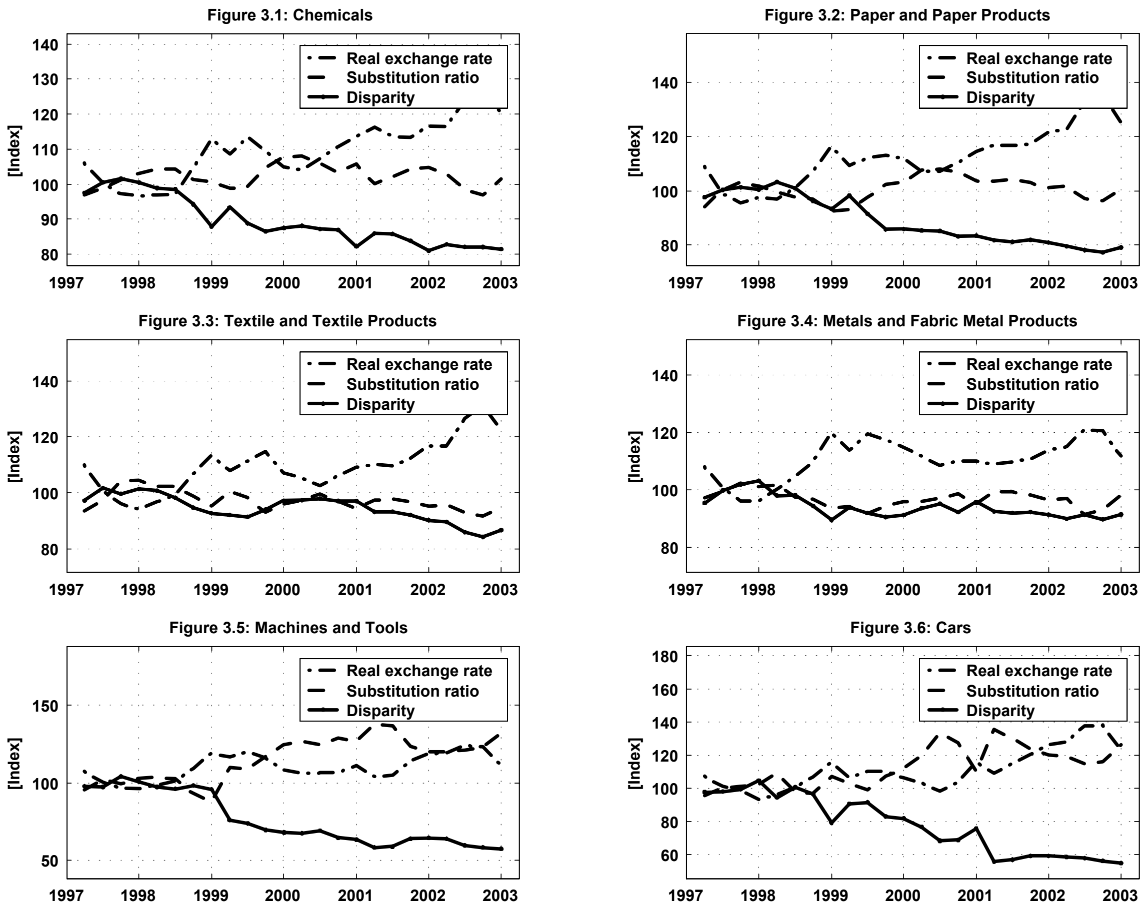

Figure 3: Slovak Koruna vs. Czech Koruna (1997a=100)

The magnitudes of the sectorial RER depreciation are greater than those found in the Slovak-German case. As we can see on Figure 3, this translates into higher disparities in RER of Slovak-Czech Koruna than was found in the case of the Slovak-German disparity. The magnitudes roughly correspond to the common sense, since the Czech-German disparity was positive and hence we would expect that the Slovak-Czech disparity will be exceeding the Slovak-German one.

`Slovenian Tolar vs. German Mark`

The developments on the partitioned sectorial RER of Slovenian Tolar vs. German Mark are presented in Figure 4 and show diverse patterns.

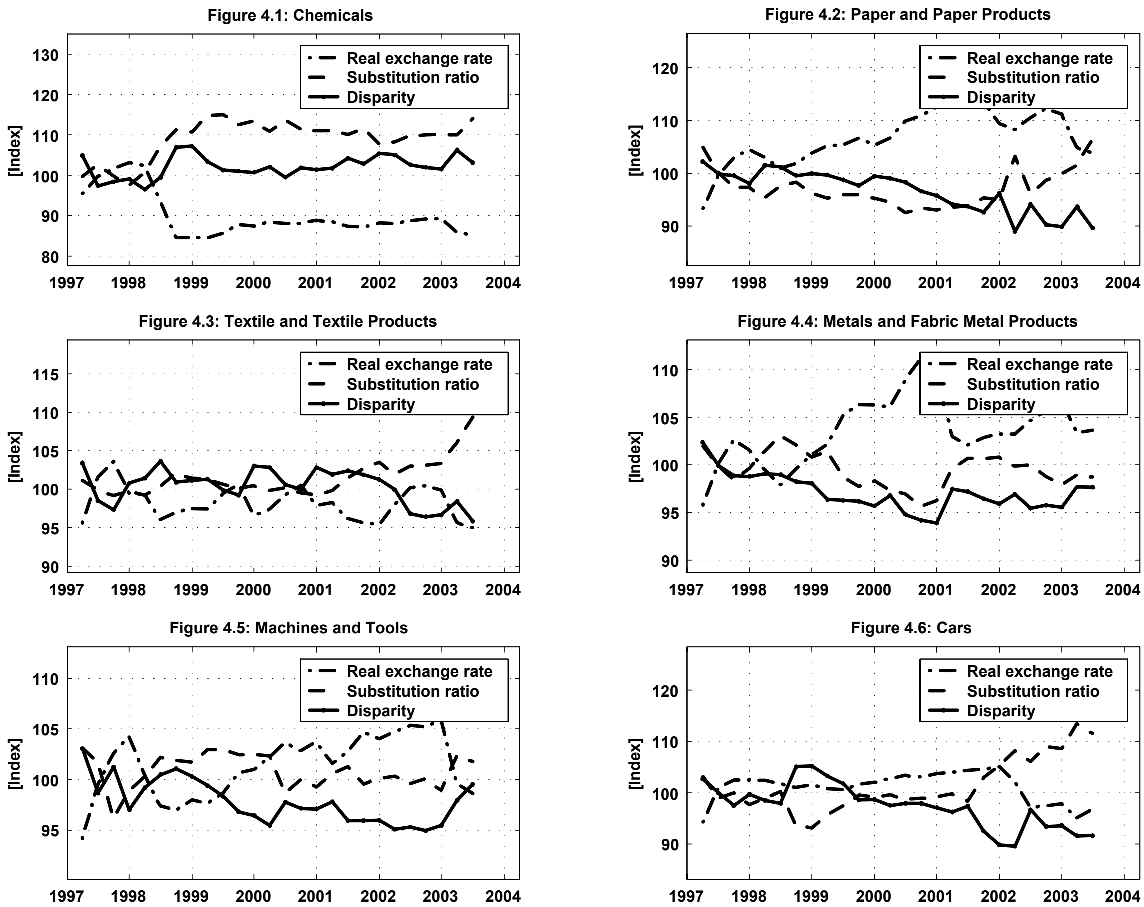

Figure 4: Slovenian Tolar vs. German Mark (1997a=100)

Whereas for some sectors such as Cars, Machines and Tools, Paper and paper products, the disparity is relatively significant and is located in the region of undervaluation, for other sectors such as Textile and Metals, the disparity is minor. A reverse development can be found in Chemical sector, where the disparity exhibits a slight overvaluation. Similarly to the results for other currencies, more differentiated goods' sectors (Machines, Cars, etc.) are characterized by higher disparity (effective market power leading to pricing to market practice) and markets for less differentiated goods exhibit minor magnitude of disparity.

5 Conclusions

Being affected by all border, substitution and measurement factors, the real exchange rate is too approximative to have a great relevance as a measure of the relative price of the home and foreign goods. It is confirmed by the empirical literature suggesting that although the deviations from purchasing power parity for tradable goods tend to die out, the convergence is extremely slow. Taking intuition of the large PPP, pass-through and pricing to market literature, we propose an extremely simple, arbitrage based model, that leads to the decomposition of the real exchange rate between substitution and pricing to market component, the real exchange rate disparity.

We document that almost by a rule the relative prices of the goods produced by the transition economy and sold on the either market segment drifted upwards. Most likely, it is attributable the quality adjustment bias. It remain to be seen whether such a process may continue. Indeed, the continued integration of the manufacturing production into the globalised economy will lead to the saturation of the process. This is a major source of the trend real exchange appreciation in tradables. Yet, this structural appreciation is slower then the 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.

On the example of the disaggregated data of manufactured products from CE transition economies and Germany we show that the disparity fluctuate 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 form testable hypotheses that regard exchange pass-through. Empirical tests may validate underlying structure. Then it might be useful for inflation forecasts. Second, it might be helpful in judgement about cyclical position of the particular economy. It stems from the fact that components extracted from the decomposition have naturally different trending and cyclical behaviour. Thus, there is open way for enhancing filtering methods for estimating various economy gaps in monetary policy models.

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