Estimating Product Quality in International Trade

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Abstract

In recent years empirical studies offer clear evidence on the increasing importance of intra-industry trade in presence of vertically differentiated products. These are goods that, within the same industry, are distinguished by different quality levels. In the new trade theory and in the neoclassical literature there is not a well-established methodology to estimate good's quality in international trade; this contribution presents different methodologies starting from a review of the literature and proposing alternative solutions. In the first part of the paper classical indicators of intra-industry trade are presented as well as original measures, in the vein of Aw and Roberts, starting observing the evolution of export to identify the qualitative changes in absolute terms and relative to competitors. These indicators can be influenced not only by quality shifts but also by other cyclical and structural factors. To overcome these limitations and give a better interpretation of the underlying phenomenon we present a micro-founded model that attempts to evaluate the effect of quality on export demand. This model is based on the underlying relation between vertical product differentiation, goods substitution effect and market power of exporting firms. In the last part an econometric methodology is presented to estimate price elasticity of volume market share as function of the difference in price against competitors in an inter-temporal framework. The policy implications of this research moves from a better assessment of countries international market positioning and price setting strategy to the identifications of competitive dynamics based on quality rather than on prices.

1 Introduction

The constant increase in products' quality is an important competitive driver influencing firms' success in the global market. In recent years empirical studies (Bernard and Jensen, 2001; Bernard *et al.*, 2003; Hallak and Schott, 2005) offer clear evidence of the increasing importance of intra-industry trade based on vertically differentiated products.

Product quality differentiation is relevant both in theoretical debate (Hallak and Schott, 2005) as well as trade policy design (Fontagné *et al.*, 2008). Considering a frame where products are vertically differentiated and consumers have preference toward higher quality products turn out that advantages in terms of productivity result in exports that have higher, not lower prices (Baldwin and Harrigan, 2007). This implies that there is not endowment-driven specialization across products but, on the contrary, endowment-driven specialization across varieties within products. Such a shift in our understanding of international specialization should leads to different trade policy and prevents us from drawing conclusions regarding the competitive pressures that high-income countries face from emerging economies. If, for instance, varieties exported by Italy and China are too different in quality to be in direct competition, then workers in the two countries do not compete in production of the same varieties. And if the different varieties are not very substitutable, there will be only a weak link between trade and factor prices.

There is therefore the need for proper tools to evaluate the relevance of this phenomenon. The current available methodologies are heterogeneous as well because they have been developed with different aims as for different definition of quality regarded among authors.

In the economic literature the concept of quality does not refer only to particular physical feature of the products, such as materials or technology embedded. For Hallak and Schott (2005) product quality refers to all the features, tangible and intangible, influencing consumers' economic valuation.

Many methodologies are related with the principle that the quality embedded in product could by captured by its price. This is simplistic, even if it is a useful shortcut for empirical applications. It is simplistic because it is an indirect measure of quality based on its effect on prices, which are influenced by other factors. However the relation occurring between quality level and price is confirmed as well from theoretical models as empirical tests; among the others Stiglitz (1987) shows that the relation between quality and price in the long run subsists even under imperfect information. The most popular proxy of prices used in trade study is the Average Unit Value (AUV) of exports; the use of AUV is increasing the interpretation ambiguity: AUV are not strict prices index but aggregated price proxies, computed as sector or product level aggregated ratio of trade values on trade quantities . They are although influenced as well by strict firms' export prices as by the product mix within the sector.

Moreover it would be important fully understand the economic implications of quality differentiation and use properly quality measurements in order to obtain meaningful results; addressing the relation intervening between these measurement and the market structure. For instance a different quality level could be the reaction to different factor intensity or technology used in the production process. A high quality level could be connected also with low good's substitution effect and, consequently, different market structure characterized by lower price elastic of demand and higher market power. On this last point there is a clear connection between quality measurement, market power and exporters pricing strategies (Bresnahan, 1989; Goldberg and Knetter, 1995; De Nardis and Pensa, 2004; Bugamelli and Tedeschi, 2005; Lamieri and Lanza, 2006). In this respect we can think of indirect measures that attempt to grasp the effects of quality differentiation on the residual demand addressed to an exporting country.

In the effort to produce a classification of existing heterogeneity measures a first distinction can be made between indicators that reveals the weight of quality differentiation in goods' trade, compared to indicators that evaluate the differences and characteristics of qualitative changes. The former is based on the literature on intra-industry trade resulting from a qualitatively different level of imports and exports. The latter indicators identify how qualitative differentiation is affecting absolute and relative market power of exporters. These measurement techniques (presented in section 2) can be applied both for a static comparison between country and competitors, and for a dynamic assessment of export quality over time. If dynamic, then, the aim is isolate the effect produced by improvement or deterioration of traded goods quality. We then derive a micro-funded model (section 3) based on the relation between qualitative differentiation, degree of goods' substitutability and market power, suggesting some alternatives to existing techniques. Section 4 concludes and suggests some policy implications. Appendix A specifies an empirical equation based on the proposed model estimating indirectly quality by an analysis of market power and the price elasticity of demand.

The description and interpretation of empirical outcomes[1] are out of scope for this contribution, which has a methodological nature. Only the estimated coefficients of the regression are reported in appendix. This contribution is part of a larger project on Italian Export Quality realized with the support and scientific contribution of Intesa Sanpaolo s.p.a., Manlio Masi Foundation, Italian Foreign Trade Institute, Italian Institute for Economic Analysis (ISAE) and Bank of Italy. The outcomes of the research project, with a full results description and interpretation, have been published in Lanza and Quintieri (2007).

2 Measuring quality variation

2.1 Intra-industry trade and international trade theory

A large body of empirical studies shows that price differentiation across destination markets is the rule, rather than the exception, in the pricing behavior of exporters of industrial countries. Exchange rate swings induce firms, endowed with some degree of market power, to adopt optimal (short run) price strategies. Two main pricing strategies are commonly considered (Basile *et al.*, 2007): (i) pricing the same good differently according to the markets where it is sold (pricing-to-market) and (ii) pricing the same good differently to competitors according to its quality level (vertical-differentiation).

Relevant macroeconomic consequences of both strategies are incomplete exchange rate pass-through and deviations from the law of one price, such that the classical textbook reaction of the current account to exchange rate modifications (based on the Marshall-Lerner requirements on export and import price elasticities) can be considerably diluted. Necessary conditions for price discrimination, consequent on exchange rate movements, involve market-structure characteristics, functional forms of demand faced by firms in the various destination markets and degree of integration of trading countries.

[1]From 2000 to 2005 the Italian economy showed a puzzle, combining a sharp decline in competitiveness with high export prices. Italian market share in volume was 8.9% in 1995, declined to 6% in 2000 and to 5.7% in 2005. During the same period, unit labour costs have increased markedly. Yet, between 2004 and the third quarter of 2007 Italian exports average unit values continued to increase at an average annual rate of 7.5% (Source: Istat, Italian Statistical Office, *www.istat.it*). This evidence is even stronger in traditional sectors where AUV increased also in conjunction with an appreciation of the Euro and an increasing international competitive pressures (Basile *et al.*, 2007). Empirical evidence shows that Italy from 2000 to 2005 seems able to defend its position in traditional sectors' upper market segment.

In this paper we focus on price-setting strategies originated by different good's quality levels leading to intra-industry trade and vertical-differentiation.

The intra-industry trade can be originated by a segmented market structure either by different process along the production chain leading to heterogeneous product's quality level among countries[2]. The portion of trade between two countries within the same sectors or products (intra-industry trade) can be revealed by the standard index proposed by Grubel and Lloyd (1975). This indicator regards as intra-industry trade only the bilateral overlapping flows of the same production; the remainder of trade between two countries is classified as inter-industry trade. This distinction brings in a theoretical critique to Grubel and Lloyd (1975) and highlights index's limitations: it is unlikely suppose to distinguish between trade flows according to various theories of international trade, regarding only the intensity of intra-industry trade in a given sector. In particular, it is simplistic separate sectors with growing scale economies and imperfect competition on the basis of the existence of two-way trade within the sector. Two-way intra-industry trade is discussed (Falvey and Kierzkowski, 1987; Davis, 1995; Petrucci and Quintieri, 2001) in the theoretical context of Heckscher-Ohlin-Ricardo. This assumption is denied by Helpman and Krugman (1985) that allows for one-way intra-industry trade flows due entirely to the very market structure: according to simple New Trade Theory models, two-way trades are allowed in countries sufficiently dissimilar in size as a consequence of the home market effect.

Furthermore, theories based on comparative advantages and those based on market structure may not be entirely alternatives. For example the New Trade Theory explains better trades at a more disaggregated level, while the neoclassical theory is better suited to explain trades between aggregates sectors (Davis and Weinstein, 2003). However in reality it is perfectly acceptable that trades between country A and country B in a given sector are caused mainly by the market structure, while trades between country A and country C in that same sector are due to comparative advantages[3].

This issue becomes more relevant introducing the concept of vertical intra-industry trade, which considers a qualitative distinction between imports and exports. In this context the use of a dichotomous distinction of flows attributable to the neoclassical theory or the new trade theory is clearly misleading. This issue is evident when quality levels match with heterogeneous factorial provision or differences in production technologies, in this case intra-industry trade is due to comparative advantages (Falvey and Kierzkowski, 1987).

2.2 Absolute export quality variation

Aw and Roberts (1986) developed a relevant methodology to measure trade policies effects of quality-upgrade on U.S. imports. It is assumed that, if the various products categories are vertically differentiated, it could be revealed by differences in AUV. A prerequisite of this approach, therefore, is focus on sufficiently homogeneous goods, so the comparison in quantity and AUV is

[2]However, the latter is less plausible when the comparison is done using high disaggregated categories (8-10 digits), where products classification already distinguish among quality levels.

[3]Imagine, for example, that country A and country B are similar, and trade varieties of the same good, while C, having a different production structure, will benefit from trading the same good with different countries.

meaningful[4]. Moreover, as Aw and Roberts design this methodology for import flows, so they partition by supplier country. However, while the quality of exported goods derives essentially from production structure and comparative advantages (Falvey and Kierzkowski, 1987; Petrucci and Quintieri, 2001), the factors influencing imports quality are more difficult to reveal (GDP per capita, internal distribution of income, preferences, demand structure etc.) as pointed out by Hallak and Schott (2005).

Aw and Roberts calculate a synthetic index, we can define it price-quality index, as the simple ratio of the total value of all goods imported (exported) in the sector and the total quantity (PQ^t).

Considering the products $g = 1, ..., n$ and importing (or exporting) countries $c = 1, ..., m$ the percentage change of the price-quality index (ΔPQ^t), is as follows:

$$\Delta PQ^t = \frac{PQ^t - PQ^{t-1}}{PQ^{t-1}} \tag{1}$$

where

$$PQ^t = \frac{\sum\limits_g \sum\limits_c v_{gc}^t}{\sum\limits_g \sum\limits_c q_{gc}^t}$$

v_{gc}^t is import (export) value of good g from (to) country c at time t , while q_{gc}^t is the corresponding quantity.

This variation over time is determined by three effects: (i) the evolution of individual product-country components of the AUV, (ii) the change in sector's product composition and (iii) changes in the geographical origin (destination) of traded goods. In particular, the PQ^t index can increase either for an increase of goods AUV, either for a growing share of high AUV goods within the sector, or for a growing weight of countries exporting (importing) higher AUV goods.

Aw and Roberts use the Tornqvist index to evaluate increase in AUV within individual product-country combination ($\Delta\tilde{P}^t$):

$$\Delta\tilde{P}^t = \sum_g \sum_c S_{gc}^t \frac{P_{gc}^t - P_{gc}^{t-1}}{P_{gc}^{t-1}} \tag{2}$$

where

$$S_{gc}^t = \frac{1}{2}\left(\frac{v_{gc}^t}{\sum_g \sum_c v_{gc}^t} + \frac{v_{gc}^{t-1}}{\sum_g \sum_c v_{gc}^{t-1}}\right) \qquad and \qquad P_{gc}^t = \frac{v_{gc}^t}{q_{gc}^t}$$

The difference between ΔPQ^t and the Tornqvist index point out the change in the overall price-quality due to a change in the composition of goods exported or imported:

$$\Delta Q^t = \Delta PQ^t - \Delta\tilde{P}^t \tag{3}$$

The index tracks effect due to composition changes in the product mix and in supplying (destination) countries. To distinguish these two effects we can

[4]It is not sufficient Including only goods denominated in the same quantity measurement units. Indeed, if one sector includes very heterogeneous goods, the comparison between AUV could be misleading.

calculate a partial Tornquist index for each of the (product or geographical) determinant.

We denote this index $\Delta\widetilde{Pi}^t$ for determinant i:

$$\Delta\widetilde{Pi}^t = \sum_i S_i^t \frac{P_i^t - P_i^{t-1}}{P_i^{t-1}} \tag{4}$$

where

$$S_i^t = \frac{1}{2}\left(\frac{\sum_j v_{ij}^t}{\sum_i \sum_j v_{ij}^t} + \frac{\sum_j v_{ij}^{t-1}}{\sum_i \sum_j v_{ij}^{t-1}}\right) \qquad and \qquad P_i^t = \frac{\sum\limits_j v_{ij}^t}{\sum\limits_j q_{ij}^t} \qquad with \qquad i,j = g,c$$

Considering the partial index we can build an indicator that gather sector composition changes as:

$$\Delta Qg^t = \Delta PQ^t - \Delta\widetilde{Pg}^t \tag{5}$$

Similarly we can estimate changes in the geographical composition of imported or exported goods:

$$\Delta Qc^t = \Delta PQ^t - \Delta\widetilde{Pc}^t \tag{6}$$

The product composition index (ΔQg^t) have a positive value if there is a shift towards goods with higher AUV on average. Similarly, if increases the weight of the countries importing (exporting) higher AUV goods, then the geographic composition index (ΔQc^t) shows a positive value. We may think that supplier countries with highest AUV in the individual goods are also specialized in higher AUV goods within the considered sector. The same may be true for exports if, in wealthy markets, exporters setting higher prices on average face higher demand for sectors with higher AUV on average. Therefore simply summing $\Delta Qg^t + \Delta Qc^t$ quality change may be overestimated (or underestimated) when there is a strong correlation between product composition and geographic composition. Is therefore necessary calculate an interaction term between the two effects (ΔQcg^t):

$$\Delta Qcg^t = \Delta Q^t - \Delta Qg^t - \Delta Qc^t \tag{7}$$

We can identify four effects affecting change in the overall price-quality: the product-country AUV effect ($\Delta\tilde{P}^t$), the product-composition effect (ΔQg^t), the geographical-composition effect (ΔQc^t) and the interaction term between product and geographical composition.

The index ΔPQ^t can be decomposed as:

$$\Delta PQ^t = \Delta\tilde{P}^t + \Delta Qg^t + \Delta Qc^t + \Delta Qcg^t \tag{8}$$

The contribution from Menzler-Hokkanen and Langhammer (1994) point out that the Aw and Roberts approach considers only macro changes rather neglecting product-country joint effects. Price or composition macro effects may be generated by the sum of different contributions sometimes with opposite sign. Considering a sharp increase in the AUV of certain products and a sharp decrease in others is substantially different from considering many small and similar variations at the product-country level, even if the aggregated outcome can be similar.

The change in the total price-quality is then split, considering the contributions of individual productions. Menzler-Hokkanen and Langhammer identify the contribution (E_{gc}^t) of each product-country variation on the aggregate price-quality change as follows:

$$E_{gc}^t = \left[\left(\frac{v_{gc}^t}{\sum_g \sum_c q_{gc}^t} - \frac{v_{gc}^{t-1}}{\sum_g \sum_c q_{gc}^{t-1}} \right) - \left(\frac{q_{gc}^t}{\sum_g \sum_c q_{gc}^t} - \frac{q_{gc}^{t-1}}{\sum_g \sum_c q_{gc}^{t-1}} \right) PQ^t \right] \frac{1}{PQ^{t-1}}$$

The authors consider $\left(v_{gc}^t / \sum_g \sum_c q_{gc}^t - v_{gc}^{t-1} / \sum_g \sum_c q_{gc}^{t-1} \right)$ as the contribution to the index change, from which a substitution effect is subtracted. Summing elements we can obtain the overall price-quality variation index:

$$\Delta PQ^t = \sum_g \sum_c E_{gc}^t \tag{9}$$

The empirical analysis conducted by Menzler, Hokkanen and Langhammer on chairs' imports in France identify that some country-product suppliers have a strong influence on the variation of the aggregate price-quality. This methodology, therefore, may provide new insight on the determinants affecting ΔPQ^t. The contribution of Menzler-Hokkanen and Langhammer (1994) compares empirical outcomes from the Menzler, Hokkanen and Langhammer and the Aw and Roberts' approach highlighting that Menzler, Hokkanen and Langhammer methodology miss the different overall effects (AUV internal variation and composition).

To tackle these difficulties we consider both the outlined concepts together. Our method, in fact, decomposes the variation in aggregate price-quality (ΔPQ^t) between overall effects (similar to Aw and Roberts) and the composition effect in each product-market.

As in Aw and Roberts (1986) the variation in aggregate price-quality (PQ_t) is calculated as the ratio of total value on quantity of exported goods. The variation of this indicator is therefore split into three different overall effects.

The internal effect (ΔP^t) aims to capture the AUV variation within the individual product-country combination between two periods in time. It is derived from a weighted average of percentage changes in the individual elements' AUV. To prevent that the internal effect is influenced by changes in the products mix or geographic mix each variation is weighed according to the share of this component in exports (imports) at the initial period. We first identify an effect on the single product-market and then a total index derived from the sum of each effect:

$$\Delta P_{gc}^t = \frac{v_{gc}^{t-1}}{\sum_g \sum_c v_{gc}^{t-1}} \frac{P_{gc}^t - P_{gc}^{t-1}}{P_{gc}^{t-1}} \qquad \text{with} \qquad P_{gc}^t = \frac{v_{gc}^t}{q_{gc}^t} \tag{10}$$

The overall price index, therefore, match with the Laspeyres index:

$$\Delta P^t = \sum_g \sum_c \Delta P_{gc}^t \tag{11}$$

The exported product-mix variation is hit by the composition effect (ΔC^t). This indicator shows a positive value if, in the sector, it is present a growing share of exports (imports) in product-market with AUV higher than average. A positive composition effect may reveal a quality improvement being based on a change in the exported (imported) goods or a modification in the supply (demand) markets composition. Although it is possible to distinguish between a product and geographic composition effect, it seems more appropriate consider the overall indicator joint with the information embedded in the product-country partition to hit goods and markets that have affected most the aggregate outcome. For any product-country pair the composition effect is defined as:

$$\Delta C_{gc}^{t} = \frac{P_{gc}^{t-1} - PQ^{t-1}}{PQ^{t-1}} \left(\frac{q_{gc}^{t}}{\sum_g \sum_c q_{gc}^{t}} - \frac{q_{gc}^{t-1}}{\sum_g \sum_c q_{gc}^{t-1}} \right) \tag{12}$$

and in aggregate terms as:

$$\Delta C^{t} = \sum_g \sum_c \Delta C_{gc}^{t} \tag{13}$$

The last effect, defined combined effect (ΔCB^{t}), takes a positive value if, in the sector, increases the market share of goods showing a significant increase in AUV, or decreases the weight of product-country with a below average AUV variation. The combined effect (ΔCB_{gc}^{t}) for each element is given by:

$$\Delta CB_{gc}^{t} = \frac{\left(P_{gc}^{t} - P_{gc}^{t-1}\right) - \left(PQ^{t} - PQ^{t-1}\right)}{PQ^{t-1}} \left(\frac{q_{gc}^{t}}{\sum_g \sum_c q_{gc}^{t}} - \frac{q_{gc}^{t-1}}{\sum_g \sum_c q_{gc}^{t-1}} \right)$$

and at the macro level:

$$\Delta CB^{t} = \sum_g \sum_c \Delta CB_{gc}^{t} \tag{14}$$

By summing the calculated effects we can determine the contribution of each combination product-country (E_{gc}^{t}) to the changes in the overall price-quality variation:

$$E_{gc}^{t} = \Delta P_{gc}^{t} + \Delta C_{gc}^{t} + \Delta CB_{gc}^{t} \tag{15}$$

Moreover, E_{gc}^{t} is designed in accordance with the Menzler-Hokkanen and Langhammer's contribution. The variation in the aggregate price-quality can be obtained either by adding the overall effects, or by aggregating the individual product-market contributions:

$$\Delta PQ^{t} = \Delta P^{t} + \Delta C^{t} + \Delta CB^{t} = \sum_g \sum_c E_{gc}^{t} \tag{16}$$

The above described methodology may provide useful insight on the in imports qualitative variation but, while analyzing exports, it is more relevant estimate the goods' quality in a specific country in relation with those of competitors. Moreover, these export quality variation measurements does not account for shifts in the geographical structure of world's demand, how this shift affect the traded product composition and how has been affected AUV of competing goods in different markets. In the next paragraph we will present a quality estimation which incorporates these dynamics.

2.3 Relative export quality variation

Assessing the exports quality of a country against competitors and its evolution over time can be an important contribution in understanding the country positioning in international trade markets[5].

Indeed, we cannot rely only on the cross-sector specialization to understand the country specific pattern of trade and analyze its strengths and weaknesses. In some case it may be relevant understand whether a country's exports are concentrated in qualitatively high or low segments within sectors. Referring to the comparative advantages frame the intra-sector quality specialization may be as relevant as the inter-sector specialization.

Given a benchmark market, which may be the world market, we propose[6] to compute as an overall index measuring the difference in price and quality among the reference exporting country i and the benchmark M. This price-quality difference (ΓPQ_i^t) is the percentage difference between the price-quality indicator seen previously computed for country i and for the total world M exports:

$$\Gamma PQ_i^t = \frac{PQ_i^t - PQ_M^t}{PQ_M^t} \qquad \text{with} \qquad PQ_j^t = \frac{\sum_g v_{gj}^t}{\sum_g q_{gj}^t} \qquad j = i, M \tag{17}$$

The indicator is positive if overall prices-quality of exported goods from country i are higher than global values. Again the aggregate indicator is determined by various effects, the price-quality effect is summarized by the following relation:

$$\Gamma PQ_i^t = \Gamma P_i^t + \Gamma C_i^t + \Gamma CB_i^t \tag{18}$$

Goods with higher AUV than world average are exported first. This is shown by the internal differentiation index (ΓP_i^t) that is computed as a weighted average of country i's AUV for each considered product.

$$\Gamma P_i^t = \sum_g \frac{q_{gM}^t}{\sum_g q_{gM}^t} \frac{P_{gi}^t - P_{gM}^t}{PQ_M^t} \qquad \text{with} \qquad P_{gj}^t = \frac{v_{gj}^t}{q_{gj}^t} \qquad j = i, M \tag{19}$$

The weights applied to the average are based on the share of each good in world exports for the sector. This procedure excludes that a country specialization would influence the internal differentiation index. Within a sector, in fact, a country may be specialized in products with high or low AUV. Overall this phenomenon is captured by the indicator defined composition difference ΓC_i^t.

The composition difference is positive if the share of export with higher AUV is larger in country i than the overall world exports' share. It is calculated as follows:

$$\Gamma C_i^t = \sum_g \frac{P_{gM}^t - PQ_M^t}{PQ_M^t} \left(\frac{q_{gi}^t}{\sum_g q_{gi}^t} - \frac{q_{gM}^t}{\sum_g q_{gM}^t} \right) \tag{20}$$

[5] In this section only export trade flows are considered, appearing the comparison to competitors a more meaningful measure for exports. However, it is meaningful fit this methodology to estimate a qualitative comparison between imports of two or more countries.

[6] This measurement method is somehow similar to the one described by Capotorti (1983).

Finally the combined difference indicator (ΓCB_i^t) has positive value if the country i is specialized in productions in which the AUV of its exports are higher than that of world exports.

$$\Gamma CB_i^t = \sum_g \frac{P_{gi}^t - P_{gM}^t}{PQ_M^t} \left(\frac{q_{gi}^t}{\sum_g q_{gi}^t} - \frac{q_{gM}^t}{\sum_g q_{gM}^t} \right) \tag{21}$$

Unlike ΓC_i^t, the effect of combined difference does not evaluate whether there is a specialization in production showing overall higher quality. Instead, the combined difference accounts for sectors in which country's exports have AUV higher than its competitors. A positive value, therefore, reveals a strong market power or a high quality level in those productions in which the country shows a specialization, while exports have AUV higher than competitors. Indeed, AUV higher in some productions would derive mainly from factors other than quality as lower production efficiency; we would expect the country specializing in these goods. Both the aggregate indicator of price-quality difference (ΓPQ_i^t) and the decomposed indexes can be calculated in different time frames; index variations can be used to assess changes in quality.

As in all the measurements that compare different scales, we must take into account the fact that changes of these indicators depends on the dynamics of different variables. In particular, both the shift of country i export quota and the changes in world exports contribute jointly to indexes change. It is not possible to distinguish the two effects within this simple framework; next section tries to overcome these interpretative limitations proposing a quality estimation methodology based on price elasticity of export demand.

3 The quality effect on price elasticity of exports residual demand

One of the problems that emerge measuring relative quality (ΓP_i^t) lies in understanding the determinants of differences in the AUV of individual goods. Similarly, when analyzing changes in absolute quality, the internal dynamics of each combination product-country (ΔP^t) lends itself to different interpretations. The key question is to understand if, for example, positive values of ΓP_i^t suggests a higher quality level towards competitors and, to what extent, positive values of ΔP^t reflect an improvement in quality. Other contingent factors (e.g. exchange rate fluctuations) and structural factors (e.g. loss of competitiveness) could affect the export prices beside quality variation. Moreover, if we account for AUV and not individual exporting firms prices, higher AUV can be induced by low-quality producers leaving the market. In this case the increased average quality level of exports will not imply a quality upgrade intended as a strategy pursued by producers of a certain sector.

We saw in the previous section as the combined difference indicator (ΓCB_i^t), may provide some evidence that highest AUV are actually related to higher quality level. But this is partial information: any horizontal differentiation among goods, even without qualitative differences, leads to differences in competitors prices (Meltiz, 2003). In this case, a less efficient country, with higher production costs, could be forced to charge higher prices. But we must stress that, if the country is specialized in the high-price production, we would have further evidence in favor of a higher quality of its exports pointing out that the country faces a less tough competition. A similar methodology has been proposed by Hallak and Schott (2005).

In this vein we can derive an indirect quality estimation based on the relation intervening between vertical differentiation and market power. We can refer at market power as the ability of a firm - or a set of exporters - to charge prices above the competitors while it has resilient position in destination markets. Quality, as not observable attribute, directly influences the degree of consumer's preference and therefore affects market power of high quality segments exporters. We can then use market power, or the level of substitutability between country i products and those of competitors, as proxy of exports quality. The market power is not only influenced by the degree of vertical differentiation, but also from other factors related primarily to the very structure of the market[7] and the presence of entry barriers[8]. Assuming that vertical differentiation is the predominant element of market power it then is more plausible focus on industries with a low supply concentration and a competitive environment near free market[9].

Section 3.1 presents a theoretical justification of the relationship between price elasticity of demand and quality changes. In particular it will prove that elasticity in absolute value would be lower if there is vertical goods differentiation.

3.1 A micro-founded model with vertically differentiated products

The choice of using price elasticity of market share[10] to estimate exports quality is based on the assumption that the products have different inherent characteristics (Lancaster, 1979) leading to different consumer's reactions to price changes (Chiarlone, 2000).

Let's consider an economy divided in s sectors, whose products meet similar needs; the representative consumer's utility function U aggregates utility associated with each sector u_s in utility level $U = U(u_1, u_2, \dots u_n)$. Assuming function U separable in its components, the consumer splits her disposable income I attributing spending to the different sectors $I = I_1 + I_2 + \cdots + I_n$. Let's assume that goods in sector j are primarily differentiated by country of origin (Armington, 1969) and that sub-utilities (u_j) shows additive preferences *addi-log*, as described in Houthakker (1960) and Clarida (1996). The representative consumer, therefore, address the following maximization problem for each sector:

[7] Factors as market concentration, the span of control of the enterprise on the distribution chain and vertical integration.

[8] Protectionism and in particular tariffs and non-tariffs barriers, incentives and regulations that limit competition.

[9] We expect these conditions being plausible for Italian traditional sectors, given the increasing international markets integration. Traditional sectors, at least in Italy, are generally characterized by small medium enterprises with small-scale structure and relatively low fixed-costs and a low-regulation that facilitate new players' entry.

[10] In this section we use the term *share* to refer to the relationship between quantity exported from one country and those of competitors in a given market. Although this ratio indicates proper volume market share, we believe that the relationship between the two concepts is so tight to make this approximation acceptable.

$$\begin{aligned} \max\ u &= \frac{X_c^{1-\alpha_1}}{1-\alpha_1} + \frac{X_i^{1-\alpha_2}}{1-\alpha_2} \\ t.c. &\quad I \leq P_i X_i + P_c X_c \end{aligned}$$

where P_i and P_c are respectively the price of goods from country i and competing country c and X is the amount consumed of the two goods. The parameters α_1 and α_2 are both positive and determine the shape of the indifference curves, therefore, the marginal substitution rate between the two products.

We can introduce quality differentiation following the specification of Lancaster (1979) whereas a further variable (Q) expresses the tangible and intangible products quality exported.

Assume further that better quality imply higher price. Prices, therefore, are also functions of goods quality, according to the relations $P_i = P(Q_i, G_i)$ and $P_c = P(Q_c, G_c)$, where G is an exogenous variable gathering price variations due to factors other than quality. G can be influenced also by factors such as country labor cost, sector productivity, exchange rate movements and pricing strategies implemented by exporters, irrespective of products quality changes. Function P, therefore, depends positively on quality $\frac{\partial P}{\partial C} > 0$ and exogenous shocks $\frac{\partial P}{\partial G} > 0$.

Trade-off between price and quality level is implicit in this relation. Increasing quality has double impact of inverse sign on demand. On one hand a higher quality means higher price, which impacts negatively on the amount demanded, on the other quality increases the marginal consumer's utility, increasing the demand. We can derive this hypothesis formally starting from maximizing the utility of a representative agent with preference toward quality:

$$\begin{aligned} \max\ u &= \frac{X_c^{1-\alpha_1} Q_c^{\gamma}}{1-\alpha_1} + \frac{X_i^{1-\alpha_2} Q_i^{\gamma}}{1-\alpha_2} \\ t.c. &\quad I \leq P_i X_i + P_c X_c \end{aligned}$$

where the parameter $\gamma \geqslant 0$ is the preference attached by the consumer to quality. This parameter is sector and market specific[11].

From the utility constrained maximization (22) we obtain the residual demand towards country i exporters:

$$X_i = X_c^{\frac{\alpha_1}{\alpha_2}} \left(\frac{Q_i}{Q_c}\right)^{\frac{\gamma}{\alpha_2}} \left(\frac{P_i}{P_c}\right)^{-\frac{1}{\alpha_2}} \tag{22}$$

with a logarithmic transformation we get:

$$\tilde{X}_i = \frac{\alpha_1}{\alpha_2}\tilde{X}_c + \frac{\gamma}{\alpha_2}\tilde{Q}_i - \frac{\gamma}{\alpha_2}\tilde{Q}_c + \frac{1}{\alpha_2}\tilde{P}_c - \frac{1}{\alpha_2}\tilde{P}_i \tag{23}$$

where $\tilde{Z} = \ln(Z)$.

The quality impact on the residual demand is captured by $h = \left(\frac{Q_i}{Q_c}\right)^{\frac{\gamma}{\alpha_2}}$. The preference parameter γ, is relevant in determine the effect of qualitative

[11] Hallak and Schott (2005) have tested empirically the importance of quality preference differentiation among different markets and sectors, to warrant international trade flows.

differentiation on demand. In particular, consumer has no preference towards better quality goods where $\gamma = 0$. It follows that h will be equal 1 and the quality effect will be zero: it is a perfectly competitive market, where the amount demanded depends solely upon price. In other instances, if country i exports products superior to those of competitors ($Q_i > Q_c$), quality differentiation will have a positive impact on residual demand.

We can now derive the quality shift effect on demand for country i. Assuming no strategic interaction between competitors on price or goods quality, the elasticity of demand to a variation of Q_i will be given by:

$$\frac{\partial \tilde{X}_i}{\partial \tilde{Q}_i} = \underbrace{\frac{\gamma}{\alpha_2}}_{+} \underbrace{- \frac{1}{\alpha_2} \frac{\partial \tilde{P}_i}{\partial \tilde{Q}_i}}_{-} \tag{24}$$

As suggested earlier, because $\frac{\partial \tilde{P}_i}{\partial \tilde{Q}_i} > 0$, an increase in quality has a dual impact on demand opposite in sign. The overall effect on the variation of the residual demand addressed to country i is not univocal, but it depends on consumer preference attached to quality (γ) and on the qualitative change effect on price ($\frac{\partial \tilde{P}_i}{\partial \tilde{Q}_i}$).

If we consider price elasticity of demand not depending on quality shift, recalling $\frac{\partial \tilde{P}_i}{\partial \tilde{G}_i} > 0$, we observe that:

$$\underbrace{\frac{\partial \tilde{X}_i}{\partial \tilde{G}_i}}_{-} = - \frac{1}{\alpha_2} \underbrace{\frac{\partial \tilde{P}_i}{\partial \tilde{G}_i}}_{+} \tag{25}$$

A positive shock of $\tilde{G}_i$ corresponds to a decrease in demanded quantity. Dividing by $\partial \tilde{P}_i$ and multiplying by $\partial \tilde{G}_i$ we get:

$$\frac{\partial \tilde{X}_i}{\partial \tilde{P}_i} = - \frac{1}{\alpha_2} \tag{26}$$

This equation describes the price elasticity of demand due to a price change caused only by factors other than quality[12]. The impact of a price shock not dependent on quality is equal to the price elasticity in case of not vertically-differentiated goods (Chiarlone, 2000)[13].

Whereas price $\tilde{P}_i$ is function of $\tilde{Q}_i$ and of $\tilde{G}_i$, and assuming constant price and quality of competitors, the demand $\tilde{X}_i$ depends ultimately upon $\tilde{Q}_i$ and $\tilde{G}_i$. Then we can express the differential equation $\tilde{X}_i$ in the form:

[12] The result from (26) is obtained from the partial derivative of $\tilde{X}_i$ respect to $\tilde{G}_i$, assuming other variables, including $\tilde{Q}_i$, stay constant.

[13] If the goods are not qualitatively differentiated the simplified form utility would be $u = \frac{\tilde{X}_c^{1-\alpha_1}}{1-\alpha_1} + \frac{\tilde{X}_i^{1-\alpha_2}}{1-\alpha_2}$. By maximizing the agent utility under budget constraint we get the demand function $\tilde{X}_i = \tilde{X}_c^{\alpha_1/\alpha_2} (\tilde{P}_i/\tilde{P}_c)^{-1/\alpha_2}$. The price elasticity in the case of homogeneous goods is therefore $\partial \tilde{X}_i / \partial \tilde{P}_i = -1/\alpha_2$.

$$\begin{aligned}
\mathrm{d}\tilde{X}_i &= \frac{\partial \tilde{X}_i}{\partial \tilde{Q}_i}\mathrm{d}\tilde{Q}_i + \frac{\partial \tilde{X}_i}{\partial \tilde{G}_i}\mathrm{d}\tilde{G}_i \\
&= \left(\frac{\gamma}{\alpha_2} - \frac{1}{\alpha_2}\frac{\partial \tilde{P}_i}{\partial \tilde{Q}_i}\right)\mathrm{d}\tilde{Q}_i - \frac{1}{\alpha_2}\frac{\partial \tilde{P}_i}{\partial \tilde{G}_i}\mathrm{d}\tilde{G}_i \\
&= \frac{\gamma}{\alpha_2}\mathrm{d}\tilde{Q}_i - \frac{1}{\alpha_2}\underbrace{\left(\frac{\partial \tilde{P}_i}{\partial \tilde{Q}_i}\mathrm{d}\tilde{Q}_i + \frac{\partial \tilde{P}_i}{\partial \tilde{G}_i}\mathrm{d}\tilde{G}_i\right)}_{\mathrm{d}\tilde{P}_i} \\
\mathrm{d}\tilde{X}_i &= \frac{\gamma}{\alpha_2}\mathrm{d}\tilde{Q}_i - \frac{1}{\alpha_2}\mathrm{d}\tilde{P}_i
\end{aligned}$$

dividing both members by $d\tilde{P}_i$ we get:

$$\frac{\mathrm{d}\tilde{X}_i}{\mathrm{d}\tilde{P}_i} = \frac{\gamma}{\alpha_2}\frac{\mathrm{d}\tilde{Q}_i}{\mathrm{d}\tilde{P}_i} - \frac{1}{\alpha_2} \tag{27}$$

Comparing results obtained from (27) and from (26), we can highlight price elasticity of demand in case of a quality shift. When the price changes depend solely upon exogenous factors (G_i) thus $\frac{\partial \tilde{X}_i}{\partial \tilde{P}_i} = -\frac{1}{\alpha_2}$ as in the case of not differentiated goods. If the price change is also linked to changes in the quality of products, the elasticity depends on a further component: $\frac{\gamma}{\alpha_2}\frac{\mathrm{d}\tilde{Q}_i}{\mathrm{d}\tilde{P}_i}$. This factor in turn has affected the importance attached by consumers to quality ($\gamma \geqslant 0$) with the factor $\frac{\mathrm{d}\tilde{Q}_i}{\mathrm{d}\tilde{P}_i}$, which is the converse of quality variation elasticity of price. So if $P(Q,G)$ is always differentiable and monotonous-growing in Q, as we have assumed, the component $\frac{\mathrm{d}\tilde{Q}_i}{\mathrm{d}\tilde{P}_i}$ will be positive and inversely proportional to quality variation on prices. We can therefore state that:

$$\frac{\gamma}{\alpha_2}\frac{\mathrm{d}\tilde{Q}_i}{\mathrm{d}\tilde{P}_i} - \frac{1}{\alpha_2} > -\frac{1}{\alpha_2} \tag{28}$$

In summary, the price elasticity of demand, in a context of vertical products differentiation reduces (in absolute value) as the quality of exported products increases.

We derive this result assuming that price, quantity and quality of competing goods remain unchanged and analyzing the variations, in absolute terms, of country i factors. However, it is relevant consider also the relative variables' dynamics including strategic interaction. For example, what is the impact on market share if the price or quality of exported goods grows in excess compared to competitors? Introducing the assumption $\alpha_1 = \alpha_2 = \alpha$, we can rewrite the demand function (22) entirely in relative terms [14]:

[14]The assumption $\alpha_1 = \alpha_2 = \alpha$ in presence of quality differentiation seems quite plausible. Indeed, if α_1 differed from α_2, this would imply that consumers have a preference, a priori and unchanging over time, for a specific country's products, regardless of the tangible and intangible characteristics (Q). The reputation of a country in the production of a certain sector, even if present, is variable over time, and quality standards must be maintained so that this advantage will not erode over the long term. This assumption would not be plausible in the frame of import demand, whereas consumer tent to be bias towards home country products.

$$\frac{X_i}{X_c} = \left(\frac{Q_i}{Q_c}\right)^{\frac{\gamma}{\alpha}} \left(\frac{P_i}{P_c}\right)^{-\frac{1}{\alpha}} \tag{29}$$

in logarithmic form:

$$\tilde{x}_{ic} = \frac{\gamma}{\alpha}\tilde{q}_{ic} - \frac{1}{\alpha}\tilde{p}_{ic} \tag{30}$$

where $\tilde{z}_{ab} = \ln(Z_a/Z_b)$.

We can analyze the elasticity of the ratio of exported quantity (which we will call for simplicity *shares*) to changes in relative prices and quality Using the same derivation seen above. Again, if changes in relative prices are not linked to changes in quality (Q_i/Q_c), the elasticity is simply equal to $-1/\alpha$. If we encounter changes in quality, the relative price elasticity of volume share will decline.

$$\frac{\mathrm{d}\tilde{x}_{ic}}{\mathrm{d}\tilde{p}_{ic}} = \frac{\gamma}{\alpha}\frac{\mathrm{d}\tilde{q}_{ic}}{\mathrm{d}\tilde{p}_{ic}} - \frac{1}{\alpha} > -\frac{1}{\alpha} \tag{31}$$

Appendix A suggests an empirical regression exercise based on the above model.

4 Conclusions and policy implications

The measurement of goods' quality in international trade and its dynamic is undoubtedly an ambitious goal. In modern economic literature several methods have been proposed, some of which are analyzed, compared and extended in this contribution. Original solutions are presented to overcome specific interpretative limitations of standard methods. The first part of this work presents intra-trade indicators, assessing the importance of vertical differentiation in international trade. Than a methodology inspired by Aw and Roberts contribution is presented: the first part study the evolution of export and the impact of absolute quality variations; the second part examine the effect of relative quality variation on country's export versus competitors. These indicators can be influenced by quality variations but also by other structural and cyclical factors (competitive advantages, exchange rate, producer price index, labor cost, etc.). The last part of the paper presents a micro-founded model based on the relation between vertical product differentiation, good's substitutability and exporter's market power showing that an increase in export quality can lead to a lower residual demand elasticity.

A strong firm selection process is in place in Europe and vertical differentiation of products may profoundly impact trade policies. Most theories of intra-industry trade predict that countries enjoying greater productivity will ship low-price varieties. Many trade policies are inspired by this framework but predictions conflict with the presented model and empirical evidences. As it turns out, advantages in terms of productivity result in exports that have higher, not lower prices (Baldwin and Harrigan, 2007). This implies that there is not endowment-driven specialization across products, but on the contrary, endowment-driven specialization across varieties within products. Such a shift

This is not the case in the proposed model because we avoid including the incumbent in the home market among country i competitors.

in our understanding of international specialization should leads to different trade policy and prevents us from drawing conclusions regarding the competitive pressures that high-income countries face from emerging economies. If varieties exported by Italy and China are too different in quality to be in direct competition, then workers in the two countries do not compete in production of the same varieties. And if the different varieties are not very substitutable, there will be only a weak link between trade and factor prices.

Insights into country relative export quality and its international specialization improve our understanding of the dynamics of international competition and leads to some policy conclusions for developed economies. We are observing shifts in world market shares, with a decreasing in export values share from developed country, actually mirroring this dissimilarity in the specialization of countries at different levels of development within products and across varieties. The popular view that the South is gaining market shares inexorably is too oversimplified; it cannot support sound policy conclusions for advanced economies if it does not include a detailed analysis of price-setting strategy and the quality differentiation among countries. These shifts profoundly differ among market segments, and different countries will be differently affected.

Empirical evidence (Lanza and Quintieri, 2007) shows that Italy from 2000 to 2005 seems able to defend its position in traditional sectors' upper market segment. This leads to trade policy oriented to stimulate quality upgrade by technological shift in traditional sectors, rather than defend internal prices with barriers. Such a shift in production technologies may well have an impact similar to biased technical progress and be detrimental to low-skilled, less adaptable workers. Exporters in emerging economies may not threaten the relative position of unskilled labor in Europe through direct competition in product markets, but indirectly through the labor market effects of up-market positioning strategies adopted by European firms in response to international competition.

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A Estimating Quality

The proposed export demand function specification refers to the theoretical structure described in the previous section (3.1). Therefore, we have to establish a functional form that relates the market shares in quantity, at the product-market level, with exporter's relative price, controlling for structural and cyclical factors affecting demand.

$$\frac{X_{it}^{mg}}{X_{ct}^{mg}} = f\left(\frac{P_{it}^{mg}}{P_{ct}^{mg}}, \Psi_{it}^{mg}, \Theta_{it}\right)$$

where X_{it}^{mg}/X_{ct}^{mg} is the ratio between the amount of country i exports and those of competitors in the market m for good g, while P_{it}^{mg}/P_{ct}^{mg} is the relation between their average unit values. Ψ_{it}^{mg} includes all the structural factors that affect country's positioning in a specific product and market. Referring to gravity models, the structural variables include the Euclidean distance between countries, the relationship between economies size and the level of specialization in the considered productions. Θ_{it} instead captures the cyclical effects influencing uniformly the residual demand of a country on all target markets and industries.

Using a logarithmic specification, we can express relative export demand as follows:

$$\log\left(\frac{X_{it}^{mg}}{X_{ct}^{mg}}\right) = \pi + \beta \log\left(\frac{P_{it}^{mg}}{P_{ct}^{mg}}\right) + \log\left(\Psi_{it}^{mg}\right) + \delta \log\left(\Theta_{t}\right) + \varepsilon_{t}^{mg} \qquad (32)$$

In order to measure dynamic changes in quality we have to compare different periods. The model presented, introducing structural effects specific to each product-market combination (Ψ_{it}^{mg}), considers the inter-temporal, cross-product and cross-market dimensions jointly, limiting the needs of long time series. If we estimate the elasticity for short time periods it is reasonable assuming that structural variables, characterizing each product-market combination, remain constant over time. The equation (32) can be rewritten as follows:

$$\log\left(\frac{X_{it}^{mg}}{X_{ct}^{mg}}\right) = \pi + \beta \log\left(\frac{P_{it}^{mg}}{P_{ct}^{mg}}\right) + \log\left(\Psi_{i}^{mg}\right) + \delta \log\left(\Theta_{it}\right) + \varepsilon_{t}^{mg} \qquad (33)$$

where Ψ_{i}^{mg} is considered constant over time, although obviously varying through target product-market combinations. Ψ_{i}^{mg} can therefore take into account all factors (observable and not observable), which affect country's positioning in a specific market and production, simply using heterogeneous-individual panel model. Specifically, it is natural believe in a correlation between these variables and the structural price differential $\log\left(P_{it}^{mg}/P_{ct}^{mg}\right)$, the most suitable estimators seems fix-effect (within-group and first-difference)[15]. The exports

[15] We considers structural effects as the distance between the exporting country and the destination market. Transportation costs, which usually affect exported goods' price creating a correlation between distance and relative prices, depend upon structural effects. Moreover, the quality in different product-market combinations can be considered a structural variable not observable, correlated with the relative prices that can be estimated through the fix-effect.

demand function is expressed in structural form. To cope with simultaneity between demand and supply instrumental variables are introduced: production price index for the considered sector and lagged endogenous variable $(P^{mg}_{i(t-1)}/P^{mg}_{c(t-1)})$. Moreover high disaggregated export data categories (HS 2002, 6-digits) by destination country are used in order to cope with relatively short time frame.

The presented model has been estimated (coefficients in appendix) for Italian exports in the traditional sectors: footwear; glass and glassware; ceramic products; wine; vegetable oil and furniture.

The product-level data sources are Eurostat *COMTRADE* and Istat *CONISTAT*, the classification used is Harmonized System (HS) at 6-digits level. The time frame considered is 1995-2005 and two sub periods (1995-2000 and 2001-2005) in the aim to compare the elasticity shift over time. We selected the product-market combinations covering 90 % of total Italian exports in each considered sector.

The structural factors Ψ^{mg}_{it} is considered invariant over time and estimated as fix-effect. The cyclical factor Θ_{it} is included as annual dummy variables [16].

Estimation coefficients are reported in appendix: OLS estimates are proposed as benchmark, then a linear fixed-effect model with first-order autoregressive disturbance GLS-AR(1)[17] and a 2SLS model are estimated and compared. The correlation between individual effects and other explanatory variables has been confirmed by Hausmann tests for comparison between model with fixed effects and variance components.

Finally, to cope with endogeneity of the independent variable $\log(P^{mg}_{it}/P^{mg}_{ct})$ due to simultaneity between demand and supply, instrumental variables are used (IV) and two-stage Least Squares (2SLS).

For detailed description and interpretation of the empirical analysis refer to Lanza and Quintieri (2007). It is beyond the scope of this paper that has a methodological nature.

[16] The annual dummy are significance at 95% only for the footwear sector.

[17] The fixed effects estimator for GLS-AR is computed first estimating a standard fixed effect OLS, the result is then used to estimate the degree of autocorrelation of residuals. Given this estimate, $hat\rho$, the Cochran-Orcutt transformation is applied for each panel. Finally, the within-group average is computed and added to the global average for each variable. The β coefficients are produced with OLS on the transformed dataset

	Model without annual effects[a]					
	Fixed-effect estimation			**2SLS with fixed-effect estimation**		
	1996-2005	**1996-2000**	**2001-2005**	**1996-2005**	**1996-2000**	**2001-2005**
β	-1.11***	-1.12***	-1.01***	**-1.46*** **	**-1.82*** **	**-1.06*** **
	-0.1	-0.18	-0.13	-0.39	-0.16	-0.91
intercept	-1.41	-1.35	-1.53	-1.29	-1.18	-1.5
	-0.04	-0.05	-0.07	-0.05	-0.05	-0.07
elasticity difference in two periods		**-0.11**			**-0.76**	
test for equal elasticity in two periods		F(1,1323) 2.82	p-value 0.09			
	Model with annual effects					
	Fixed-effect estimation			**2SLS with fixed-effect estimation**		
	1996-2005	**1996-2000**	**2001-2005**	**1996-2005**	**1996-2000**	**2001-2005**
β	-1.04***	-1.12***	-0.95***	**-1.58*** **	**-1.83*** **	**-1.40*** **
	-0.04	-0.18	-0.16	-0.15	-0.17	-0.15
intercept	-1.23	-1.22	-1.54	-1.31	-1.21	-1.41
	-0.05	-0.07	-0.06	-0.06	-0.06	-0.08
test for significative conjoint annual effects	F(9,1316) 5.11	p-value 0.00		chi2(6) 19.42	p-value 0.00	
elasticity difference in two periods		**-0.17**			**-0.43**	
test for equal elasticity in two periods		F(1,1315) 3.44	p-value 0.06			

Table 1: Footware

[a]Standard errors are robust to heteroskedasticity and internal product-market autocorrelation. *** 99% significative level.

Glassware[a]								
	β		**intercept**		**Oss.**	**F**	**Hausman test**[b]	
OLS[c]							**Diff.**	χ^2
(a) 1995-2005	-0.940228	(-14.34) ***	-2.347158	(-88.27) ***	836	F(1,759)=205.69 ***	0.0388028	5.50 **
(b) 1995-2000	-0.861831	(-9.47) ***	-2.288043	(-72.43) ***	456	F(1,379)=89.61 ***	0.0881235	8.39 ***
(c) 2001-2005	-0.953641	(-11.51) ***	-2.424507	(-73.85) ***	380	F(1,303)=132.46 ***	0.0429786	2.84 *
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =-0.0918091							
	F(1,303)=1.23							
	P-Value=0.2687							
GLS-AR [d]	β		**intercept**		**Oss.**	**F**	ρ	
(a) 1995-2005	-0.968156	(-15.97) ***	-2.377042	(-99.66) ***	760	F(1,683)=255.00 ***	0.5194499	
(b) 1995-2000	-0.971090	(-9.71) ***	-2.275662	(-69.58) ***	380	F(1,303)=94.21 ***	0.35032253	
(c) 2001-2005	-0.991673	(-12.37) ***	-2.521512	(-79.53) ***	304	F(1,227)=153.02 ***	0.30640963	
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =-0.0205833							
	F(1,227)=0.07							
	P-Value=0.7976							
2SLS [e]	β		**intercept**		**Oss.**	**F**		
(a) 1995-2005	-1.331291	(-6.98) ***	-2.316831	(-15.85) ***	835	F(1,834)=48.76 ***		
(b) 1995-2000	-1.598546	(-6.57) ***	-2.230388	(-15.86) ***	455	F(1,454)=43.18 ***		
(c) 2001-2005	-1.316993	(-5.44) ***	-2.396289	(-14.28) ***	380	F(1,379)=29.56 ***		
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.281553							
	F(1,379)=1.35							
	P-Value=0.2458							

Table 2: Glassware

[a] t-statistic absolute values in brackets. Significant: * 10%, ** 5%, *** 1%

[b] Test Hausman H_0 = coefficient difference Fixed Effect - Random Effect not significative

[c] Panel estimation with fixed-effects

[d] Linear model with fixed-effects and $AR(1)$ disturbance, method Durbin-Watson $y_{it} = a + x_{it}B + u_i + e_{it}$ where $e_{it} = \rho * e_{i,t-1} + z_{it}$

[e] 2SLS with instrumental variable $log(P_{it}/P_c)$ lag 1 year.

Ceramic Products[a]								
	β		**intercept**		**Oss.**	**F**	**Hausman test**[b]	
OLS[c]							**Diff.**	χ^2
(a) 1995-2004	-1.256531	(-19.30) ***	-0.783978	(-30.51) ***	410	F(1,368)=372.54 ***	0.1266133	38.11 ***
(b) 1995-2000	-1.653994	(-13.83) ***	-0.66284	(-16.99) ***	246	F(1,204)=191.34 ***	0.0918736	1.26
(c) 2001-2004	-1.057380	(-17.26) ***	-0.8754	(-34.96) ***	164	F(1,122)=298.05 ***	0.0918848	20.39 ***
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.596614							
	F(1,122)=94.89							
	P-Value=0.0000							
GLS-AR [d]	β		**intercept**		**Oss.**	**F**	ρ	
(a) 1995-2004	-1.136200	(-20.02) ***	-0.775052	(-41.84) ***	369	F(1,327)=400.92 ***	0.50851627	
(b) 1995-2000	-1.216661	(-13.23) ***	-0.67898	(-27.18) ***	205	F(1,163)=174.97 ***	0.47723695	
(c) 2001-2004	-1.091419	(-12.10) ***	-0.76411	(-22.87) ***	123	F(1,81)=146.49 ***	-0.07178526	
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.125242							
	F(1,81)=1.93							
	P-Value=0.1687							
2SLS [e]	β		**intercept**		**Oss.**	**F**		
(a) 1995-2004	-1.901321	(-11.53) ***	-0.623559	(-6.87) ***	409	F(1,408)=132.94 ***		
(b) 1995-2000	-1.761593	(-13.93) ***	-0.62907	(-8.51) ***	245	F(1,244)=193.95 ***		
(c) 2001-2004	-1.694078	(-8.39) ***	-0.71327	(-5.32) ***	164	F(1,163)=70.40 ***		
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.067515							
	F(1,163)=0.11							
	P-Value=0.7385							

Table 3: Ceramic Products

[a] t-statistic absolute values in brackets. Significant: * 10%, ** 5%, *** 1%

[b] Test Hausman H_0 = coefficient difference Fixed Effect - Random Effect not significative

[c] Panel estimation with fixed-effects

[d] Linear model with Fixed-Effects and $AR(1)$ disturbance, method Durbin-Watson $y_{it} = a + x_{it}B + u_i + e_{it}$ where $e_{it} = \rho * e_{i,t-1} + z_{it}$

[e] 2SLS with instrumental variable $log(P_{it}/P_c)$ lag 1 year.

			Vegetable Oil [a]					
	β		**intercept**		**Oss.**	**F**	**Hausman test**[b]	
OLS[c]							**Diff.**	χ^2
(a) 1995-2005	-2.557172	(-14.94) ***	-2.184210	(-47.69) ***	803	F(1,729)=223.33 ***	0.2788911	54.00 ***
(b) 1995-2000	-2.449501	(-12.03) ***	-2.1624	(-41.32) ***	438	F(1,364)=144.81 ***	0.3390306	48.42 ***
(c) 2001-2005	-1.199973	(-4.32) ***	-2.42652	(-37.74) ***	365	F(1,291)=18.63 ***	0.7095797	73.15 ***
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =1.249528							
	F(1,291)=20.20							
	P-Value=0.0000							
GLS-AR [d]	β		**intercept**		**Oss.**	**F**	ρ	
(a) 1995-2005	-1.957421	(-12.21) ***	-2.279787	(-58.63) ***	730	F(1,656)=149.08 ***	0.45666248	
(b) 1995-2000	-2.128798	(-11.16) ***	-2.20231	(-45.27) ***	365	F(1,291)=124.49 ***	0.26447511	
(c) 2001-2005	-1.155141	(-3.73) ***	-2.47997	(-37.25) ***	292	F(1,218)=13.93 ***	0.23096583	
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.973657							
	F(1,218)=9.90							
	P-Value=0.0019							
2SLS [e]	β		**intercept**		**Oss.**	**F**		
(a) 1995-2005	-9.093745	(-9.74) ***	-1.202733	(-4.61) ***	802	F(1,801)=94.78 ***		
(b) 1995-2000	-8.733564	(-13.90) ***	-1.18657	(-6.94) ***	437	F(1,436)=193.21 ***		
(c) 2001-2005	-7.701446	(-6.96) ***	-1.4863	(-5.12) ***	365	F(1,364)=48.40 ***		
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =1.032118							
	F(1,364)=0.87							
	P-Value=0.3518							

Table 4: Vegetable Oil

[a] t-statistic absolute values in brackets. Significant: * 10%, ** 5%, *** 1%

[b] Test Hausman H_0 = coefficient difference Fixed Effect - Random Effect not significative

[c] Panel estimation with fixed-effects

[d] Linear model with fixed-effects and $AR(1)$ disturbance, method Durbin-Watson $y_{it} = a + x_{it}B + u_i + e_{it}$ where $e_{it} = \rho * e_{i,t-1} + z_{it}$

[e] 2SLS with instrumental variable $log(P_{it}/P_c)$ lag 1 year.

Wine [a]								
	β		**intercept**		**Oss.**	**F**	**Hausman test**[b]	
OLS[c]							**Diff.**	χ^2
(a) 1995-2005	-1.399407	(-8.15) ***	-1.670044	(-21.38) ***	132	F(1,119)=66.42 ***	-0.3792022	24.08 ***
(b) 1995-2000	-1.633574	(-7.16) ***	-1.91738	(-18.43) ***	72	F(1,59)=51.25 ***	-0.4748452	17.59 ***
(c) 2001-2005	-0.858166	(-4.83) ***	-1.28211	(-17.44) ***	60	F(1,47) ***	-0.1952246	7.35 ***
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.7754084							
	F(1,47)=19.04							
	P-Value=0.0001							
GLS-AR [d]	β		**intercept**		**Oss.**	**F**	ρ	
(a) 1995-2005	-1.677141	(-11.81) ***	-1.660771	(-51.63) ***	120	F(1,107)=139.40 ***	0.65288332	
(b) 1995-2000	-2.218325	(-11.28) ***	-2.10495	(-34.09) ***	60	F(1,47)=127.15 ***	0.38449791	
(c) 2001-2005	-1.007998	(-4.69) ***	-1.33795	(-15.88) ***	48	F(1,35)=21.95 ***	0.01154392	
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =1.210327							
	F(1,35)=31.65							
	P-Value=0.0000							
IV [e]	β		**intercept**		**Oss.**	**F**		
(a) 1995-2005	-1.846218	(-3.85) ***	0.053035	(1.71) *	118	F(1,116)=14.86 ***		
(b) 1995-2000	-2.115386	(-3.66) ***	0.04246	(-0.87)	58	F(1,56)=13.42 ***		
(c) 2001-2005	-0.399858	(-0.42)	-0.02892	(-0.49)	48	F(1,46)=0.17		
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$=1.715528							
	F(1,46)=3.21							
	P-Value=0.0799							

Table 5: Wine

[a] t-statistic absolute values in brackets. Significant: * 10%, ** 5%, *** 1%

[b] Test Hausman H_0 = coefficient difference Fixed Effect - Random Effect not significative

[c] Panel estimation with fixed-effects

[d] Linear model with fixed-effects and $AR(1)$ disturbance, method Durbin-Watson $y_{it} = a + x_{it}B + u_i + e_{it}$ where $e_{it} = \rho * e_{i,t-1} + z_{it}$

[e] IV First-Difference with instrumental variable $log(P_{it}/P_c)$, lag 2 years.

Furniture [a]								
	β		**intercept**		**Oss.**	**F**	**Hausman test**[b]	
OLS[c]							**Diff.**	χ^2
(a) 1995-2005	-1.149136	(-30.72) ***	-1.913947	(-152.29) ***	3872	F(351,3519)=943.42 ***	0.0379664	40.00 ***
(b) 1995-2000	-1.273753	(-26.11) ***	-2.00142	(-147.01) ***	2112	F(1,1759)=681.97 ***	0.0435622	21.69 ***
(c) 2001-2005	-1.316901	(-28.85) ***	-1.75131	(-114.58) ***	1760	F(1,1407)=832.35 ***	0.0515088	24.87 ***
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =-0.0431480000000002							
	F(1,1407)=0.89							
	P-Value=0.3447							
GLS-AR [d]	β		**intercept**		**Oss.**	**F**	ρ	
(a) 1995-2005	-1.186109	(-39.66) ***	-1.808433	(-211.45) ***	3520	F(1,3167)=1572.64 ***	0.67646998	
(b) 1995-2000	-1.164888	(-25.17) ***	-1.93737	(-154.88) ***	1760	F(1,1407)=63360 ***	0.49015127	
(c) 2001-2005	-1.257005	(-24.75) ***	-1.74623	(122.96) ***	1408	F(1,1055)=612.68 ***	0.35706409	
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =-0.092117							
	F(1,1055)=3.29							
	P-Value=0.0700							
2SLS [e]	β		**intercept**		**Oss.**	**F**		
(a) 1995-2005	-1.673742	(-13.88) ***	-1.824161	(-2079) ***	3871	F(1,3870)=192.58 ***		
(b) 1995-2000	-2.500418	(-24.48) ***	-1.86997	(-46.18) ***	2111	F(1,2110)=599.21 ***		
(c) 2001-2005	-1.831506	(-11.51) ***	-1.6235	(-17.36) ***	1760	F(1,1759)=132.46 ***		
Wald test $\beta_b = \beta_c$	$\beta_c - \beta_b$ =0.668912							
	F(1,1759)=17.67							
	P-Value= 0.0000							

Table 6: Furniture

[a] t-statistic absolute values in brackets. Significant: * 10%, ** 5%, *** 1%

[b] Test Hausman H_0 = coefficient difference Fixed Effect - Random Effect not significative

[c] Panel estimation with fixed-effects

[d] Linear model with fixed-effects and $AR(1)$ disturbance, method Durbin-Watson $y_{it} = a + x_{it}B + u_i + e_{it}$ where $e_{it} = \rho * e_{i,t-1} + z_{it}$

[e] 2SLS with instrumental variable $log(P_{it}/P_c)$ lag 1 year.