Made in China: How Much Does it Affect Measures of Competitiveness?

PRELIMINARY VERSION – DECEMBER 2013

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Abstract

We propose a comprehensive measure of a country's overall competitiveness which accounts for price, non-price and other factors such as changes in the value added content of trade by combining two datasets – highly disaggregated trade data from UN COMTRADE with internationally integrated Supply and Use Tables from the WIOD database. We conclude that advanced economies have lost non-price competitiveness relative to emerging economies over the period 1995 to 2009 when focussing on gross exports. As soon as fragmentation of production is considered, this picture changes. We find that in particular the US, Canada, Germany and Italy have been able to keep relative quality of their export goods unchanged. Likewise, relative quality improvement of Brazil's, Russia's and India's export goods largely arose due to outsourcing rather than improvements in the quality of domestic production. Nevertheless, gains in Chinese non-price competitiveness remain impressive even after accounting for the role of global value chains (GVCs).

Keywords: value added content of trade, fragmentation, non-price competitiveness, China, BRIC, G7
JEL-codes: C43, F12, F15, L15, O47

1 Introduction

The competitiveness of an economy is a widely discussed and at the same time unclearly defined concept. The definition of competitiveness at the country level is so broad that it includes an extremely large set of macroeconomic and microeconomic issues: per capita income levels, performance of institutions, levels of productivity, comparative costs, and many others not mentioned here. It is usual to limit the analysis of competitiveness to export performance based on exports as an indicator that is well able to "reveal" a country's underlying comparative advantages. Furthermore, trade data have traditionally been characterized by being easily available, of good quality and reported at a highly disaggregated level which allows to analyse dynamics of market shares, extensive and intensive margins, unit values etc. As a consequence, the most common definition of competitiveness is narrowed down to reflecting a country's ability to sell goods measured in gross terms rather than in value added terms (which would correspond to the common measurement of domestic output via GDP). While we do not dispute that competitiveness should reflect a country's competence in producing goods for the world market – in line with the OECD's definition: "Competitiveness is a measure of a country's advantage or disadvantage in selling its products in international markets" – we claim that this competence should be measured in value added terms, i.e. net of foreign value added embodied in intermediate inputs.

Otherwise, such an approach would ignore both the increasing global integration of production and shifts in geographical patterns of production chains. In an economically integrated world characterized by global production chains, the following issues obtain crucial importance for a correct assessment of competitiveness: how big is the country's value added share in the products it sells in international markets? What happens to country's competitiveness if its value added share changes over time as a result of changes in international fragmentation? Some recent case studies suggest that share of domestic value added could be very small for certain countries and certain products (see for example the famous iPod example analysed by Linden et al., 2009). Internationalization of production leads to a diminishing domestic component in the production of exports. Therefore data on (gross) export flows is no more an adequate representative of a country's own ability to produce goods for the world market and hence competitiveness.[1] Our approach in this paper makes an attempt to overcome this problem by combining data from two sources. Similar to traditional analyses, we also make full use of highly disaggregated trade data as summarized for all countries and all products in the UN Comtrade database. We extract export data at the most detailed 6-digit HS level, thus our analysis is based on more than 5,000 products for each possible pair of trading partners in the world. However, we make further use of the recently constructed World Input-Output database (WIOD, see Timmer et al., 2012), which covers 27 EU countries and 13 other major countries in the world for the period from 1995 to 2009. By combining the two, we are able to assess the impact of global value chains (GVCs) on competitiveness. Our approach has several advantages: similar to traditional analyses of

[1] A more philosophical question relates to the ability of a country to engage in international production chains, which can also be seen as a country's own achievement in terms of competitiveness. Nevertheless, from a welfare point of view, the value added produced in the country is relevant, hence we consider the value-added concept of competitiveness adopted in this paper as the appropriate concept for the derivation of policy recommendations.

competitiveness we also derive a comprehensive index of competitiveness. Thus, we arrive at a simple tool that can easily be used to inform policy makers on changes in a country's competitiveness over time and its standing relative to its competitors. However, unlike traditional measures, our index is not a black box but yields by construction a decomposition of overall competitiveness into individual contributions from underlying factors. We distinguish between price and non-price factors, extensive margin, shifts in global demand structure, changes in the set of competitors and shifts in global production chains.

Our starting point is the decomposition of export market share changes recently developed by Benkovskis and Wörz (2013). The abovementioned paper proposes a theoretical framework to explain gains and losses in export market share by their price and non-price determinants. According to the empirical analysis, non-price factors (e.g. quality and taste) play the dominant role in explaining the competitive gains of BRIC countries and the concurrent decline in the G7's share of world exports. Although the indicator is a useful tool to measure a country's non-price competitiveness, it can be significantly affected by shifts in international production chains. Imagine the situation when the final assembly of a high-quality product is moved from US to China. The trade data will report a significant increase in China's exports, both in value and volume terms accompanied by a growing export price. Despite a very low domestic value added content in the production of China's exports of the high-quality product this situation will be interpreted as a rise in China's non-price competitiveness and decline in the US non-price competitiveness. This may lead to wrong policy conclusions while our index makes such shifts in national value-added explicit.

The paper proceeds as follows: Section 2 motivates the use of two data sources in analysing competitiveness and discusses virtues and drawback of each source. Section 3 describes the methodology in detail, while section 4 reports the results and section 5 concludes.

2 Joining two data sources – why and how?

Joining trade data with input-output data is not new in the literature. For example, various vintages of the Global Trade Analysis Project (GTAP) database contain country input-output tables and bilateral international trade data by industry for several benchmark years, with the latest database offering data for 129 regions, 57 commodities and two reference years, 2004 and 2007 (Narayanan et al., 2012). Daudin et al. (2011), Johnson and Noguera (2012), and Koopman et al. (2010) use this data to measure value-added trade. The more recently established World Input-Output Database (WIOD) combines information from national supply and use tables, National Accounts time series on industry output and final use, and bilateral trade in goods and services for a 40 countries, 59 commodities and over a time-series from 1995 to 2009 (see Timmer et al., 2012 for more details). We will make use of this dataset, even though our paper differs substantially from both approaches. In short, we combine WIOD data despite its high level of aggregation with bilateral commodity trade data on the most disaggregate level. This is similar to Koopman et al. (2010) who also use the most detailed level of disaggregation to identify intermediate goods; however, we do it for a different reason. We need disaggregate trade data to interpret unit values as prices of cross-border transactions.

There is another distinction between our paper and the vast literature on vertical specialisation: disaggregated trade data remains our main source of information, while input-output data serves as a useful extension. We want to retain the numerous virtues of very detailed commodity trade data – high degree of harmonization across countries, timeliness, world-wide coverage, availability of price information (unit values) – as these features make disaggregated trade data a natural choice for the assessment of a country's competitiveness. Our recently proposed decomposition of changes in export market shares (see Benkovskis and Wörz, 2013) is based on UN Comtrade data using the six-digit level of the Harmonized System (HS) introduced in 1996 (5,132 products). The import dataset contains annual data on imports of 188 countries from 236 countries between 1996 and 2011.[2]

The use of highly detailed trade data allows to disentangle price and non-price drivers of export market share changes; however, the use of trade data also implies several limitations. One of those is the disregard of international production fragmentation, which may alter the assessment of a country's performance on external markets dramatically. The WIOD data, although available for a considerably smaller set of countries (40 countries, including all EU-27 members), a much lower level of disaggregation (59 products according to CPA classification), and a significant time lag (offering only annual data between 1995 and 2009), can fill this gap.

The data from WIOD gives us an opportunity to calculate the share of country k in the production of good g exported by country c using the inverse Leontieff transformation, which

[2] Since our theoretical framework is developed from consumer's utility maximization problem we analyse changes in export market shares using information on import data of partner countries. This has the further advantage that import data is often better reported, especially since the majority of world imports is still flowing into advanced economies with better reporting systems.

allows to switch from gross export market share changes (decomposed in Benkovskis and Wörz, 2013) to value-added export market share changes. Thus, we will be able to infer something about the performance of domestic producers (not exporters) on external markets, which should improve our understanding of strong and weak sides of a country.

The lower level of disaggregation in WIOD imposes some difficulties, however, and we need to assume an equal structure of value added for all HS 6-digit level products within a broad CPA category. This is a very strong assumption, but we have no other options for a broad analysis on a macro level. Another limitations is the lower country coverage (now calculations can be done for 40 exporter and producer countries instead of 236), but this is an acceptable limitation for us as we are primarily interested in the competitiveness of the world's major exporters, and especially in the performance of EU members which are fully covered in WIOD. A final limitation is given by the time dimension as WIOD data ends at 2009 (which, perhaps, was not the most typical year in the economic history). In normal times, one can assume that global production structures do not change much within a few years. Thus, we will also make this assumption.

3 Comprehensive, GVC-compatible index of competitiveness

This section describes the methodology to evaluate the performance of a country's producers on external markets, which is largely built on our recently developed decomposition of changes in gross export market shares (see Benkovskis and Wörz, 2013, see Appendix, section A.1, for a brief description of decomposition). We extend this approach to include also the effects of international fragmentation of production in the decomposition. We first distinguish between gross export market shares and the global market share of value-added exports. Second, we split changes in market shares of value-added exports into six components (instead of five as in Benkovskis and Wörz, 2013): extensive margin, price competitiveness, non-price competitiveness, change in the set of competitors, shifts in demand structure, and a new term which captures shifts in a country's integration in global production chains.

3.1. Value-added export market share

The international fragmentation of production changed the nature of the international economy dramatically and gross exports are no longer a valid indicator of a country's competitiveness. In the majority of cases, the goods exported by a specific country are only partly produced domestically, but sometimes the fraction of domestic value added is very small. This calls for a refined indicator which is able to capture competitiveness-relevant features of the ongoing fragmentation process. In this paper, we propose to focus on market shares of value-added exports, i.e. gross exports corrected for the fraction of foreign value added.

Hummels et al. (2001) provide one of the first systematic evidences on vertical specialisation and measure the value of imported inputs embodied in exported goods. This approach misses an important part of vertical specialisation chain, however, as one country's exports may be used as inputs into another country's production of export goods. Recently, Daudin et al. (2011), Johnson and Noguera (2012), and Koopman et al. (2010) proposed new approaches to assess value-added trade.

Two important measures introduced by Koopman et al. (2010) are worth being mentioned here. The first one is called "value added in gross exports" (*VAS*, closely related to value added in trade, as named by Stehrer, 2012) that simply decomposes gross exports by producers:

$$VAS = V \cdot B \cdot X = V \cdot (\mathrm{I} - A)^{-1} \cdot X, \tag{1}$$

$$V \equiv \begin{bmatrix} V_1 & 0 & \cdots & 0 \\ 0 & V_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & V_K \end{bmatrix}, \quad V_r \equiv u\left(\mathrm{I} - \sum_s A_{sr}\right), \quad X \equiv \begin{bmatrix} diag(X_1) & 0 & \cdots & 0 \\ 0 & diag(X_2) & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & diag(X_K) \end{bmatrix},$$

where *VAS* is $K \times KN$ matrix that provide disaggregated value added by producer country in gross exports for each exporting country and sector, K is the number of countries and N is number of sectors. V is $K \times KN$ block-diagonal matrix, V_r is $1 \times N$ direct value-added coefficient vector and each element gives the share of direct domestic value added in total output of country r in each sector ($r = 1,..., K$). Input-output coefficients are comprised in the $KN \times KN$ matrix A, which is constructed from the $N \times N$ blocks A_{rs}. Those blocks contain information on intermediate use by country s of the goods produced in country r. X is a $KN \times KN$ diagonal matrix of gross exports, and X_r is a $N \times 1$ vector of country r's exports by sector. Finally, B is the Leontieff inverse matrix $B = (\mathrm{I} - A)^{-1}$, and u is a $1 \times N$ unity vector. So, the *VAS* measure captures all upstream sectors' contributions to value added in gross exports.

The second measure is termed "value-added exports" (*VAX*). It is closely related to value added in gross exports (*VAS*), but differs insofar as it reflects how a country's exports are used by importers. As defined by Koopman et al. (2010, p.9), value-added exports "... is the value-added generated by a country but absorbed by another country". This is given by:

$$VAX = \hat{V} \cdot B \cdot Y = \hat{V} \cdot (\mathrm{I} - A)^{-1} \cdot Y, \qquad (2)$$

$$\hat{V} \equiv \begin{bmatrix} \hat{V}_1 & 0 & \cdots & 0 \\ 0 & \hat{V}_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \hat{V}_K \end{bmatrix}, \quad \hat{V}_r \equiv diag(V_r),$$

where VAX is $K \times KN$ matrix that provides disaggregated value added by producer country in final consumption for each country and each sector. Y is the $KN \times K$ final demand matrix. It contains blocks Y_{sr}, which is the $N \times 1$ final demand vector that gives demand in country r for final goods shipped from country s.

Although similar, the two indicators (*VAS* and *VAX*) give slightly different results, as *VAS* focuses on gross exports – thus including exports and intermediate goods and therefore double-counting some value-added activities – while *VAX* focuses on final use, including the a country's demand for its own production (which is given by the diagonal element of *VAX;* Koopman et al., 2010, suggest that these elements should be replaced by zero).

Despite these rather clear conceptual underpinnings, we face a difficult choice in the empirical implementation: Should we use highly detailed trade data (i.e. rely on *VAS*) or more aggregated, but double-accounting-free final demand data (basing our indicator on *VAX*). The main advantage when using data on gross export flows available from commodity trade statistics is that we can work with detailed trade data, which allows us to get information on prices (unit values) and volumes. This information allows us to identify the contribution of price and non-price factors for the overall performance of value-added exports (similar to Benkovskis and Wörz, 2013). Obvious drawbacks of this choice are the complete lack of data on trade in services on the one hand and double-counting due to exports of intermediate products on the other hand. In contrast, with final demand data we avoid the double-counting problem and we can include information on services. However, we will not be able to study price and non-price contributions due to the lack of detailed price and volume data.

In this paper we propose to use the *VAS* indicator from equation (1), although we modify it such that we avoid double-counting. Double-counting occurs when a country provides value added in exports of intermediate products that are used in the production of other (final) export goods. We presume that this problem can be avoided by analysing only gross exports of final use products. Since we obtain trade data at a very fine level of disaggregation, we can exclude exports of intermediate products (according to the BEC classification) and focus on products for final use. Still, final use of domestic goods and of services is missing. However, this does not imply that service sectors are excluded from the analysis as such, as we will assess an indirect value-added of services sectors in final use of commodities.

Summarizing the discussion above, in building our comprehensive index we propose to solve the problem of international fragmentation by relying on a country k's market share changes in terms of value added in gross exports of final use products (VASF) rather than gross exports. Thus, we make use of the advantage of the *VAS* index insofar as we use highly disaggregated trade data for both, values and quantities to distinguish between price and non-price factors. At the same time we avoid double counting by ignoring intermediate goods. Thus, our measure of value added market share is defined as follows:

$$MS_{k,t}^{VASF} = \frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}}{\sum_{v\in C}\sum_{i\in I}\sum_{g\in G}\sum_{c\in C} P(i)_{gc,t} M(i)_{gc,t} V(v)_{gc,t}} = \frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}}, \tag{3}$$

where $MS_{k,t}^{VASF}$ is VASF market share of a country k, i is a running index for importing countries, g denotes the final use product, c the exporting country and v stands for value-added contributing countries. $M(i)_{gc,t}$ represents the quantity of country i's final goods imports from exporting country c (or country c's final gods exports to country i), while $P(i)_{gc,t}$ is the price of the respective trade flow. $V(k)_{gc,t}$ stands for the share of country k in the production of a specific good g exported by country c. Note, that $V(k)_{gc,t}$ includes both direct and indirect contributions of country k. The $V(k)_{gc,t}$ is evaluated as an element of $V\cdot(\mathrm{I}-A)^{-1}$ from equation (1) assuming that the value-added structure of country c's final exports does not depend on the respective destination. As mentioned in section 2, $V(k)_{gc,t}$ is calculated from the WIOD database by assuming identical value added structure of all final use products g in the HS 6-digit classification falling within the same CPA category. Finally, I, G and C are the sets of importing countries, final use products, and exporting countries respectively whereby the latter set coincides with the set of producing countries. Therefore, the numerator of (1) shows the value-added of country k in total world's exports of final products, while the denominator represents total world exports of final goods.

3.2. Intensive and extensive margins

Having derived a country k's world market share in value added terms, we then follow the framework of Benkovskis and Wörz (2013) and split changes in these market shares into the contributions arising from the extensive and the intensive margin:

$$dMS_{k,t}^{VASF}=\frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t}M(i)_{gc,t}V(k)_{gc,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t}M(i)_{gc,t}}\frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t-1}M(i)_{gc,t-1}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t-1}M(i)_{gc,t-1}V(k)_{gc,t-1}}=dEM_{k,t}^{VASF}\times dIM_{k,t}^{VASF}, \tag{4}$$

$$dEM_{k,t}^{VASF}=\frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t}M(i)_{gc,t}V(k)_{gc,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}}P(i)_{gc,t}M(i)_{gc,t}V(k)_{gc,t}}\frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}}P(i)_{gc,t-1}M(i)_{gc,t-1}V(k)_{gc,t-1}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t-1}M(i)_{gc,t-1}V(k)_{gc,t-1}},$$

$$dIM_{k,t}^{VASF}=\frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}}P(i)_{gc,t}M(i)_{gc,t}V(k)_{gc,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t}M(i)_{gc,t}}\frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G}P(i)_{gc,t-1}M(i)_{gc,t-1}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}}P(i)_{gc,t-1}M(i)_{gc,t-1}V(k)_{gc,t-1}},$$

where $dEM_{k,t}^{VASF}$ denotes extensive margin of the value added in gross exports of final goods market share changes, $dIM_{k,t}^{VASF}$ the intensive margin, $G(i)_{c,t,t-1}$ is the set of products shipped from country c to country i in both periods, t and t–1.

The extensive margin equation is similar to Feenstra's (1994) index accounting for changes import variety, although it is redefined for the value-added case. The extensive margin is defined in our case as the ratio of country k's value added in traditional products to total value-added exports. Value added in traditional products is the value added in products exported by any country to any destination market in both periods t and t–1. The ratio decreases (increases) over time if the share of value added in disappeared products is smaller (greater) than the share of value added in newly exported products. In this case, the contribution of the extensive margin to changes in VASF market share is positive (negative). The intensive margin is obtained as the residual and simply represents the growth of country k's value added in traditional products compared to growth of total world trade.

3.3. Further decomposition of the intensive margin

We then proceed by decomposing the intensive margin into four factors: price-, and non-price-factors, the effect of changes in the set of competitors and shifts in production chains. This is done by solving the consumer utility maximization problem of the importing country as in Broda and Weinstein (2006, see Appendix, section A.2 for technical details):

$$dIM(i)_{k,t}^{VASF}=\underbrace{PP(i)_{k,t}^{VASF}}_{1}\underbrace{CC(i)_{k,t}^{VASF}}_{2}\underbrace{QQ(i)_{k,t}^{VASF}}_{3}\underbrace{VV(i)_{k,t}^{VASF}}_{4}= \tag{5}$$

$$=\underbrace{\sum_{g\in G(i)_{c,t,t-1}}\sum_{c\in C}\left(w(k,i)_{gc,t}^{VASF}\left(\frac{\pi(i)_{gc,t}}{\prod_{m\in C(i)_g}\pi(i)_{gm,t}^{w(i)_{gm,t}}}\right)^{1-\sigma(i)_g}\left(\frac{\prod_{m\in C(i)_g}\pi(i)_{gm,t}^{w(i)_{gm,t}}}{\prod_{j\in G}\prod_{m\in C(i)_g}\pi(i)_{jm,t}^{w(i)_{jm,t}w(i)_{j,t}}}\right)^{1-\gamma(i)}\right)}_{1}\times$$

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

$$\times \underbrace{\sum_{g\in G(i)_{c,t,t-1}} \sum_{c\in C} \left(w(k,i)_{gc,t}^{VASF} \frac{q(i)_{gc,t}}{\prod_{m\in C(i)_g} q(i)_{gm,t}^{w(i)_{gm,t}}} \left(\frac{\prod_{m\in C(i)_g} q(i)_{gm,t}^{\frac{w(i)_{gm,t}}{1-\sigma(i)_g}}}{\prod_{j\in G} \prod_{m\in C(i)_g} q(i)_{jm,t}^{\frac{w(i)_{jm,t} w(i)_{j,t}}{1-\sigma(i)_j}}} \right)^{1-\gamma(i)} \right)}_{3} \times \underbrace{\sum_{g\in G(i)_{c,t,t-1}} \sum_{c\in C} \left(w(k,i)_{gc,t}^{VASF} \frac{V(k)_{gc,t}}{V(k)_{gc,t-1}} \right)}_{4},$$

$$w(k,i)_{gc,t}^{VASF} = \frac{P(i)_{gc,t-1} M(i)_{gc,t-1} V(k)_{gc,t-1}}{\sum_{g\in G(i)_{c,t,t-1}} \sum_{c\in C} P(i)_{gc,t-1} M(i)_{gc,t-1} V(k)_{gc,t-1}}, \quad \pi(i)_{gc,t} = \frac{P(i)_{gc,t}}{P(i)_{gc,t-1}}, \quad q(i)_{gc,t} = \frac{Q(i)_{gc,t}}{Q(i)_{gc,t-1}}.$$

where $dIM(i)_{k,t}^{VASF}$ is the contribution of intensive margin growth to changes in VASF market share in a single destination country *i*. $PP(i)_{k,t}^{VASF}$ is the contribution of price factors, $CC(i)_{k,t}^{VASF}$ the contribution of changes in the set of exporters (i.e. changes in the set of competitors from the exporting countries point of view), $QQ(i)_{k,t}^{VASF}$ the contribution of non-price factors (changes in taste or quality), and $VV(i)_{k,t}^{VASF}$ is the contribution of geographical shifts in international production chains. $\sigma(i)_g$ is elasticity of substitution among varieties of good g, $\gamma(i)$ is elasticity of substitution among import goods, $w(i)_{gc,t}$ and $w(i)_{g,t}$ are Sato-Vartia weights representing the structure of country *i*'s imports. Finally, $\lambda(i)_{j,t}$ is Feenstra's (1994) seminal term that takes into account utility gains arising from changes in varieties available to consumers in country *i*'s.

Although the split in (5) is similar to the one proposed in Benkovskis and Wörz (2013) (see equation A9 in the Appendix), there are two important innovations which makes the present index compatible with market share in value added terms. First, an additional term appears in equation (5) that measures shifts in production chains: The last term in equation (5) implies that an increase in country *k*'s value-added in the production of exports positively affects VASF market share. Such an increase can be achieved either by a higher domestic content in country *k*'s gross exports or by more active involvement in GVCs leading to a higher value-added share in other countries' exports. We calculate growth in VASF market share for each product exported and then aggregate to the country level using Laspeyres weights of country *k*'s value added exports in final goods ($w(k,i)_{gc,t}^{VASF}$).

The second innovation applies to all components of (5). Although the interpretation of first three terms remains broadly the same as in Benkovskis and Wörz (2013) (which will briefly be discussed below), we use a different weighting scheme. In our previous paper we focused on the performance of country k's direct exports. Now the focus is broader, as – at least theoretically – virtually all exported final use products in the world may contain some (indirect) input from country k. Therefore, equation (5) analyses competitiveness of all products exported by all countries, taking into account country k's value added in each exported product when aggregating the measure to the country level. As mentioned before, country k's VASF depends on the value of its exports in global exports of final use products plus its inputs into the production process of final goods.

The first three components contributing to a change in the intensive margin of a country's value added export share in equation (5) should be interpreted in the following way: the first term represents the contribution of price factors to country k's competitiveness and is similar to the term derived by Armington (1969). This term is analogous to a real effective exchange rate based on unit values and accounting for market characteristics – relative price changes have larger consequences in markets with a high elasticity of substitution. The main difference to the derivation in Benkovskis and Wörz (2013) is that we now care about relative price changes for VASF of country k, not about gross exports. It is important to note that we are forced to assume that price changes of the final product are equally distributed at all stages in the international production chain.

The second term captures the contribution of changes in the set of competitors to gains or losses in country k's VASF market shares. This term accounts for changes in the set of competitors in all final product markets which is tantamount to increasing or decreasing variety on any product market from the consumer's point of view. Hence, it influences consumers' choice among various final use products and thus affects an exporter's ability to sell.

The third term represents the contribution of non-price factors (such as taste and quality) to a country's competitiveness. As before, now we take into account relative quality or taste changes for any final use product exported by any country and aggregate these results using the VASF structure of country k. One restrictive assumption we make here is that quality changes are identical on all stages of production. This is analogous to the assumption above concerning the distribution of price changes along the production chain. Despite the fact that the quality or taste parameter is unobservable, the third term can be calculated as a residual (note, that the intensive margin and all other components are observable).

$$QQ(i)_{k,t}^{VASF} = \frac{dIM(i)_{k,t}^{VASF}}{PP(i)_{k,t}^{VASF}\, CC(i)_{k,t}^{VASF}\, VV(i)_{k,t}^{VASF}} = \qquad (6)$$

$$= \sum_{g \in G(i)_{c,t,t-1}} \sum_{c \in C} \left(w(k,i)^{VASF}_{gc,t} \frac{\mu(i)_{gc,t}}{\prod_{g \in G} \prod_{c \in C(i)_g} \mu(i)^{w(i)_{gc,t} w(i)_{g,t}}_{gc,t}} \left(\frac{\pi(i)_{gc,t}}{\prod_{m \in C(i)_g} \pi(i)^{w(i)_{gm,t}}_{gm,t}} \right)^{\sigma(i)_j} \left(\frac{\prod_{m \in C(i)_g} \pi(i)^{w(i)_{gm,t}}_{gm,t}}{\prod_{j \in G} \prod_{m \in C(i)_g} \pi(i)^{w(i)_{jm,t} w(i)_{j,t}}_{jm,t}} \right)^{\gamma(i)} \times \right.$$

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

$$\mu(i)_{gc,t} = M(i)_{gc,t} / M(i)_{gc,t-1}.$$

Equation (6) 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 position. We can see that price dynamics is an important proxy (but not the determinant) of changes in relative quality or taste. If the price of a good imported from one country rises faster than the price of the same good imported from another country, this indicates either improving quality of or increasing preference for the first country's 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 equation (6) is about – unobservable change in taste and quality proxied for by changes in relative prices, as well as changes in real market share. The last two terms of (6) 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.

The aggregation of all these components to arrive at the intensive margin of VASF market share growth is further complicated by the fact that the structure of world trade changes over time. To account for this, we explicitly allow for different growth rates of various destination markets (countries) by adding another term to our decomposition: changes in the intensive margin due to shifts in the consuming country's share in world imports, $dDS(i)_t$:

$$dIM^{VASF}_{k,t} = \sum_{i \in I} s(i)^X_{k,t-1} dDS(i)_t dIM(i)^{VASF}_{k,t}, \tag{7}$$

$$dDS(m)_t = \frac{\sum_{c \in C} \sum_{g \in G} P(m)_{gc,t} M(m)_{gc,t}}{\sum_{i \in I} \sum_{c \in C} \sum_{g \in G} P(i)_{gc,t} M(i)_{gc,t}} \frac{\sum_{i \in I} \sum_{c \in C} \sum_{g \in G} P(i)_{gc,t-1} M(i)_{gc,t-1}}{\sum_{c \in C} \sum_{g \in G} P(m)_{gc,t-1} M(m)_{gc,t-1}}, \quad s(i)^X_{k,t} = \frac{\sum_{g \in G} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i \in I} \sum_{g \in G} P(i)_{gk,t} M(i)_{gk,t}}.$$

Thus, from the exporter's point of view, the intensive margin of changes in export market share is decomposed into five parts: price factors, changes in the set of competitors, non-price factors, shifts in production chains, and global demand shifts.

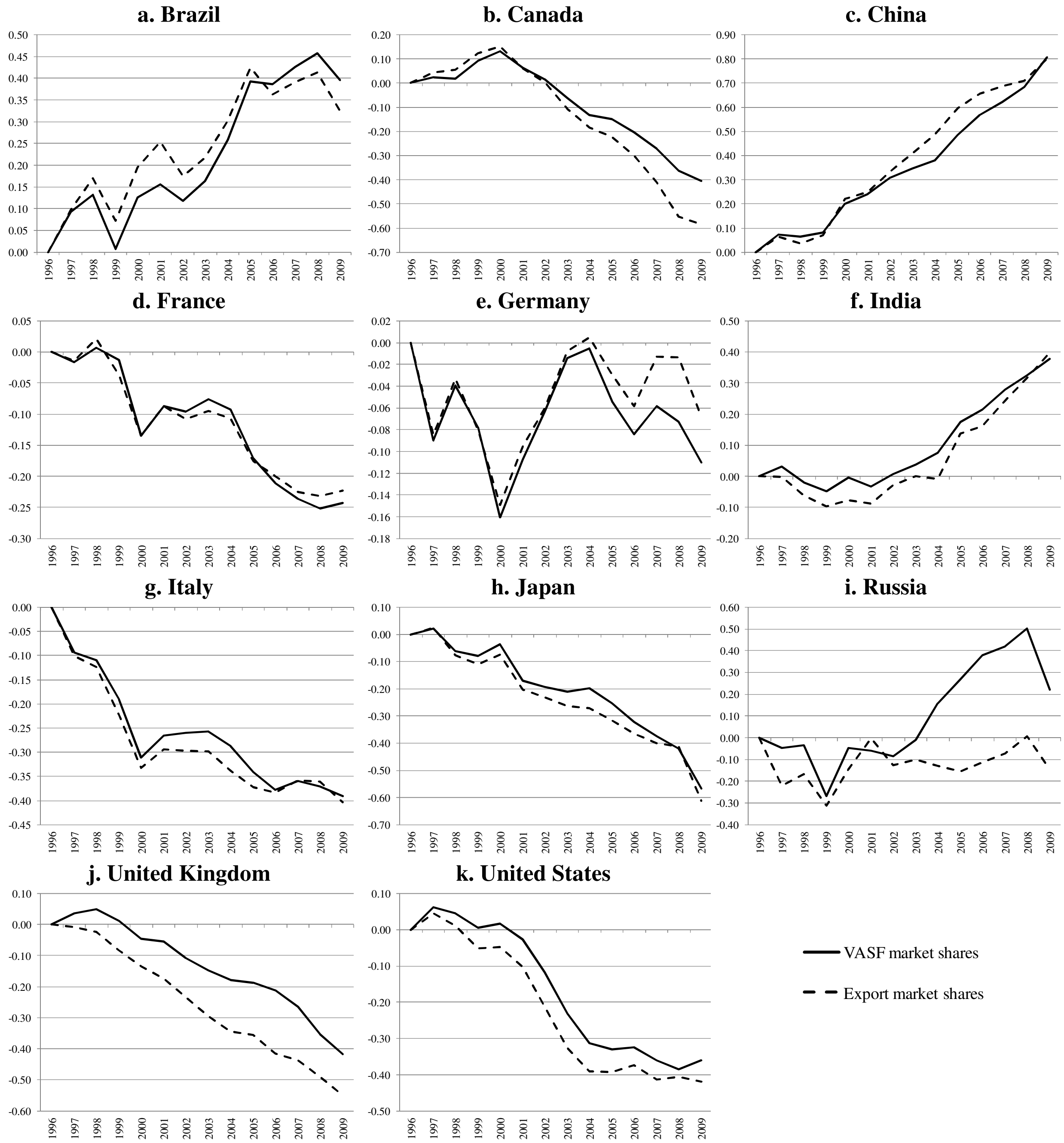
Let us make a final technical remark on the elasticities of substitution (σ's and γ's). We estimate elasticities of substitution between varieties (σ's) following the approach proposed by Feenstra (19994) and developed by Broda and Weinstein (2006) and Soderbery (2010, 2012). Technical details on the methodology and obtained estimates for 10 largest destination countries are provided in Appendix A.4. Theoretically, it is possible to apply a similar estimation methodology for elasticities of substitution between products (γ's) by deriving supply and demand equations and solving the system by exploiting the panel nature of 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 and rather low substitution elasticity between radically different products. 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 to 2 for all destination markets, which is below the median substitutability among varieties (see Appendix, Table A.1). This also corresponds to the elasticity used by Romer (1994). Benkovskis and Wörz (2013) showed that main economic conclusions about the decomposition of gross exports market share changes are robust for alternative (and reasonable) values of γ's.

4 Results

We start by comparing cumulative changes in VASF markets shares over the period 1996-2009 to cumulative changes in gross export market shares (see Chart 1). The solid line shows cumulative log-changes of the VASF market share, while the dashed line indicates cumulative log-changes of traditional (i.e. gross) export market shares. Thus, these two lines represent a summary measures of a country's competitiveness whereby an increase marks rising competitiveness (i.e. gains in global market shares).

In some G7 countries (Canada, UK and US) the difference between the two lines is pronounced and VASF market share dynamics report smaller losses in competitiveness relative to the traditional export market share indicator. These countries show the strongest degree of outsourcing among the G7-countries in our data in 2009 and the UK and Canada also show a strong decrease in the share of directly exported goods over the observation period. Thus, the better performance in value added terms can be attributed to the outsourcing of final production stages to other countries and is in line with evidence that these countries move upstream along the value chain, away from the final consumer (see De Backer and Miroudot, 2013).In line with their lower degree of outsourcing, the difference between VASF market shares and export market shares is rather small for other European G7 countries (France, Germany, Italy) and for Japan. It is further interesting to note that Germany performs better in gross exports as compared to VASF market shares. As for the BRIC countries, VASF export shares suggest smaller competitiveness gains for China and Brazil in the middle of the sample period as compared to gains in gross export market shares, whereas in 2009 cumulative gains in VASF terms matched or even outperformed cumulative gains in gross export terms. China is clearly the most downstream country in the entire sample in the sense that it shows the lowest degree of outsourcing. Around 90% of Chinese VASF exports arise from final assembly in China and China has gained enormous importance as a destination for final assembly by other exporters. Likewise, Germany appears to have gained importance as final assembly exporter. China and Germany are the only two partners featuring among the top-five destinations for indirect exports via foreign final assembly for all countries in our sample. Potentially this downstream movement in the production chain explains the worse performance of value added market shares compared to gross export market shares in Germany. For India and even more so for Russia, VASF export market share growth indicated considerably larger gains in competitiveness than gross export market share growth. Russia has by far the highest degree of outsourcing, only one third of all exports are due to final assembly in the country, which is obvious given its export structure. Hence, the case of Russia is hard to analyse, as the main positive (indirect) contribution to this rise in competitiveness stems from exports of mineral products and is thus strongly related to the price of oil.

Chart 1. Value-added and gross export market share changes for final use products



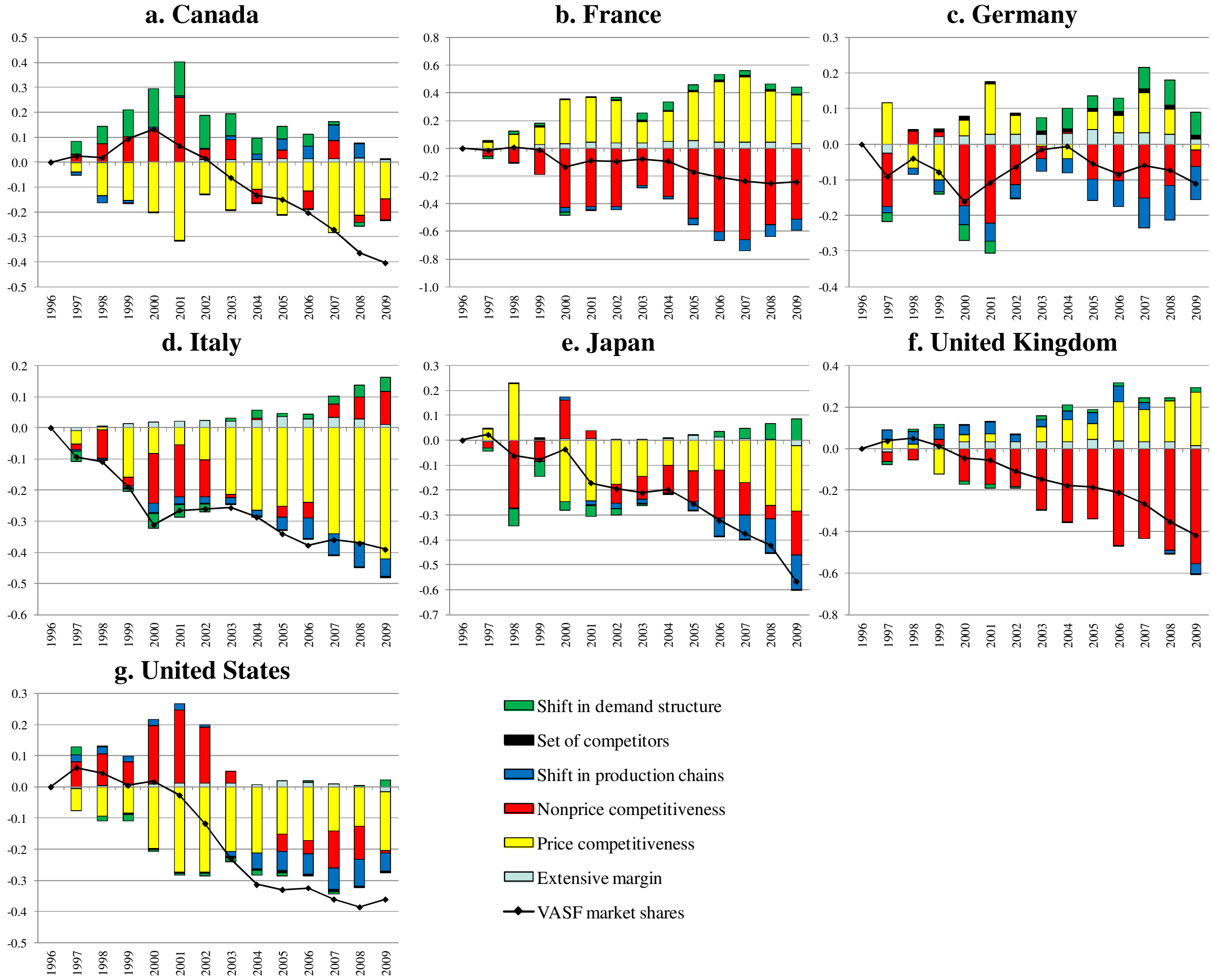
Source: WIOD, UN Comtrade, authors' calculations

Our results so far suggest that the increasing international fragmentation of production matters strongly for a country's competitiveness. The analysis of gross export market shares potentially underestimates competitiveness gains of developing countries due to outsourced production, while it may overestimate competitiveness gains due to relative taste or quality. In other words, the relative quality of emerging markets' gross exports improves due to fragmentation, but at the same time those more qualitative products have a higher content of intermediates which originate from developed countries like Germany and Japan. By the same reasoning, the non-price competitiveness of developed countries looks better when we take into account shifts in GVCs.

A unique novel feature about our indicator is the fact that it allows for a deeper analysis of individual factors standing behind the changes in VASF market shares. This comprehensive, GVC-compatible competitiveness index and its contributions are depicted in Chart 2 (for the G7 countries) and Chart 3 (for the BRIC countries) below. In these charts, log-changes of VASF market shares (i.e. the overall GVC-adjusted competitiveness measure) are decomposed into the six abovementioned effects (extensive margin, price competitiveness, non-price competitiveness, changes in the set of competitors, shifts in production chains and shifts in global demand).[3]

[3] The log-linear approximation of the VASF market share decomposition is described in Appendix, section A.3. Note that for computational reasons the sum of these contributions does not exactly correspond to changes in VASF market shares (as it should theoretically) due to the log-linear approximation and missing information on unit values.

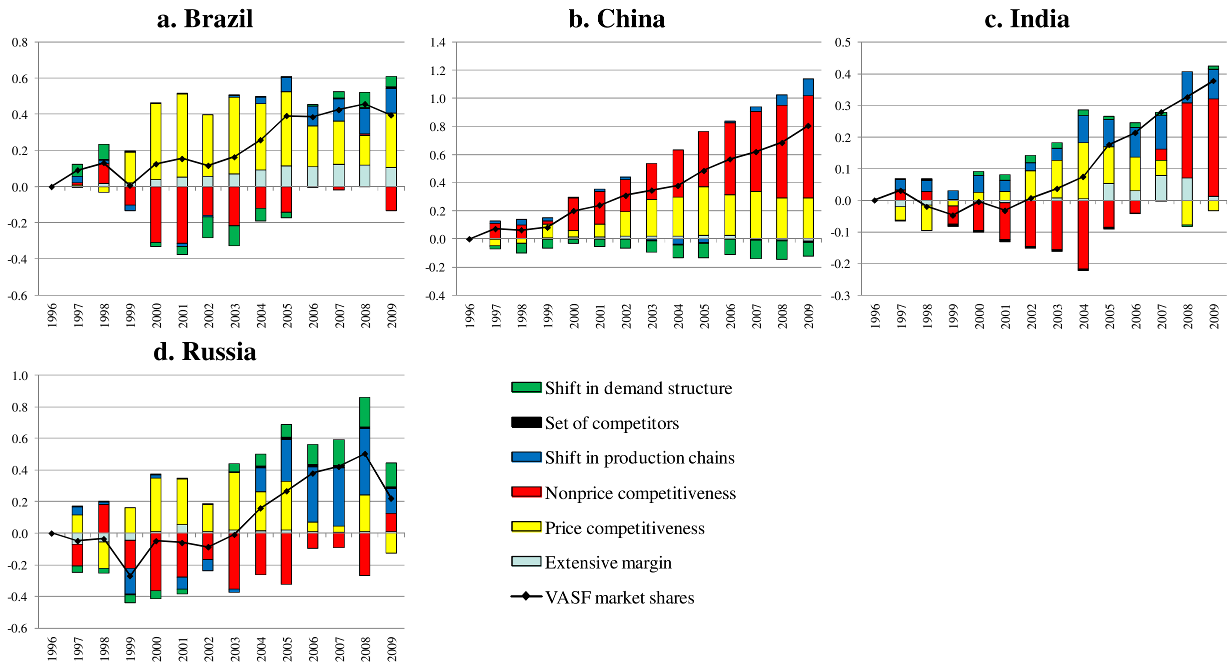
Chart 2. Decomposition of value-added export market share changes for final use products in G7 countries



Source: WIOD, UN Comtrade, authors' calculations

In general, price and non-price factors contribute most strongly to changes in VASF market shares. This finding is similar to the results reported in Benkovskis and Wörz (2013) for gross market shares (see Chart A.1 for the decomposition of gross export market shares for final use products for our sample). However, shifts in global production chains give a non-negligible positive contribution to the competitiveness of BRIC countries, while their contribution is often negative for the G7 countries (France, Germany, Italy, Japan and the US since 2003). In the case of developed countries, GVC-shifts show a positive contribution to competitiveness only for Canada as well as the UK during the pre-crisis period.

Chart 3. Decomposition of value-added export market share changes for final use products in BRIC countries



Source: WIOD, UN Comtrade, authors' calculations

Price factors always show a positive contribution for the BRIC countries, while their effects differ between G7 countries: France, the UK and decreasingly so Germany could gain market shares due to increased price competitiveness, while Canada, Italy, Japan and the US lost price competitiveness. In most cases losses in competitiveness in G7 countries are to a large extent also driven by non-price factors, e.g. developed countries are confronted by a decline in the relative quality (or taste) of their exports.[4] However, these losses are smaller in value added terms than in gross exports as reported in Benkovskis and Wörz (2013) (see Appendix, Chart A.1, for fully comparable results). This arises because developed countries indirectly contribute to the production of high-quality products in developing countries. The most striking cases are US, Canada, Germany and Italy, which show almost no changes in relative quality of their production. In comparison to Benkovskis and Wörz (2013), the conclusions are also altered for BRIC countries. The huge markets share gains of China are determined by increasing relative quality of or taste for Chinese products even after we control for the fragmentation of production process. However, in contrast to previous findings, we now see that non-price competitiveness does not play any important role for

[4] Please note that we only capture dynamics here and cannot make any statement about the ordering of absolute quality of goods produced by G7 versus BRICs. Thus, in absolute terms we still expect a sizeable quality gap to prevail between G7 and BRIC exports on average.

other BRIC countries with the exception of India in recent years. Thus, we conclude that the improvement of export product quality in emerging economies arose mainly from outsourcing of higher-quality products rather than from improvements in the quality of domestic production.

Finally, the extensive margin plays a minor role in both subsamples. It shows a small positive contribution to competitiveness in France, Germany, Italy, the UK, the US, Brazil and in some years in India. Also the effect of changes in the set of competitors for a product is negligible for all countries.

5 Conclusions

In this paper, we condense various aspects of competitiveness, including the influence of international fragmentation, into one comprehensive measure. Our analysis accounts on the one hand for non-price factors (such as changes in the quality of exported products or consumer tastes) and on the other hand corrects for differences and changes in the value added content of trade. Combining two datasets – highly disaggregated trade data from UN COMTRADE with internationally integrated Supply and Use Tables from the WIOD database, we are able to depart from the narrow definition of competitiveness which focuses on a country’s ability to maximise gross exports, and focus on the value added export market shares.

Changing the focus from traditional gross export market shares to VASF market shares does not alter the general picture much – developing countries are gaining VASF market shares as much as they are gaining gross export market shares while developed countries are losing market shares. Still, the inclusion of international fragmentation alters the underlying story. We observe that the global production process is gradually shifting toward developing countries, thus positively contributing to VASF market share changes in the BRIC countries and eroding G7 countries’ competitiveness. However, accounting for GVCs, we observe that the catching-up process of emerging countries in terms of the quality of their goods (or consumers’ tastes towards their goods) proceeds more slowly than gross exports would suggest. Hence, we can conclude that non-price competitiveness losses of developed countries are lower than claimed before, as they remain important suppliers of high quality intermediates in the GVCs. In particular, the US, Canada, Germany and Italy are well able to the keep relative quality of their produced goods unchanged.

Thus, our previous analysis based on gross exports (Benkovskis and Wörz, 2013) overemphasized the role of non-price factors in competitiveness gains of BRIC countries. After controlling for shifts in production chains one can observe that improvements in Brazil's, Russia's and India's export product quality arose to a non-negligible extent from the outsourcing of higher-quality products rather than from improvements in the quality of their domestic production. Nevertheless, non-price competitiveness gains of China remain impressive even after accounting for the role of global value chains.

References

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

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

Benkovskis, K. and Wörz, J. (2013). "What Drives the Market Share Changes? Price Versus Non-Price Factors," BOFIT (Bank of Finland Institute for Economies in Transition) Discussion Paper No. 18.

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

Daudin, G., Rifflart, C., Schweisguth, D. (2011). "Who Produces from Whom in the World Economy?" *Canadian Journal of Economics*, 44(4), 1403-1437.

De Backer, K. and Miroudot, S. (2013). "Mapping Global Value Chains," The Competitiveness Research network (CompNet), mimeo.

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

Hummels, D., Ishii, J., Yi, K.-M. (2001). "The Nature and Growth of Vertical Specialization in World Trade," *Journal of International Economics*, 54(1), 75-96.

Johnson, R.C., Noguera, G. (2012). "Accounting for Intermediates: Production Sharing and Trade in Value Added," *Journal of International Economics*, 86(2), 224-236.

Koopman, R., Powers, W., Wang, Z., and Wei, S.-J. (2010). "Give Credit where Credit is Due: Tracing Value Added in Global Production Chains," NBER Working Paper No. 16426, September.

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.

Linden, G., Kraemer, K.L., Dedrick, J. (2009). "Who Captures Value in a Global Innovation Network? The Case of Apple's iPod," *Communications of the ACM*, 52(3), March, 140-144.

Narayanan, B., Aguiar, A., McDougall, R. (eds.) (2012). "Global Trade, Assistance, and Production: The GTAP 8 Data Base," Center for Global Trade Analysis, Purdue University. Available online at: http://www.gtap.agecon.purdue.edu/databases/v8/v8_doco.asp

Romer, P.M. (1994). "New Goods, Old Theory, and the Welfare Costs of Trade Restrictions," NBER Working Paper No. 4452, September.

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

Soderbery, A. (2012). "Estimating Import Supply and Demand Elasticities: Analysis and Impications," (Unpublished results), Department of Economics, Krannert School of Management, Purdue University, August.

Stehrer, R. (2012). "Trade in Value Added and the Value Added in Trade," The Vienna Institute for International Economic Studies (wiiw) Working Paper No. 81, June.

Timmer, M. (ed.), Erumban, A., Gouma, R., Los, B., Temurshoev, U., de Vries, G.J., Arto, I., Genty, V., Neuwahl, F., Rueda-Cantuche, J.M., Villanueva, A., Francois, J., Pindyuk, O., Pöschl, J., Stehrer, R., and Streicher, G. (2012). "The World Input-Output Database (WIOD): Contents, Sources and Methods," WIOD Working Paper No. 10, downloadable from: http://www.wiod.org/publications/papers/wiod10.pdf

Appendix

A.1 Decomposition of changes in gross export market shares

This section of the Appendix briefly reports the decomposition of gross export market share changes recently developed in Benkovskis and Wörz (2013). First, changes in country *k*'s global export market share ($dMS_{k,t}$) are decomposed into intensive ($dIM_{k,t}$) and extensive ($dEM_{k,t}$) margin:

$$dMS_{k,t} = \frac{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}} \frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}}{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t-1} M(i)_{gk,t-1}} = dEM_{k,t} \times dIM_{k,t}, \tag{A1}$$

$$dEM_{k,t} = \frac{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t} M(i)_{gk,t}} \frac{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t-1} M(i)_{gk,t-1}}{\sum_{i\in I}\sum_{g\in G} P(i)_{gk,t-1} M(i)_{gk,t-1}}, \tag{A2}$$

$$dIM_{k,t} = \frac{\sum_{i\in I}\sum_{g\in G(i)k_{g,t,t-1}} P(i)_{gk,t} M(i)_{gk,t}}{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}} \frac{\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}}{\sum_{i\in I}\sum_{g\in G(i)_{k,t,t-1}} P(i)_{gk,t-1} M(i)_{gk,t-1}}. \tag{A3}$$

In order to decompose intensive margins into price and non-price factors, one needs to construct the price index that takes into account changes in variety, quality and taste. Benkovskis and Wörz (2013) use a constant elasticity of substitution (CES) utility function for a representative household from importing country *i* consisting of three nests (similar to Broda and Weinstein, 2006):

$$U(i)_t = \left(D(i)_t^{\frac{\kappa(i)-1}{\kappa(i)}} + M(i)_t^{\frac{\kappa(i)-1}{\kappa(i)}} \right)^{\frac{\kappa(i)}{\kappa(i)-1}}, \quad \kappa(i) > 1, \tag{A4}$$

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

$$M(i)_{g,t} = \left(\sum_{c\in C} Q(i)_{gc,t}^{\frac{1}{\sigma(i)_g}} M(i)_{gc,t}^{\frac{\sigma(i)_g-1}{\sigma(i)_g}} \right)^{\frac{\sigma(i)_g}{\sigma(i)_g-1}}, \quad \sigma(i)_g > 1 \quad \forall \quad g \in G, \tag{A6}$$

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, $M(i)_{g,t}$ is the subutility from consumption of imported good *g*, $\gamma(i)$ is elasticity of substitution among import goods, $Q(i)_{gc,t}$ is the taste and quality parameter, and $\sigma(i)_g$ is elasticity of substitution among varieties of good *g*.

Consumers' utility maximization problem allows to decompose the intensive margin in equation (A3) further. First, one can focus on changes of country *k*'s exports of product *j*'s nominal share in total imports of country i, denoted by $dIM(i)_{jk,t}$. By using utility maximization problem in (A4)-(A6), $dIM(i)_{jk,t}$ can be expressed as:

$$dIM(i)_{jk,t} = \frac{P(i)_{jk,t}M(i)_{jk,t}}{P(i)_t M(i)_t}\frac{P(i)_{t-1}M(i)_{t-1}}{P(i)_{jk,t-1}M(i)_{jk,t-1}} = \frac{\pi(i)_{jk,t}^{1-\sigma(i)_j}\left(Q(i)_{jk,t}/Q(i)_{jk,t-1}\right)}{\pi(i)_{j,t}^{1-\sigma(i)_j}}\frac{\pi(i)_{j,t}^{1-\gamma(i)}}{\pi(i)_t^{1-\gamma(i)}}, \tag{A7}$$

$$\pi(i)_{gc,t} = P(i)_{gc,t}/P(i)_{gc,t-1}, \quad \pi(i)_{g,t} = P(i)_{g,t}/P(i)_{g,t-1}, \quad \pi(i)_t = P(i)_t/P(i)_{t-1},$$

where $P(i)_{g,t}$ denotes minimum unit-cost of import good g for consumers in country i, and $P(i)_t$ is minimum unit-cost of total imports of country i. Equation (A7) 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. However, one needs to take into account that minimum unit-costs of imports are driven by non-price factors like changes in variety and quality as well.

Benkovskis and Wörz (2011) extend the work of Feenstra (1994) and Broda and Weinstein (2006) by relaxing assumption of unchanged taste or quality. They introduce an import price index that adds a term to capture changes in taste and quality:

$$\pi(i)_{g,t} = \prod_{c\in C(i)_g}\pi(i)_{gc,t}^{w(i)_{gc,t}}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{1}{\sigma(i)_g-1}}\prod_{c\in C(i)_g}\left(\frac{Q(i)_{gc,t}}{Q(i)_{gc,t-1}}\right)^{\frac{w(i)_{gc,t}}{1-\sigma(i)_g}}, \quad \pi(i)_t = \prod_{g\in G}\pi(i)_{g,t}^{w(i)_{g,t}}, \tag{A8}$$

where $\pi(i)_{gc,t} = P(i)_{gc,t}/P(i)_{gc,t-1}$ and $P(i)_{gc,t}$ is the price of good g imported from country c. Sato-Vartia 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:

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

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

while $\lambda(i)_{g,t}$ and $\lambda(i)_{g,t-1}$ are Feenstra's (1994) index accounting for changes in variety:

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

Combination of equations (A7) and (A8) leads to the following decomposition of $IM(i)_{jk,t}$ into three parts:

$$IM(i)_{jk,t} = \underbrace{PP(i)_{jk,t}}_{1}\underbrace{CC(i)_{jk,t}}_{2}\underbrace{QQ(i)_{jk,t}}_{3} = \underbrace{\left(\frac{\pi(i)_{jk,t}}{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}\right)^{1-\sigma(i)_j}\left(\frac{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}{\prod_{g\in G}\prod_{c\in C(i)_g}\pi(i)_{gc,t}^{w(i)_{gc,t}w(i)_{g,t}}}\right)^{1-\gamma(i)}}_{1}\times \tag{A9}$$

$$\times \underbrace{\left(\frac{\lambda(i)_{j,t}}{\lambda(i)_{j,t-1}}\right)^{\frac{\gamma(i)-\sigma(i)_j}{1-\sigma(i)_j}} \prod_{g\in G}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{(1-\gamma(i))w(i)_{g,t}}{1-\sigma(i)_g}}}_{2} \times$$

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

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. The third term of equation (A9) is unobservable, but it can be easily obtained as residual. Equation (A10) 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:

$$IM(i)_{jk,t} = \underbrace{\left(\frac{\pi(i)_{jk,t}}{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}\right)^{1-\sigma(i)_j} \left(\frac{\prod_{c\in C(i)_j}\pi(i)_{jc,t}^{w(i)_{jc,t}}}{\prod_{g\in G}\prod_{c\in C(i)_g}\pi(i)_{gc,t}^{w(i)_{gc,t}w(i)_{g,t}}}\right)^{1-\gamma(i)}}_{1} \times \tag{A10}$$

$$\times \underbrace{\left(\frac{\lambda(i)_{j,t}}{\lambda(i)_{j,t-1}}\right)^{\frac{\gamma(i)-\sigma(i)_j}{1-\sigma(i)_j}} \prod_{g\in G}\left(\frac{\lambda(i)_{g,t}}{\lambda(i)_{g,t-1}}\right)^{\frac{(1-\gamma(i))w(i)_{g,t}}{1-\sigma(i)_g}}}_{2}$$

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

Finally, Benkovskis and Wörz (2013) aggregate up to the intensive margin of world market share growth taking into account shifts in the country's share of world imports, $DS(i)_t$:

$$IM_{k,t} = \sum_{i\in I} s(i)^X_{k,t-1} DS(i)_t IM(i)_{k,t} = \sum_{i\in I}\sum_{g\in G} s(i)^X_{k,t-1} s(i)^X_{gk,t-1} DS(i)_t IM(i)_{gk,t}, \tag{A11}$$

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

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

Thus, the intensive margin of changes in gross export market share is decomposed into four parts: changes in price factors, changes in the set of competitors, changes in non-price factors, and global demand shifts.

A.2. Decomposition of the intensive margin of value-added export market share changes

The share of country k's VASF exports in total imports of a country i, $IM(i)_{k,t}^{VASF}$, can be rearranged in the following way:

$$IM(i)_{k,t}^{VASF} = \frac{\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}}{\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}} = \frac{\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}}{P(i)_t M(i)_t} = \tag{A12}$$

$$= \sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}} \frac{P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}}{P(i)_{g,t} M(i)_{g,t}} \frac{P(i)_{g,t} M(i)_{g,t}}{P(i)_t M(i)_t}.$$

The first order conditions of the consumer utility maximization problem (A4)-(A6) s.t. budget constraints are the following:

$$M(i)_{gc,t} = Q(i)_{gc,t} P(i)_{gc,t}^{-\sigma(i)_g} U(i)_t^{\frac{\sigma(i)_g}{\kappa(i)}} M(i)_t^{\frac{\sigma(i)_g}{\gamma(i)}-\frac{\sigma(i)_g}{\kappa(i)}} M(i)_{g,t}^{1-\frac{\sigma(i)_g}{\gamma(i)}} \lambda(i)_t^{-\sigma(i)_g}, \tag{A13}$$

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

$$M(i)_{g,t} = P(i)_{g,t}^{-\gamma(i)} U(i)_t^{\frac{\gamma(i)}{\kappa(i)}} M(i)_t^{1-\frac{\gamma(i)}{\kappa(i)}} \lambda(i)_t^{\gamma(i)}. \tag{A14}$$

From (A12), (A13) and (A14) follows that country k's VASF exports share in total imports of a country i is driven by minimum unit-costs, taste and quality parameters and value-added share of country k in the production of various goods exported to destination market i:

$$IM(i)_{k,t}^{VASF} = \sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}} \frac{P(i)_{gc,t}^{1-\sigma(i)_g} Q(i)_{gc,t} V(k)_{gc,t}}{P(i)_{g,t}^{1-\sigma(i)_g}} \frac{P(i)_{g,t}^{1-\gamma(i)}}{P(i)_t^{1-\gamma(i)}}, \tag{A15}$$

Using the fact that $dIM(i)_{k,t}^{VASF} = IM(i)_{k,t}^{VASF} / IM(i)_{k,t-1}^{VASF}$, and combining it with import price index in (A8), one can obtain VASF market share decomposition described in (5).

A.3. Log-linear approximation of VASF market share decomposition

The system of equations (4)-(7) 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:[5]

[5] We log-linearise 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

$$dms_{k,t}^{VASF} \approx dem_{k,t}^{VASF} + pp_{k,t}^{VASF} + cc_{k,t}^{VASF} + qq_{k,t}^{VASF} + vv_{k,t}^{VASF} + ds_{k,t}, \tag{A16}$$

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

$$dms_{k,t}^{VASF} = \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}\right) - \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1} V(k)_{gc,t-1}\right) - \tag{A17}$$
$$- \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t}\right) + \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1}\right).$$

These are decomposed into six parts. Extensive margins of log changes of country *k*'s market share changes, $dem_{k,t}^{VASF}$, defined as:

$$dem_{k,t}^{VASF} = \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}\right) - \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G} P(i)_{gc,t-1} M(i)_{gc,t-1} V(k)_{gc,t-1}\right) - \tag{A18}$$
$$- \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}} P(i)_{gc,t} M(i)_{gc,t} V(k)_{gc,t}\right) + \ln\left(\sum_{i\in I}\sum_{c\in C}\sum_{g\in G(i)_{c,t,t-1}} P(i)_{gc,t-1} M(i)_{gc,t-1} V(k)_{gc,t-1}\right).$$

The remaining part (intensive margins) is further decomposed into five components. First is price component of market shares' log changes, $pp_{k,t}^{VASF}$:

$$pp_{k,t}^{VASF} = \sum_{i\in I} \tilde{s}(i)_{k,t}^{X}\, pp(i)_{k,t}^{VASF}, \tag{A19}$$

$$pp(i)_{k,t}^{VASF} = \sum_{g\in G(i)_{c,y,y-1}} \sum_{c\in C} w(k,i)_{gc,t}^{VASF} \left((1-\sigma(i)_g)\ln \pi(i)_{gc,t} - (\gamma(i)-\sigma(i)_g) \sum_{m\in C(i)_j} w(i)_{gm,t} \ln \pi(i)_{gm,t} \right) -$$
$$- (1-\gamma(i)) \sum_{j\in G} \sum_{m\in C(i)_g} w(i)_{jm,t}\, w(i)_{j,t} \ln \pi(i)_{jm,t},$$

where weights $\tilde{s}(i)_{k,t}^{X}$ are defined as Tornquist shares of country *k*'s export structure:

$$\tilde{s}(i)_{k,t}^{X} = 0.5 s(i)_{k,t}^{X} + 0.5 s(i)_{k,t-1}^{X}.$$

Second is competitors' set component of market shares' log changes, $cc_{k,t}^{VASF}$:

$$cc_{k,t}^{VASF} = \sum_{i\in I} \sum_{g\in G(i)_{c,y,y-1}} \sum_{c\in C} \tilde{s}(i)_{k,t}^{X}\, w(k,i)_{gc,t}^{VASF} \frac{\gamma(i)-\sigma(i)_g}{1-\sigma(i)_g} \left(\ln \lambda(i)_{g,t} - \ln \lambda(i)_{g,t-1}\right) + \tag{A20}$$
$$+ \sum_{i\in I} \tilde{s}(i)_{k,t}^{X}\, w(k,i)_{gc,t}^{VASF} \frac{(1-\gamma(i)) w(i)_{g,t}}{1-\sigma(i)_g} \sum_{j\in G} \left(\ln \lambda(i)_{j,t} - \ln \lambda(i)_{j,t-1}\right).$$

Third component are non-price factors of market shares' log changes, $qq_{k,t}^{VASF}$:

$$qq_{k,t}^{VASF} = \sum_{i\in I} \tilde{s}(i)_{k,t}^{X}\, qq(i)_{k,t}^{VASF}, \tag{A21}$$

$$qq(i)_{k,t}^{VASF} = \sum_{g\in G(i)_{c,y,y-1}} \sum_{c\in C} w(k,i)_{gc,t}^{VASF} \left(\ln \mu(i)_{gc,t}\, \sigma(i)_g \ln \pi(i)_{gc,t} + (\gamma(i)-\sigma(i)_g) \sum_{m\in C(i)_j} w(i)_{gm,t} \ln \pi(i)_{gm,t} \right) -$$
$$- \sum_{j\in G} \sum_{m\in C(i)_g} w(i)_{jm,t}\, w(i)_{j,t} \ln \mu(i)_{jm,t} - \gamma(i) \sum_{j\in G} \sum_{m\in C(i)_g} w(i)_{jm,t}\, w(i)_{j,t} \ln \pi(i)_{jm,t} +$$

---

than the cumulated changes. Second, the results reported in Charts 2 and 3 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).

$$\left(\sum_{g \in G(i)_{c,y,y-1}} \sum_{c \in C} w(k,i)^{VASF}_{gc,t} \frac{\sigma(i)_g - \gamma(i)}{1-\sigma(i)_g} \left(\ln \lambda(i)_{g,t} - \ln \lambda(i)_{g,t-1} \right) + \frac{\left(\gamma(i) - \sigma(i)_g\right) w(i)_{g,t}}{1-\sigma(i)_g} \sum_{j \in G} \left(\ln \lambda(i)_{j,t} - \ln \lambda(i)_{j,t-1} \right) \right).$$

Fourth are shifts in production chains in log changes, $vv_{k,t}^{VASF}$:

$$vv^{VASF}_{k,t} = \sum_{i \in I} \sum_{g \in G(i)_{c,y,y-1}} \sum_{c \in C} \tilde{s}(i)^X_{k,t} \, w(k,i)^{VASF}_{gc,t} \left(\ln V(k)_{gc,t} - \ln V(k)_{gc,t-1} \right). \qquad \text{(A22)}$$

Finally, fifth is the demand structure component of market shares' log changes, $ds_{k,t}$:

$$ds_{k,t} = \sum_{i \in I} \tilde{s}(i)^X_{k,t} \, ds(i)_t, \qquad \text{(A23)}$$

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

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

A.4. 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 in terms of market share, taking first differences and ratios to a reference country l:

$$\Delta \ln \frac{s(i)^M_{gc,t}}{s(i)^M_{gl,t}} = -\left(\sigma(i)_g - 1 \right) \Delta \ln \frac{P(i)_{gc,t}}{P(i)_{gl,t}} + \varepsilon(i)_{gc,t}, \qquad \text{(A24)}$$

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.

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

$$\Delta \ln \frac{P(i)_{gc,t}}{P(i)_{gl,t}} = \frac{\omega(i)_g}{1+\omega(i)_g} \Delta \ln \frac{s(i)^M_{gc,t}}{s(i)^M_{gl,t}} + \delta(i)_{gc,t}, \qquad \text{(A25)}$$

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 (A24) and (A25) is the absence of exogenous variables to identify and estimate elasticities. 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 $\delta(i)_{gc,t}$.[6] This is done by multiplying both sides of the equations. After transformation, the following equation is obtained:

$$\left(\Delta\ln\frac{P(i)_{gc,t}}{P(i)_{gl,t}}\right)^2 = \theta_1\left(\Delta\ln\frac{s(i)^M_{gc,t}}{s(i)^M_{gl,t}}\right)^2 + \theta_2\left(\Delta\ln\frac{P(i)_{gc,t}}{P(i)_{gl,t}}\right)\left(\Delta\ln\frac{s(i)^M_{gc,t}}{s(i)^M_{gl,t}}\right) + u(i)_{gc,t}, \tag{A26}$$

$$\theta_1 = \frac{\omega(i)_g}{\left(1+\omega(i)_g\right)\left(\sigma(i)_g - 1\right)}, \quad \theta_2 = \frac{1-\omega(i)_g\left(\sigma(i)_g - 2\right)}{\left(1+\omega(i)_g\right)\left(\sigma(i)_g - 1\right)}, \quad u(i)_{gc,t} = \varepsilon(i)_{gc,t}\,\delta(i)_{gc,t}.$$

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 papers by Soderbery (2010, 2012), however, reports that this methodology generates severely biased elasticity estimates (median elasticity of substitution is overestimated by over 35%). Soderbery (2010, 2012) 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, 2012) 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, 2012) and use hybrid estimator combining LIML with a constrained nonlinear LIML to estimate elasticities of substitution between varieties using the Feenstra's (1994) method.

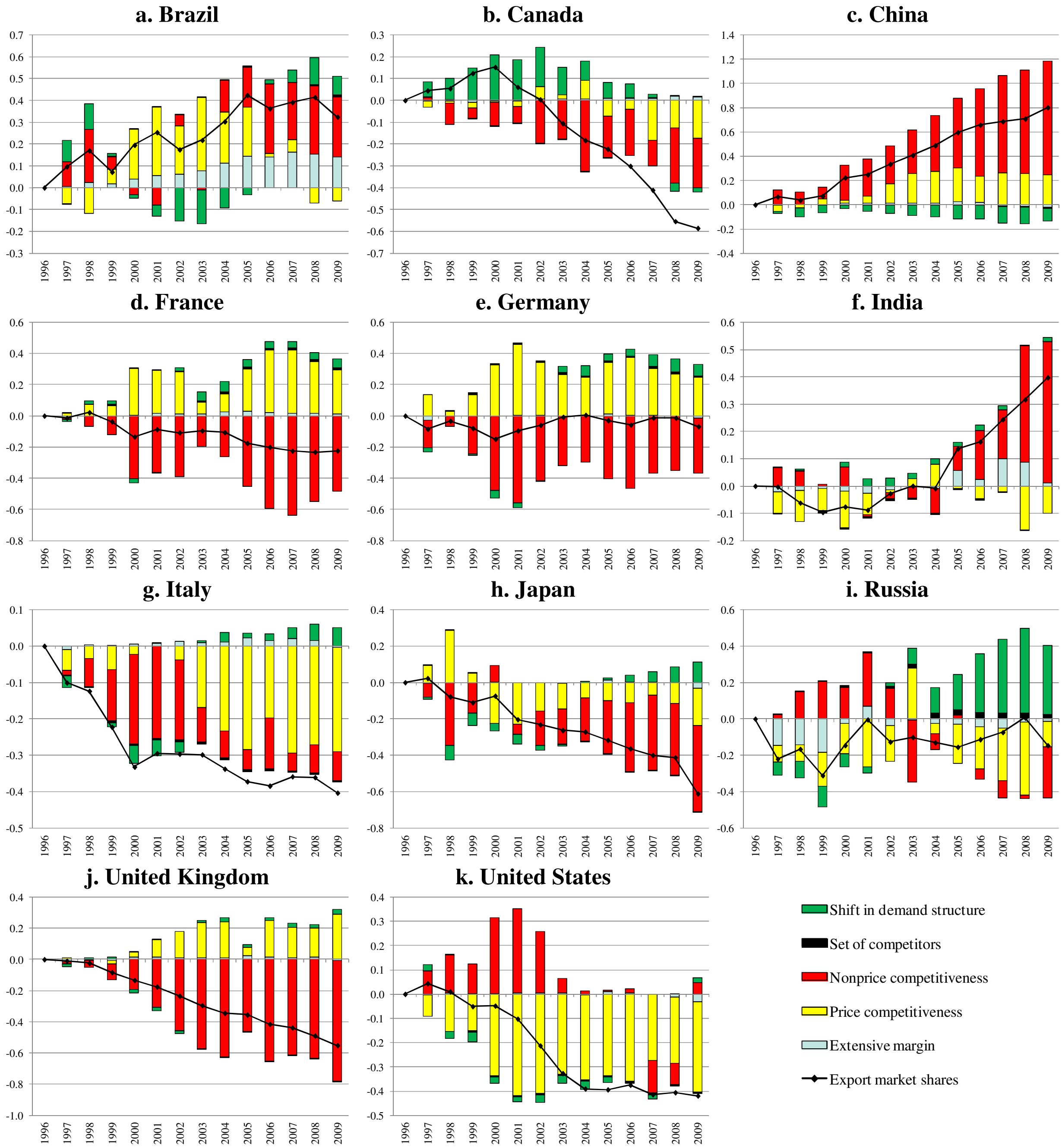
[6] The independence assumption relies on the assumption that taste and quality does not enter the residual of the relative supply equation ($\delta(i)_{gc,t}$). If this does not hold, then errors are not independent, since changes in taste and quality enter $\varepsilon(i)_{gc,t}$. The assumption of 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.

Table A.1. Elasticities of substitution between varieties for final use products (top 10 importers)

	No. of estimated elasticities	Mean	Minimum	Maximum	25th percentile	**Median**	75th percentile
United States	1263	6053.56	1.0657	97707	2.10	**3.60**	15.66
China	1278	4378.92	1.0328	95774	2.55	**4.84**	23.51
Germany	1736	144.95	1.1122	88870	2.46	**3.99**	7.54
Japan	1541	737.30	1.0818	84967	1.99	**3.05**	5.56
France	1790	78.44	1.0040	65741	2.27	**3.56**	6.50
United Kingdom	1808	10.56	1.0577	8007	1.96	**2.95**	5.19
Italy	1793	34.77	1.0024	41792	2.18	**3.41**	6.53
Korea	1494	48.72	1.0226	39413	2.25	**3.33**	5.78
Hong Kong (China)	1175	5511.42	1.0052	98765	2.62	**5.56**	1650.2
Netherlands	1571	337.74	1.0047	50732	2.17	**3.43**	7.96

Note: Calculated using UN Comtrade data for disaggregated imports of 188 countries using equation (A26). The estimates are based on data between 1996 and 2011 for 244 exporters.

Chart A.1. Decomposition of gross export market share changes for final use products



Source: UN Comtrade, authors' calculations