Non-Price Competitiveness Gains of Central, Eastern and Southeastern European Countries in the EU Market

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We propose an export price indicator adjusted for non-price factors as a more meaningful measure of a country's competitiveness than traditional indicators. Our starting point is the approach developed by Broda and Weinstein (2006), who adjust price developments for changes in varieties of imported products. We relax their assumption of unchanged quality over time and use the proposed index to analyze the momentum of export prices of the ten CESEE EU members which acceded in 2004 and 2007. The index is calculated using data from Eurostat Comext at the highly disaggregated eight-digit CN product level. Our analysis spans the time period 1999 to 2011, thus including the recent global recession period in 2009. The results show that all CESEE-10 countries experienced a loss in price competitiveness, but that the loss was much smaller than is usually suggested by traditional CPI- or ULC-based real effective exchange rate measures. Although relative export prices (unit values) increased more strongly in the CESEE-10 countries as compared to their competitors, the average quality of their goods increased even more strongly, thus fully compensating for the rise in prices. These improvements in non-price competitiveness were pronounced in all CESEE-10 countries.

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1 Introduction

The countries of Central, Eastern and Southeastern Europe (CESEE) have demonstrated tremendous gains in international competitiveness during their transition from centrally planned to market economies. Productivity levels are substantially higher today than they were 20 years ago and the world market share of the region has risen considerably. These developments have fueled an unprecedented process of catching-up with Western Europe. However, catching-up has implied convergence to Western Europe in both income and price levels. The convergence process was in fact accompanied by a real appreciation trend of CESEE currencies over the past two decades, which could suggest a loss in price competitiveness as a result of the catching-up progress.

This example demonstrates that the widespread notion of competitiveness is in fact an ill-defined concept. In the broadest perspective, a nation's competitiveness is reflected by its relative global ranking in per capita income levels. This broad assessment of competitiveness can be accompanied by an evaluation of taxation policies, regulation, market rigidities and labor market conditions as important explanatory factors which determine competitiveness. Such a perspective reflects the World Economic Forum's definition of competitiveness as "… the set of institutions, policies, and factors that determine the level of productivity of a country." (Sala-i-Martin, 2010). In a narrower sense, the business community and the economic policy discussion alike look at relative prices of goods and services (see De Grauwe, 2010, for a comprehensive overview of competitiveness). Clearly, relative prices reflect different supply conditions and hence influence the ability to sell in the global market. Policy discussions are often dominated by the analysis of price and cost measures. In particular the real effective exchange rate is often used

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as a general proxy of competitiveness despite the fact that price measures ignore important non-price aspects of competitiveness, such as quality improvements or shifts in consumer preferences. Further, price and cost measures may show divergent developments, making it difficult to identify a single price indicator of competitiveness. Therefore it should always be acknowledged that individual indicators emphasize different aspects of competitiveness, and it is clearly insufficient to keep the analysis limited to price competitiveness measures.

In this analysis we try to incorporate important non-price features of a country's competitiveness. We correct a country's export price index for any bias which might arise from non-price factors such as physical quality, variations in consumers' tastes and competitive pressure exerted by newly entering competitors. Hence, our proposed comprehensive measure of export price developments can be divided into three parts: changes in relative export unit values, changes in the set of competitors and changes in the relative quality of products. While this measure still neglects some important aspects of competitiveness, such as institutional factors and human capital, it gives a more unbiased picture of a country's ability to sell goods on a certain market. We apply this adjusted export price index to the export performance of the ten CESEE member countries which acceded to the EU in 2004 and 2007. We are able to show that according to this measure most CESEE countries unambiguously showed gains in non-price competitiveness since 1999 on the EU market. These competitiveness gains are rather pronounced for all CESEE member countries.

The next section explains the rationale behind our proposed measure of competitiveness. Section 3 then explains the theoretical background, section 4 illustrates the database and section 5 presents the empirical results. Finally, section 6 concludes.

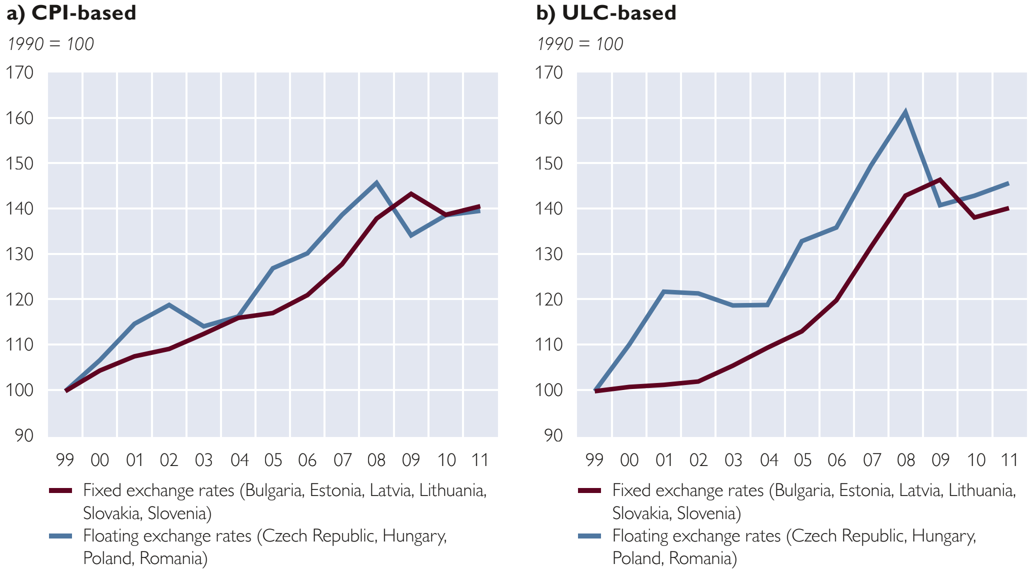
2 From Price to Non-Price Competitiveness

The real effective exchange rate is one of the most widely used tools in the analysis of a country's international competitiveness. It reflects relative changes in the prices of a country's goods and services as a result of changes in nominal exchange rates and inflation differentials. Inflation differentials can be captured in various ways leading to different measures of the real exchange rate. The most popular measure is based on inflation differentials as measured by the CPI. This popularity is obviously explained by data availability and comparability issues, for example due to the availability of harmonized CPI measures within the EU. Other popular definitions are PPI-based and ULC-based real exchange rates. Chart 1 shows two such measures for the ten CESEE EU member countries, one based on consumer prices and the other one based on unit labor costs.

Both indicators show a steep increase for CESEE over the sample period from 1999 to 2011 relative to other exporters, which can be interpreted as a clear loss in price competitiveness. This process was not uniform across countries or over the years: the cumulated real exchange rate dynamics were rather heterogeneous in the region. While Slovenia showed almost no deterioration in price competitiveness, Romania, Slovakia and the Czech Republic were severely affected. Over time, the most rapid losses in price competitiveness were observed during the boom years. In 2009 price competitiveness improved in the Czech Republic, Poland and Hungary due to a nominal depreciation of the national currency, while

Chart 1

Real Effective Exchange Rates of CESEE-10 (36 Trading Partners)



Source: Eurostat.

Note: An increase denotes a real appreciation of the national currency, which can be interpreted as a loss of competitiveness.

in 2009–2010 such an improvement was also observed in countries with fixed exchange rates (in the Baltic states and Bulgaria, the CPI-based index shows the improvement only in 2010, which can be explained by the inertia of consumer prices and tax rate increases in 2009 in some countries). However, such a simple interpretation of the long-run real appreciation trend in CESEE can be quite misleading for various reasons.

First, traditional real exchange rate measures have several drawbacks. The CPI-based index shows the dynamics of relative consumer prices, which can be a rather poor approximation of the dynamics in relative export prices. Domestic and export prices face different demand and supply conditions and can therefore differ greatly. Further, the CPI-based index includes changes in indirect taxes, like VAT, which do not affect export activities directly. Although the PPI-based index is closer to the production side of the economy, it still includes production for the domestic market (data on export-oriented PPI are usually very scarce). The ULC-based index has a similar drawback, especially when it refers to the total economy, including the services sector. In addition, unit labor costs refer only to some production costs and ignore important factors like profit margins. A solution to these shortcomings is to use a relative export price index – an indicator that is often used in macroeconomic models when explaining the dynamics of real exports. However, if an aggregate export deflator is used to construct a measure of competitiveness, there is still one serious problem – the structure of exports differs across countries. The solution to this problem is to conduct the analysis on the most disaggregated level to ensure that similar export products are compared for different countries before aggregating the results at the country level.

Second, real exchange rate indices measure only the price competitiveness of exports while ignoring non-price factors that affect the performance of exports.

One such non-price factor, emphasized by Flam and Helpman (1987), is connected to vertical differentiation or to the quality of exported products. Another non-price factor is a change in consumers' tastes, which can be driven by objective as well as by subjective factors like image or branding.

Finally, as emphasized in particular in the recent empirical trade literature, consumers gain additional utility from increased product variety through international trade. Therefore, changes in the set of rivals can affect the competitiveness of an exporter (higher amount of rivals, exporting the same product to one particular market means increasing variety for consumers). Although several price measures (CPI and PPI) are adjusted for changes in product quality, they do not provide the possibility to incorporate changes in consumers' tastes or product variety.

3 Theoretical Framework

In this paper, we propose a quality- and variety-adjusted relative export price index which overcomes many of the above-mentioned drawbacks and describes both price and non-price competitiveness of exports. In our context, we define *quality* as any tangible or intangible attribute of a good that changes consumers' valuation of it (definition by Hallak and Schott, 2008). Hence, quality encompasses both physical attributes of a product (e.g. size, available functions, durability) and intangible attributes or matters of taste (e.g. product image, brand name). We identify *variety* with products imported from different countries of origin within the same product category, i.e. we adopt the Armington (1969) assumption as in Broda and Weinstein (2006).[2] As our focus is on export prices in this paper, variety in our case means the set of countries (rivals) who export the same product category to a particular market.

Although our final goal is to evaluate an adjusted relative *export* price index, we define the theoretical model from the *import* side. There are two reasons for focusing on imports rather than on exports. First, to describe the role of quality and variety in international trade one primarily needs to understand how consumers value quality and variety. This can be done by using a representative household's utility function, which includes domestic and imported products. Second, our decision to work with imports as the mirror-image of exports also in the empirical analysis is motivated by our choice of database. As explained in section 4 below, we work with Eurostat's Comext database, as the only way to obtain information on competitors of CESEE from outside the EU (e.g. U.S.A. and China) is to use total imports of all EU Member States.

Our theoretical model to measure price and non-price competitiveness is based on Benkovskis and Wörz (2011), who extend the variety-adjusted import price index developed by Feenstra (1994) and Broda and Weinstein (2006) by evaluating changes in the quality of traded goods. A more detailed exposition of the theoretical background underlying the methodology used in this paper is given in the appendix. A detailed description of the augmented import price index underlying our adjusted relative export price index can be found in Benkovskis and

[2] *The Armington (1969) assumption, although very restrictive, is widely used in empirical research due to data limitations. Obviously, the definition of variety (set of competitors) on a firm or brand level would be more realistic, but this definition would require micro-level data. See Bloningen and Soderbery (2010) and Sheu (2011) for examples of such an approach.*

Wörz (2011). The evaluation of the unobserved quality or taste parameter follows the work by Hummels and Klenow (2005).

Given consumers' valuation of variety (set of exporters for a specific product) and quality, we model consumers' utility through a nested constant elasticity of substitution (CES) utility function with three nests. By solving the consumers' maximization problem respecting the budget constraint it is possible to introduce the above-mentioned non-price factors into a measure for relative export prices (see appendix A1–A3 for technical derivations). Based on the formula for a variety- and quality-adjusted import price index obtained from Benkovskis and Wörz (2011, see appendix A1), we use the mirror image of trade flows in this paper and apply this formula to export prices (see appendix A2). In other words, we interpret imports of product *g* originating in country *c* as country *c*'s export of product *g* to the importing market.

Hence, we obtain the following formula for a variety- and quality-adjusted relative export price index (RXP) reflecting changes in the relative export price of good *g* exported by exporter *k* to a particular market in time *t*:

$$RXP_{gkt} = \prod_{c \in C_g^{-k}} \left(\frac{p_{gkt}}{p_{gct}} \frac{p_{gct-1}}{p_{gkt-1}} \right)^{w_{gct}^{-k}} \left(\frac{\lambda_{gt}^{-k}}{\lambda_{gt-1}^{-k}} \right)^{\frac{1}{1-\sigma_g}} \prod_{c \in C_g^{-k}} \left(\frac{d_{gkt}}{d_{gct}} \frac{d_{gct-1}}{d_{gkt-1}} \right)^{\frac{w_{gct}^{-k}}{1-\sigma_g}} \tag{1}$$

where C_g^{-k} is the set of product varieties available in both periods, excluding varieties coming from country *k*; w_{gct}^{-k} and λ_{gt}^{-k} are calculated similar to w_{gct} and λ_{gt} (see equation A5), again excluding country *k* from the set of exporters (varieties).

The index of adjusted relative export prices in (1) can be divided into three parts:

- The first term gives the traditional definition of changes in relative export prices which are driven by changes in relative export unit values weighted by the importance of competitors on a given market (represented by w_{gct}^{-k}). An increase in relative export unit values is interpreted as a loss in price competitiveness.
- The second term represents Feenstra's (1994) term capturing changes in varieties (i.e. the set of exporters of this product in our case). This term is calculated excluding exports coming from country *k*. It can be interpreted as the effect stemming from a changing set of competitors – more competitors for the same product increase utility and lower minimum unit costs for consumers while at the same time lowering the market power of exporters from country *k*. Therefore, more competitors imply a positive contribution to the adjusted relative export price index and are associated with a loss in non-price competitiveness.
- The third term is simply the change in the relative quality of exports. If the quality of country *k*'s exports is rising faster than that of its rivals, the contribution to the adjusted relative export price index is negative, thus signaling improvements in non-price competitiveness.

Finally, we need to design an aggregate relative export price as the index in (1) describes relative export prices just for one specific product which is exported to one particular market. Therefore we relax the assumption of a single destination for exports and allow for various importing countries. We moreover assume consumers to be maximizing their utility in all those countries. Of course, all parameters and variables entering the three-layered utility function can be different across countries. If we denote the export price, export volume and relative export price index of a product g exported by country k to country i as $p(i)_{gkt}$, $x(i)_{gkt}$ and $RXP(i)_{gkt}$ accordingly, the aggregate adjusted relative export price index can be defined as

$$RXP_{kt} = \prod_{i\in I}\prod_{g\in G} RXP(i)_{gkt}^{W_{igt}}$$

where (2)

$$W_{igt} = \frac{\left(S_{igt} - S_{igt-1}\right)/\left(\ln S_{igt} - \ln S_{igt-1}\right)}{\sum_{i\in I}\sum_{g\in G}\left(\left(S_{igt} - S_{igt-1}\right)/\left(\ln S_{igt} - \ln S_{igt-1}\right)\right)}\ ;\ S_{igt} = \frac{p(i)_{gkt}\, x(i)_{gkt}}{\sum_{i\in I}\sum_{g\in G} p(i)_{gkt}\, x(i)_{gkt}}\ .$$

Equation (2) shows that the aggregated index is just another Sato (1976) and Vartia (1976) index and its weights are computed using the share of product g exports to country i out of total exports by country k.[3] The reason for using export rather than import shares in (2) is straightforward. As RXP_{kt} is designed to describe the price and non-price competitiveness of country k's exports, the importance of various products and markets in this index should be determined by country k's export structure.

4 Description of the Database

For the empirical analysis we use the trade data available from Eurostat's Comext database. While this limits our analysis to the EU market and therefore precludes the evaluation of non-price competitiveness of CESEE's exports on other important markets (e.g. Russia or Turkey), it gives a good representation of total export performance as the EU-27 is by far the largest trading partner for all CESEE-10.[4] Further, data release is very timely in the case of Eurostat's Comext database – annual figures are available approximately three months after the end of the year, which gives us an opportunity to include recent years in the analysis. Another advantage over other data sources (e.g. U.N. Comtrade) is the disaggregation level. As we need to break down nominal trade flows into prices and volumes, we carried out the analysis at the most detailed level, which is the eight-digit level of the CN (Combined Nomenclature) classification in Eurostat's Comext yielding approximately 10,000 products each year.

[3] *In this case the use of Sato-Vartia index cannot be explained by the CES aggregation function, as in equation (A5). The choice of this index was instead driven by other justifications. The Sato-Vartia index satisfies most of the bilateral index tests except circularity and monotonicity (see Diewert, 1993a, for the description of these tests and Reinsdorf and Dorfman, 1999, for a discussion of the Sato-Vartia index and monotonicity axiom). The alternative would have been to use the Fisher index, which would also satisfy the monotonicity test. However, the Fisher index was not an option because it reflects changes in absolute export prices whereas* $RXP(i)_{gkt}$ *denotes a change in relative prices. Moreover, the Fisher index would have required an evaluation of absolute quality. Benkovskis and Wörz (2011) show how to evaluate absolute quality of imported products, although this requires additional assumptions (i.e. on a benchmark product) and is much less robust than relative quality estimates.*

[4] *The share of CESEE-10 exports to the EU-27 is reasonably high, ranging between 61% and 85% in 2011 (62.5% for Bulgaria, 83.0% for the Czech Republic, 66.2% for Estonia, 75.9% for Hungary, 65.9% for Latvia, 61.4% for Lithuania, 77.8% for Poland, 71.1% for Romania, 84.7% for Slovakia and 71.0% for Slovenia).*

Although we analyze the performance of CESEE-10 on the EU-27 market, we cannot simply treat the EU-27 as one importer.[5] The EU market is not only large but also heterogeneous, and the performance of exporters in different parts of the market has to be analyzed separately (e.g. Latvia's exports to Lithuania have to be distinguished from Germany's exports of the same product to France). Therefore we disaggregate imports not only by products, but also by importing countries within the EU-27, which represents the most detailed geographical disaggregation. Our dataset contains annual data on imports of all 27 EU Member States at the eight-digit CN level between 1999 and 2011.[6] To keep the calculation burden within reasonable limits, we restrict the list of partners to 50 different countries inside and outside the EU-27. The list of partner countries includes all EU Member States, several CIS countries (e.g. Russia, Ukraine, Belarus, Kazakhstan) and other important trading partners (e.g. U.S.A., Japan, Canada, Australia, China, India, Brazil).[7] We use unit value indices (euro per kg) as a proxy for prices and trade volume (kg) as a proxy for quantities.

The use of the most detailed eight-digit CN classification has one significant drawback that can affect final results – the CN classification is regularly revised. Each year a significant amount of CN codes are subject to changes; some are just relabeled, others are split or merged.[8] Pierce and Schott (2009) analyzed the reclassifications in the ten-digit U.S. Harmonized System and illustrated the importance of tracking these changes when conducting empirical research; therefore we cannot ignore this issue. The most problematic cases are splits or mergers of the codes (growing and shrinking family trees in the terminology of Pierce and Schott, 2009). One feasible solution to such cases is to merge the values and volumes of the respective categories. Although this leads to a broadening of several categories and some problems in interpreting the unit values, it helps to retain the consistency of the analysis over time while keeping coverage reasonably high.[9]

We made two further adjustments to our database. First, in many cases we have data for either values or volumes but not for both. In these cases no unit value index can be calculated. Such incomplete observations were ignored and removed from the database. The second adjustment is related to structural changes within the categories of goods. Although we use the most detailed classification available, we may still be comparing apples and oranges within some categories, as would be

[5] *Such an approach which ignores the heterogeneity of the EU-27 market was used in Benkovskis and Rimgailaite (2011).*

[6] *The exceptions are Poland and Slovakia, for which the most disaggregated data in terms of products at CN eight-digit level are available only starting from 2004.*

[7] *This sample of partners provides a representative picture of the overall imports, as it covers between 82.3% of total imports in Cyprus and 99.2% of total imports in Estonia in 2011.*

[8] *For more detailed information on CN reclassifications see http://ec.europa.eu/eurostat/ramon/nomenclatures/.*

[9] *During the period 1999 to 2011 we observe 14,518 different eight-digit CN product codes in our database, only 7,376 of which were not subject to reclassification issues, however. After implementing the algorithm described above, we were left with 9,020 product codes. Obviously, some of these codes now refer to more than one product. According to Eurostat information, the total number of eight-digit CN subheadings was 9,294 in 2011. Therefore the problem is not severe, as only 274 products are not observable separately in that year.*

reflected by large price level differences within a product code. Consequently, all observations with outlying unit value indices were excluded from the database.[10]

5 Results

As a first step we need to estimate the elasticities of substitutions between varieties in all EU countries. Then we are able to calculate variety- and quality-adjusted relative export price indices for the CESEE-10's exports and make inferences about their non-price competitiveness. We do these calculations for total CESEE-10 exports to the EU-27 and for main export categories and destinations.

5.1 Elasticities of Substitutions in EU Countries

The elasticity of substitution between varieties is estimated for all products where data on at least 3 countries of origin were available (see appendix A4 for technical details).[11] Table 1 displays the main characteristics of estimated elasticities of substitution between varieties. The mean elasticities are very high, in the range between 20 and 32, which is not very informative, however, as the distribution is skewed to the right. Therefore, the main focus could be on the median elasticity of substitution between varieties. For easier interpretation one can calculate the median mark-up, which equals $\sigma_g/(\sigma_g-1)$. The median elasticity of substitution lies in a range between 5 and 8. This gives quite a plausible range for median mark-ups – between 15% and 25%. Cyprus is a clear outlier, perhaps due to the small number of estimated elasticities.

The estimates in table 1 are generally higher than the estimate results reported in Broda and Weinstein (2006) for U.S. imports, who estimated the median elasticity to be 3.7 for seven-digit (TSUSA) goods in the period between 1972 and 1988 and 3.1 for ten-digit (HTS) goods in the period between 1990 and 2001. To our knowledge, the only paper which reports similar estimates for all EU-27 countries is Mohler and Seitz (2010). Again, our estimates are roughly one-third higher than theirs. This could be attributed to some differences in estimation methodology[12] as well as to the different sample period. Mohler and Seitz (2010) cover the period between 1999 and 2008; so 2009, the year of the significant trade collapse was not analyzed. Nevertheless, our results provide a similar ordering with low elasticities for Greece, Luxembourg, Portugal, Slovakia, and high elasticities for Germany, Hungary, Latvia, Lithuania and Romania.

[10] *An observation is treated as an outlier if the absolute difference between the unit value and the median unit value of the product category in the particular year exceeds four median absolute deviations. The exclusion of outliers does not significantly reduce the coverage of the database. For example, in 2011 outliers accounted for 1.8% of total import value in Germany and for 10.0% in Malta.*

[11] *The number of products for which this condition was met is indicated in the first column of table 1. Although the coverage is reduced, it still remains reasonably high. Even taking into account that we restricted ourselves to just 50 partner countries, excluded outliers and required at least 3 countries of origin, the coverage ratio ranged from 61.0% of total aggregated imports (for Malta) to 87.0% (for the Czech Republic) in 2011.*

[12] *Mohler and Seitz (2010) follow Feenstra's (1994) methodology, which provides estimates of σ_g only as long as $\theta_1 > 0$ and use a regression on sample means over t.*

Table 1

Elasticities of Substitution between Varieties

	No. of estimated elasticities	Mean	Standard deviation	Maximum	Minimum	Median	Median mark-up
Austria	5899	23.42	63.3	1959.7	1.03	6.19	19.3
Belgium	6475	23.46	205.6	16067.8	1.03	6.69	17.6
Bulgaria	4426	25.25	51.8	1023.7	1.03	7.53	15.3
Cyprus	3405	31.64	49.0	524.2	1.01	9.78	11.4
Czech Republic	5715	23.77	56.0	1455.1	1.02	7.11	16.4
Denmark	5410	23.05	81.4	4344.4	1.01	6.43	18.4
Estonia	3843	24.87	61.3	1555.8	1.02	6.92	16.9
Finland	4943	21.03	45.0	1542.7	1.00	6.85	17.1
France	7097	20.39	48.0	1284.2	1.05	6.88	17.0
Germany	7015	20.44	60.7	3895.1	1.06	7.80	14.7
Greece	5154	26.00	90.8	4014.5	1.03	5.84	20.7
Hungary	5382	24.42	59.9	1791.9	1.02	7.47	15.5
Ireland	4595	28.04	142.2	6663.9	1.02	6.32	18.8
Italy	6720	20.17	46.7	938.3	1.05	7.30	15.9
Latvia	3848	25.27	61.8	1607.7	1.01	7.14	16.3
Lithuania	4202	23.33	56.0	1208.2	1.01	7.10	16.4
Luxembourg	3520	29.77	125.6	4663.3	1.01	4.91	25.6
Malta	2357	28.30	65.6	1084.4	1.03	5.79	20.9
Netherlands	6164	22.83	67.1	2771.9	1.02	7.17	16.2
Poland	5642	20.38	53.4	1505.4	1.05	6.42	18.4
Portugal	5348	24.72	92.8	4746.8	1.02	5.93	20.3
Romania	5320	24.06	51.3	1521.4	1.01	7.57	15.2
Slovakia	4203	30.11	84.7	1676.9	1.01	5.52	22.1
Slovenia	4719	23.63	50.9	991.2	1.05	6.89	17.0
Spain	6429	21.47	47.9	998.9	1.00	6.51	18.2
Sweden	5510	24.15	58.1	1387.1	1.01	6.98	16.7
U.K.	6698	20.20	46.8	1385.9	1.01	6.26	19.0

Source: Eurostat Comext, authors' calculations.

Note: Elasticities of substitutions are estimated using equation (A12) for all products where data on at least 3 countries of origin were available.

5.2 Relative Export Prices Adjusted by Non-Price Factors

Finally, we can calculate the adjusted relative export price index for CESEE-10 exports to the EU-27, which will take into account several non-price factors like quality of exports and changes in the set of rivals. This is done using equations (1) and (2), while unobserved relative quality is evaluated by equation (A8). Chart 2 shows three different relative export price indices for every country. The first one is the conventional relative export price index (RXP), which does not take into account changes in quality and the set of competitors and is calculated using the first term in equation (1). This index can serve as a benchmark denoting the pure price competitiveness of CESEE-10 exports. The second index also takes into account changes in the composition of competitors on the market. It is calculated using the first two terms in equation (1). A comparison with the conventional export price index indicates the contribution of changes in the set of rivals to competitiveness. Finally, the relative export price index adjusted by non-price factors is calculated using all three terms in equation (1). This index includes all non-price competitiveness factors analyzed in this paper. By comparing it with the RXP adjusted by the set of rivals we can highlight the role of quality and tastes in export competitiveness.

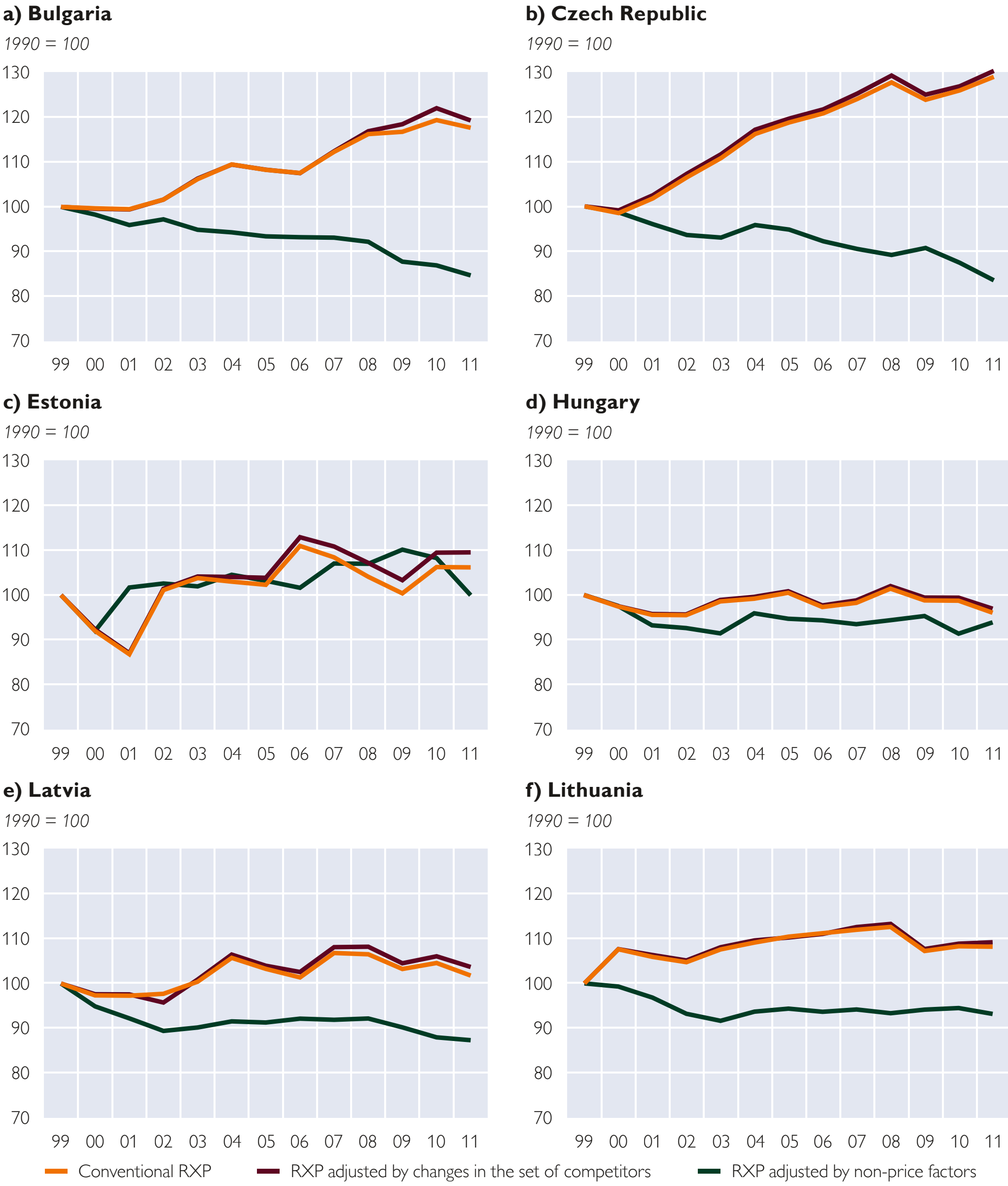
Before analyzing the role of these different factors for export competitiveness we shall contrast our relative export price index – based on trade data – to the more frequently used exchange rate-based indices reported in chart 1. As both CPI- and ULC-based real exchange rates describe price competitiveness, we must compare them with the conventional relative export price index. There are some differences in scope between these traditional measures and our index. Chart 1 reflects the price competitiveness of exports to the rest of the world while our calculations are limited to exports to the EU market. Still, the EU represents by far the most important trading partner for all countries in our sample, so this limitation should not pose a major problem. On the other hand, our indicator compares the competitiveness of the CESEE countries with that of 49 competitors (including all other 26 EU members, the most important CIS countries and other important trading partners like the U.S.A., Japan, China) while the traditional indicators in chart 1 are calculated with respect to 36 trading partners.

The indicators coincide in signaling losses in price competitiveness between 1999 and 2011 for all CESEE-10 countries. Moreover, the ranking is very similar – almost no losses for Slovenia and the highest relative price increases in Romania, Slovakia and Czech Republic. The time pattern of conventional RXP also gives rise to similar conclusions, with the most rapid increase during the boom years and a decrease in 2009. The difference to the CPI-based index for the Baltic states can be explained by an increase in indirect taxes in that year. However, there is an important distinction between the results in chart 1 and chart 2. The scale of price competitiveness losses is significantly smaller when measured by conventional relative export prices. This could be driven by various factors including structural differences between the economies which are not taken into account in chart 1, increasing indirect tax rates in the case of the CPI-based index or more rapid productivity improvements in export-oriented sectors of the economies and countercyclical behavior of profit margins in the case of the ULC-based index. The comparison of RXP adjusted by changes in the set of competitors with the conventional RXP shows no meaningful effect from changes in the set of rivals. In other words, a rising or falling number of rivals is not an important driver of CESEE's export competitiveness. In all cases the difference between the two indexes is marginal. The most pronounced effects are observed for Bulgaria and Estonia, where the second index is a bit higher, indicating an increasing number of competitors and a slight loss of market power. The opposite effect, although also marginal, is observed for Romania whose exporters seem to be facing fewer rivals and thus experienced a gain in market power compared to the beginning of the sample period.

Finally, when we look at the RXP adjusted by non-price factors we observe a rather strong impact of changes in quality on export competitiveness. Chart 2 shows that this index has notably decreased for all CESEE-10. Decreases were particularly steep for Poland, Slovakia and the Czech Republic and far less pronounced for Estonia, Slovenia and Hungary. This indicates that all CESEE-10 covered here were gaining non-price competitiveness. Although their export unit values were increasing faster than those of their main rivals, the quality of their exports was rising even faster. This, of course, includes tangible as well as intangible components of quality, as our methodology does not allow disentangling the two compo-

Chart 2

CESEE-10 Export Prices Relative to Their Competitors' Export Prices (Exports to EU Market)

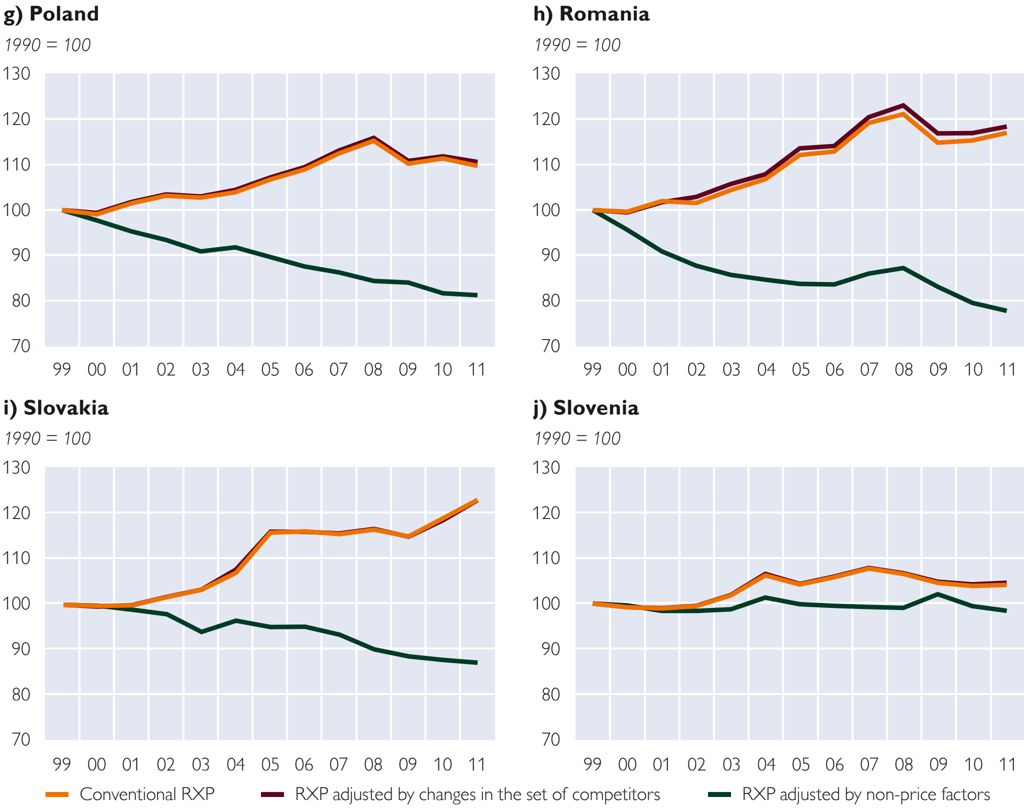


Source: Eurostat Comext, authors' calculations.

Note: Relative export prices are calculated by cumulating RXP changes from equations (1) and (2). An increase denotes losses in competitiveness.

Continued Chart 2

CESEE-10 Export Prices Relative to Their Competitors' Export Prices (Exports to EU Market)



Source: Eurostat Comext, authors' calculations.

Note: Relative export prices are calculated by cumulating RXP changes from equations (1) and (2). An increase denotes losses in competitiveness.

nents. Most probably the CESEE-10 were able to improve the physical quality of their production as well as their image branding and market placement.

This finding is corroborated by earlier literature. Aturupane, Djankov and Hoekman (1999) and Landesmann and Stehrer (2002) give early evidence for increasing unit value ratios of CESEE-10 exports. Dulleck et al. (2005) consider three dimensions of quality upgrading (across industries, across different quality segments within industries and within quality segments inside industries), whereby their third notion of quality upgrading (upgrading inside products) refers directly to our definition of quality. For the time period from 1995 to 2000, just prior to our observation period, they find evidence for quality increases in CESEE-10 exports, whereby the five Central European countries (Poland, the Czech Republic, Slovakia, Hungary and Slovenia) show higher initial levels of quality and exhibit a faster upgrading process than the Southeastern and Baltic countries. Further, it is only for those five CESEE economies that quality upgrading in this period was associated with improvements in both physical properties and nontangible properties such as image of the products; for the remaining five countries, the evidence pointed toward technological and physical upgrading only. Finally, Fabrizio, Igan and Mody (2007) state that the gains in market shares of CESEE countries, despite the pronounced appreciation trend of their currencies, can be ascribed to an impressive shift in the quality of their exports. However, they also caution that this process and the positive development effects arising from it may attenuate soon.

As mentioned above, the contribution of changes in tastes and quality to export competitiveness can be inferred from the difference between the RXP adjusted by non-price factors to the RXP adjusted only by changes in the set of competitors. The negative gap between these two indices in all ten countries suggests a positive contribution of quality to these countries' export performance and hence competitiveness. The strongest quality improvements were observed in Poland, Bulgaria, the Czech Republic and Romania; the lowest improvements were shown by Estonia, Hungary and Slovenia, while the other Baltic states were in the middle of the scale. Very clearly, the disadvantage of the Southeastern European countries in terms of quality, which was observed by Dulleck et al. (2005), had diminished considerably. Concerning the time path of adjustments, in some countries, like the Czech Republic or Latvia, relative quality improvements occurred gradually, while in other countries, like Lithuania, large improvements happened in specific years.

Our methodology is based on highly disaggregated data, which enables us to identify changes in relative quality within different product groups and on individual importing countries inside the EU market. The results of this detailed analysis[13] reveal that quality improvements were strongest for almost all countries (with the exception of Hungary and Lithuania) in machinery and mechanical appliances, followed by vehicles and other transport equipment (notably for the Czech Republic, Hungary, Poland and Romania). Hungary also showed impressive quality improvements in chemicals (possibly related to strong foreign direct investment in this industry), likewise Lithuania. Lithuania and Poland further recorded large improvements in plastics. In regional terms, most countries showed the strongest quality improvements on the German market, but also in France. Further results point towards the fact that strong mutual trade ties and/or proximity exert an upward pressure on quality. We can identify a couple of neighboring country pairs with notable quality improvements in bilateral trade. For example, Slovakia and Slovenia recorded strong improvements on the Austrian market and Bulgaria experienced large gains in relative export quality in Greece. Further, Latvia showed strong quality upgrading on the Lithuanian market and vice versa. Latvia was moreover able to strongly raise the average quality of its export products also on the Estonian market, while Estonian export products gained in relative quality in Sweden. Further, the quality of the Czech Republic exports to Slovakia rose notably.

6 Conclusions

Despite a trend of real appreciation, which temporarily reversed during the crisis, the CESEE-10 countries showed an impressive export performance over the past one and a half decades. This apparent puzzle – a real appreciation of the currency is very broadly associated with a loss in price competitiveness – can be solved by looking into the non-price aspects of competitiveness. In this paper we develop a relative export price index which allows us to disentangle the impact of changes in

[13] *Relative quality improvements are calculated for each country and four main sections of exports as well as four main partner countries in the EU. These results are available from the authors on request.*

relative quality from changes in price competitiveness. This index is calculated using data from Eurostat's Comext at the highly disaggregated eight-digit CN product level for imports of all EU members from 50 main trading partners inside and outside the EU. We used annual data over the time period 1999 to 2011, thus including also the most recent episode of the global trade collapse in early 2009.

Our relative export price index is derived from the theoretically well-founded variety- and quality-adjusted relative import price index as proposed by Benkovskis and Wörz (2011). In addition to controlling for a changing variety in traded goods, this index also allows for changes in product quality. This adjusted relative export price index can be divided into three parts. First, the traditional definition of relative export prices, which is driven by changes in relative export unit values weighted by both the importance of competitors on a particular market and the share of a particular market in the respective country's exports. Second, Feenstra's (1994) term capturing changes in the set of rivals exporting a particular product (changes in variety in our context). And third, the change in relative quality of the exported product compared to the average quality of the same product when exported by all competitors.

Our results show that all CESEE-10 countries experienced a loss in pure price competitiveness over the sample period. Thus, our pure price index reflects the results obtained from traditional measures of price competitiveness, i.e. the CPI- or ULC-based real effective exchange rate, although our pure price index signals that losses in price competitiveness were somewhat smaller than suggested by exchange rate-based measures. This could be driven by various factors including changes in indirect tax rates, differences in export structures, countercyclical behavior of profit margins and more rapid productivity improvements in export-oriented sectors of CESEE-10 countries. We further find that changes in the set of competitors (which could be interpreted as changes in variety for consumers in the importing market) do not affect competitiveness. Our interpretation of this finding is that changes in market power were too small to affect the export competitiveness of any of CESEE-10 economies over the sample period.

Finally, taking quality changes into account, we are able to show that improvements in the relative quality of exports (compared to 49 rivals, including all other 26 EU members, the most important CIS countries and other important trading partners like the U.S.A., Japan, China) have greatly influenced the competitive position of the CESEE-10 countries and enhanced their export performance. In line with earlier findings in the literature we find substantial quality improvements of CESEE-10 exports. Over the past decade, quality improvements were particularly pronounced in Bulgaria and Romania, but also in Poland and the Czech Republic. Lithuania and Latvia also showed strong and continuous quality improvements.

In a sectoral perspective, quality improvements were most pronounced in those industries which represent the region's major export goods. Almost all countries showed the strongest quality gains in machinery and mechanical goods, in many countries followed by improvements in vehicles and other transport equipment.

Our analysis illustrates that quality improvements in CESEE-10 export goods were not only substantial over the past decade, but also large enough to comfortably offset negative developments in price competitiveness of these countries.

Clearly, the loss in price competitiveness is a result of the convergence process which has characterized the economic development of these countries up to date. Along with income convergence, also price and wage levels experienced an upward trend, resulting in trend appreciation of the currencies. However, improvements in quality – i.e. physical quality as well as intangible aspects related to labeling and consumers' tastes – were considerably stronger over the observation period. Our analysis does not enable us to make any inferences regarding the underlying reasons for these quality improvements. For example, FDI rather than purely domestic structural change may have played an important role for this process of quality upgrading. In any case, these developments have influenced the region's trade performance positively.

As a result, CESEE-10's competitiveness has increased over time, thus explaining the large gains in market shares on the European market. In general, these gains were felt most strongly in Western European destination countries. However, there were also quality improvements of some CESEE-10 countries in peer markets; for example Latvia and Lithuania showed strong mutual quality improvements, which may be influenced by similar consumer tastes present in those two countries.

Another important result points towards differences in the speed of quality upgrading between countries. Unlike in earlier studies we find no evidence that peripheral (i.e. the Baltic and Southeastern European) countries are closing the quality gap more slowly than the Central Eastern European countries. The process of quality upgrading still appears to be heterogeneous throughout the region, with Slovenia and Hungary – potentially starting from a much higher level – showing rather weak improvements at the economy-wide level compared to other countries. But nevertheless, especially at the sectoral level, all countries show unambiguous evidence of quality upgrading in a broad sense in important export goods.

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Technical Appendix

A1. A Variety and Quality-Adjusted Import Price Index

We start by defining a nested, constant elasticity of substitution (CES), utility function of a representative household which consists of three nests as proposed by Broda and Weinstein (2006). On the upper level a composite import good and the domestic good are consumed:

$$U_t = \left(D_t^{\frac{\kappa-1}{\kappa}} + M_t^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}}; \quad \kappa > 1 \tag{A1}$$

where D_t is the domestic good, M_t is composite imports, and κ is the elasticity of substitution between domestic and foreign good. At the second level of the utility function, composite imported good consists of individual imported products:

$$M_t = \left(\sum_{g \in G} M_{gt}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \quad ; \quad \gamma > 1 \tag{A2}$$

where M_{gt} is the subutility from consumption of imported good g, γ is elasticity of substitution between different import goods, while G denotes the set of imported goods.

At the third level of the utility function variety and quality are introduced. Each import good M_{gt} is defined by a nonsymmetric CES function:

$$M_{gt} = \left(\sum_{c \in C} d_{gct}^{\frac{1}{\sigma_g}} m_{gct}^{\frac{\sigma_g-1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g-1}} \quad ; \quad \sigma_g > 1 \quad \forall \quad g \in G \tag{A3}$$

where m_{gct} denotes quantity of variety g from country c, C is a set of all partner countries, d_{gct} is a taste or quality parameter, and σ_g is the elasticity of substitution among varieties of good g. After solving the utility maximization problem subject to the budget constraint, the minimum unit-cost function of import good g is represented by

$$\varphi_{gt} = \left(\sum_{c \in C} d_{gct} p_{gct}^{1-\sigma_g} \right)^{\frac{1}{1-\sigma_g}} \tag{A4}$$

where φ_{gt} denotes minimum unit-cost of import good g, P_{gct} is the price of good g imported from country c and σ_g is the elasticity of substitution among varieties of good g.[14] Equation A4 shows that the minimum unit-cost of each import good depends not only on prices (or unit values), but also on a quality or taste parameter d_{gct}.

The price indices for good g can be defined as a ratio of minimum unit-costs in the current period to minimum unit-costs in the previous period ($P_g = \varphi_{gt}/\varphi_{gt-1}$).[15]

The conventional assumption is that quality or taste parameters are constant over time for all varieties and products, ($d_{gct} = d_{gct-1}$) and the price index is calculated over the set of product varieties $C_g = C_{gt} \cap C_{gt-1}$ available in both periods t and $t-1$, where $C_{gt} \subset C$ is the subset of all varieties of goods consumed in period t. Sato (1976) and Vartia (1976) proved that for a CES function the conventional price index P_g^{conv} will be given by

$$P_g^{conv} = \prod_{c \in C_g} \left(\frac{p_{gct}}{p_{gct-1}} \right)^{w_{gct}} \tag{A5}$$

[14] *This approach is based on the famous "duality approach" to modeling international trade in a general equilibrium framework developed by Dixit and Norman (1980). In this approach consumer behavior is modeled through expenditure or indirect utility functions and producer behavior by cost, revenue or profit functions. Cost minimization can therefore be seen as being equivalent to utility maximization. From the consumers' perspective, the price paid for one unit of utility can be minimized either by choosing a cheaper product or choosing a more qualitative product.*

[15] *See Diewert (1993b) for more details.*

whereby weights w_{gct} are computed using cost shares s_{gct} in the two periods as follows:

$$w_{gct}=\frac{\left(s_{gct}-s_{gct-1}\right)/\left(\ln s_{gct}-\ln s_{gct-1}\right)}{\sum_{c\in C_g}\left(\left(s_{gct}-s_{gct-1}\right)/\left(\ln s_{gct}-\ln s_{gct-1}\right)\right)}$$

and x_{gct} is the cost-minimizing quantity of good g imported from country c.

The import price index in (A5) ignores possible changes in quality and variety (set of partner countries). The underlying assumption that variety is constant was relaxed by Feenstra (1994) and further by Broda and Weinstein (2006). According to their innovation, the price index derived in (A5) is multiplied by an additional term which captures the role of new and disappearing variety:

$$\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g-1}}, \text{where } \lambda_{g,t}=\frac{\sum_{c\in C_g}p_{gc,t}x_{gc,t}}{\sum_{c\in C_{g,t}}p_{gc,t}x_{gc,t}} \text{ and } \lambda_{g,t-1}=\frac{\sum_{c\in C_g}p_{gc,t-1}x_{gc,t-1}}{\sum_{c\in C_{g,t-1}}p_{gc,t-1}x_{gc,t-1}}$$

This approach is not limited to the number of varieties only, but also takes into account expenditure shares, therefore giving higher weight to varieties with a high weight in the consumption bundle. In case the expenditure share of new varieties exceeds that of disappearing varieties, their additional term is smaller than unity, which lowers the import price index in (A6) below. In other words, if a new competitor appears on the market, consumer utility rises and minimum unit costs shrink. The effect from a changing set of variety also depends on the elasticity of substitution between varieties. That is, if varieties are close substitutes, the additional term is close to unity and changes in available varieties do not have a significant effect on the price index.

Benkovskis and Wörz (2011) further relax the assumption that taste or quality parameters are unchanged for all varieties of all goods ($d_{gct}=d_{gct-1}$). Thus, they allow for vertical product differentiation. The resulting variety- and quality-adjusted import price index P_g^q is thus:

$$P_g^q=\left(\frac{\sum_{c\in C_{gt}}d_{gct}p_{gct}^{1-\sigma_g}}{\sum_{c\in C_{gt-1}}d_{gct-1}p_{gct-1}^{1-\sigma_g}}\right)^{\frac{1}{1-\sigma_g}}=$$

$$=\prod_{c\in C_g}\left(\frac{p_{gct}}{p_{gct-1}}\left(\frac{d_{gct}}{d_{gct-1}}\right)^{\frac{1}{1-\sigma_g}}\right)^{w_{gct}}\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g-1}}=P_g^{conv}\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g-1}}\prod_{c\in C_g}\left(\frac{d_{gct}}{d_{gct-1}}\right)^{\frac{w_{gct}}{1-\sigma_g}} \tag{A6}$$

The additional term $\prod_{c\in C_g}\left(\frac{d_{gct}}{d_{gct-1}}\right)^{\frac{w_{gct}}{1-\sigma_g}}$ captures changes in the quality and taste parameter. This term states that if aggregate product quality increases over time, this gives higher utility to consumers and reduces the minimum unit-costs (note that minimum costs in (A4) are defined as euro per unit of utility). The additional term also depends on the product-specific elasticity of substitution between varieties. If σ_g is high, the term reflecting changes in quality goes to unity. In other words, changes in quality for close substitutes have no large effect on import prices and welfare. At the extreme, in perfect competition all goods are standardized and there is no room for quality changes. Quality only becomes important in monopolistic competition where goods are differentiated, i.e. in the case of imperfect substitutes.

A2. From Import to Export Prices

So far, the index derived is equal to the one we derive in Benkovskis and Wörz (2011). In what follows, we move from an index for import prices to an index for export prices. We can easily interpret x_{gct} – which are imports of product g originating from country c – as country's c exports of a product g to the importing market (for the moment let's assume that all exporting countries target a single destination – the importing country where the representative household resides).[16] Another problem arises from the need to compare the performance of one particular country with that of its competitors, while equation (A6) gives the aggregate import price from all suppliers. We propose to define changes in the adjusted relative export price of good g exported by country k in the following way:

$$RXP_{gkt} = \frac{\varphi_{gt}^{k} / \varphi_{gt-1}^{k}}{\varphi_{gt}^{-k} / \varphi_{gt-1}^{-k}} = \frac{\left(p_{gkt}/p_{gkt-1}\right)\left(d_{gkt}/d_{gkt-1}\right)^{\frac{1}{1-\sigma_g}}}{\varphi_{gt}^{-k} / \varphi_{gt-1}^{-k}} \qquad \text{(A7)}$$

where φ_{gt}^{k} denotes the minimum unit-cost of good g when exported by (imported from) country k, while φ_{gt}^{-k} is the minimum unit cost of good g when exported by (imported from) all countries except k. In other words, φ_{gt}^{k} is obtained by maximizing the nested utility function if country k is the only exporter. It is obvious that $\varphi_{gt}^{k} = p_{gkt} d_{gkt}^{\frac{1}{1-\sigma_g}}$ and the minimum unit costs of good g exported by (imported from) country k depend on the export price (unit values) and on the quality of the exported product. Analogously, φ_{gt}^{-k} is obtained from maximizing utility under the assumption that exports from country k are zero.[17] After combining (A6) and (A7) we obtain

$$RXP_{gkt} = \prod_{c \in C_g^{-k}} \left(\frac{p_{gkt}}{p_{gct}} \frac{p_{gct-1}}{p_{gkt-1}} \right)^{w_{gct}^{-k}} \left(\frac{\lambda_{gt}^{-k}}{\lambda_{gt-1}^{-k}} \right)^{\frac{1}{1-\sigma_g}} \prod_{c \in C_g^{-k}} \left(\frac{d_{gkt}}{d_{gct}} \frac{d_{gct-1}}{d_{gkt-1}} \right)^{\frac{w_{gct}^{-k}}{1-\sigma_g}} \qquad (1)$$

where C_g^{-k} is a set of product varieties available in both periods, excluding varieties coming from country k, $w_{gc,t}^{-k}$ and $\lambda_{g,t}$ are calculated similar to $w_{gc,t}$ and $\lambda_{g,t}$, again excluding country k from the set of exporters (varieties).

[16] *We will relax this assumption in equation (A9) below.*

[17] *Note that excluding exports originating from country k does not affect the optimal structure of remaining trade flows in the utility maximization problem. This is because the relative quantity of imports coming from two different origins is only determined by relative prices and by the quality of imports from those origins.*

A3. Evaluation of Relative Quality

The calculation of the adjusted relative export price index in (1) is a challenging task due to the fact that relative quality is unobservable. As in Hummels and Klenow (2005) we evaluate unobserved quality from the utility optimization problem in the following way: after taking first-order conditions and following transformation into log-ratios we can express relative quality in terms of relative prices, volumes and the elasticity of substitution between varieties as

$$\ln\left(\frac{d_{gc,t}}{d_{gk,t}}\right)=\sigma_g \ln\left(\frac{p_{gc,t}}{p_{gk,t}}\right)+\ln\left(\frac{x_{gc,t}}{x_{gk,t}}\right) \quad \text{(A8)}$$

where k denotes a benchmark country.

This expression is similar to equation (6) in Hummels and Klenow (2005), except that we allow the elasticity of substitution to differ between individual goods and the right-hand side is multiplied by the inverted elasticity of substitution, due to a slightly different definition of the utility function. Equation (A8) shows that relative quality is to a large extent indicated by relative prices. If the price of a specific good exported by country c (measured by its unit value) is higher than the price of the same good exported by country k, this is an indication of a higher quality of the former. Moreover, when different varieties are close substitutes, the role of relative prices increases. However, relative price is not the only indicator of relative quality, as also relative consumed quantity of a single variety gives a contribution to the evaluation of relative quality. A greater amount of consumption is a clear sign of better quality, and relative quantity is a more important indicator of relative quality when the elasticity of substitution between varieties is small.

A4. Estimation of Elasticities

The elasticity of substitution between varieties (σ_g) cannot be directly obtained from statistical data. Instead, one needs to specify the demand and supply equations. The demand equation is defined by re-arranging the minimum unit-cost function in terms of the market shares, taking first differences and a reference country:

$$\frac{\Delta \ln s_{gct}}{\Delta \ln s_{gkt}}=-\left(\sigma_g-1\right)\frac{\Delta \ln p_{gct}}{\Delta \ln p_{gkt}}+\varepsilon_{gct} \quad \text{(A9)}$$

where $\varepsilon_{gct}=\Delta lnd_{gct}$, therefore we assume that the log of quality is a random walk process. The export supply equation relative to country k is given by:

$$\frac{\Delta \ln p_{gct}}{\Delta \ln p_{gkt}}=\frac{\omega_g}{1+\omega_g}\frac{\Delta \ln s_{gct}}{\Delta \ln s_{gkt}}+\delta_{gct} \quad \text{(A10)}$$

where $\omega_g \geq 0$ is the inverse supply elasticity assumed to be the same across partner countries. A weakness of the system of equations (A9) and (A10) is the absence of exogenous variables, which would be needed to identify and estimate elasticities. To get these estimates, one needs to transform the system of two equations into a single equation by exploiting Leamer's (1981) approach and the independence of errors ε_{gct} and δ_{gct}.[18] This is done by multiplying both sides of equations. After such transformations, the following equation is obtained:

$$\left(\frac{\Delta \ln p_{gct}}{\Delta \ln p_{gkt}}\right)^2 = \theta_1 \left(\frac{\Delta \ln s_{gct}}{\Delta \ln s_{gkt}}\right)^2 + \theta_2 \left(\frac{\Delta \ln p_{gct}}{\Delta \ln p_{gkt}}\right)\left(\frac{\Delta \ln s_{gct}}{\Delta \ln s_{gkt}}\right) + u_{gct} \qquad \text{(A11)}$$

where

$$\theta_1 = \frac{\omega_g}{\left(1+\omega_g\right)\left(\sigma_g - 1\right)}; \theta_2 = \frac{1-\omega_g\left(\sigma_g - 2\right)}{\left(1+\omega_g\right)\left(\sigma_g - 1\right)} u_{gct} = \varepsilon_{gct}\delta_{gct}$$

It should be noted that the evaluation of Θ_1 and Θ_2 leads to inconsistent estimates, as the relative price and relative market shares are correlated with the error u_{gct}. However, it is still possible to obtain consistent estimates by exploiting the panel nature of the data. Broda and Weinstein (2006) argue that one needs to define a set of moment conditions for each good g by using the independence of the unobserved demand and supply disturbances for each country over time:

$$G(\beta_g)=E_t(u_{gct}(\beta_g))=0 \ \forall c$$

where $\beta_g = (\sigma_g, \omega_g)$ represents the vector of estimated elasticities. For each good g the following GMM estimator is obtained:

$$\hat{\beta}_g = \arg\min_{\beta \in B} G^*\left(\beta_g\right)' W G^*\left(\beta_g\right) \qquad \text{(A12)}$$

where $G^*(\beta_g) =$ is the sample analog of $G(\beta_g)$ and B is a set of economically feasible values of β (σg>1 and ωg≥0). W is a positive definite weighting matrix, which weights the data such that the variance depends more on large shipments and becomes less sensitive to measurement error. Broda and Weinstein (2006) first estimate Θ_1 and Θ_2 by solving an unconstrained minimization problem and then apply a grid search in case this produces imaginary numbers or the wrong sign for elasticities. We use a direct approach and solve equation (A12) as a constrained minimization problem.

[18] *It can be argued, however, that the quality or taste parameter can implicitly enter the residual of both demand and supply equations (A9) and (A10). This is more likely when the quality reflects tangible properties of a product and as such increases the production costs of high-quality product. This problem cannot be addressed without a well-derived supply side in the model. Therefore we leave this question to further research.*