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WHAT DRIVES THE MARKET SHARE CHANGES? PRICE VERSUS NON-PRICE FACTORS

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ABSTRACT

The paper proposes a theoretical framework for explaining gains and losses in export market shares by considering both price and non-price determinants. Starting from a demand-side model à la Armington (1969), we relax several restrictive assumptions to evaluate the contribution of unobservable changes in taste and quality, taking into account differences in elasticities of substitution across product markets. Using highly disaggregated trade data from UN Comtrade, our empirical analysis for the major world exporters (G7 and BRIC countries) reveals the dominant role of non-price factors in explaining the competitive gains of BRIC countries and concurrent decline in the G7's share of world exports.

JEL classification

C43, F12, F14, L15

Keywords

export market share decomposition, non-price competitiveness, real effective exchange rate

NON-TECHNICAL SUMMARY

Export market shares and the real effective exchange rate (REER) are, perhaps, the two most popular indicators in order to assess a country's competitiveness on a macro level. Both indicators are extensively used in the policy analysis for obvious reasons: The calculation of changes in export market shares is easy and straightforward, while the REER, although being computationally more demanding, can serve as a comprehensive measure of a country's price and cost competitiveness, thus providing some insights about the causes of export performance. However, both indicators are also limited by serious drawbacks: Gains or losses in market shares only describe an outcome, while the driving forces behind underlying changes in competitiveness remain uncovered.

The REER, while providing some information with respect to competitiveness, is at the same time limited by its narrowness, as only price factors are taken into account. In practice, the REER cannot fully explain changes in external competitiveness. This becomes especially apparent in the context of emerging countries, where strong export performance often goes hand in hand with an appreciation of the REER, thus suggesting a loss in price competitiveness. The disregard of potentially important non-price factors, like taste or quality, impedes the ability of the REER to explain market share dynamics.

Another limitation of REER comes from its underlying set of highly restrictive assumptions which compensate for the lack of available data on prices and elasticities of substitution at the disaggregated product level. In order to overcome these data shortcomings, the calculation of a REER index relies on the restrictive assumption that changes in individual product prices are equal to those of an aggregate price index and the elasticity of substitution between any two suppliers is the same for each commodity.

The goal of our paper is to overcome some limitations of the REER, while retaining the virtues of an export market share indicator. To achieve this, we decompose changes in export market shares into several components that reflect contributions of price and non-price factors. In our demand-side oriented theoretical model (following in spirit Armington, 1969) we relax several restrictive assumptions and in our empirical calculations we use highly disaggregated data.

Two main advantages of our approach should be mentioned here: First, our decomposition takes into account market structure and hence the degree of competition in a market. Obviously, price factors play less important role in markets where suppliers hold a high degree of monopolistic power. Second, since we are working on the very detailed product level we are able to distinguish between competitiveness gains along the intensive and extensive margin (i.e. following the most recent strand of the trade literature), and we can further take into account aspects of non-price competitiveness such as changes in taste and quality of exports. These improvements are highly policy relevant, as our indicator allows for a more comprehensive evaluation of the factors driving a country's competitiveness. Thus, our results should also allow for more accurate policy recommendations than those based on traditional indicators – both on macro and micro level.

In this paper, we apply our proposed comprehensive competitiveness indicator to the world's major exporters, the G7 and BRIC countries over the period 1996 to 2011. Our main conclusions are the following: First, non-price factors (taste and quality) contribute most strongly to cumulative changes in export market shares, while the contribution of price factors is lower in all countries under consideration. The role of other factors for competitive gains or losses is considerably smaller. Second, all G7 countries suffered losses in non-price competitiveness, while the BRIC countries experienced gains in non-price competitiveness. These findings are robust even when we exclude trade in mineral products or use alternative elasticities of substitution between products. The sole exception was Russia, where the results depend strongly on including mineral products and vary with different substitution elasticities between products, thus emphasizing the importance of oil and energy exports for Russia's competitive position.

I INTRODUCTION

Measuring changes in export market shares is a natural way to assess a country's competitiveness as rising market shares reveal a strong performance of a country's producers in international markets and vice versa.[1] The calculation of changes in export market shares is easy and straightforward. However, the market share indicator provides only a limited amount of information for the analysis: it describes the outcome, while the driving forces of changes in competitiveness remain uncovered. The real effective exchange rate (REER) is another commonly used indicator in macroeconomic analysis. It typically serves as a comprehensive measure of a country's price and cost competitiveness, thus providing some insights about the causes of export performance. Despite the differences in calculation procedure and informational content, the REER and changes in markets share are strongly linked in theoretical models.

The REER can be derived as the deviation from multilateral purchasing power parity, a concept that holds empirically in its relative form over the long run. The seminal work of Armington (1969) on demand for imported goods is another starting point to understand the connection between relative prices and market shares. This paper stresses the distinction between products by kind and geographical origin, i.e. it focuses on imperfect substitutes. Specifically, Armington decomposes the change in a particular trade flow into two components: a demand-driven component keeping market shares constant and a price-driven component based on geographic origin (i.e. reflecting the producer's competitiveness). Thus, the latter term, essentially the direct ancestor of the REER, serves as a measure of changes in market shares. Notably, Armington does not propose an aggregated indicator and limits his derivations to a single product market. McGuirk (1987) takes Armington's findings to construct a rudimentary REER indicator of price competitiveness with a weighting scheme based on a disaggregated system of demand equations.

In practice, however, the REER cannot fully explain the dynamics of market shares as a range of factors in addition to price and cost factors influence the ability of a country to export. Non-price factors like taste and quality also affect consumers' utility which is restricted to depending solely on consumed quantities in the models based on Armington's approach. Therefore, the ability of the REER to explain market share dynamics is impeded by the disregard of potentially important non-price factors.

[1] This corresponds to the OECD definition of competitiveness: "... a measure of a country's advantage or disadvantage in selling its products in international markets." See *OECD Glossary of Statistical Terms* at http://stats.oecd.org/glossary/detail.asp?ID=399

Another limitation comes from a set of highly restrictive assumptions that are compensate for the lack of detailed data on prices and elasticities of substitution. In order to overcome these data shortcomings, McGuirk (1987) assumes that changes in individual product prices are similar to those of an aggregate price index and the elasticity of substitution between any two suppliers is the same for each commodity.[2] Official calculations of real effective exchange rates today are still based on these principles and assumptions, although the range of weighting schemes and the number of data sources has increased.[3] Recent authors have begun to question the restrictive assumption of constant elasticity of substitution between any two suppliers for every commodity. Spilimbergo and Vamvakidis (2003), for example, argue that if such an assumption is valid, then splitting the real exchange rate into components should not increase its predictive power in an export demand equation. They perform empirical investigations on a panel of 56 countries over 26 years and find that the elasticity of exports to the REER with respect to OECD countries is less than with respect to non-OECD countries. This finding does not support the assumption of constant elasticity. Despite the red flag raised by Spilimbergo and Vamvakidis, the popularity of traditional REER indicators remains intact.

Quite recently, we have seen attempts to modify traditional REER indicators. For example, Bems and Johnson (2012) argue for recognition of the growing importance of vertical specialization and global value chains. To improve the performance of the REER, they derive a value-added REER and advocate the use of GDP deflators and trade measured in value-added terms. Benkovskis and Wörz (2013) construct a modified relative export price index that adjusts for changes in the non-price factors such as taste, quality, and variety.

The goal of this paper is somewhat similar to these assumption-modifying approaches, but instead of modifying the REER itself, we decompose changes in export market shares. This is done using a demand-side oriented theoretical model in the spirit of Armington (1969) with less restrictive assumptions and use of highly disaggregated data in the empirical calculations. The advantages of this approach are twofold. On one hand, relaxing the assumption of constant elasticity of substitution across goods and varieties, market structure (or the degree of competition in a consumer market) is able to influence the competitiveness of individual suppliers. Price competition, for example, does not play a big role in markets where suppliers

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[2] This restrictive homogeneity assumption is at least partially overcome by Wickham (1987), who distinguishes between commodity products and manufactured goods. Wickham (1987) assumes that commodity prices are determined by the interaction of world supply and demand. On the other hand, price differentials for manufactured goods can exist, so exchange rate movements may drive export and import substitution and hence trade performance. The calculation of aggregation weights distinguishes between manufactures and commodities.

[3] See Durand et al. (1992) for a description of OECD's methodology; Turner and Van't dack (1993) for the BIS system overview; Bayoumi et al. (2006) for the IMF; Loretan (2005) for the Federal Reserve System; Schmitz et al. (2012) for the ECB; and Chinn (2007) for a general comparison of the different price measures and weighting schemes.

hold a high degree of monopolistic power. On the other hand, the decomposition of market share gains (or losses) at the detailed product level (instead of using an aggregate price indices) makes it possible to move the analysis substantially beyond simply measuring price and cost competitiveness. In addition to price and cost factors, our proposed indicator can distinguish between competitiveness gains along the intensive and extensive margin and takes into account aspects of non-price competitiveness such as changes in taste and quality of exports, as well as structural features related to demand- and supply-side factors. We then apply this theoretical framework to assess the roles of various (price and non-price) factors in shaping the competitiveness of the major world exporters, i.e. the G7 and BRIC countries. Our empirical analysis is based on trade data from UN Comtrade database at the finest level of disaggregation (6-digit HS codes) between 1996 and 2011.

Also, we should mention the limitations of our approach. Following Melitz (2003), the focus of researchers shifted to the introduction of firm heterogeneity into the models of international trade. Heterogeneity with respect to individual firms' productivity plays a crucial role. Eaton and Kortum (2002) show that a Ricardian trade model (with perfect substitution between varieties) can explain the patterns of international trade when heterogeneity of technology and geographic barriers are introduced. Moreover, heterogeneous firm-level productivity maps heterogeneous elasticities of substitution (see Eaton and Kortum, 2002; Imbs and Mejean, 2012). The absence of firm-level data forces us to ignore firms' heterogeneity and stick to Armington assumptions. However, Arkolakis et al. (2012) show that welfare effects from trade are equivalent for a range of trade models, including Armington (1969), Eaton and Kortum (2002) and Melitz (2003). Thus, while we are able to capture the full welfare effect from trade, we cannot identify some of the underlying sources of trade gains which arise from productivity increases and efficiency gains. As such, we are not able to analyze factors behind changes in the extensive margin as in Chaney (2008).

The paper is structured as follows. The theoretical model on drivers of changes in global export market shares is outlined in the next section. Section 3 describes the UN Comtrade data, while Section 4 uses our theoretical decomposition of changes in competitiveness into price and non-price factors and presents the empirical results. Specifically, we report estimated elasticities of substitution and illustrate the role of non-homogenous elasticities of substitution for an empirical evaluation of price competitiveness. Finally, we decompose aggregate competitiveness gains or losses into the main driving factors and present some robustness checks. Section 5 concludes.

2 A “BACK-TO-BASICS” THEORETICAL MODEL OF MARKET SHARE CHANGES

In this section, we derive a theoretical model that explains changes in global market shares by identifying contributions from price and non-price factors. As changes in global market shares are a measurable outcome of underlying changes in a country’s global competitiveness, we offer a comprehensive analysis of macroeconomic competitiveness leading to policy-relevant conclusions. In our theoretical derivation, we work with the mirror image of trade flows by looking at a country’s export competitiveness from the import demand side. This is in the spirit of the model by Armington (1969), which describes consumers’ utility as a CES function combining demand for domestic and foreign products. Here, imported products are differentiated by origin. Otherwise, we go back to a rather standard and familiar theoretical model, adding a few novel features to the analysis and relaxing some restrictive assumptions. Specifically, we rework the model to be able to take into account the extensive margin of trade and evaluate the role of non-price factors such as taste and quality for changes in a country’s competitive position.

2.1 MARKET SHARE GROWTH ALONG THE INTENSIVE AND EXTENSIVE MARGIN

Armington’s model assumes an unchanged set of products and destinations. In formal terminology, it focuses solely on the intensive margin. Although this assumption simplifies mathematical derivations, it obviously does not hold in practice. Thus, our first step in decomposing changes in global market shares (competitiveness) is to distinguish between market shares gains along the intensive margin (expansion in conquered markets) and those along the extensive margin (exploration of new markets or changes in the set of products/destinations).

Several papers propose ways to decompose *trade* growth (e.g. Felbermayr and Kohler, 2006; or Besedes and Prusa, 2011). Our goal, however, is a less trivial task: the decomposition of changes in export market *shares*.[4]

As we want our decomposition to be compatible with the Armington model, it is not possible to measure the extensive margin simply by counting the *number* of products that a country exports as in Dennis and Shepherd (2007). Therefore, we propose the following disaggregation of

[4] Hummels and Klenow (2005) propose a methodology for decomposing relative exports (and thus also the export market share) into extensive and intensive margins. Their methodology, however, is intended to compare different exporters at a single point in time. Here, we seek a dynamic analysis of competitiveness over time.

changes in country k's global export market share ($MS_{k,t}$) into its intensive ($IM_{k,t}$) and extensive ($EM_{k,t}$) margin:

$$MS_{k,t} = \frac{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}} \frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}}{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t-1} M(i)_{gk,t-1}} = EM_{k,t} \times IM_{k,t}\,, \tag{1}$$

where i is a running index for importing countries, g for products, and c for exporting countries, while k indicates the exporting country under consideration. $M(i)_{gc,t}$ represents the quantity of country i's imports of product g from exporting country c, while $P(i)_{gc,t}$ is the price of the respective import flow. I, G and C are the respective sets of importing countries, products, and exporting countries.

In the spirit of Galstyan and Lane (2008) and Amiti and Freund (2010), we define the contribution of extensive margin to changes in export market share as

$$EM_{k,t} = \frac{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t} M(i)_{gk,t}} \frac{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t-1} M(i)_{gk,t-1}}{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t-1} M(i)_{gk,t-1}}\,, \tag{2}$$

where $G(i)_{k,t,t\text{-}1}$ is the set of products shipped by exporter k to country i in both periods. This is similar to Feenstra's (1994) index accounting for changes in import variety. Equation (2) compares the share of traditional markets in country k's total exports in periods t–1 and t. If this share decreases over time, it means that the share of disappeared export markets was smaller than the share of new export markets, and the contribution of the extensive margin to changes in the export market share is positive.[5]

By combining equations (1) and (2), it is easy to obtain the following expression for the intensive margin of market share changes

$$IM_{k,t} = \frac{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}} \frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}}{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t-1} M(i)_{gk,t-1}}\,, \tag{3}$$

which simply represents growth of country k's exports on existing markets relative to growth of total world imports (changes in export share on markets where exports are non-zero in both periods).

Empirically, there are two crucial points that influence the relative magnitude of the two margins. First, the analysis can be conducted at the product level (Amiti and Freund, 2010), the country level (Felbermayr and Kohler, 2006), or at the country-product level (Besedes and

[5] As mentioned by Amiti and Freund (2010), Feenstra's (1994) index reports the balance between new and disappearing markets, not the contribution of new markets as such.

Prusa, 2011). We follow the third approach, defining distinctions at the product-country level. Thus, exporting an existing product to a new destination or a new product to an existing destination qualifies as extensive margin. This obviously leads to a higher contribution of the extensive margin to exports than alternative definitions, especially in a detailed disaggregation of trade flows. The second important issue is the relative time dimension (for a full discussion, see Besedes and Prusa, 2011). Here, we follow the mainstream and examine year-to-year survival of an exporter in a particular market. Exports to a new market are classified as an extensive margin during the first year of appearance. If the exporter continues to export that product, it is reclassified in the intensive margin in the consecutive year. In other words, the definition of extensive margin is restricted to those markets in which no exports are observed either in period t–1 or in period t. All cases where exports are present in both periods are classified as an intensive margin. This definition clearly decreases the contribution of the extensive margin, and should be kept in mind when interpreting the results.

2.2 CONSUMER UTILITY MAXIMIZATION AND THE IMPORT PRICE INDEX

Having obtained an expression for the intensive margin of changes in export market shares, our next goal is to decompose it into changes in price and non-price competitiveness. For this, we must explain how changes in variety,[6] as well as other non-price factors like taste and quality, enter the consumer utility function and hence the derived import price index.

Similar to Broda and Weinstein (2006), we define a constant elasticity of substitution (CES) utility function for a representative household from importing country i consisting of three nests. At the topmost level, a composite import good and domestic good are consumed:

$$U(i)_t = \left(D(i)_t^{\frac{\kappa(i)-1}{\kappa(i)}} + M(i)_t^{\frac{\kappa(i)-1}{\kappa(i)}} \right)^{\frac{\kappa(i)}{\kappa(i)-1}} ; \quad \kappa(i) > 1, \tag{4}$$

where $D(i)_t$ is the domestic good, $M(i)_t$ is composite imports and $\kappa(i)$ is the elasticity of substitution between domestic and foreign goods. At the middle level of the utility function, the composite imported good consists of individual imported products:

$$M(i)_t = \left(\sum_{g \in G} M(i)_{g,t}^{\frac{\gamma(i)-1}{\gamma(i)}} \right)^{\frac{\gamma(i)}{\gamma(i)-1}} ; \quad \gamma(i) > 1, \tag{5}$$

6 Note that changes in variety imply a greater range of available origins for the same product. From the exporter's point of view, this simply means that more competitors offer the same product on the market. While this affects the exporter's competitive position, it does not affect his extensive margin, which is defined as either serving a new destination or providing a new product (or both simultaneously).

where $M(i)_{g,t}$ is the subutility from consumption of imported good g, $\gamma(i)$ is elasticity of substitution among import goods.

The bottom-level utility function introduces variety and quality into the model. Each imported good consists of varieties. That is, goods have different countries of origin, so product variety indicates the set of competitor countries in a particular market. A taste and quality parameter denotes the subjective or objective quality consumers attach to a given product. $M(i)_{g,t}$ is defined by a non-symmetric CES function:

$$M(i)_{g,t} = \left(\sum_{c \in C} Q(i)_{gc,t}^{\frac{1}{\sigma(i)_g}} M(i)_{gc,t}^{\frac{\sigma(i)_g - 1}{\sigma(i)_g}} \right)^{\frac{\sigma(i)_g}{\sigma(i)_g - 1}} ; \quad \sigma(i)_g > 1 \quad \forall \quad g \in G, \tag{6}$$

where $Q(i)_{gc,t}$ is the taste and quality parameter, and $\sigma(i)_g$ is elasticity of substitution among varieties of good g.[7]

After solving the utility maximization problem subject to the budget constraint, the minimum unit-cost function of import good g is represented by

$$P(i)_{g,t} = \left(\sum_{c \in C} Q(i)_{gc,t} P(i)_{gc,t}^{1-\sigma(i)_g} \right)^{\frac{1}{1-\sigma(i)_g}}, \tag{7}$$

where $P(i)_{g,t}$ denotes minimum unit-cost of import good g, $P(i)_{gc,t}$ is the price of good g imported from country c. Finally, the minimum unit-cost function of total imports, $P(i)_t$, is given by:

$$P(i)_t = \left(\sum_{g \in G} P(i)_{g,t}^{1-\gamma(i)} \right)^{\frac{1}{1-\gamma(i)}}. \tag{8}$$

The import price indices for good g could be defined as a ratio of minimum unit-costs in the current period to minimum unit-costs in the previous period ($\pi(i)_{g,t} = P(i)_{g,t} / P(i)_{g,t-1}$). The conventional assumption is that taste and quality parameters are constant over time for all varieties and products, $Q(i)_{gc,t} = Q(i)_{gc,t-1}$, so the price index is calculated over the set of product varieties $C(i)_g = C(i)_{g,t} \cap C(i)_{g,t-1}$ available both in periods t and $t-1$, where $C(i)_g \subset C$ is the subset of all varieties of goods consumed in period t. Sato (1976) and Vartia (1976) show that, for a CES function, the exact price index will be given by the log-change price index

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7 $Q(i)_{gc,t}$ includes both taste and quality, following the definition of Hallak and Schott (2011): "...any tangible or intangible attribute of a good that increases all consumers' valuation of it." This parameter thus encompasses both the physical attributes of a product (size, set of available functions, durability, etc.) summarized as *quality*, and the intangible attributes (product image, brand name, etc.) summarized as *taste*. As our approach is solely based on the consumer's utility maximization problem, it is limited to the demand side and cannot be used to distinguish the relative significance of quality and taste. To differentiate quality and taste, one would need to model the behavior of firms as in Feenstra and Romalis (2012) or use individual product characteristics as in Sheu (2011).

$$\pi(i)^{conv}_{g,t} = \prod_{c\in C(i)_g} \pi(i)^{w(i)_{gc,t}}_{gc,t} \text{ and } \pi(i)^{conv}_{t} = \prod_{g\in G}\left(\pi(i)^{conv}_{g,t}\right)^{w(i)_{g,t}} = \prod_{g\in G}\prod_{c\in C(i)_g} \pi(i)^{w(i)_{gc,t}\,w(i)_{g,t}}_{gc,t}\,, \tag{9}$$

where $\pi(i)_{gc,t} = P(i)_{gc,t} / P(i)_{gc,t-1}$. Weights $w(i)_{gc,t}$ and $w(i)_{g,t}$ are computed using cost shares $s(i)^M{}_{gc,t}$ and $s(i)^M{}_{g,t}$ in the two periods as follows:

$$w(i)_{gc,t} = \frac{\left(s(i)^M_{gc,t} - s(i)^M_{gc,t-1}\right) / \left(\ln s(i)^M_{gc,t} - \ln s(i)^M_{gc,t-1}\right)}{\sum_{c\in C(i)_g}\left(\left(s(i)^M_{gc,t} - s(i)^M_{gc,t-1}\right) / \left(\ln s(i)^M_{gc,t} - \ln s(i)^M_{gc,t-1}\right)\right)};\; s(i)^M_{gc,t} = \frac{P(i)_{gc,t}M(i)_{gc,t}}{\sum_{c\in C(i)_g} P(i)_{gc,t}M(i)_{gc,t}};$$

$$w(i)_{g,t} = \frac{\left(s(i)^M_{g,t} - s(i)^M_{g,t-1}\right) / \left(\ln s(i)^M_{g,t} - \ln s(i)^M_{g,t-1}\right)}{\sum_{g\in G}\left(\left(s(i)^M_{g,t} - s(i)^M_{g,t-1}\right) / \left(\ln s(i)^M_{g,t} - \ln s(i)^M_{g,t-1}\right)\right)};\; s(i)^M_{g,t} = \frac{\sum_{g\in G} P(i)_{gc,t}M(i)_{gc,t}}{\sum_{g\in G}\sum_{c\in C(i)_g} P(i)_{gc,t}M(i)_{gc,t}}.$$

The import price index in (9) ignores changes in variety over time, which is tantamount to ignoring changes in the set of competitor countries from the exporter's view. Broda and Weinstein (2006), following Feenstra (1994), relax the underlying assumption of constant variety. They posit that if $Q(i)_{gc,t} = Q(i)_{gc,t-1}$ for $c \in C(i)_g = (C(i)_{g,t} \cap C(i)_{g,t-1})$, $C(i)_g \neq \emptyset$, then the exact price index for good g can be given by

$$\pi(i)^{bw}_{g,t} = \pi(i)^{conv}_{g,t}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{1}{\sigma(i)_g - 1}} \text{ and } \pi(i)^{bw}_{t} = \prod_{g\in G}\left(\pi(i)^{bw}_{g,t}\right)^{w(i)_{g,t}}, \tag{10}$$

where $\lambda(i)_{g,t} = \dfrac{\sum_{c\in C(i)_g} P(i)_{gc,t}M(i)_{gc,t}}{\sum_{c\in C(i)_{g,t}} P(i)_{gc,t}M(i)_{gc,t}}$ and $\lambda(i)_{g,t-1} = \dfrac{\sum_{c\in C(i)_g} P(i)_{gc,t-1}M(i)_{gc,t-1}}{\sum_{c\in C(i)_{g,t-1}} P(i)_{gc,t-1}M(i)_{gc,t-1}}$.

As a result, the price index derived in (9) is multiplied by an additional term to capture the role of new and disappearing varieties.[8]

Broda and Weinstein (2006) still assume that taste and quality parameters are unchanged for all varieties of all goods, $Q(i)_{gc,t} = Q(i)_{gc,t-1}$, i.e. vertical product differentiation is ignored. To overcome this, Benkovskis and Wörz (2011) introduce an import price index that adds a term to capture changes in taste and quality:

$$\pi(i)_{g,t} = \prod_{c\in C(i)_g} \pi(i)^{w(i)_{gc,t}}_{gc,t}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{1}{\sigma(i)_g - 1}} \prod_{c\in C(i)_g}\left(\frac{Q(i)_{gc,t}}{Q(i)_{gc,t-1}}\right)^{\frac{w(i)_{gc,t}}{1-\sigma(i)_g}} \text{ and } \pi(i)_t = \prod_{g\in G} \pi(i)^{w(i)_{g,t}}_{g,t}. \tag{11}$$

Equation (11) is thus a modified version of equation (10) where the last term captures changes in the taste and quality parameter. This term states that a rise in consumer taste or quality

[8] This additional term is similar to the extensive margin in equation (2), but its interpretation is different. The extensive margin focuses on changes in a set of exported products/markets from the exporter's point of view, while equation (10) defines how changes in variety affect consumers (i.e. importers).

reduces the growth of minimum unit-cost and thus increases the utility of consumers. The additional term also depends on the product-specific elasticity of substitution between varieties. If $\sigma(i)_g$ is high, the additional term goes to unity. In other words, non-price factors play an important role for imperfect substitutes.

2.3 DECOMPOSING THE INTENSIVE MARGIN

Drawing together the previous two subsections, we now decompose the intensive margin in equation (3) further. Here, we focus on changes of country k's exports of product j's nominal share in total imports of country i. This is denoted by $IM(i)_{jk,t}$. In other words, we consider only those products for which exports are non-zero in both periods. Appendix A.1 proves that by using utility maximization problem in (4)–(6), $IM(i)_{jk,t}$ can be expressed as:

$$IM(i)_{jk,t} = \frac{P(i)_{jk,t}M(i)_{jk,t}}{P(i)_t M(i)_t} \frac{P(i)_{t-1}M(i)_{t-1}}{P(i)_{jk,t-1}M(i)_{jk,t-1}} = \frac{\pi(i)_{jk,t}^{1-\sigma(i)_j}\left(Q(i)_{jk,t}/Q(i)_{jk,t-1}\right)}{\pi(i)_{j,t}^{1-\sigma(i)_j}} \frac{\pi(i)_{j,t}^{1-\gamma(i)}}{\pi(i)_t^{1-\gamma(i)}}. \tag{12}$$

Equation (12) shows that changes in market share are not only driven by price factors but also by changes in export quality or consumer preference (taste) for country k's goods. But there is another factor at play here. Equation (11) states that changes in minimum unit costs $\pi(i)_{j,t}$ and $\pi(i)_t$ depend on changes in variety (as well as taste/quality). By combining equations (11) and (12), we easily obtain the following decomposition of $IM(i)_{jk,t}$ into three parts:

$$IM(i)_{jk,t} = \underbrace{PP(i)_{jk,t}}_{1}\underbrace{CC(i)_{jk,t}}_{2}\underbrace{QQ(i)_{jk,t}}_{3} = \underbrace{\left(\frac{\pi(i)_{jk,t}}{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}\right)^{1-\sigma(i)_j}\left(\frac{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}{\prod_{g\in G}\prod_{c\in C(i)_g}\pi(i)_{gc,t}^{w(i)_{gc,t}w(i)_{g,t}}}\right)^{1-\gamma(i)}}_{1} \times \tag{13}$$

$$\times\underbrace{\left(\frac{\lambda(i)_{j,t}}{\lambda(i)_{j,t-1}}\right)^{\frac{\gamma(i)-\sigma(i)_j}{1-\sigma(i)_j}}\prod_{g\in G}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{(1-\gamma(i))w(i)_{g,t}}{1-\sigma(i)_g}}}_{2}\times\underbrace{\frac{Q(i)_{jk,t}/Q(i)_{jk,t-1}}{\prod_{c\in C(i)_j}\left(Q(i)_{jc,t}/Q(i)_{jc,t-1}\right)^{w(i)_{jc,t}}}\left(\frac{\prod_{c\in C(i)_j}\left(Q(i)_{jc,t}/Q(i)_{jc,t-1}\right)^{\frac{w(i)_{jc,t}}{1-\sigma(i)_j}}}{\prod_{g\in G}\prod_{c\in C(i)_g}\left(Q(i)_{gc,t}/Q(i)_{gc,t-1}\right)^{\frac{w(i)_{gc,t}w(i)_{g,t}}{1-\sigma(i)_g}}}\right)^{1-\gamma(i)}}_{3}$$

,

where $PP(i)_{jk,t}$ is the contribution of price factors to changes of country k's exports of product j's nominal share in total imports of a country i, $CC(i)_{jk,t}$ is the contribution of changes in the set of exporters (i.e. changes in set of competitors) and $QQ(i)_{jk,t}$ is the contribution of other non-price factors that we interpret here as changes in taste and quality.

Equation (13) deserves a more detailed discussion and interpretation. The first term, which represents the contribution of price factors, is similar to one derived by Armington (1969). The main difference is that it takes into account both changes in the price of product j originating from country k relative to changes of the average import price of product j and changes of the average import price of product j relative to total import price changes. An increase of country's k price of product j relative to its competitors, as well as an increase of product j's average import price relative to total import prices reduces the share of country k's exports of product j in total imports of country i. The degree of market share reaction to changes in relative prices is determined by elasticities of substitutions. A high substitutability between varieties of product j, as well as a high elasticity of substitution between different products, implies a strong role for prices changes.

The second term, while less intuitive, can be interpreted as follows. In equation (10), the ratio $\lambda(i)_{j,t}/\lambda(i)_{j,t-1}$ denotes changes in imported varieties of product j. While this interpretation is correct from the consumer point of view (demand-side interpretation), this term captures changes in the number of exporters from the supplier point of view (competitors in the import market). It changes whenever a competitor enters or leaves the market. Therefore, we interpret the second term here as the contribution of changes in set of competitors to gains or losses in country k's nominal market shares. Note that this term accounts for changes in set of competitors in all product markets as increasing or decreasing variety on any product market affects consumer choice among various products.

The third term represents the contribution of other non-price factors (taste and quality) to changes in $IM(i)_{jk,t}$. Interpretation of the third term is straightforward. If the quality of country k's exports of a product j (or consumers' taste for product j originating from country k) improves relative to product j's average over all providers, this increases the share of country k's export of product j in total imports of receiving country i. In addition, j's export share will increase if country i's import structure shifts in favor of product j due to some positive changes in taste or quality relative to other products.

2.4 NON-PRICE FACTORS – A MEANINGFUL RESIDUAL

Despite this clear intuition, the expression in (13) still suffers from a significant flaw: the taste and quality parameter $Q(i)_{gc,t}$ is unobservable. Even so, it is still possible to evaluate it from observed quantities and prices. If elasticities of substitutions are known,[9] the contribution of non-price factors can be derived as a residual from equation (13) and is given in equation (14):

[9] For the moment, we assume they are known. The estimation strategy for obtaining substitution elasticities is explained in Section 4.1 and Appendix A.3.

$$QQ(i)_{jk,t} = \frac{IM(i)_{jk,t}}{PP(i)_{jk,t}CC(i)_{jk,t}} = \frac{\mu(i)_{jk,t}}{\prod_{g\in G}\prod_{c\in C(i)_g}\mu(i)_{gc,t}^{w(i)_{gc,t}w(i)_{g,t}}}\left(\frac{\pi(i)_{jk,t}}{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}\right)^{\sigma(i)_j} \times \tag{14}$$

$$\times\left(\frac{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}{\prod_{g\in G}\prod_{c\in C(i)_g}\pi(i)_{gc,t}^{w(i)_{gc,t}w(i)_{g,t}}}\right)^{\gamma(i)}\left(\frac{\lambda(i)_{j,t}}{\lambda(i)_{j,t-1}}\right)^{\frac{\sigma(i)_j-\gamma(i)}{1-\sigma(i)_j}}\prod_{g\in G}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{(\gamma(i)-\sigma(i)_g)w(i)_{g,t}}{1-\sigma(i)_g}},$$

where $\mu(i)_{gc,t} = M(i)_{gc,t}/M(i)_{gc,t-1}$. Note, that equation (14) does not state that changes in prices and volumes determine non-price competitiveness, as quality and taste are exogenous and do not depend on trade price and volumes in our model. Equation (14) simply reflects the fact that observed variables contain useful information for the derivation of a proxy that captures the impact of non-price factors in shaping a country's competitive position.

The residual determined by equation (14) is not a black box, hence it can be interpreted. As noted by Hummels and Klenow (2005), the unobserved taste and quality parameter can be expressed by observed prices and quantities using the same optimization problem which we described in equations (4)–(6) above. After taking first order conditions, transforming into log-ratios and first-differencing, changes in relative taste and quality are given by:

$$\Delta\ln\left(\frac{Q(i)_{gc,t}}{Q(i)_{gk,t}}\right) = \Delta\ln\left(\frac{M(i)_{gc,t}}{M(i)_{gk,t}}\right) + \sigma(i)_g\Delta\ln\left(\frac{P(i)_{gc,t}}{P(i)_{gk,t}}\right). \tag{15}$$

We need to stress again that equation (15) does not claim that relative quality or taste depends on relative trade volumes and prices (quality or taste parameter is exogenous variable). Rather it shows that changes in relative taste and quality are reflected in relative price and volume dynamics. In fact, equation (15) is just a narrowed version of equation (14), as it ignores changes in varieties and substitution between different products. However, it is much easier to understand the underlying logic now.

Price dynamics is an important proxy (but not the determinant) of relative quality or taste. If the price of a good g imported from country c is rises faster than the price of the same good imported from country k, this indicates either improving quality or increasing preference for the country c good. Moreover, when different varieties are close substitutes, the role of relative prices as a proxy for relative quality increases. It should be noted, however, that relative price is not the sole indicator of relative taste and quality. Changes in relative quantity of a single variety in total consumption also reflect the perception of changes in relative taste and quality. Increasing consumption of a certain variety is a clear sign of improving taste or quality, and relative quantity gains importance when the elasticity of substitution is small. This is exactly what the first three terms of equation (14) are about – unobservable change in taste and quality proxied for by changes in relative prices (price of country *k'*s exports of product *j* relative to the average import price of product *j* and the average price of product *j* relative to the price for all imported goods), as well as changes in real market share. The last two terms of (14) are less intuitive. They are driven by the interaction between taste/quality and variety. Our calculations show that the role of two last terms is negligible in empirical estimations.

Finally, we can rearrange the decomposition of changes in export market share for a particular product and destination country. Equation (16) is a combination of equations (13) and (14) and it extracts three main components: contribution of price factors (1), contribution of changes in the set of exporters (2), and contribution of other non-price factors (3), proxied by observable variables:

$$
\begin{aligned}
IM(i)_{jk,t} = {} & \underbrace{\left(\frac{\pi(i)_{jk,t}}{\prod\limits_{c \in C(i)_j} \pi(i)_{jc,t}^{w(i)_{jc,t}}} \right)^{1-\sigma(i)_j} \left(\frac{\prod\limits_{c \in C(i)_j} \pi(i)_{jc,t}^{w(i)_{jc,t}}}{\prod\limits_{g \in G} \prod\limits_{c \in C(i)_g} \pi(i)_{gc,t}^{w(i)_{gc,t} w(i)_{g,t}}} \right)^{1-\gamma(i)}}_{1} \times \underbrace{\left(\frac{\lambda(i)_{j,t}}{\lambda(i)_{j,t-1}} \right)^{\frac{\gamma(i)-\sigma(i)_j}{1-\sigma(i)_j}} \prod_{g \in G} \left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}} \right)^{\frac{(1-\gamma(i)) w(i)_{g,t}}{1-\sigma(i)_g}}}_{2} \times \qquad (16) \\
& \times \underbrace{\frac{\mu(i)_{jk,t}}{\prod\limits_{g \in G} \prod\limits_{c \in C(i)_g} \mu(i)_{gc,t}^{w(i)_{gc,t} w(i)_{g,t}}} \left(\frac{\pi(i)_{jk,t}}{\prod\limits_{c \in C(i)_j} \pi(i)_{jc,t}^{w(i)_{jc,t}}} \right)^{\sigma(i)_j} \left(\frac{\prod\limits_{c \in C(i)_j} \pi(i)_{jc,t}^{w(i)_{jc,t}}}{\prod\limits_{g \in G} \prod\limits_{c \in C(i)_g} \pi(i)_{gc,t}^{w(i)_{gc,t} w(i)_{g,t}}} \right)^{\gamma(i)} \left(\frac{\lambda(i)_{j,t}}{\lambda(i)_{j,t-1}} \right)^{\frac{\sigma(i)_j-\gamma(i)}{1-\sigma(i)_j}} \prod_{g \in G} \left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}} \right)^{\frac{(\gamma(i)-\sigma(i)_g) w(i)_{g,t}}{1-\sigma(i)_g}}}_{3}
\end{aligned}
$$

Although the third term is derived as a residual, it nevertheless has clear economic interpretation (see discussion above). Definitely, this equation cannot be estimated (due to overidentification). However, for given elasticities of substitution γ and σ's one can detect the driving factors behind changes in export markets shares using observable variables (trade prices and volumes). Equation (16) contains a duality: the decomposition can be done either by calculating all three components and then summing them up, or by evaluating any two components (e.g. contribution of price factors and changes in the set of exporters) and calculating the remaining component as a residual.[10]

[10] It should be noted that in practice we are unable to perform the decomposition of changes in export market share for several products. This is due to absence of data on unit values and/or impossibility to estimate elasticities of substitution. However, the evaluation is not limited for the left hand side variable (changes in export market shares).

2.5 AGGREGATION AND THE ROLE OF COUNTRY EFFECTS

The final step in our decomposition analysis is the aggregation of changes in market shares of individual products in individual import markets to country *k*'*s* world market share. The aggregation over all products imported by receiving country *i*, $IM(i)_{k,t}$, is straightforward:

$$IM(i)_{k,t} = \sum_{g\in G} s(i)^X_{gk,t-1} IM(i)_{gk,t} \ , \tag{17}$$

where $s(i)^X{}_{gk,t}$ is the share of country *k*'s exports of product *j* to country *i* in total exports of country *k* to country *i*, defined as

$$s(i)^X_{jk,t} = \frac{P(i)_{jk,t} M(i)_{jk,t}}{\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}} \ .$$

The aggregation up to the intensive margin of world market share growth is trickier as the structure of world trade changes over time. Under the theoretical framework here, shifts in product composition of country *i*'s imports can be explained by changes in relative prices and non-price factors. This does not work, however, for shifts in the country composition of world imports since the framework in (4)−(6) describes the demand of an individual country, not world demand. Import growth rates between individual countries differ due to fundamental factors such as demography, saving rates, economic structure, and the institutional environment. To account for these different importer characteristics, we add another term to our decomposition: changes in the intensive margin due to shifts in the country's share of world imports, $DS(i)_t$:[11]

$$IM_{k,t} = \sum_{i\in I} s(i)^X_{k,t-1} DS(i)_t IM(i)_{k,t} = \sum_{i\in I}\sum_{g\in G} s(i)^X_{k,t-1} s(i)^X_{gk,t-1} DS(i)_t IM(i)_{gk,t} \ , \tag{18}$$

where $DS(m)_t = \dfrac{\sum_{c\in C}\sum_{g\in G} P(m)_{gc,t} M(m)_{gc,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}} \dfrac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}}{\sum_{c\in C}\sum_{g\in G} P(m)_{gc,t-1} M(m)_{gc,t-1}}$

and $s(i)^X_{k,t} = \dfrac{\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}}$.

Thus, from the exporter's point of view, the intensive margin of changes in export market share is decomposed into four parts: price factors, changes in the set of competitors, non-price factors, and global demand shifts. The decomposition into these four factors is accomplished with equations (16) and (18). Combining these with equations (1) and (2), we can decompose changes in world market share (changes in global competitiveness) into five parts, the above-

[11] In our framework, the role of $DS(i)_t$ is similar to the country effect in a Constant Market Share Analysis (CMSA).

mentioned price, non-price and structural factors for the intensive margin, plus the extensive margin. The system of above-mentioned equations, unfortunately, creates a nasty combination of sums and multiplications that complicates decomposition. Therefore, for empirical applications it is more convenient to use a log-linear approximation of the system as described in Appendix A.2.[12]

We draw attention at this point to the most salient improvements over the traditional REER indicator offered by our proposed analysis. An obvious analytical gain is the inclusion of factors other than prices and costs into the analysis. While the traditional REER deals solely with price competitiveness, the decomposition of market share developments described here uncovers the role of other, and potentially quite significant, non-price and structural factors. Indeed, our results in Section 4 show that the contribution of non-price factors (interpreted as changes in taste and quality) to competitiveness in most of the cases studied here is substantially *more important* than the contribution of price factors. Thus, while the real effective exchange rate only illustrates the price aspect, our analysis delivers a comprehensive picture of competitiveness.

Moreover, the difference in methodologies extends further. Even if we focus solely on the contribution of price factors, we offer an improvement by relaxing the assumption of a constant elasticity of substitution across goods and origins. Thus, while both indicators share common features, the flexibility embedded in our proposed aggregation scheme offers a huge conceptual advantage. Indeed, both approaches have their theoretical roots in Armington's (1969) model and the economic intuition is very similar, i.e. higher prices lead to decreasing competitiveness. Also the weighting scheme is close in spirit to the models proposed by Durand (1986) and McGuirk (1987) as it takes into account both the relative importance of each market in total exports of country k and the relative importance of competing countries on individual markets weighted by the importance of that markets for the exporting country. There is a crucial difference, however – the REER is an aggregate indicator. As McGuirk (1987) notes, it is assumed that changes in individual product prices are similar to those of an aggregate price index, and more importantly, the elasticity of substitution is the same for every product. The evaluation of a contribution of price factors on a disaggregate level in equations (16) and (18), however, takes into account the differences in elasticities of substitution across markets. As a result, the importance of a price change in a particular market is determined by its weight in the country's exports and by the degree of substitutability among varieties and products. Compared

12 We log-linearize around the constant state (no changes in volumes or prices between periods t and t–1). Although the log-linear approximation works well only for small changes, it is still valid in this application. First, we apply log-linear approximation for year-to-year changes in volumes or prices, which are much smaller than the cumulated changes. Second, the results reported in Chart 1 show the adequacy of log-linear approximation for G7 and BRIC countries (it should be noted that missing unit values data induce large part of the discrepancy).

to the REER, markets that are closer to perfect competition obtain more weight in our analysis. The results in Section 4 show that, in several cases, this additional weighting by the degree of competition in a market reveals interesting differences in the evaluation of price competitiveness.

3 DESCRIPTION OF THE DATA

Before looking at the results, we should explain our choice of database for the empirical analysis. As in the case of REER, the theoretical framework described in Section 2 gives no strict definition of what data should be used. Nevertheless, we can infer that they should meet certain requirements.

Highly detailed information at the product level is necessary. This need arises from our claim that the degree of competition in a particular market has a significant influence on the contribution of price versus non-price factors. Hence, to empirically illustrate this theoretical improvement the data should be disaggregated. Moreover, any analysis of the contribution of variety, taste and quality calls for detailed data. Disentangling taste/quality from variety is a non-trivial task that requires detailed data (ideally, data at the micro level).[13]

Data should also be available for both price and volume. Although such micro data is not available for the broad range of products and countries, commodity trade statistics offer a single source of harmonized, detailed information on prices and volumes. Despite obvious advantages such as detailed disaggregation, high coverage, and harmonization across countries, commodity trade statistics come with several notable drawbacks. The most significant flaw is the exclusion of domestic sales from the analysis. Although the theoretical framework in Section 2 is rather flexible and allows for inclusion of domestic sales, we lack such data with the similar level of disaggregation. Another important drawback is the exclusive focus on goods trade − an ever-increasing limitation given to enlarging role of services in world trade.

For our empirical analysis, we use trade data from UN Comtrade. Despite a lower level of disaggregation and longer publication lag compared to, say, Eurostat's Comext data, the worldwide coverage of the UN database is a significant advantage. We use the most detailed level reported by UN Comtrade, the six-digit level of the Harmonized System (HS) introduced in 1996. This gives us 5,132 products, which should be enough to ensure a reasonable level of disaggregation. While this is lower than the 8-digit CN (Combined Nomenclature) level available through Eurostat's Comext (which covers over 10,000 products), the UN Comtrade data are quite sufficient for calculating unit values.

[13] Hummels and Klenow (2005) claim it is impossible to disentangle quality from within-category variety in the absence of detailed data on the precise number of varieties per good from another source. Bloningen and Soderbery (2010) argue that the Armington (1969) definition of variety by different origins hides substantial variety changes within providers. They find that the additional introduction of new varieties by foreign affiliates adds gains around 70% larger than those calculated only from the country of origin. To fully assess the number of imported brands, we would need firm-level data that is unavailable for a broad range of products (especially under the global view we adopt here). Therefore, we have no alternative but to keep with the Armington assumption.

Although our ultimate goal is to decompose the changes in export market shares, we rely on the import data of partner countries in the analysis. As mentioned at the beginning of Section 2, the argument for focusing on partner imports rather than the origin country exports is driven by the theoretical framework on which our evaluation of price and non-price competitiveness is based. Recall that our methodology starts with the consumer's utility maximization problem. Thus, import data are clearly preferred as imports are reported in CIF (cost, insurance, freight) prices, giving us the cost of the product at the point when it arrives at the importer country's border. From the consumer's point of view, import data provide a better comparison of prices.

Of course, there are also drawbacks related to imports. The data on imports from emerging countries, in particular, do not necessarily coincide with the respective countries' reported exports due to differences in valuation, timing, sources of information, and incentives to report. That said (especially with respect to emerging economies still subject to import tariffs for a considerable range of their products), import data as a rule are fairly well reported; national authorities have an interest in the proper recording of imports on which they collect tariff revenue.

Our import dataset contains annual data on imports of 188 countries at the six-digit HS level between 1996 and 2011.[14] The dataset contains information on 236 partner countries (exporters), so we obtain the most full and detailed information on world trade available from the UN Comtrade. We use unit value indices as a proxy for prices (dollars per quantity unit, e.g. kilograms). Trade volume (mainly measured in kilograms, although other measures of quantity such as number of units are used for certain products) is used as a proxy for quantities.

Where data are missing for values or volumes, or data on volumes is not observed directly but estimated by statistical authorities, a unit value index cannot be calculated. Moreover, estimating unit values is complicated for many reporting countries. Even the US, the world's top importer, only publishes import data that allow calculation of unit values for about 70% of imports in 2011 (in value terms). The situation is better for the EU, China, Japan, India, Brazil, but other countries such as Canada, Mexico, and Australia, provide coverage of 50% or less. Coverage is also generally worse for the first half of the sample period, making the analysis of non-price competitiveness more challenging and implying that our results should be taken with a grain of salt. On the other hand, low coverage of available unit values in some countries is rather homogenous across product groups, so we argue this problem is unlikely to affect our results significantly.

[14] Although data are not available for many reporting countries in all years between 1996 and 2011, the only major world importers with missing data in some years are Russia and Singapore (trade data for 1996 is not reported in HS1996), Thailand and Saudi Arabia (trade data for 1996−1998 is not reported in HS1996).

Our other adjustment to the database relates to structural changes within the categories of goods. Although we use the most detailed classification available, it is still possible that we might be comparing apples and oranges within a particular category. One indication of such a problem is given by large price level differences within a product code. Consequently, all observations with outlying unit value indices are excluded from the database.[15]

[15] 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 three median absolute deviations. The exclusion of outliers does not significantly reduce the coverage of the database. In the majority of cases, less than 4−5% of the total import value was treated as outliers.

4 RESULTS

This section reports the empirical results obtained from our proposed competitiveness indicator. We start with a discussion of how elasticities of substitution are estimated, then we investigate the importance of heterogeneous elasticities of substitution for the evaluation of price competitiveness. Next, we offer a decomposition of changes in export market shares for G7 and BRIC countries into the five effects outlined above: contribution of extensive margin, price changes, non-price factors, changes in demand structure, and changes in the set of competitors. We end the section with some robustness checks of the results.

4.1 ELASTICITIES OF SUBSTITUTION

The final ingredient needed for decomposition of changes in export market shares is the estimation of unobservable substitution elasticities. Following the approach proposed by Feenstra (1994) and developed by Broda and Weinstein (2006) and Soderbery (2010, 2013), we specify a system of demand and supply equations for each individual product g in every importing country i. Technical details are provided in Appendix A.3. The estimation methodology above is applied to all products g where data on at least three countries of origin are available. Table A1 in Appendix A.3. displays the main characteristics of estimated elasticities of substitution between varieties for the top 20 world importers.[16] The median elasticities of substitution between varieties are rather similar across countries and typically around 2: e.g. US (2.00), China (2.23), Germany (2.03), and Japan (2.08). These results are significantly lower than those reported by Broda and Weinstein (2006) for the US,[17] but they are quite comparable to those obtained by Soderbery (2010, 2013). Despite similarities of median elasticities of substitution between varieties across countries, Table A1 signals a remarkable variation in elasticities of substitutions across products. Literally, elasticities vary between unity and infinity, meaning that some markets operate under perfect competition, while others can seem to operate under monopolistic competition. This highlights a significant potential drawback of the traditional REER, which assumes the same elasticity of substitution for all products.

Up to this point, we have focused solely on the elasticity of substitution between varieties of the same good. Now we apply $\gamma(i)$, the elasticity of substitution between goods. Theoretically, it is possible to apply a similar estimation methodology as the one explained in Appendix A.3, by deriving supply and demand equations and solving the system by exploiting the panel nature of

16 Results for other countries are available upon request.

17 They report a median elasticity of 3.7 for the period between 1972 and 1988 for seven-digit (TSUSA) goods and 3.1 for the period between 1990 and 2001 for ten-digit (HTS) goods.

the data. However, this method seems inappropriate here. The assumption of a single elasticity of substitution among varieties of a particular good is reasonable, while the assumption of a single elasticity among different products is likely overly restrictive. One would expect a high elasticity of substitution between highly similar products (e.g. vegetables and fruits) and rather low substitution elasticity between radically different products (e.g. vegetables and fuel). As we cannot solve this problem within the existing theoretical framework based on a CES utility function, we calibrate the elasticity of substitution between goods. Obviously, the substitutability of various products should not exceed the substitutability among varieties. Therefore, our calculations assume that γ is equal to 2, close to the estimated median elasticity of substitution among varieties. This corresponds to the elasticity used by Romer (1994) and is borne out by our robustness check below.

4.2 HETEROGENEOUS ELASTICITIES OF SUBSTITUTION

The results of the previous subsection prove that elasticities of substitution among varieties are not homogenous across products, thus invalidating the underlying assumption of the REER that elasticity of substitution among all suppliers is the same for every commodity (McGuirk, 1987). As mentioned in the introduction, the validity of this assumption was questioned by Spilimbergo and Vamvakidis (2003), who estimated manufacturing export equations using panel data on 56 countries. They claim that if the assumption of constant elasticity of substitution is valid, splitting the real exchange rate into two or more components should not increase its predictive power in an export demand equation. They go on to show that this assertion is not supported by empirical estimations as the elasticity of exports to the REER with respect to OECD countries is lower than with respect to non-OECD countries, and the export equations that contain two REER indices perform on average considerably better than the traditional ones. In terms of our theoretical framework, the empirical findings of Spilimbergo and Vamvakidis (2003) may be explained by different elasticities of substitution among varieties in different product markets. OECD countries typically specialize in manufactured goods with a lower elasticity of substitution among varieties, while non-OECD countries tend to have exports dominated by commodities with a high elasticity of substitution. As a result, price competition should be expected to play a smaller role for OECD countries compared to non-OECD countries.

We employ a different strategy here to check empirically the relevance of the assumption of homogenous elasticities of substitution. We calculate our proposed indicator in two ways: assume a constant elasticity of substitution between any two suppliers in spirit of

McGuirk (1987), and allow elasticities of substitution among varieties to vary across products using the results reported in Table A1.

We bring our decomposition methodology described in Section 2 closer to the assumptions of aggregate REER by assuming that all elasticities of substitution among varieties are equal to the elasticity of substitution between products ($\sigma(i)_g = \gamma(i) = 2$). Our justification for setting all elasticities equal to 2 is based on the fact that most median elasticities of substitution among varieties are close to this value. Moreover, this simplifies calculation, particularly in the case of calculating the contributions of price factors to changes in market shares:

$$pp_{k,t}^{const} = -\left(\sum_{i\in I}\sum_{g\in G}\widetilde{s}(i)_t^X \widetilde{s}(i)_{g,t}^X \ln\pi(i)_{gk,t} - \sum_{i\in I}\sum_{g\in G}\sum_{c\in C(i)_g}\widetilde{s}(i)_t^X w(i)_{gc,t} w(i)_{g,t} \ln\pi(i)_{gc,t} \right). \tag{19}$$

The inverse of (19) can be viewed as an analogue of the aggregate real effective exchange rate based on unit values of exported products.[18] Note, that the first term of (19) represents average changes in country k's export prices, while the second term reflects changes in competitors' export prices weighted by their importance on the third markets and the importance of the respective import market in country k's exports. Thus, the equation shows the contribution of relative export unit values of country k to overall competitiveness. By comparing results from (19) with the more sophisticated calculations from (A9) in Appendix A.2, we assess the restrictiveness of the common assumption of constant substitution elasticity for the evaluation of price competitiveness.

This comparison is presented in Chart A1. It clearly shows that disaggregated calculations and relaxing the assumption of homogenous elasticities plays an important role in several cases. We find significant differences in the evaluation of price competitiveness for Canada, the UK, and to a lesser extent, the US. Assuming equal elasticities across all suppliers (as in the REER calculations) overestimates losses in price competitiveness for Canada, which may be due to the fact that such losses were concentrated in exports of products with a relatively low elasticity of substitution and relatively high market power of suppliers. This conclusion is bolstered by similar results for the US, where disaggregated calculations indicate higher price competitiveness as commonly shown by REER indices. The opposite situation is observed for the UK; our detailed estimates flag larger losses in price competitiveness that may signal more pronounced increases in the relative prices of products with relatively high elasticities of substitution.

[18] To ensure comparability with results obtained under the assumption of heterogeneous elasticities, calculations are performed only for those products where we could estimate an elasticity of substitution among varieties.

4.3 NON-PRICE FACTORS

Although the previous subsection establishes that the use of highly disaggregated data can affect our conclusions on price competitiveness, the main feature of our proposed methodology is that it fully decomposes changes in export market shares into *price-* and *non-price-related effects*. It allows comparing the contribution of price factors to the contribution of such non-price factors as changes in the set of competitors, shifts in taste or quality, and changes in world demand structure. Chart 1 below reports the market share growth decomposition for G7 and BRIC countries, the engines of global exports.[19]

Chart 1 shows that, in all cases, the contribution of non-price factors (taste and quality) to cumulative changes in export market shares (competitiveness) is the highest, while the second largest contribution to competitiveness comes from changes in relative price. However, the sign of the contributions by price and taste/quality factors contributions varies greatly among exporters. While the contributions of the two sets of factors coincide in the case of China and the UK, they are of opposite signs for Germany or Russia. All other factors play only a limited role for changes in competitiveness. While shifts in foreign demand still show some effect for most exporters (especially in recent years), the negligible contribution of the extensive margin may be explained by our chosen definition that export destination/variety is marked as "new" only for the first year (see Section 2.1). Further, entry and exit of new competitors is relevant only for some exporters (positive contribution in the case of Canada, Japan, and the UK; negative contribution for France, Germany, and Italy).

We also observe losses in non-price competitiveness for all G7 countries. Our index reveals a decrease in the relative quality of exports from or diminishing relative consumer tastes for G7 production. The opposite is observed for the BRICs, where the cumulative contribution of taste and quality to export competitiveness is positive. This is in line with results by Benkovskis and Wörz (2013), who report that China, Brazil, Russia, and India all showed significant gains in international competitiveness due to non-price factors over the past decade. The growing role of non-price factors for China, Brazil and India is also noted by Fu et al. (2012), Pula and Santabarbara (2011), and Brunner and Cali (2006). It should be noted however that our findings for Russia are not robust to excluding oil products, further they hinge strongly on the chosen elasticity of substitution among products. We will discuss these findings in more detail in Section 4.4.

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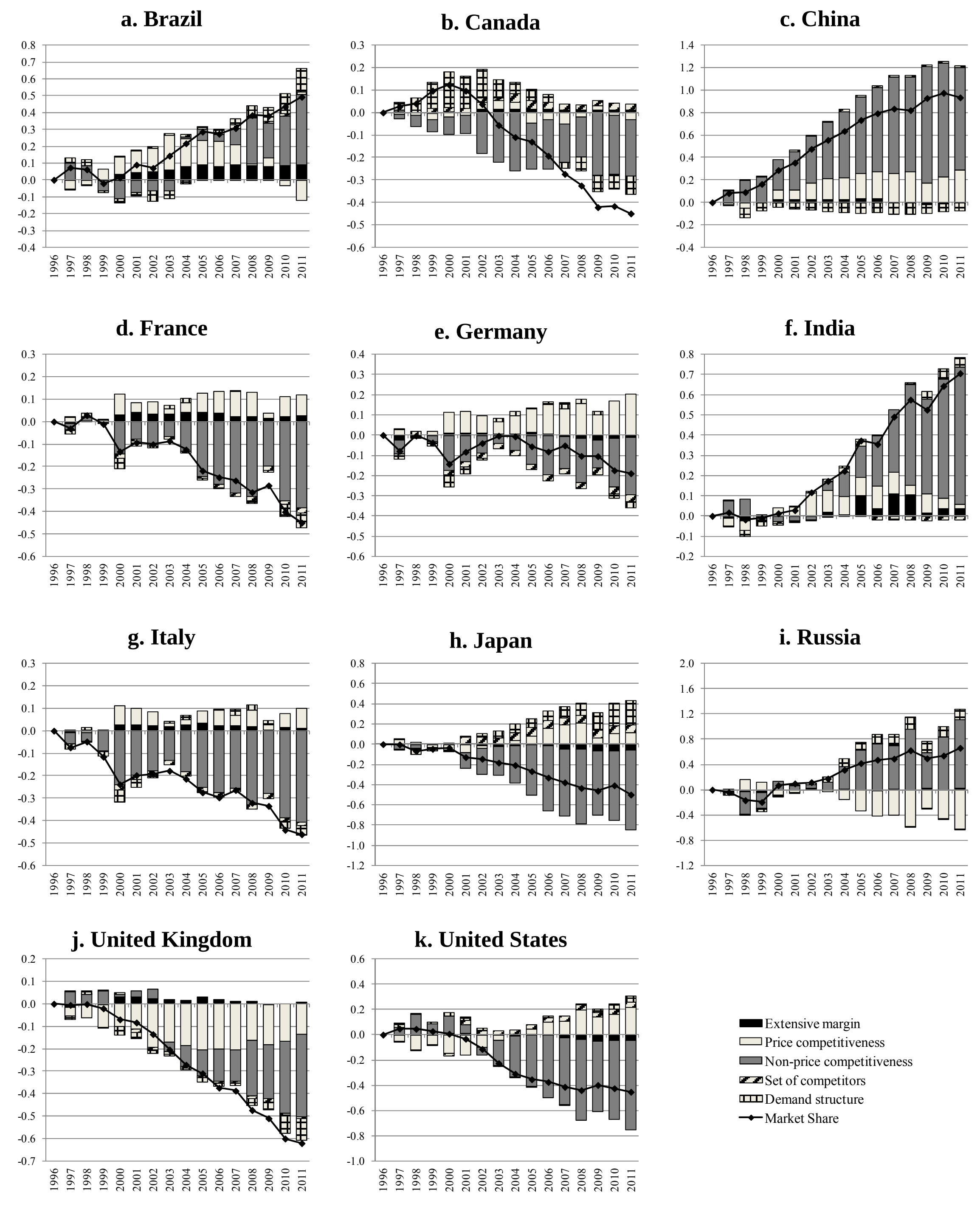
19 We decompose market shares country-by-country, comparing the performance of an individual country (k) with the aggregated world performance. Note that the change of country k does not require a re-estimation of substitution elasticities (σ's). Estimates of elasticities are robust to the choice of benchmark country l (see the discussion Appendix A.3); moreover, the benchmark country in the estimation of elasticities (l) can differ from the country used in the decomposition exercise (k).

Chart 1 Decomposition of export market share changes



Note: Calculated using UN Comtrade data for disaggregated imports of 188 countries using equations (A6)–(A13), elasticities of substitution among varieties are estimated using equation (A16), elasticity of substitution between products assumed to be equal to 2. The sum of contributions is not equal to total changes in export market shares due to log linearization and missing unit values data.

Moreover, while the direction of price competitiveness changes may differ from total changes in export market shares, the changes in non-price competitiveness always coincides with the direction of total market share changes (positive for BRIC, negative for G7 countries).

The nice clustering here (G7 versus BRIC), however, may evidence the increasing importance of global value chains. As final assembly of products is often shifted to emerging countries, it increases observed market shares of emerging countries when looking at gross trade flows. It also raised their export prices due to the higher quality of finished products. Under our methodology, this would imply an artificial increase in the non-price competitiveness for countries involved in the final stage of production. This, however, does not reflect the true competitive position of countries at different stages of the global production chain. Bems and Johnsons (2012) propose the use of a value-added deflator to estimate price competitiveness, but obviously this does little to solve the problem of assessing non-price competitiveness. Exploring the impact of global value chains and trade in value added in order to accurately assess competitiveness is doubtless an important theme of future research, but exceeds the scope of the current discussion.

4.4 ROBUSTNESS CHECK

As a first robustness check for the results reported in Chart 1, we exclude mineral products (HS group 27) from the analysis. This is not only a common robustness check in trade analysis, it is also motivated by the fact that the share of mineral products is positively correlated with changes in oil prices. Thus, the assumption that elasticity of substitution between mineral products and other products exceeds one is unrealistic. Our decomposition of export market share changes excluding trade in mineral products is reported in Chart A2.

Excluding this important trade commodity does not alter the results for our focus countries with a significant exception, Russia. The perception of Russia's competitiveness changes dramatically after the exclusion of mineral product exports.[20] First, the overall cumulative increase in export market shares falls from approximately 70% to less than 20%. Second, the cumulative contribution of taste and quality to changes in the share of non-mineral exports turns negative. We interpret this as showing that improvements in Russian non-price competitiveness were solely driven by developments in mineral products. This finding corresponds well to Benkovskis and Wörz (2013), who claim that oil exports account for most of Russia's large gains in non-price competitiveness, and Ahrend (2006), who finds that increases in Russian labor productivity has been largely limited to a small number of commodity sectors.

As a second robustness check, we alter the elasticity of substitution between goods. The results presented in Chart 1 rely on the assumption that the elasticity of substitution between products (γ) is equal to 2. We check how sensitive the results are to changes in γ and estimate exact

20 Mineral products (which includes oil & gas) accounted for over 70% of Russia's total exports in 2011.

import price index for $\gamma = 3$, $\gamma = 1.5$, and $\gamma = 0.5$.[21] The results of this robustness check are reported Chart A3. Despite rather significant changes in substitution elasticity among products, the results are fairly robust to the extent that the dominant role of non-price factors remains unchanged. Also the split between G7 countries (negative cumulative contribution of taste and quality) and BRIC countries (positive cumulative contribution of non-price factors) is retained. More significant changes are observed in the contribution of price factors. The role of prices and costs generally decreases with lower elasticity of substitution, in line with theoretical predictions. Moreover, assuming $\gamma = 0.5$ (rather unrealistic for non-commodity products) leads to the reversal in the sign of price factors in most cases.

Similar to the previous robustness check, the only striking change in results when altering substitution elasticities is observed for Russia. Assuming an elasticity of substitution between products of 0.5 radically alters the perception of Russia's competitiveness. In the latter case the increase in market share appears to be achieved by price competitiveness, not taste and quality. This, again, is explained by the high presence of mineral products and other commodities in Russian exports (products, for which the assumption of $\gamma = 0.5$ seems more reasonable, therefore results in the third column of Chart A3 can be viewed as the most appropriate description of Russian competitiveness). Chart A3 indicates that rising oil and other commodity prices in recent years has led to an increase in Russia's export market shares due to the shift in nominal world imports in favor of oil and other commodities, while the role of non-price factors is negligible as would be expected for commodity products.

[21] Although these changes in γ seem small, what is important here is that γ–1 enters the model. Even marginal changes to low substitution elasticities imply significant differences in market characteristics. The most extreme check would be to assume that $\gamma = 0.5$, which corresponds to the assumption of mutual supplementarity of all products.

5 CONCLUSIONS

We propose a theoretical framework based on the model pioneered by Armington (1969) to achieve a more comprehensive analysis of export competitiveness. Specifically, we presented a novel indicator that allows decomposition of changes in global market shares into several contributions, including price and non-price factors. Both our theoretical derivations and empirical calculations work with mirror-image trade flows. We depart from Armington's demand-side model, relaxing several restrictive assumptions such as constant parameters for taste and quality, to decompose changes in global export market shares into five components: price factors, changes in the set of competitors, non-price factors, global demand shifts, and contributions from the extensive margin to market share growth. The use of highly disaggregated trade data from UN Comtrade makes it possible to account for differences in elasticities of substitution across product markets and to evaluate the contribution of unobservable changes in taste and quality.

We demonstrate that disaggregated calculations and relaxing the assumption of homogenous elasticities of substitution substantially improved assessment of competitiveness in the case of several countries. For example, we found significant differences between our measure and the traditional REER analysis in the evaluation of price competitiveness for Canada, the UK, and to a lesser extent the US. However, the most important feature of the proposed methodology is that it fully decomposes changes in export market shares. Thus, it permits evaluation of the contribution of price factors against the contribution of other factors such as changes in competition, shifts in taste and quality, and changes in global demand structure.

There were two main findings regarding the factor composition of changes in competitiveness. First, for all countries under consideration, the contribution of non-price factors (taste and quality) to cumulative changes in export market shares (competitiveness) is strongest, while relative prices add the second largest contribution to competitiveness. The role of other factors for competitive gains or losses is considerably smaller. Second, our results suggest that all G7 countries suffered losses in non-price competitiveness, while the BRIC countries experienced gains in non-price competitiveness. Indeed, the cumulative contribution of taste and quality to export competitiveness was always positive for the BRICs.

These findings are robust even when trade in mineral products is excluded or alternative elasticities of substitution between products are used. The sole exception was Russia, where the results depended strongly on including mineral products and varied with different substitution elasticities between products. Our analysis suggests that rising oil and other commodity prices have led to an increase in Russia’s global market share in recent years, while the role of non-price factors is negligible for Russia’s competitiveness.

REFERENCES

Ahrend, R. (2006). Russian Industrial Restructuring: Trends in Productivity, Competitiveness and Comparative Advantage. *Post-Communist Economies*, 18(3), 277-295.

Amiti, M., & Freund, C. (2010). An Anatomy of China's Export Growth. In R. C. Feenstra & S. J. Wei (eds.), *China's Growing Role in World Trade*), University of Chicago Press, 35-56.

Arkolakis, C., Costinot, A., & Rodriguez-Clare, A., (2012). *New Trade Models, Same Old Gains?* American Economic Review, 102(1), 94-130.

Armington, P.S., (1969). A Theory of Demand for Products Distinguished by Place of Production. *International Monetary Fund Staff Papers*, 16, 159-178.

Bayoumi, T., Lee, J., & Jayanthi, S. (2006). New Rates from New Weights. *International Monetary Fund Staff Papers*, 53(2), 272-305.

Bems, R., & Johnson, R.C. (2012). Value-Added Exchange Rates. National Bureau of Economic Research Working Paper No. 18498.

Benkovskis, K., & Wörz, J. (2011). How Does Quality Impact on Import Prices? Oesterreichische Nationalbank Working Papers No. 175.

Benkovskis, K., & Wörz, J. (2013). Non-price competitiveness of exports from emerging countries. European Central Bank Working Paper No. 1612, November.

Besedes, T., & Prusa, T. J. (2011). The Role of Extensive and Intensive Margins and Export Growth. *Journal of Development Economics*, 96(2), 371-379.

Bloningen, B.A., & Soderbery, A. (2010). Measuring the Benefits of Foreign Product Variety with an Accurate Variety Set. *Journal of International Economics*, 82, 168-180.

Broda, C., & Weinstein, D. E. (2006). Globalization and the Gains from Variety. *Quarterly Journal of Economics*, 121(2), 541-585.

Brunner, H.P., & Cali, M. (2006). The Dynamics of Manufacturing Competitiveness in South Asia: An Analysis through Export Data. *Journal of Asian Economics*, 17(4), 557-582.

Chaney, T. (2008). Distorted Gravity: The Intensive and Extensive Margins of International Trade. *American Economic Review*, 98(4), 1707-1721.

Chinn, M.D. (2006). A Primer on Real Effective Exchange Rates: Determinants, Overvaluation, Trade Flows and Competitive Devaluation. *Open Economies Review*, 17(1), 115-143.

Dennis, A., & Shepherd, B. (2007). Trade Costs, Barriers to Entry, and Export Diversification in Developing Countries. World Bank Policy Research Working Paper No. 4368.

Durand, M. (1986). Method of Calculating Effective Exchange Rates and Indicators of Competitiveness. OECD Economic Department Working Paper No. 29.

Durand, M., Simon, J., & Webb, C. (1992). OECD's Indicators of International Trade and Competitiveness. OECD Economic Department Working Paper No. 120.

Eaton, J., & Kortum, S. (2002). Technology, Geography, and Trade. *Econometrica*, 70(5), 1741-1779.

Feenstra, R. C. (1994). New Product Varieties and the Measurement of International Prices. *American Economic Review*, 84(1), 157-177.

Feenstra, R.C., & Romalis, J. (2012). International Prices and Endogenous Quality. National Bureau of Economic Research Working Paper No. 18314.

Felbermayr, G. J., & Kohler, W. (2006). Exploring the Intensive and Extensive Margins of World Trade. *Review of World Economics*, 142(4), 642-674.

Fu, X., Kaplinsky, R., & Zhang, J. (2012). The Impact of China on Low and Middle Income Countries, Export Prices in Industrial-Country Markets. *World Development*, 40(8), 1483-1496.

Galstyan, V., & Lane, P.R. (2008). External Imbalances and the Extensive Margin of Trade. *Economic Notes*, 37(3), 241-257.

Hallak, J.C., & Schott, P.K. (2011). Estimating Cross-Country Differences in Product Quality. *Quarterly Journal of Economics*, 129, 417-474.

Hummels, D., & Klenow, P.J. (2005). The Variety and Quality of a Nation's Exports. *American Economic Review*, 95(3), 704-723.

Imbs, J., & Mejean, I. (2012). Elasticity Optimism. (Unpublished results), May.

Leamer, E.E. (1981). Is it a Demand Curve, or is it a Supply Curve? Partial Identification through Inequality Constraints. *Review of Economics and Statistics*, 63(3), 319-327.

Loretan, M. (2005). Indexes of the Foreign Exchange Value of Dollar. *Federal Reserve Bulletin*, Winter.

McGuirk, A.K. (1987). Measuring Price Competitiveness for Industrial Country Trade in Manufactures. International Monetary Fund Working Paper No. 87/34.

Melitz, M.J. (2003). The Impact of Trade on Intra-Industry Reallocatioins and Aggregate Industry Productivity. *Econometrica*, 71(6), 1695-1725.

Mohler, L., (2009). On the Sensitivity of Estimated Elasticities of Substitution. FREIT Working Paper No. 38, March.

Pula, G., & Santabarbara, D. (2011). Is China Climbing up the Quality Ladder? Estimating Cross Country Differences in Product Quality Using Eurostat's Comext Trade Database. European Central Bank Working Paper No. 1310, March.

Romer, P.M. (1994). New Goods, Old Theory, and the Welfare Costs of Trade Restrictions. National Bureau of Economic Research Working Paper No. 4452.

Sato, K. (1976). The Ideal Log-Change Index Number. *Review of Economics and Statistics*, 58(2), 223-228.

Schmitz, M., De Clercq, M., Fidora, M., Lauro, B., & Punheiro, C. (2012). Revisiting the Effective Exchange Rates of the Euro. European Central Bank Occasional Paper Series No. 134.

Sheu, G. (2011). Price, Quality, and Variety: Measuring the Gains from Trade in Differentiated Products. (Unpublished results), US Department of Justice, September.

Soderbery, A (2010). Investigating the Asymptotic Properties of Import Elasticity Estimates. *Economics Letters*, 109(2), 57–62.

Soderbery, A. (2013). Estimating Import Supply and Demand Elasticities: Analysis and Implications. (Unpublished results), Department of Economics, Purdue University.

Spilimbergo, A., & Vamvakidis, A. (2003). Real Effective Exchange Rate and the Constant Elasticity of Substitution Assumption. *Journal of International Economics,* 60(2), 337-354.

Turner, P., & Van't dack, J. (1993). Measuring International Price and Cost Competitiveness. Bank for International Settlements Economic Paper No. 39.

Vartia, Y. O. (1976). Ideal Log-Change Index Numbers. *Scandinavian Journal of Statistics*, 3(3), 121-126.

Wickham, P. (1987). A Revised Weighting Scheme for Indicators of Effective Exchange Rates. International Monetary Fund Working Paper No. 87/87.

APPENDIX

A1 DECOMPOSITION OF INTENSIVE MARGIN

The changes of country k's exports of product j's share in total imports of a country i, $IM(i)_{jk,t}$, can be decomposed into two parts: changes of country k's export share in country i's imports of product j (1), and changes of country i's imports of product j's share in total country i's imports (2):

$$IM(i)_{jk,t} = \frac{P(i)_{jk,t}M(i)_{jk,t}}{P(i)_t M(i)_t}\frac{P(i)_{t-1}M(i)_{t-1}}{P(i)_{jk,t-1}M(i)_{jk,t-1}} = \tag{A1}$$

$$= \underbrace{\frac{P(i)_{jk,t}M(i)_{jk,t}}{P(i)_{j,t}M(i)_{j,t}}\frac{P(i)_{j,t-1}M(i)_{j,t-1}}{P(i)_{jk,t-1}M(i)_{jk,t-1}}}_{1} \times \underbrace{\frac{P(i)_{j,t}M(i)_{j,t}}{P(i)_t M(i)_t}\frac{P(i)_{t-1}M(i)_{t-1}}{P(i)_{j,t-1}M(i)_{j,t-1}}}_{2} .$$

The first order conditions of the consumer utility maximization problem (4)–(6) s.t. budget constraints are the following:

$$M(i)_{gc,t} = Q(i)_{gc,t}P(i)_{gc,t}^{-\sigma(i)_g}U(i)_t^{\frac{\sigma(i)_g}{\kappa(i)}}M(i)_t^{\frac{\sigma(i)_g}{\gamma(i)}-\frac{\sigma(i)_g}{\kappa(i)}}M(i)_{g,t}^{1-\frac{\sigma(i)_g}{\gamma(i)}}\lambda(i)_t^{-\sigma(i)_g} , \tag{A2}$$

where $\lambda(i)_t$ is Lagrange multiplier. By rearranging and summing over c one can obtain the following expression:

$$M(i)_{g,t} = P(i)_{g,t}^{-\gamma(i)}U(i)_t^{-\frac{\gamma(i)}{\kappa(i)}}M(i)_t^{1-\frac{\gamma(i)}{\kappa(i)}}\lambda_t^{\gamma(i)} . \tag{A3}$$

Using equation (A2), country k's export share in country i's imports of product j can be expressed as a function of product j's relative price and relative quality or taste:

$$\frac{P(i)_{jk,t}M(i)_{jk,t}}{P(i)_{j,t}M(i)_{j,t}} = \frac{Q(i)_{jk,t}P(i)_{jk,t}^{1-\sigma(i)_j}}{\sum_{c\in C}Q(i)_{jc,t}P(i)_{jc,t}^{1-\sigma(i)_j}} = Q(i)_{jk,t}\left(\frac{P(i)_{jk,t}}{P(i)_{j,t}}\right)^{1-\sigma(i)_j} , \tag{A4}$$

while the changes of country i's imports of product j in total country i's imports can be explained by the import price of product j relative to total import price:

$$\frac{P(i)_{j,t}M(i)_{j,t}}{P(i)_t M(i)_t} = \frac{P(i)_{j,t}^{1-\gamma(i)}}{\sum_{g\in G}P(i)_{g,t}^{1-\gamma(i)}} = \left(\frac{P(i)_{j,t}}{P(i)_t}\right)^{1-\gamma(i)} . \tag{A5}$$

From (A1), (A4) and (A5) follows that changes of country k's exports of product j's share in total imports of a country i is driven by changes in minimum unit-costs and changes in taste and quality parameters:

$$IM(i)_{jk,t} = \frac{\pi(i)_{jk,t}^{1-\sigma(i)_j}\left(Q(i)_{jk,t} / Q(i)_{jk,t-1}\right)}{\pi(i)_{j,t}^{1-\sigma(i)_j}} \frac{\pi(i)_{j,t}^{1-\gamma(i)}}{\pi(i)_{t}^{1-\gamma(i)}}. \tag{12}$$

A2 LOG-LINEAR APPROXIMATION OF MARKET SHARE DECOMPOSITION

The system of equations (1), (2), (16) and (18) has an unpleasant property to be a combination of sums and multiplications, which complicates the decomposition. For empirical applications it is more convenient to use log-linear approximation of the market share decomposition:

$$ms_{k,t} \approx em_{k,t} + pp_{k,t} + cc_{k,t} + qq_{k,t} + ds_{k,t}, \tag{A6}$$

where log changes of country k's market shares changes ($ms_{k,t}$) are defined as

$$ms_{k,t} = \ln\left(\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}\right) - \ln\left(\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t-1} M(i)_{gk,t-1}\right) - \tag{A7}$$

$$-\ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}\right) + \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}\right).$$

These are decomposed into five parts. Extensive margins of log changes of country k's market share changes, $em_{k,t}$, defined as:

$$em_{k,t} = \ln\left(\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}\right) - \ln\left(\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t-1} M(i)_{gk,t-1}\right) - \tag{A8}$$

$$-\ln\left(\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t} M(i)_{gk,t}\right) + \ln\left(\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t-1} M(i)_{gk,t-1}\right).$$

The remaining part (intensive margins) are further decomposed into price component of market shares' log changes, $pp_{k,t}$:

$$pp_{k,t} = \sum_{i\in I}\sum_{g\in G} \tilde{s}(i)_{k,t}^{X} \tilde{s}(i)_{gk,t}^{X} pp(i)_{gk,t} \tag{A9}$$

where $pp(i)_{jk,t} = \left(1-\sigma(i)_j\right)\ln\pi(i)_{jk,t} - \left(\gamma(i)-\sigma(i)_j\right)\sum_{c\in C(i)_j} w(i)_{jc,t}\ln\pi(i)_{jc,t} -$

$$-\left(1-\gamma(i)\right)\sum_{g\in G}\sum_{c\in C(i)_g} w(i)_{gc,t}\, w(i)_{g,t}\ln\pi(i)_{gc,t};$$

The competitors' set component of market shares' log changes, $cc_{k,t}$:

$$cc_{k,t} = \sum_{i\in I}\sum_{g\in G} \tilde{s}(i)_{k,t}^{X} \tilde{s}(i)_{gk,t}^{X} \frac{\gamma(i)-\sigma(i)_g}{1-\sigma(i)_g}\left(\ln\lambda(i)_{g,t} - \ln\lambda(i)_{g,t-1}\right) + \tag{A10}$$

$$+\sum_{i\in I}\widetilde{s}(i)^X_{k,t}\frac{(1-\gamma(i))w(i)_{g,t}}{1-\sigma(i)_g}\sum_{g\in G}\left(\ln\lambda(i)_{g,t}-\ln\lambda(i)_{g,t-1}\right);$$

The component of other non-price factors (taste and quality) of market shares' log changes, $qq_{k,t}$:

$$qq_{k,t}=\sum_{i\in I}\sum_{g\in G}\widetilde{s}(i)^X_{k,t}\widetilde{s}(i)^X_{gk,t}qq(i)_{gk,t}+ \tag{A11}$$

$$+\sum_{i\in I}\sum_{g\in G}\widetilde{s}(i)^X_{k,t}\widetilde{s}(i)^X_{gk,t}\frac{\sigma(i)_g-\gamma(i)}{1-\sigma(i)_g}\left(\ln\lambda(i)_{g,t}-\ln\lambda(i)_{g,t-1}\right)+$$

$$+\sum_{i\in I}\widetilde{s}(i)^X_{k,t}\frac{(\gamma(i)-\sigma(i)_g)w(i)_{g,t}}{1-\sigma(i)_g}\sum_{g\in G}\left(\ln\lambda(i)_{g,t}-\ln\lambda(i)_{g,t-1}\right),$$

where $qq(i)_{gk,t}=\ln\mu(i)_{gk,t}-\sum_{g\in G}\sum_{c\in C(i)_g}w(i)_{gc,t}w(i)_{g,t}\ln\mu(i)_{gc,t}+\sigma(i)_j\ln\pi(i)_{jk,t}+$

$$+\left(\gamma(i)-\sigma(i)_j\right)\sum_{c\in C(i)_j}w(i)_{jc,t}\ln\pi(i)_{jc,t}-\gamma(i)\sum_{g\in G}\sum_{c\in C(i)_g}w(i)_{gc,t}w(i)_{g,t}\pi(i)_{gc,t};$$

And finally, the demand structure component of market shares' log changes, $ds_{k,t}$:

$$ds_{k,t}=\sum_{i\in I}\widetilde{s}(i)^X_{k,t}ds(i)_t\,, \tag{A12}$$

where $ds(m)_t=\ln\left(\sum_{c\in C}\sum_{g\in G}P(m)_{gc,t}M(m)_{gc,t}\right)-\ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t}M(i)_{gc,t}\right)-$

$$-\ln\left(\sum_{c\in C}\sum_{g\in G}P(m)_{gc,t-1}M(m)_{gc,t-1}\right)+\ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t-1}M(i)_{gc,t-1}\right).$$

Weights $\widetilde{s}(i)^X_{gk,t}$ and $\widetilde{s}(i)^X_{k,t}$ are defined as a Tornquist shares of country k's export structure:

$$\widetilde{s}(i)^X_{gk,t}=0.5s(i)^X_{gk,t}+0.5s(i)^X_{gk,t-1}; \tag{A13}$$

$$\widetilde{s}(i)^X_{k,t}=0.5s(i)^X_{k,t}+0.5s(i)^X_{k,t-1}.$$

A3 ELASTICITIES OF SUBSTITUTION BETWEEN VARIETIES

We estimate elasticities of substitution between varieties according to the methodology proposed by Feenstra (1994) and later applied by Broda and Weinstein (2006). To derive the elasticity of substitution, one needs to specify both demand and supply equations. The demand equation is defined by re-arranging the minimum unit-cost function from (7) in terms of market share, taking first differences and ratios to a reference country l:[22]

$$\Delta\ln\frac{s(i)^{M}_{gc,t}}{s(i)^{M}_{gl,t}}=-(\sigma(i)_g-1)\Delta\ln\frac{P(i)_{gc,t}}{P(i)_{gl,t}}+\varepsilon(i)_{gc,t}, \tag{A14}$$

where $\varepsilon(i)_{gc,t} = \Delta\ln Q(i)_{gc,t} + \xi(i)_{gc,t}$, and $\xi(i)_{gc,t}$ is an error term (due to e.g. measurement error) in the demand equation. Following Feenstra (1994) and Broda and Weinstein (2006) we treat $\varepsilon(i)_{gc,t}$ as an unobserved random variable, reflecting changes in the quality of product variables. Note, that $Q(i)_{gc,t}$ reflects fundamental characteristics of a particular variety and should be treated as exogenous.[23]

The export supply equation relative to country l is given by:

$$\Delta\ln\frac{P(i)_{gc,t}}{P(i)_{gl,t}}=\frac{\omega(i)_g}{1+\omega(i)_g}\Delta\ln\frac{s(i)^{M}_{gc,t}}{s(i)^{M}_{gl,t}}+\delta(i)_{gc,t}, \tag{A15}$$

where $\omega(i)_g \geq 0$ is the inverse supply elasticity assumed to be the same across partner countries, and $\delta(i)_{gc,t}$ is an error term of supply equation which is assumed to be independent of $\varepsilon(i)_{gc,t}$.

A nasty feature of the system of (A14) and (A15) is the absence of exogenous variables to identify and estimate elasticities. By rearranging (A14) and (A15) one can get the following system[24] that clearly cannot be estimated:

$$\Delta\ln\frac{P(i)_{gc,t}}{P(i)_{gl,t}}=\frac{\omega(i)_g}{1+\omega(i)_g\sigma(i)_g}\left(\Delta\ln Q(i)_{gc,t}+\xi(i)_{gc,t}\right)+\frac{1+\omega(i)_g}{1+\omega(i)_g\sigma(i)_g}\delta(i)_{gc,t},$$

$$\Delta\ln\frac{s(i)^{M}_{gc,t}}{s(i)^{M}_{gl,t}}=-\frac{(1-\omega(i)_g)(\sigma(i)_g-1)}{1+\omega(i)_g\sigma(i)_g}\delta(i)_{gc,t}+\frac{1+\omega(i)_g}{1+\omega(i)_g\sigma(i)_g}\left(\Delta\ln Q(i)_{gc,t}+\xi(i)_{gc,t}\right).$$

To get the estimates, we transform the system of two equations into a single equation by exploiting the insight of Leamer (1981) and the independence of errors $\varepsilon(i)_{gc,t}$ and $\delta(i)_{gc,t}$.[25] This

[22] Although the choice of l could be arbitrary in theory, Mohler (2009) shows that estimates are more stable if the dominant supplier (country exporting the respective product for the most time periods) is chosen.

[23] Equation (15) states that one can proxy $Q(i)_{gc,t}$ by other variables, but it does not state the type of dependence.

[24] Here we can see why the positive correlation appears between the quality or taste parameter and the price, as well as between the quality or taste parameter and the nominal trade share. It is due to the fact that price and market share depend on quality or taste, not vice versa.

[25] The independence assumption relies on the assumption that taste and quality does not enter the residual of the relative supply equation ($\delta(i)_{gc,t}$). If this does not hold, then errors are not independent, since changes in taste and quality enter $\varepsilon(i)_{gc,t}$. The assumption of the irrelevance for the supply function seems realistic for taste (if we ignore the possibility that taste is manipulated by advertisement; however, advertisement costs can be viewed as fixed, which should reduce the correlation with the error term). But it is difficult to argue that changes in physical quality of a product should not affect the $\delta(i)_{gc,t}$. The empirical literature did not address this issue until now and the size of induced bias is unclear.

is done by multiplying both sides of the equations. After transformation, the following equation is obtained:

$$\left(\Delta \ln \frac{P(i)_{gc,t}}{P(i)_{gl,t}}\right)^2 = \theta_1 \left(\Delta \ln \frac{s(i)^M_{gc,t}}{s(i)^M_{gl,t}}\right)^2 + \theta_2 \left(\Delta \ln \frac{P(i)_{gc,t}}{P(i)_{gl,t}}\right)\left(\Delta \ln \frac{s(i)^M_{gc,t}}{s(i)^M_{gl,t}}\right) + u(i)_{gc,t}, \qquad \text{(A16)}$$

where

$$\theta_1 = \frac{\omega(i)_g}{\left(1+\omega(i)_g\right)\left(\sigma(i)_g - 1\right)};\ \theta_2 = \frac{1-\omega(i)_g\left(\sigma(i)_g - 2\right)}{\left(1+\omega(i)_g\right)\left(\sigma(i)_g - 1\right)};$$

$$u(i)_{gc,t} = \varepsilon(i)_{gc,t}\delta(i)_{gc,t}.$$

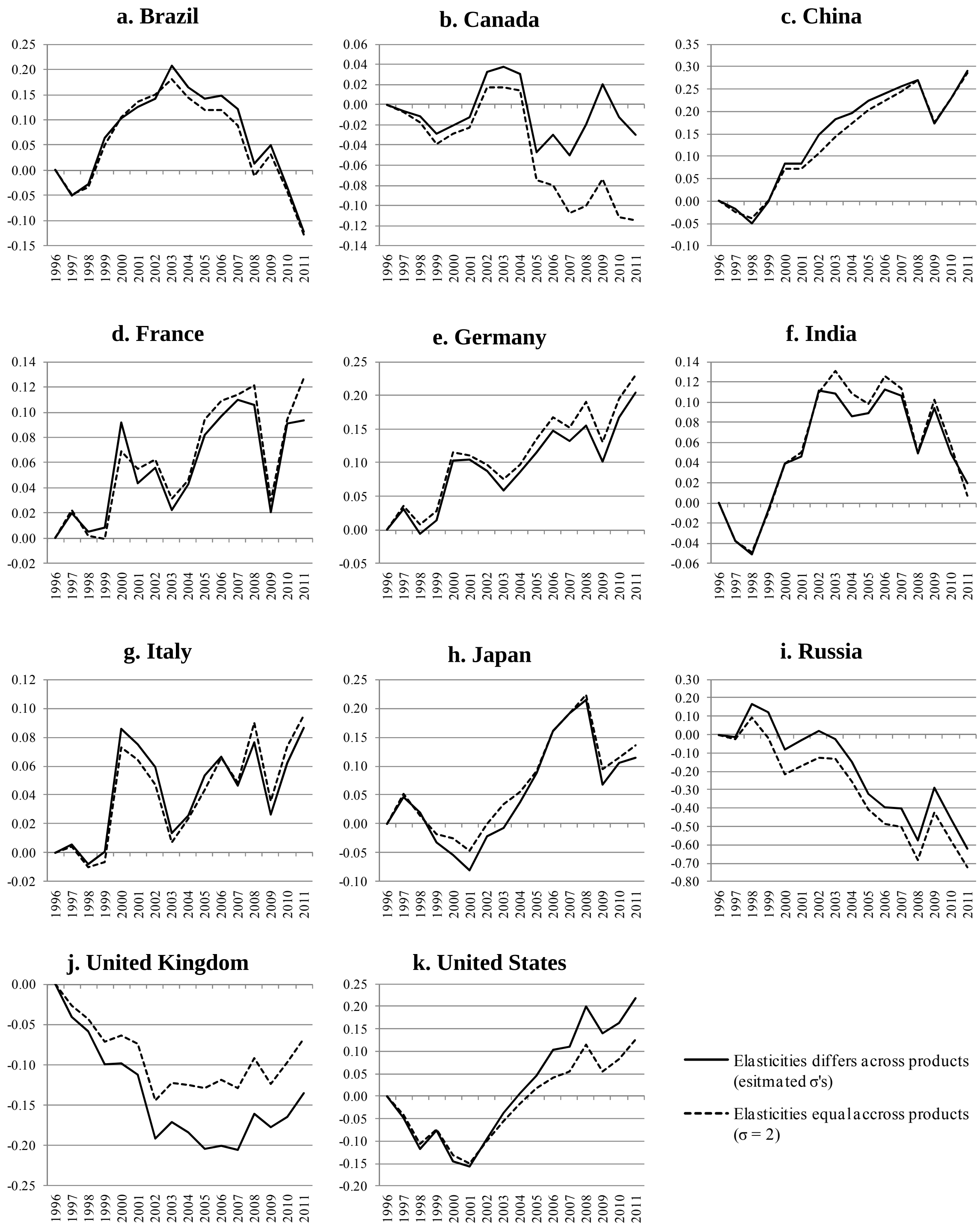
Note that the evaluation of θ_1 and θ_2 leads to inconsistent estimates, as relative price and relative market share are correlated with the error $u(i)_{gc,t}$. Broda and Weinstein (2006) argue that it is possible to obtain consistent estimates by exploiting the panel nature of data and define a set of moment conditions for each good *g*. If estimates of elasticities are imaginary or of the wrong sign the grid search procedure is implemented. Broda and Weinsten (2006) also address the problem of measurement error and heteroskedasticity by adding a term inversely related to the quantity and weighting the data according to the amount of trading flows. A recent paper by Soderbery (2010, 2013), however, reports that this methodology generates severely biased elasticity estimates (median elasticity of substitution is overestimated by over 35%). Soderbery (2010, 2013) proposes the use of a Limited Information Maximum Likelihood (LIML) estimator instead. Where estimates of elasticities are not feasible ($\hat{\theta}_1$<0), nonlinear constrained LIML is implemented. Monte Carlo analysis performed by Soderbery (2010, 2013) demonstrates that this hybrid estimator corrects small sample biases and constrained search inefficiencies. It further shows that Feenstra's (1994) original method of controlling measurement error with a constant and correcting for heteroskedasticity by the inverse of the estimated residuals performs well. We thus follow Soderbery (2010, 2013) and use hybrid estimator combining LIML with a constrained nonlinear LIML to estimate elasticities of substitution between varieties using the Feenstra's (1994) method.

Table A1 Elasticities of substitution between varieties (top 20 importers)

	No. of estimated elasticities	Mean	Minimum	Maximum	25th percentile	**Median**	75th percentile
United States	3725	19.97	1.0010	6442	1.64	**2.00**	3.13
China	3951	26.33	1.0021	46325	1.74	**2.23**	3.53
Germany	4708	13.39	1.0037	41612	1.68	**2.01**	2.83
Japan	4126	6.41	1.0015	3038	1.65	**2.08**	3.04
France	4899	4.75	1.0022	3698	1.68	**2.03**	2.84
United Kingdom	4846	7.70	1.0014	12862	1.63	**1.95**	2.74
Italy	4861	7.32	1.0029	7908	1.65	**2.02**	2.86
Korea	4260	17.55	1.0012	36421	1.69	**2.22**	3.35
Hong Kong (China)	3243	48.16	1.0016	75165	1.80	**2.49**	5.00
Netherlands	4126	24.31	1.0016	64064	1.69	**2.15**	3.25
Belgium	4679	10.24	1.0021	22747	1.73	**2.20**	3.41
India	3610	28.20	1.0032	21899	1.85	**2.66**	5.54
Canada	3308	29.33	1.0073	17279	1.83	**2.51**	4.91
Singapore	2823	45.70	1.0010	49488	1.79	**2.55**	5.76
Spain	4776	8.18	1.0011	16343	1.68	**2.07**	2.98
Mexico	3664	12.08	1.0010	1113	1.69	**2.17**	3.38
Russia	4070	5.84	1.0052	1617	1.68	**2.11**	3.10
Turkey	4000	18.15	1.0035	38896	1.69	**2.21**	3.46
Australia	2698	6.31	1.0014	1935	1.75	**2.27**	3.56
Thailand	3497	47.67	1.0020	68239	1.77	**2.48**	4.76

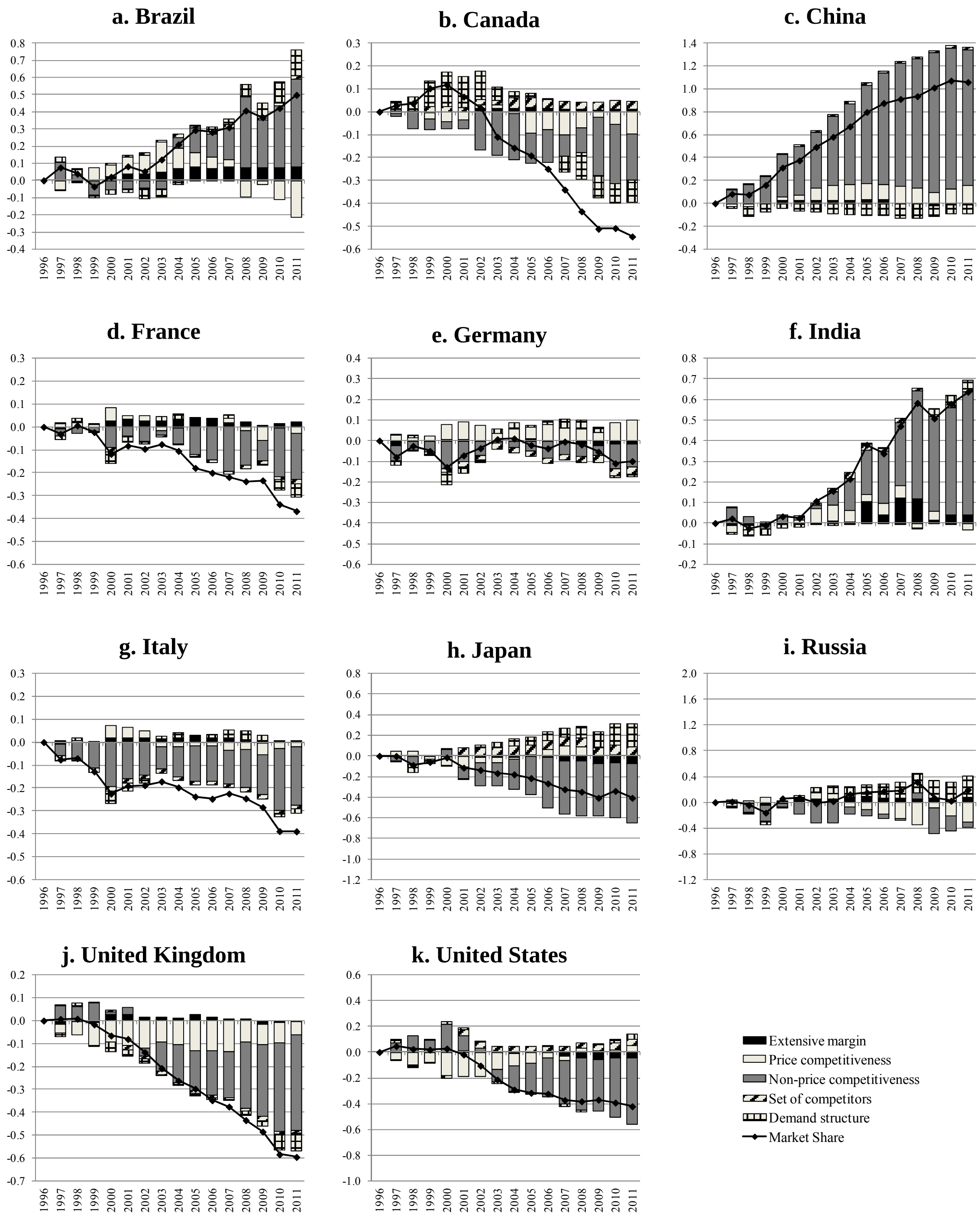
Note: Calculated using UN Comtrade data for disaggregated imports of 188 countries using equation (A16).

Chart A1 Contribution of price competitiveness to changes in market shares: aggregated versus disaggregated approach



Note: Calculated using UN Comtrade data for disaggregated imports of 188 countries using equations (A9) and (19), elasticities of substation between varieties are estimated using equation (A16), elasticity of substitution between products assumed to be equal to 2.

Chart A2 Decomposition of export market share changes excluding mineral products



Note: Calculated using UN Comtrade data for disaggregated imports of 188 countries using equations (A6)-(A13), elasticities of substitution between varieties are estimated using equation (A16), elasticity of substitution between products assumed to be equal to 2. The sum of contributions is not equal to the total changes in export market shares due to log linearization and missing unit values data.

Chart A3 Decomposition of export market share changes with different assumptions for elasticity of substitution between products (γ)

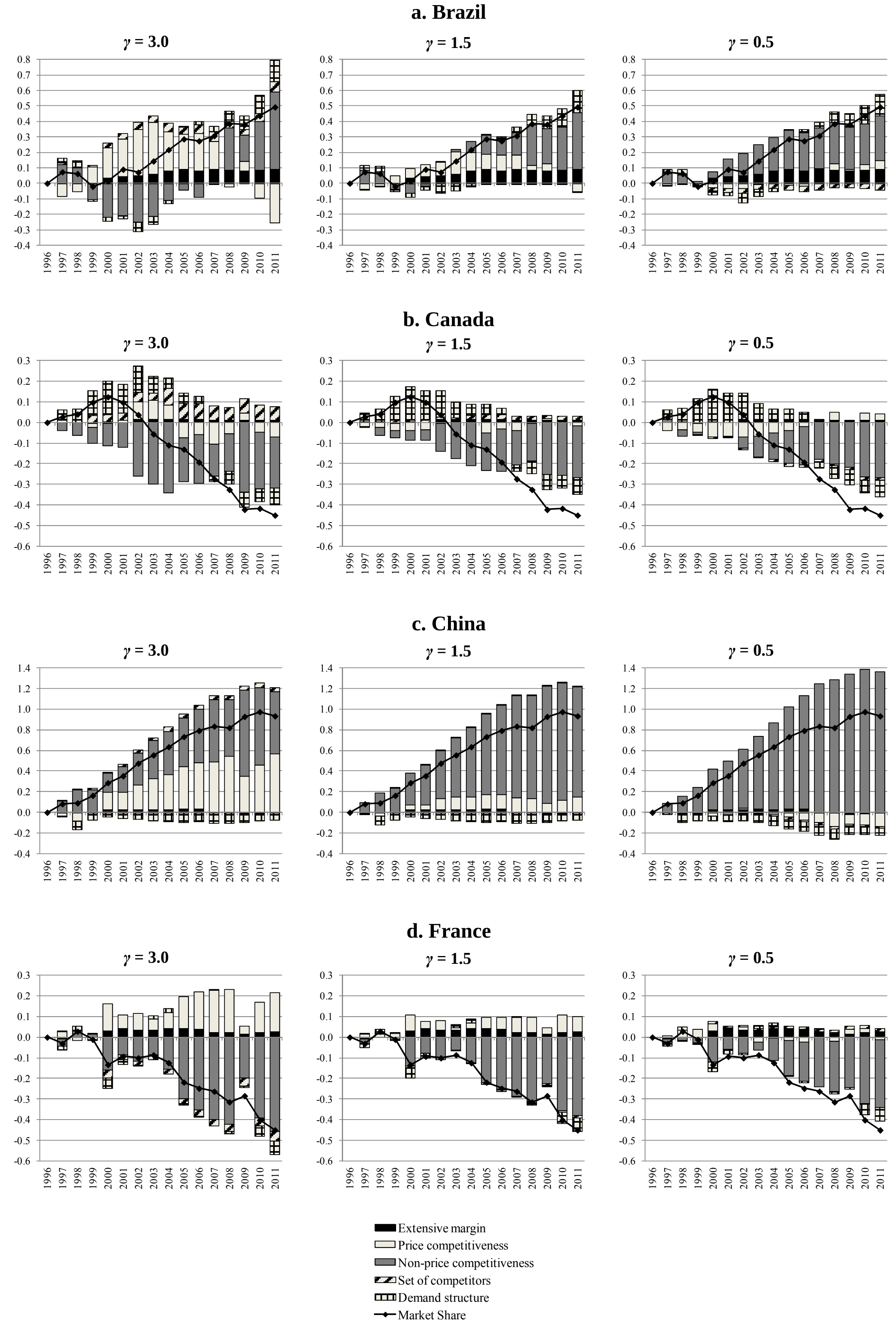


Chart A3 (cont) Decomposition of export market share changes with different assumption for elasticity of substitution between products (γ)

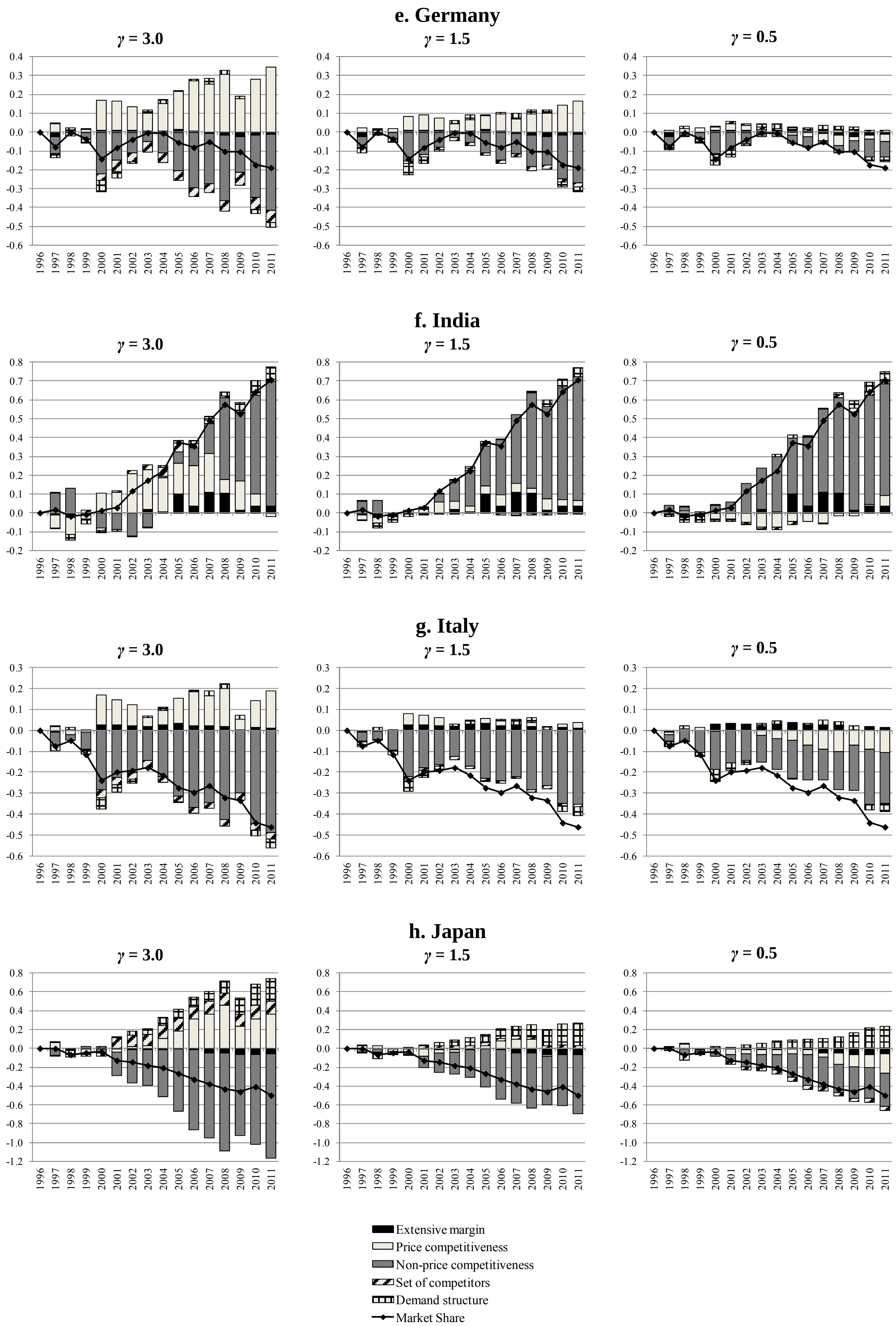
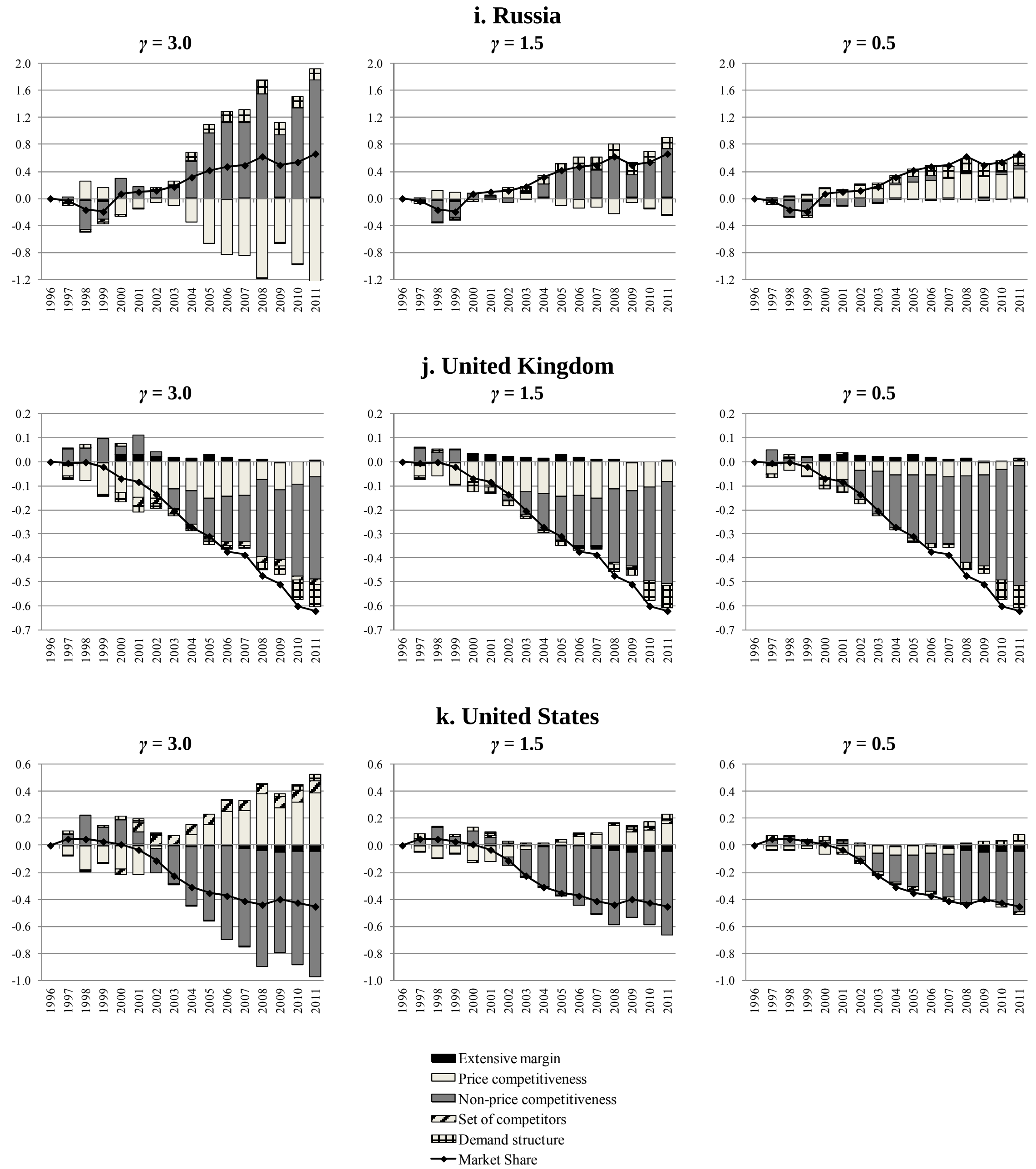


Chart A3 (cont) Decomposition of export market share changes with different assumptions for elasticity of substitution between products (γ)



Note: Calculated using UN Comtrade data for disaggregated imports of 188 countries using equations (A6)-(A13), elasticities of substitution between varieties are estimated using equation (A16). The sum of contributions is not equal to the total changes in export market shares due to log linearization and missing unit values data.