Low-Wage Countries Competition and the Quality of French Exports

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Abstract

We ask how the quality composition of French exports is affected by competitive pressures in foreign markets. We show that, over the 1995-2005 period, the mean quality of French manufacturing exports has increased by more than 10%. The quality upgrading explains by a reallocation of demand in favor of higher quality producers, at the intensive and the extensive margins. Quality growth is affected by changes in the competitive pressures French firms face in foreign markets. It is more pronounced in markets where the penetration of developing countries increases. This suggests low-wage countries competition has a heterogeneous impact on French exporters, with lower quality producers being more strongly hurt. This is consistent with a world of within-product specialization in different cones of diversification.

Keywords: Firm-Level Data, Quality Heterogeneity, Chinese Competition.
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1 Introduction

In 2009, China overtook Germany as the world's number one exporter. This announcement came as no surprise: Chinese export growth (in dollar terms) stood at 10% per year over most of the nineties, and has risen to 20% per year since 2000. As a result, the fear of Chinese products invading developed countries' markets has been at the core of economic debates for a while. The main questioning surrounding those debates concerns the end effect low-wage countries competition will have on developed countries' export patterns. Will China becomes "the factory of the world"?

According to the neo-classical theory of international trade, the answer is negative. In the HOS model, developing countries' opening to international trade induces inter-industry specialization patterns, with rich countries increasing their exports of capital-intensive goods. The growth of China in world exports however casts doubts on this view. While the country obviously has a comparative advantage in the production of labor-intensive goods, the growth of its exports is increasingly driven by capital-intensive sectors (Amiti & Freund 2010). If these products substitute to the ones traditionally produced in developed countries, it may well be that China, and more generally low-wage countries, is going to concentrate most of the world production of manufacturing goods in the near future.

This scenario is not yet realized however. Developed countries continue exporting despite the increased competition from low-wage nations. Schott (2004) thus shows the US now import the same products from *both* rich and developing countries. And the reason why these varieties can coexist is that they are vertically differentiated. In particular, those Chinese goods that compete with OECD countries' products are of lower quality, on average (Schott 2008, Fontagné, Gaulier & Zignago 2008). According to Schott, these patterns of international trade are inconsistent with factor-proportion specialization *across* products but suggest specialization occurs *within* products (Schott 2004, Schott 2008). International trade would now induce countries to specialize in different cones of diversification, with capital-abundant countries exploiting their comparative advantage in the production of better quality goods.

This paper tests the assumption using a panel of firm-level data on French exports.

Namely, we ask whether changes in the structure of competition French firms face in foreign markets affect the quality composition of French exports. We first develop a simple model that describes the conditions under which changes in the nature of competition firms face in foreign markets modifies the quality composition of the export basket. Our framework borrows from the industrial organization literature, notably Gabszewicz & Thisse (1979). We consider a highly simplified economy in which two French firms compete with a third foreign one to sell goods in the same import market. Firms are differentiated along the quality dimension.[1] We study what happens to the relative sales of each French firm when the foreign firm's competitiveness improves. We show the shock induces a quality upgrading in aggregate French exports if the foreign competitor produces a low enough quality. Under this condition, competitive pressures are disproportionately felt by the low quality producer in France. As a result, it looses market share with respect to the high quality, and eventually exits the market.[2] At the aggregate level, the asymmetric impact of competitive pressures on French firms' sales implies that the mean quality of French exports improves.

This highly stylized model thus emphasizes a potential relationship between the mean quality of a country's exports and the nature of competition it faces in foreign markets. In particular, the model predicts increased competition from low-wage countries should induce a quality upgrading in French exports if the goods sold by these countries are of low quality, on average.[3] In the empirical exercise, we use the heterogeneity across sectors in the mean quality of French products, as well as the heterogeneity across markets in the penetration of developing countries, to ask whether this mechanism is at play in the data.

The empirical exercise is conducted using firm-level data on French exports. Our measure

[1]The recent trade literature provides evidence of firm heterogeneity in the quality dimension. See among others Crozet, Head & Mayer (2009) on wine exporters producing in France, Verhoogen (2008) on Mexican data or Hallak & Sivadasan (2009) in data covering Indian, US, Chilean and Colombian firms.

[2]The quality upgrading phenomenon we describe is thus driven by intensive as well as extensive margin adjustments. This differentiates us from previous models of trade with quality heterogeneity that discuss quality upgrading induced by the selection of firms into export markets. See, among others, Baldwin & Harrigan (2007), Helbe & Okubo (2008), Johnson (2008), Verhoogen (2008), Kugler & Verhoogen (2007), Hallak & Sivadasan (2009). Beyond these extensive margin adjustments, our model shows changes in the competitive environment is likely to induce heterogeneous responses from firms that are different in terms of the quality they produce.

[3]The results in Schott (2004), Hallak (2006) and Khandelwal (2009) suggest it is indeed the case that low income countries tend to export goods of worse quality, on average.

of quality relies on the methodology proposed by Boorstein & Feenstra (1987) and recently used by Harrigan & Barrows (2009) on sectoral data. Boorstein & Feenstra (1987) propose that the aggregate quality of a basket of goods is measured by the mean utility its consumption induces per unit of good. Using this definition, they show one can quantify quality improvements in a basket of goods from the comparison of unit value and ideal price indices. We adapt the methodology to our data. In firm-level data, there is a lot of entries and exits and we pay a particular attention to this dimension. Namely, we disentangle quality improvements due to a reallocation of market shares toward high-quality producers, from those caused by an exit of the poor qualities from the export market. Our estimates suggest that, over the 1995-2005 period, the overall mean quality of French exports has improved by 11%. Three quarters of the improvement are attributable to extensive margin adjustments, namely high quality producers entering export markets.

Despite the trend in aggregate quality, our data exhibits a huge amount of heterogeneity in the direction and magnitude of quality changes. In particular, the variance in quality growth rates is high between sectors and across destination markets, within sectors. Our empirical analysis shows this heterogeneity relates to changes in the competition French firms face in foreign markets. Quality upgrading is stronger in those sectors in which the competition from low-wage countries has increased the most. We interpret these results as evidence in favor of factor-proportion specialization *within* products with France being increasingly specialized in high-quality goods.

The result that low-wage country competition induces a flight to quality has deep macroeconomic implications. A specialization of rich countries in high quality goods is expected to modify the relative demand of skilled and unskilled workers with an end effect on wage inequalities and employment rates. This may help explaining the increased wage premium between skilled and unskilled workers observed in a number of developed countries.[4] A

[4]The within-industry shift in demand away from unskilled and toward skilled workers is documented in a number of papers. See, among others, Berman, Bound & Griliches (1994) and Bernard & Jensen (1997) for the US, Strauss-Kahn (2004) and Biscourp & Kramarz (2007) for France and Machin & Reenen (1998) and Berman, Bound & Machin (1998) for a panel of developed countries. Berman et al. (1994), Machin & Reenen (1998) and Berman et al. (1998) interpret the evidence as the result of skilled-biased technological change. Results in Bernard & Jensen (1997) rather suggest the lion's share of the rise in wage premia comes

change in the mix of exported products could also affect growth potential, as discussed in Hausmann, Hwang & Rodrik (2007). If quality goods are associated with higher productivity levels, a country specialization toward high qualities should increase its aggregate prospects. Finally, quality upgrading may be a way for developed countries to maintain their level of exports in a world of increasing competitive pressures from low-wage countries. Specializing in high-quality goods will insulate them from wage movements in developing countries (Khandelwal 2009).

There is a growing literature studying North-South trade and its heterogeneous impact on firms located in developed countries. Bernard, Jensen & Schott (2006) decomposes the reallocation of US manufacturing within and between industries, and between firms in the same industry. They show competition from low-wage countries reallocates production towards capital-intensive plants.[5] Evidence in this paper offer an interpretation of the phenomenon, related to the quality differentiation of international trade. Our results also relate to Khandelwal (2009)'s. He shows Chinese competition is more painful (in terms of employment in the US) in sectors with a shorter "quality ladder", that are less vertically differentiated. This is consistent with our model, in which vertical differentiation protects high quality producers from competitive pressures exerted by low-wage countries producers.

Our paper is also related to a growing literature discussing the impact of quality heterogeneity in international trade. While the theoretical dimension of the problem has been extensively discussed, the confrontation to the data is still in its infancy because of obvious data constraints. Three approaches have been used to measure quality. The first one assumes a technology function for quality (Hallak & Sivadasan 2009, Verhoogen 2008). The second approach uses case studies and measures quality using objective criteria.[6] The third

from shifts from production to non-production intensive establishments within the same industry. Biscourp & Kramarz (2007) and Strauss-Kahn (2004) relate the phenomenon to international trade.

[5] Bloom, Draca & Van Reenen (2009) obtain similar results in a panel of European firms. In addition, they observe technology upgrading within firms induced by Chinese competition. See also Mion, Vandenbussche & Zhu (2009) for evidence of within-firm skill upgrading based on Belgian data and Fernandes & Paunov (2009) on Chilean firms. It has to be noted that our method is silent about within-firm quality changes.

[6] Crozet et al. (2009) measure the quality of exported wines using producer ratings found in wine guides. In the case study section of his paper, Verhoogen (2008) compares exports of the old and new version of Volkswagen's "New Beetle".

strategy is based on revealed preferences. It uses the information on consumed quantities and observed prices to infer measures of quality. The intuition is straightforward. Conditional on prices, a variety that is consumed in large quantities must have intrinsic characteristics that make it more valuable from the point of view of consumers. These revealed intrinsic characteristics are related to quality. The approach has been used in Boorstein & Feenstra (1987), Hallak & Schott (2008) and Khandelwal (2009). To our knowledge, we are the first ones to use this systematic approach to infer quality heterogeneity at the firm-level.

The rest of the paper is organized as follows. Section 2 builds a partial equilibrium model describing the conditions under which changes in the structure of foreign competition induces quality upgrading in French exports. Section 3 presents the strategy and data we use to test the prevalence of this mechanism. We discuss the results in Section 4. Finally, Section 5 concludes.

2 Theoretical Background

This section develops a simple model of quality differentiation describing the impact of low-wage country competition on the quality composition of French exports. Our intuition is based on the assumption that low-wage countries have a comparative advantage in the production of labor-intensive, low quality goods. If it is indeed the case that these countries produce and export low qualities, competitive pressures coming from there should be felt disproportionately by low-quality producers in France. One may thus observe a redistribution of market shares in favor of high-quality producers when competition from low-wage countries becomes more intense. Our model describes the conditions under which this "quality upgrading" indeed occurs.

We use a simple model of quality differentiation based on Tirole (1988). There are three firms in the economy, that compete in prices to sell goods in a third import market. Two firms are located in France, while the third one is in a low-wage country, say China. Exporting is costly and we model these barriers to trade by means of a country-specific ad-valorem cost. Following Gabszewicz & Thisse (1979), firms are assumed to be endowed with a quality level, while they are able to choose their price strategically. In the following, we denote L, M and

H the three varieties available in the import market, with L being the lowest quality and H the highest one.

In this framework, we consider what happens to the relative sales of each French firm when competition from the low-wage country becomes more intense. Here, stronger competition is modeled as a reduction in the relative trade cost the Chinese firm faces in the import market. Said otherwise, we consider a unilateral liberalization of trade from China. The liberalization reduces the CIF price of Chinese products in the import market, thus increasing competitive pressures faced by French firms.[7]

The direct effect of increased competition is to redistribute French firms' sales to the Chinese firm. If the Chinese firm sells a low quality, the producer of the lowest quality in France suffers from a larger market share loss. This tends to increase the average quality of French exports. Behind this direct effect however, our model also accounts for the possibility that producers strategically adjust their price following the shock. The ultimate impact of Chinese trade liberalization on the relative market share of each French firm thus depends on their relative quality with respect to the Chinese firm and the way they react to competitive pressures. Finally, our model also accounts for the possibility that increased competition from China forces one or both French firms to exit the market. Said otherwise, we consider intensive as well as extensive adjustments modifying the relative sales of each French firm.

2.1 Demand side

Following Tirole (1988), the demand side of the market consists of a large number of consumers with discrete preferences. Utility is increasing in the quality of the consumed variety. Consumers are heterogeneous in terms of their marginal rate of substitution between income and quality. This assumption is equivalent to supposing income is heterogeneous across

[7] In the following, we refer to the shock as a trade liberalization. But other types of exogenous shocks could have been considered as well. For instance, the depreciation of the low-wage country's currency with respect to the euro is likely to induce increased competitive pressures. The nature of the shock is irrelevant for the derivation of the model, the only assumption being that the relative price of French products increases.

consumers. Utility of a consumer with marginal rate of substitution $1/\theta$ is:

$$U = \begin{cases} s_i - \frac{1}{\theta}\tau_i p_i & \text{if he buys a good of quality } s_i \\ 0 & \text{if he does not buy the differentiated good} \end{cases}$$

s_i is the quality level of the variety the consumer buys for a price $\tau_i p_i$, with $s_L < s_M < s_H$ by assumption. The price is the product of an ad-valorem cost τ_i and the price p_i chosen by the firm selling the consumed variety. In the following, τ_i is assumed country-specific.

In this framework, the wealthier is the consumer, the higher is θ. We further assume that there is a mass 1 of consumers which marginal rate of substitution θ is distributed according to some density $f(\theta)$ with cumulative distribution function $F(\theta)$. For sake of simplicity, we solve the model assuming F is uniform on $[\underline{\theta}, \overline{\theta}]$. Following Tirole (1988), the market is assumed to be covered i.e. all consumers consume the differentiated good.[8] Moreover, the delivered price per unit of quality is supposed to increase in quality:

$$\frac{\tau_L p_L}{s_L} < \frac{\tau_M p_M}{s_M} < \frac{\tau_H p_H}{s_H}$$

This condition guarantees that the three qualities are sold in equilibrium.

In this framework, the poorest consumers choose the lowest quality L, while the richest ones buy the highest quality H. The consumer with $\theta = \tilde{\theta}_{LM}$ is indifferent between consuming the lowest and the medium quality, with $\tilde{\theta}_{LM}$ such that $U(\tilde{\theta}_{LM}, s_M, \tau_M p_M) = U(\tilde{\theta}_{LM}, s_L, \tau_L p_L)$:

$$\tilde{\theta}_{LM} = \frac{\tau_M p_M - \tau_L p_L}{s_M - s_L}$$

Similarly, the consumer with a θ just equal to:

$$\tilde{\theta}_{MH} = \frac{\tau_H p_H - \tau_M p_M}{s_H - s_M}$$

is indifferent between consuming the medium and the high quality.

[8]In analytical terms, this condition is fulfilled as long as there exists at least one variety i the poorest consumer is willing to buy. This occurs if $\underline{\theta} s_i > \tau_i p_i$.

From this, one can easily derive the demand addressed to each producer, as a function of the distribution of incomes and the previously defined income thresholds. Respectively for the high, medium and low quality producers, we have:

$$D_H = \overline{\theta} - F(\tilde{\theta}_{MH}) \tag{1}$$

$$D_M = F(\tilde{\theta}_{MH}) - F(\tilde{\theta}_{LM}) \tag{2}$$

$$D_L = F(\tilde{\theta}_{LM}) - \underline{\theta} \tag{3}$$

2.2 Supply side

Firms are differentiated in terms of the quality they sell and compete in prices. As in Gabszewicz & Thisse (1979), we assume quality is an exogenous characteristic of the firm. Each quality level is associated with a marginal cost c_i, which is increasing in s_i. Without loss of generality, the maximum quality gap is normalized to unity in the rest of the analysis: $s_H - s_L = 1$. We further note: $s_H - s_M = \alpha$ and $s_M - s_L = 1 - \alpha$.

The profit function of firm i is given by:

$$\pi_i = (p_i - c_i) D_i(\tau_L p_L, \tau_M p_M, \tau_H p_H)$$

Using the demands (1)-(3), one can compute the best response functions associated to each firm:

$$\begin{aligned} MR_H &= \frac{c_H}{2} + \frac{1}{2\tau_H}\left[\tau_M p_M + \alpha\overline{\theta}\right] \\ MR_M &= \frac{c_M}{2} + \frac{1}{2\tau_M}\left[\alpha\tau_L p_L + (1-\alpha)\tau_H p_H\right] \\ MR_L &= \frac{c_L}{2} + \frac{1}{2\tau_L}\left[\tau_M p_M - (1-\alpha)\underline{\theta}\right] \end{aligned}$$

This implicitly defines optimal prices as a function of the firm and its competitors' marginal costs as well as the full set of trade barriers (see details in Appendix A).

2.3 Trade liberalization and optimal prices

Using the optimal price strategies just derived, it is easy to show how French firms react to a change in Chinese trade barriers. This however requires an additional assumption about the ranking of firms in terms of qualities. If the Chinese firm produces the lowest quality ($i = L$), the response of French firms to the shock is as follows:

$$\frac{dp_H}{d\tau_L} = \frac{\alpha c_L}{6\tau_H} > 0 \quad \text{and} \quad \frac{dp_M}{d\tau_L} = \frac{\alpha c_L}{3\tau_M} > 0$$

Both French firms reduce their price following Chinese trade liberalization (a drop in τ_L). However, the price adjustment is more pronounced for the firm producing the medium quality: $\frac{dp_H}{d\tau_L} < \frac{dp_M}{d\tau_L}$.[9] This firm is directly hurt by increased competitive pressures Chinese trade liberalization induces and must reduce its mark-up. On the other hand, the highest quality producer is only indirectly impacted, through the price adjustment of its French competitor.

In case the Chinese firm is endowed with the medium quality, both firms are directly affected by the competitiveness loss. As a consequence, they adjust their price in a symmetric way:

$$\frac{dp_H}{d\tau_M} = \frac{dp_L}{d\tau_M} = \frac{c_M}{3\tau_H}$$

Finally, if the Chinese firm produces the highest quality in the market, the better quality produced in France is more strongly hurt and has to adjust its price in a more pronounced way:

$$\frac{dp_M}{d\tau_H} = \frac{(1-\alpha)c_H}{3\tau_M} \quad > \quad \frac{dp_L}{d\tau_H} = \frac{(1-\alpha)c_H}{6\tau_L}$$

2.4 Trade liberalization and market shares

Having derived the impact of Chinese trade liberalization on optimal price strategies, it is now easy to show what happens to the relative sales of both French firms. In the following, we consider adjustments at the intensive and the extensive margins. We first derive the impact of the shock assuming both firms continue to export. We then compute the conditions under which one or both firms are pushed out of the market.

[9] This rests on the assumption that trade costs are homogeneous across French firms: $\tau_H = \tau_M$.

When the Chinese firm is endowed with the lowest quality, the demand addressed to French firms diminishes following trade liberalization:

$$\frac{dD_H}{d\tau_L} = \frac{c_L}{6} > 0 \quad \text{and} \quad \frac{dD_M}{d\tau_L} = \frac{c_L}{3(1-\alpha)} > 0$$

Once again, the medium-quality firm is more strongly affected by the shock than its high-quality competitor. As a consequence, its market share loss is more pronounced: $\frac{dD_H}{d\tau_L} < \frac{dD_M}{d\tau_L}$. If the trade cost reduction is strong enough, the medium quality can even be pushed out of the market. This happens if the (absolute) trade cost cut is large enough (see details in Appendix). In the case of a deep trade liberalization, the high-quality firm could also exit the market. One can however show that, under reasonable conditions, the medium-quality firm is more likely to exit the market following a trade liberalization. Once again, the medium-quality producer is more vulnerable since it is directly affected by the Chinese firm's competitiveness gain.[10]

When the Chinese firm produces the lowest quality in the market, our model thus shows that the trade liberalization reduces the aggregate market share of French firms in the foreign market. In parallel, market shares among French firms are redistributed in favor of the high-quality firm, as the medium-quality firm is more vulnerable to competitive pressures exerted by the Chinese producer. This is true in real terms as in nominal terms (since both the price and the demand of the medium-quality firm reduce in a more intense way as those of the high-quality producer). This result also holds true at the extensive margin under plausible assumptions: in case the trade cost reduction is large enough, the medium-quality producer is more likely to exit the market. All in all, these results suggest stronger competition from low-quality Chinese producers induces a quality upgrading in French exports.

We finish the analysis asking what happens if the Chinese firm produces a medium or high quality. Depending on the sector we consider, it may well be the case that exporting firms from competing countries produce better qualities than French ones. Our empirical analysis accounts for this possibility. It is thus important to consider it in the model as well.

[10]The exact condition is: $c_H - c_L < \alpha H$. It is fulfilled if the medium and high qualities are differentiated enough (high α) or if their production costs are not too different (low $c_H - c_L$).

When the medium quality product ($i = M$) is sold by the Chinese firm, the response of French firms sales to the shock are as follows:

$$\frac{dD_H}{d\tau_M} = \frac{c_M}{3\alpha} > 0 \quad \text{and} \quad \frac{dD_L}{d\tau_M} = \frac{c_M}{3(1-\alpha)} > 0$$

Both firms reduce their foreign sales as they are directly hurt by increased competitive pressures. However, the lowest-quality firm (L) is more strongly hurt (i.e. $dD_L/d\tau_M > dD_H/d\tau_M$) if α is larger than one half. As α increases, the quality produced by the Chinese firm becomes more and more substitutable to the variety the low-quality firm offers. Its sales thus strongly reduce. Under this condition, we again observe a quality upgrading of French exports since some of the low-quality firm's market share is redistributed to the high-quality producer. This holds true in real terms as in nominal terms. As shown in Appendix A, a large enough α parameter also ensures that the low-quality firm is the first one to exit the market in case of a deep trade liberalization. Again, extensive margin adjustments tend to reinforce the quality upgrading induced by the Chinese firm becoming more competitive.

Finally, if the highest quality in the foreign market is produced by the Chinese firm ($i = H$), the situation is the symmetric of the first case, except that the low-quality producer is less hurt than its medium-quality competitor. As a consequence, the trade liberalization more strongly reduces the sales of the medium-quality firm:

$$\frac{dD_M}{d\tau_H} = \frac{c_H}{3\alpha} \quad > \quad \frac{dD_L}{d\tau_H} = \frac{c_H}{6}$$

Under realistic assumption, the low-quality is also less likely to exit the market. This means that, in sectors in which China produces high-quality goods, Chinese trade liberalization will induce a quality-downgrading of French exports.

Our model thus allows refining our initial intuition concerning the impact of competition on the mean quality of French exports. Results suggest one can expect to observe a quality upgrading phenomena in those sectors in which competition from low-quality producers increases. The quality upgrading is induced by intensive margin adjustments, a redistribution of market shares in favor of high-quality producers located in France, and by extensive margin adjustments, the exit of the lowest qualities from export markets. Finally, quality upgrading should be more pronounced in sectors with a larger scope for quality differentiation.

3 Measuring Quality in the Data

3.1 Definition of Quality

In our model, quality changes are driven by a reallocation of demand across firms serving the same market with different qualities of the same good. There are two challenging issues to deal with when it comes to measuring this in the data. First, one obviously need firm-level data allowing to capture reallocations of demand *across* heterogeneous firms. Second, one need to measure how the relative quality of goods exported by those firms evolves over time.

Because we want to have a method that is general enough and covers the whole set of exporting firms, we choose to measure quality using the approach proposed by Boorstein & Feenstra (1987). They define the "quality" of a basket of goods as the mean utility its consumption induces per unit of goods:

$$Q_t = \frac{g(c_{1t}, ..., c_{It})}{\sum_{i=1}^{I} c_{it}}$$

where Q_t is the quality index, c_{it} is the consumed quantity of variety i, $g()$ is an aggregate of the I consumed varieties and $\sum_{i=1}^{I} c_{it}$ is the aggregate volume of consumption. This definition is general in the sense that it does not associate the "quality" of a variety to any specific observable characteristic. Instead, it relies on a revealed preferences approach and considers a variety that induces more utility to consumers, conditional on the quantity consumed, as being of better quality. The method has been applied to product-level data by Aw & Roberts (1986), Boorstein & Feenstra (1987) and more recently Harrigan & Barrows (2009).

An interesting feature of Boorstein and Feenstra's quality index is that its computation requires little information on the considered set of varieties. Namely, changes in the aggregate quality index can be inferred from the comparison of the unit value and ideal price indices computed over the set of varieties under consideration:

$$\Delta \ln(Q_t) = \Delta \ln(UV_t) - \Delta \ln(\pi(p_t)) \tag{4}$$

where Δ is the first-order difference operator. Here, $\Delta \ln(Q_t)$ is a percentage change in the quality composition of the considered basket of goods, $\Delta \ln(UV_t)$ is the growth of its unit value and $\Delta \ln(\pi(p_t))$ is an ideal price index.[11] The intuition surrounding the decomposition is the following. A change in the average price of the good, measured by $\Delta \ln(UV_t)$, can either comes from a price adjustment or a change in the relative weight of each variety in aggregate consumption. Any unit value adjustment that is not fulfilled by an equivalent price increase is thus the result of consumption being reallocated toward more expensive varieties. From the point of view of consumers, such an adjustment is only optimal if that variety is of better quality. The aggregate quality index increases as a consequence.[12]

3.2 Data

In what follows, we measure changes in the quality composition of French exports using firm-level data provided to us by the French customs. The dataset exhaustively describes exports by French firms toward each of their export markets between 1995 and 2005. Our empirical analysis is however restricted to France's main partners, namely Germany, UK, Spain, Italy, Belgium, the US, the Netherlands, Switzerland, Japan, Portugal, Sweden, China, Austria, Poland, Algeria, Turkey, Greece, Hong Kong and Morocco. We also drop exports in non-manufacturing industries that are less likely to be vertically differentiated as well as the tobacco industry, that is very concentrated in France, and the industries of "Other food

[11] The decomposition is detailed in Boorstein & Feenstra (1987). It crucially relies on two assumptions. First, $g()$ must be homogeneous of degree one. Second, the considered basket of goods has to be separable from other consumptions in the aggregate utility function. In particular, the consumption of varieties produced in France is assumed separable from the consumption of goods produced in other countries. This (strong) assumption is necessary in the absence of firm-level data on non-French export flows.

[12] Quality improvements captured by Boorstein & Feenstra (1987)'s index are thus the result of consumption being reallocated across varieties of different quality. In their model as in Section 2, the quality produced by a given firm is assumed exogenous. It may well be the case that changes in competitive pressures also induce within-firm quality adjustments. Such changes in the nature of exported goods are not captured by our measure of quality upgrading. We however suspect that they should go in the same direction as the reallocation of demand we observe. This means our measure of quality upgrading is probably a lower bound.

products, not elsewhere classified" and "Miscellaneous products of petroleum and coal". This lets us with a sample of 19 countries that covers 60% of French exports. In this sample, observations are identified by a firm number (f), a product category (p) defined at the 8-digit level of the combined nomenclature (nc8), a destination market (c) and a time period (t). Each elementary time-series (fpc) corresponds to a "variety" entering the index. Its quality is assumed constant over the period under consideration (1995-2005). Based on this assumption, we can aggregate data across firms selling the same good in a given market to compute a sector- and market-specific quality index Q_{kct}. The index measures changes over time in the quality of French exports in sector k and country c due to a reallocation of demand across "varieties" (i.e. across firms). As our measure of quality upgrading is an index, it can be compared across sectors and/or destination countries to study the relative evolution of quality in different French export markets.

For varieties to be comparable in terms of the utility they induce and the quantity consumed, they have to be similar enough. In what follows, quality indices are thus computed at the 6-digit level of the harmonized system. A "good" is thus a hs6 sector while a variety is the product sold by a particular firm in that sector. Since the analysis uses the time-dimension of the panel, a particular attention has to be paid to potential changes in the nomenclature. Before computing the quality indices, product data are thus concorded over time using a procedure similar to the one used by Pierce & Schott (2009) for the US HS nomenclature. After the harmonization, the data covers 207,360 firms producing goods in 7,739 nc8 categories.

For each bilateral flow (each "variety"), the customs data record the FOB value in Euros (v_{fpct}) as well as the exported quantity in tons (q_{fpct}). This allows computing the unit value index for good k, defined as:

$$\Delta \ln(UV_{kct}) = \Delta \ln \frac{\sum_{(p,f)\in I_{kct}} v_{fpct}}{\sum_{(p,f)\in I_{kct}} q_{fpct}} \tag{5}$$

where I_{kct} is the set of varieties of good k exported in country c in year t.

As in Harrigan & Barrows (2009), the ideal price index for good k is built using the

Sato-Vartia-Feenstra formula, that assumes $g()$ has a CES form:[13]

$$\Delta \ln(\pi_{kc}(p_t)) = \underbrace{\sum_{(p,f)\in I_{kc}} w_{fpct}(I_{kc})\Delta \ln(p_{fpct})}_{\text{Intensive component}} + \underbrace{\frac{1}{\sigma_k - 1}\Delta \ln \lambda_{kct}}_{\text{Extensive component}} \tag{6}$$

$$\begin{aligned}
\text{where} \quad & w_{fpct}(I_{kc}) \equiv \frac{\left(\frac{s_{fpct}(I_{kc})-s_{fpct-1}(I_{kc})}{\ln s_{fpct}(I_{kc})-\ln s_{fpct-1}(I_{kc})}\right)}{\sum_{(p,f)\in I_{kc}}\left(\frac{s_{fpct}(I_{kc})-s_{fpct-1}(I_{kc})}{\ln s_{fpct}(I_{kc})-\ln s_{fpct-1}(I_{kc})}\right)} \\
\text{with} \quad & s_{fpct}(I_{kc}) \equiv \frac{v_{fpct}}{\sum_{(p,f)\in I_{kc}} v_{fpct}} \\
\text{and} \quad & \lambda_{kct} \equiv \frac{\sum_{(p,f)\in I_{kc}} v_{fpct}}{\sum_{(p,f)\in I_{kct}} v_{fpct}}
\end{aligned}$$

The first component of equation (6) is the ideal price index computed over the sub-sample of varieties present in the market during the whole period under consideration (i.e. $I_{kc} = I_{kct} \cap I_{kct-1}$). The second part corrects the price index from extensive margin effects. As discussed in Feenstra (1994), an entry (resp. exit) of firms into the market represents a drop (resp. increase) in the ideal price index since the price of the variety falls from above the consumer's reservation price to the newly observed price (resp. increases from the previously observed price to above the consumer's reservation price). The end effect on the aggregate price index is all the more important since the share of the new/disappeared varieties in consumption is high. This is what the λ ratio of equation (6) captures. Moreover, the utility effect of these virtual price adjustments is stronger, the lower is σ_k, the elasticity of substitution between varieties of good k.[14] This decomposition of price adjustments into an intensive and an extensive components is only exact in the particular case of the CES utility function. On the other hand, any other price index formula consistent with other forms of preferences would neglect the impact that extensive margin adjustments have on

[13] See Sato (1976), Vartia (1976) and Feenstra (1994).

[14] In the empirics, we use a homogeneous calibrated value for σ_k, equal to 5. We also tried using estimates based on the same procedure and data as in Imbs & Méjean (2009). This however reduces the sample of goods under consideration, without strongly affecting quality estimates.

the aggregate price level. Since extensive margin adjustments are important in firm-level data, we chose to impose the CES assumption and use the Sato-Vartia-Feenstra formula.[15]

The ideal price index (6) aggregates price adjustments observed at the variety (firm) level. These individual prices are proxied by unit values:

$$p_{fpct} \equiv \frac{v_{fpct}}{q_{fpct}}$$

As noted by Kravis & Lipsey (1974), unit values are a biased measure of prices because of quality composition effects. Our indicator of quality thus assumes away within-firm changes in quality and is downward biased, in absolute terms. At the very high level of disaggregation we consider, we however expect these measurement errors to be small. At least in the medium run, most quality adjustments should occur between firms rather than within firms. Unit values may however be polluted by other measurement errors, notably reporting mistakes on the value or quantity of exports. We account for this possibility using a trimming procedure. Namely, we drop from the sample annual growth rates in unit values larger than 300% (in absolute value). The number of observations shrinks as a consequence, by less than 3%. The procedure avoids huge outliers to drive our measure of quality. Finally, note that the proxy for individual prices is free on board, while the model in section 2 implicitly carries on prices net of transport costs. This discrepancy should not bias our decomposition however if transport costs are roughly constant over time and/or the same for all French exporters of a given product.

Using the previous unit value and ideal price indices computed at the product-level, (5) and (6), we can infer a quality index from the decomposition in (4). The annual growth in aggregate quality is computed on the whole sample, and on the "intensive" sample, i.e. on the sub-sample of trade flows that are present in the data over two consecutive years. This intensive quality indicator is obtained from the intensive component of the ideal price index (the first term in (6)) and a unit value index defined as in (5) but computed on the

[15] We also tried measuring quality changes as the difference between the unit value index and a Tornqvist price index. The Tornqvist price index assumes preferences take a translog form. Most of the regression results presented in section 4 are robust to the definition of the price index. Since extensive margin adjustments are important in the data, quantitative results are however sensitive to the price index formula.

sub-sample of intensive firms (over I_{kc} rather than I_{kct}). The comparison of the aggregate and intensive quality indices conveys information about the sources of aggregate quality changes. The evolution of the intensive quality indicator can be attributed to the demand being reallocated between firms producing different quality levels. Additional movements in the aggregate quality indicator come from the relative quality of firms exiting/entering the market being different than the mean quality of firms already in the market.

In what follows, the product- and market-specific quality indices (Q_{kct}) are either used as regressors or aggregated at the country- or sector-level to obtain a broader picture of aggregate quality changes. The aggregation of hs6-specific quality indices into more aggregated indicators uses a Tornqvist formula. Finally, we measure quality changes on a year-by-year basis. We then chain quality indices to compute the growth rate in quality over the whole 1995-2005 period.

4 Results

4.1 Patterns in the quality of French exports

At the ISIC level, our sample contains 492 individual time-series. Table 1 gives summary statistics about the corresponding end-period quality indices, as well as their components. Over 1995-2005, the mean quality has increased by 11%. Most of this quality upgrading comes from adjustments at the extensive margin, i.e. from a net entry of firms selling goods of better quality.[16] At the intensive margin, the quality index has increased by less than 4%. In the meantime, firm-level export prices raised, by 7% on average.[17]

These summary statistics do not account for the composition of the French export basket, across sectors and destinations. Figure 1 aggregates the 488 series into a multilateral quality index, using a Tornqvist formula that reflects the specialization of French exports. The evolution of quality is compared to the price index (expressed in the currency of the importer), over the whole sample (panel (a)) and over the "intensive" sub-sample that abstracts from

[16]The evolution in the number of French flows is depicted in Figure B.1 of Appendix B.

[17]Note that the unit value index, that the literature uses as an indicator of either price or quality competitiveness has increased by 12% over the period. This is consistent with Khandelwal (2009) which results suggest sectoral unit values are poor indicators of either prices or qualities.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	N
Quality (Intensive + Extensive)	110.66	24.69	492
Quality (Intensive)	103.24	15.76	492
Price (Intensive + Extensive)	102.24	25.67	492
Price (Intensive)	107.10	25.13	492
Unit Value	111.99	33.65	492

Note: Summary statistics computed over the distribution of sector- and destination-specific indices for 2005. Sectors are defined in the ISIC revision 2 nomenclature.

entries and exits (panel (b)). The figure confirms quality adjustments mainly come from firms entries and exits. While the aggregate quality index increases by more than 10% over the period, the intensive index is almost flat.

The evolution of quality is roughly monotonous over time. This is not true of the behavior of prices that is correlated with exchange rate fluctuations (see Figure B.2 in Appendix). Between 1995 and 1999, export prices decreased by 8%, mainly because of the depreciation of the effective exchange rate (6.7% over the period). After 1999 however, the price index started increasing at a higher rate than the appreciation of the euro (+13% between 1999 and 2005 when the effective exchange rate appreciates by 5%).

It has to be noted that the price inflation is moderated in the whole sample, in comparison with the intensive sub-sample. This comes from new firms entering the market. The impact of extensive margin adjustments on the price index is entirely due to the love-for-variety assumption, that implies consumers are always better off when the number of varieties increases. What is newer, and less model-dependent, is the additional impact this extensive margin has on the quality index. Our results indeed suggest these new firms sell better qualities, on average. They are responsible for the lion's share of the quality upgrading measured over 1995-2005.

Previous aggregate evolutions however hide a strong degree of heterogeneity, between countries and sectors. This is illustrated in Figures B.3 and B.4 in Appendix that respectively compare the evolution of quality across export destinations and sectors. Together, these additional pieces of evidence illustrate the double dimension of heterogeneity the analysis has to account for.

Figure 1: Evolution of the aggregate quality of French exports

Note: Multilateral quality index obtained from a Tornqvist agrgegation of sectoral and country-specific quality indices. The "Intensive margin" sample is defined has the set of firms present in the considered market over the two consecutive years used to compute the quality index. Price indices are corrected from exchange rate changes between France and the destination country. They reflect price inflation in the destination country.

On the geographical dimension, Figure B.3 shows quality upgrading is stronger, on average in the US, most of the European Union and Poland. On the other hand, quality is almost unchanged, or even deteriorates, for exports towards Hong Kong, Greece and Portugal. With the exception of Greece, the impact of extensive adjustments is always positive, which suggests that firms of better quality enter the market (or that bad quality producers exit). But the magnitude of intensive margin adjustments is very heterogeneous across countries. On the sectoral dimension, quality upgrading is on average stronger for food, leather products, furniture, footwear and measuring equipment while almost zero for wearing apparel, paper products, printing and metal products. But the sectoral differences are not homogeneous across countries. For furniture for instance, the mean quality of exports in Sweden, UK, Japan and Morocco has decreased between 1995 and 2005 while it has increased for sales in Hong Kong, Germany, Portugal and Italy.

Table 2: Variance Decomposition

Source	Partial SS	degree of freedom	MS	F	Prob > F
Model	79604.8	43	1851.3	1.98	.000
Country FE	21047.3	18	1169.3	1.25	.215
Sector FE	59798.1	25	2391.9	2.56	.000
Residual	414145.3	444	932.6		
Total	493750.1	487	1013.9		

Note: Variance decomposition obtained from the following regression:

$$Q_{kc2005} = \sum_k \delta_k FE_k + \sum_c \alpha_c FE_c + \varepsilon_{kc}$$

where Q_{kc2005} is the 2005 quality index computed for the ISIC sector k in destination market c, $\{FE_k\}$ is a set of sector fixed effects and $\{FE_c\}$ a vector of country fixed effects.

Table 2 presents a variance decomposition that provides a more systematic view of the sources of heterogeneity. It is obtained from a regression of the quality indices (measured in 2005) on country and sector fixed effects. Together, fixed effects only explain 16% of the total sum of squares, with the lion's share being attributable to sectoral effects. Country-specific fixed effects are not jointly significant. But most of the heterogeneity we observe in the distribution of qualities comes from determinants that have the double geographic *and* sectoral dimension. The important role of sector-specific determinants is consistent with the IO literature, that explains vertical differentiation by structural features. However, our results suggest that quality changes are not only driven by technological shocks. Instead, the fact we observe a strong degree of heterogeneity within sectors between destination markets means shifts in the quality composition of French exports are affected by the local environment in the destination market.

4.2 Impact of the Structure of Competition

Previous section documents an overall increase in the quality of French exports between 1995 and 2005. But it also shows quality changes are strongly heterogeneous between sectors and between countries within sectors. This suggests quality adjustments in bilateral exports are partly driven by local forces. This is consistent with the model discussed in Section 2 that underlines the impact of local competition.

In our model, changes in the quality composition of French exports is triggered by competitive pressures from other exporting countries. In particular, quality upgrading can arise when French producers face increased competition from low quality producers. In the following, we measure changes in the mean quality French firms face in foreign markets using an index inspired from the "PRODY" indicator used in Hausmann et al. (2007). Our indicator measures how the mean GDP per capita of French firms' competitors in foreign markets evolves over time. It is defined as:

$$\Delta \ln QComp_{kct} = \Delta \ln \sum_{j \in N_{kct}} w_{jkct} GDPc_{jt} \tag{7}$$

where N_{kct} is the set of exporting countries (excluding France) serving market c in goods k in period t, $GDPc_{jt}$ is country j's GDP per capita (in current US dollars) and $w_{jkct} \equiv IMP_{jkct}/(\sum_{jinN_{kct}} IMP_{jkct})$ is the share of country j in market c's imports of product k (that do not come from France).[18] The index decreases if France's competitors become poorer or if less developed countries increase their market share/enter the market. In the following, we use $\Delta \ln QComp_{kct}$ as an approximation of changes in the mean quality of products France is competing in foreign markets. The approximation is valid if a country's GDP per capita is correlated with the quality of its exports, as argued by Schott (2004).

How does the mean quality of France's competitors evolve over time? The answer strongly

[18] GDPs per capita data are taken from the World Bank's *World Development Indicators* and market shares are computed using ComTrade import flows declarations.

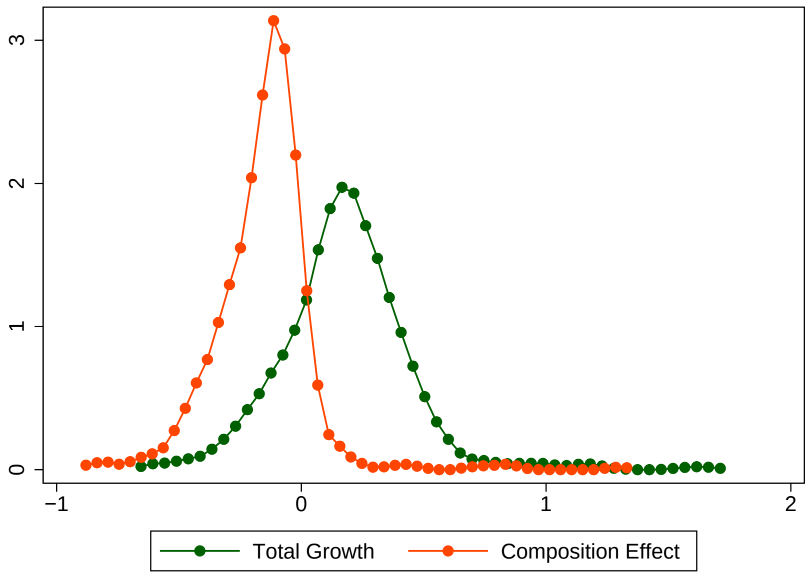
varies across importing countries and sectors. Figure 2 illustrates the kernel distribution of $\Delta \ln QComp_{kct}$ over sectors and destination countries. The median change in the GDP per capita of French firms' "mean" competitor is positive, equal to 16%. But the sign and magnitude of this growth rate strongly vary across sectors and destinations, as illustrated by the distribution depicted in green in Figure 2.

The positive median growth rate suggests that French firms now face competitive pressures coming from countries that are wealthier, on average, and thus should produce better qualities. This result is surprising if we think of the debates concerning the surge of low-wage countries in international trade. But this number is in fact an artefact of world growth in GDP per capita. As all countries face positive GDP per capita growth over the period under consideration, the mean GDP per capita French firms face in export markets naturally increases. The kernel distribution depicted in red in Figure 2 abstracts from this source of growth in our indicator. Namely, it computes $\Delta \ln QComp_{kct}$ using the same formula as the one described in (7) but assuming GDPs per capita are constant over the period. Based on this assumption, changes in $QComp_{kct}$ are entirely attributable to market shares being redistributed between competitors of different income levels. In particular, the fact the median growth rate in the mean GDP per capita is now negative is consistent with foreign markets being increasingly served by low-income countries.

We test the assumption that changes in the competition faced by French firms in foreign markets explain the evolution in the quality composition of French exports. To this aim, we regress our measure of quality growth on the previously described indicator measuring changes in the mean GDP per capita of France's competitors in foreign markets. Results are presented in Table 3. The first three columns use data computed at the ISIC product level while the last three use hs6-specific data. The aggregation of hs6 data at the ISIC level smooths our quality growth estimates from measurement errors inherent to the procedure. However, it strongly reduces the size of the sample and generates additional changes in the variable due to composition effects. When it comes to evaluating the source of quality upgrading, it is thus convenient to use data at the most disaggregated level.

Whatever the specification, regression results indicate a negative correlation between

Figure 2: Mean GDP per capita of France's competitors, Kernel distribution across sectors and importing countries



Note: Kernel distribution of sector- and market-specific growth rates in the mean GDP per capita of France's competitors in foreign markets (growth rate computed over 1995-2005, indicator computed at the ISIC Rev2 level). The "Total growth" line captures changes induced by competitors becoming wealthier as well as the reallocation of market shares between competitors of different income levels. The "Composition effect" line only reflects the second determinant. It is computed using (7) assuming GDPs per capita are constant over time.

Table 3: Quality upgrading and the mean GDP per capita of France's competitors

	Dep. Var: Quality Growth 1995-2005					
	ISIC level			HS6 level		
	(1)	(2)	(3)	(4)	(5)	(6)
Growth in quality competition	-.173[a]	-.118[b]	-.129[b]	-.038[a]	-.050[a]	-.046[b]
	(.046)	(.050)	(.056)	(.015)	(.017)	(.023)
Constant	.107[a]	.100[a]	.110[a]	.109[a]	.111[a]	.123[a]
	(.011)	(.011)	(.013)	(.006)	(.005)	(.007)
Sector FE	No	Yes	Yes	No	Yes	Yes
Restriction	-	-	FRA MSh <.20	-	-	FRA MSh <.20
Obs	466	466	342	23,409	23,409	15,057
# sectors	26	26	26	3,255	3,255	2,985
R2	.029	.029	.035	.000	.000	.000
rho		.154	.139		.305	.323

Standard deviations in parentheses with [b] and [a] indicating significance at the 5 and 1% level.

changes in the quality composition of French exports and the GDP per capita growth of France's mean competitor. The correlation holds on the overall sample (columns (1) and (4)) as well as within sectors in the regressions with sector fixed effects of columns (2) and (4). While the regression implicitly assumes a causal link from changes in the mean GDP per capita of French firms' competitors to the quality growth of French exports, it may well be the case that the causality goes the other way. Competition from French products of increased quality may indeed modify the structure of competition in foreign markets. Ultimately, the quality competition indicator has to be instrumented to account for the reversed causality. In a first step however, we deal with this possibility by excluding from the sample those markets in which the position of France is large enough to affect the structure of competition. Namely, we restrict the sample to sectors in which the market share of France in 2005 is lower than 20%. In those markets, we expect the impact of quality upgrading in French exports to have a minor impact on the aggregate structure of the market. Columns (3) and (6) confirm the negative impact of changes in the GDP per capita of France's competitors on the quality composition of French exports. Coefficients remain more or less stable, which suggests endogeneity is not the main driver of our results.

5 Conclusion

to be completed

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A Solution of the Model

The best response functions for each firm are defined as:

$$
\begin{aligned}
MR_H &= \frac{c_H}{2} + \frac{1}{2\tau_H}\left[\tau_M p_M + \alpha\overline{\theta}\right] \\
MR_M &= \frac{c_M}{2} + \frac{1}{2\tau_M}\left[\alpha\tau_L p_L + (1-\alpha)\tau_H p_H\right] \\
MR_L &= \frac{c_L}{2} + \frac{1}{2\tau_L}\left[\tau_M p_M - (1-\alpha)\underline{\theta}\right]
\end{aligned}
$$

The Nash equilibrium yields the following optimal prices:

$$
\begin{aligned}
p_H &= c_H - \frac{2+\alpha}{6}c_H + \frac{\tau_M}{3\tau_H}c_M + \frac{\alpha\tau_L}{6\tau_H}c_L + \frac{\alpha(4-\alpha)}{6\tau_H}\overline{\theta} - \frac{\alpha(1-\alpha)}{6\tau_H}\underline{\theta} \\
p_M &= c_M - \frac{1}{3}c_M + \frac{(1-\alpha)\tau_H}{3\tau_M}c_H + \frac{\alpha\tau_L}{3\tau_M}c_L + \frac{\alpha(1-\alpha)}{3\tau_M}(\overline{\theta} - \underline{\theta}) \\
p_L &= c_L - \frac{3-\alpha}{6}c_L + \frac{\tau_M}{3\tau_L}c_M + \frac{(1-\alpha)\tau_H}{6\tau_L}c_H + \frac{\alpha(1-\alpha)}{6\tau_L}\overline{\theta} - \frac{(1-\alpha)(3+\alpha)}{6\tau_L}\underline{\theta}
\end{aligned}
$$

Prices equal marginal cost plus a markup. The markup positively depends on the costs of the two competitors, and market size (define via $\overline{\theta}$ and $\underline{\theta}$). Markups negatively depend on the own cost of the firm. This means firms incompletely pass their cost through prices to remain competitive.

Integrating this into the demand functions, one obtains the equilibrium sales of each firm, as a function of trade costs, marginal costs and the income distribution parameters:

$$\begin{aligned}
D_H &= -\frac{2+\alpha}{6\alpha}\tau_H c_H + \frac{1}{6}\tau_L c_L + \frac{1}{3\alpha}\tau_M c_M + \frac{1-\alpha}{6}(\overline{\theta}-\underline{\theta}) + \frac{1}{2}\overline{\theta} && \text{(A.1)}\\
D_M &= -\frac{1}{3\alpha(1-\alpha)}\tau_M c_M + \frac{1}{3(1-\alpha)}\tau_L c_L + \frac{1}{3\alpha}\tau_H c_H + \frac{1}{3}(\overline{\theta}-\underline{\theta}) && \text{(A.2)}\\
D_L &= -\frac{3-\alpha}{6(1-\alpha)}\tau_L c_L + \frac{1}{3(1-\alpha)}\tau_M c_M + \frac{1}{6}\tau_H c_H + \frac{\alpha}{6}(\overline{\theta}-\underline{\theta}) - \frac{1}{2}\underline{\theta} && \text{(A.3)}
\end{aligned}$$

<u>Case 1:</u> **The Chinese firm produces the lowest quality:** This paragraph considers the case in which the lowest quality (L) is produced by the Chinese firm while the two French firms respectively produce the medium and high qualities. Starting from a situation in which both demands are strictly positive, it is easy to show that a reduction in the trade cost faced by the Chinese firm ($\Delta\tau_L < 0$)) reduces the demand addressed to each firm, but the demand loss is stronger for the medium quality producer:

$$\frac{dD_H}{d\tau_L} = \frac{c_L}{6} \quad < \quad \frac{dD_M}{d\tau_L} = \frac{c_L}{3(1-\alpha)}$$

Following the trade liberalization, both French firms thus reduce their sales in the US market. If the sale reduction is large enough, one or both firms can even be pushed out of the market. This happens if the trade cost drop is large enough for post-liberalization sales to be negative. Calling $\Delta\tau_L$ the absolute drop in Chinese trade cost, this means, respectively for the medium-and the high-quality firms:

$$\begin{aligned} D_M(\tau_L - \Delta\tau_L, \tau_M, \tau_H, c_L, c_M, c_H, \overline{\theta}, \underline{\theta}, \alpha) &< 0 \\ D_H(\tau_L - \Delta\tau_L, \tau_M, \tau_H, c_L, c_M, c_H, \overline{\theta}, \underline{\theta}, \alpha) &< 0 \end{aligned}$$

Using the demand functions (A.1)-(A.2), we find that, following the trade liberalization, the medium-quality firm exits the market if the drop in transport costs is larger than:

$$\Delta\bar{\tau_L}^M = \tau_L - \frac{\tau_M c_M}{\alpha c_L} + \frac{(1-\alpha)\tau_H c_H}{\alpha c_L} + \frac{(1-\alpha)(\overline{\theta} - \underline{\theta})}{c_L}$$

while the high-quality firm exits if the drop exceeds:

$$\Delta\bar{\tau_L}^H = \tau_L + \frac{2\tau_M c_M}{\alpha c_L} - \frac{(2+\alpha)\tau_H c_H}{\alpha c_L} + \frac{(1-\alpha)(\overline{\theta} - \underline{\theta})}{c_L} + \frac{3\overline{\theta}}{c_L}$$

Following a trade cost reduction, the medium-quality French producer is the first one to exit the market if:

$$\begin{aligned} & \Delta\bar{\tau_L}^H > \Delta\bar{\tau_L}^M \\ \Leftrightarrow \quad & \tau_H c_H - \tau_M c_M < \alpha\overline{\theta} \end{aligned}$$

i.e. if the high quality firm has a large 'exclusive demand' (large $\overline{\theta}$), if the cost differential is moderated ($c_H - c_M$ is low enough) or if the two French qualities are not strong substitute (α is high).

<u>Case 2:</u> **The Chinese firm produces the medium quality:** This paragraph considers the situation in which the Chinese firm is endowed with the median quality and benefits from a trade cost reduction ($\Delta\tau_M < 0$). Once again, both French firms suffer from a sales drop as a result of the Chinese firm becoming more competitive:

$$\frac{dD_H}{d\tau_M} = \frac{c_M}{3\alpha} \quad \text{and} \quad \frac{dD_L}{d\tau_M} = \frac{c_M}{3(1-\alpha)}$$

For the shock to redistribute French market shares in favor of the high quality firm, it has to be true that:

$$\begin{aligned} \frac{dD_H}{d\tau_M} &< \frac{dD_L}{d\tau_M} \\ \Rightarrow \quad \alpha &> \frac{1}{2} \end{aligned}$$

A large fall in the Chinese firm trade cost may again induce extensive margin adjustments. This happens if:

$$\begin{aligned} D_L(\tau_L, \tau_M - \Delta\tau_M, \tau_H, c_L, c_M, c_H, \overline{\theta}, \underline{\theta}, \alpha) &< 0 \\ D_H(\tau_L, \tau_M - \Delta\tau_M, \tau_H, c_L, c_M, c_H, \overline{\theta}, \underline{\theta}, \alpha) &< 0 \end{aligned}$$

The low-quality French producer exits the market if the trade cost drop exceeds:

$$\Delta\bar{\tau}_M{}^L = \tau_M - \frac{(3-\alpha)\tau_L c_L}{2c_M} + \frac{(1-\alpha)\tau_H c_H}{2c_M} + \frac{\alpha(1-\alpha)}{2c_M}(\overline{\theta} - \underline{\theta}) - \frac{3(1-\alpha)}{2c_M}\underline{\theta}$$

while the high-quality producer is pushed out of the market if $\Delta\tau_M$ is larger than:

$$\Delta\bar{\tau}_M{}^H = \tau_M - \frac{(2+\alpha)\tau_H c_H}{2c_M} + \frac{\alpha\tau_L c_L}{2c_M} + \frac{\alpha(1-\alpha)}{2c_M}(\overline{\theta} - \underline{\theta}) + \frac{3\alpha}{2c_M}\overline{\theta}$$

Following a trade cost reduction, the low-quality French producer is the first one to exit the market if:

$$\begin{aligned} & \Delta\bar{\tau}_M{}^H > \Delta\bar{\tau}_M{}^L \\ \Leftrightarrow \quad & \tau_H c_H - \tau_L c_L < \alpha\overline{\theta} + (1-\alpha)\underline{\theta} \\ \Leftrightarrow \quad & \alpha > \frac{\tau_H(c_H - c_L) - L}{\overline{\theta} - \underline{\theta}} \end{aligned}$$

Again, if the Chinese firm is close enough from the low-quality producer in France (i.e. if α is large enough), this firm is more likely to exit the market than its high-quality competitor.

<u>Case 3:</u> **The Chinese firm produces the high quality:** Following the trade liberalization ($\Delta\tau_H < 0$), both French firms suffer from a drop in their sales:

$$\frac{dD_M}{d\tau_H} = \frac{c_H}{3\alpha} > 0 \quad \text{and} \quad \frac{dD_L}{d\tau_H} = \frac{c_H}{6} > 0$$

However, the medium-quality firm ($i = M$) is more strongly affected as $\frac{dD_M}{d\tau_H} > \frac{dD_L}{d\tau_H}$.

The fall in Chinese trade costs induces adjustments at the extensive margin if:

$$\begin{aligned} D_L(\tau_L, \tau_M, \tau_H - \Delta\tau_H, c_L, c_M, c_H, \overline{\theta}, \underline{\theta}, \alpha) &< 0 \\ D_M(\tau_L, \tau_M, \tau_H - \Delta\tau_H, c_L, c_M, c_H, \overline{\theta}, \underline{\theta}, \alpha) &< 0 \end{aligned}$$

The medium-quality producer exits the market if the trade cost drop exceeds:

$$\bar{\Delta\tau_H}^M = \tau_H - \frac{\tau_M c_M}{(1-\alpha)c_H} + \frac{\alpha\tau_L c_L}{(1-\alpha)c_H} + \frac{\alpha}{c_H}(\overline{\theta} - \underline{\theta})$$

The low-quality firm is pushed out of the market if it exceeds:

$$\bar{\Delta\tau_H}^L = \tau_H + \frac{2\tau_M c_M}{(1-\alpha)c_H} - \frac{(3-\alpha)\tau_L c_L}{(1-\alpha)c_H} + \frac{\alpha}{c_H}(\overline{\theta} - \underline{\theta}) - \frac{3}{c_H}\underline{\theta}$$

Following a trade cost reduction, the medium-quality French producer is the first one to exit the market if:

$$\begin{aligned} &\bar{\Delta\tau_H}^L > \bar{\Delta\tau_H}^M \\ \Leftrightarrow \quad &\tau_M c_M - \tau_L c_L > (1-\alpha)\underline{\theta} \end{aligned}$$

The medium-quality firm exits first if the market for the low quality firm is sufficiently high ($\underline{\theta}$ small), if the two French qualities are not close substitutes (α large) and if the cost gap between the firms is not too small.

B Additional Results

Figure B.1: Evolution in the number of French export flows

Figure B.2: Correlation of local currency prices and the effective exchange rate

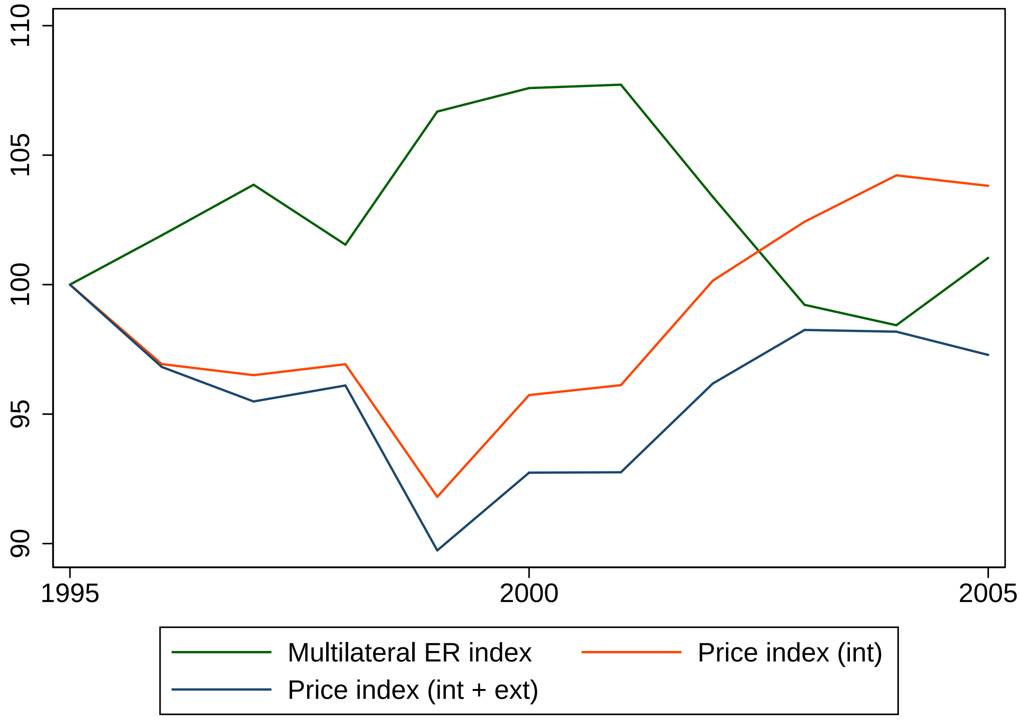
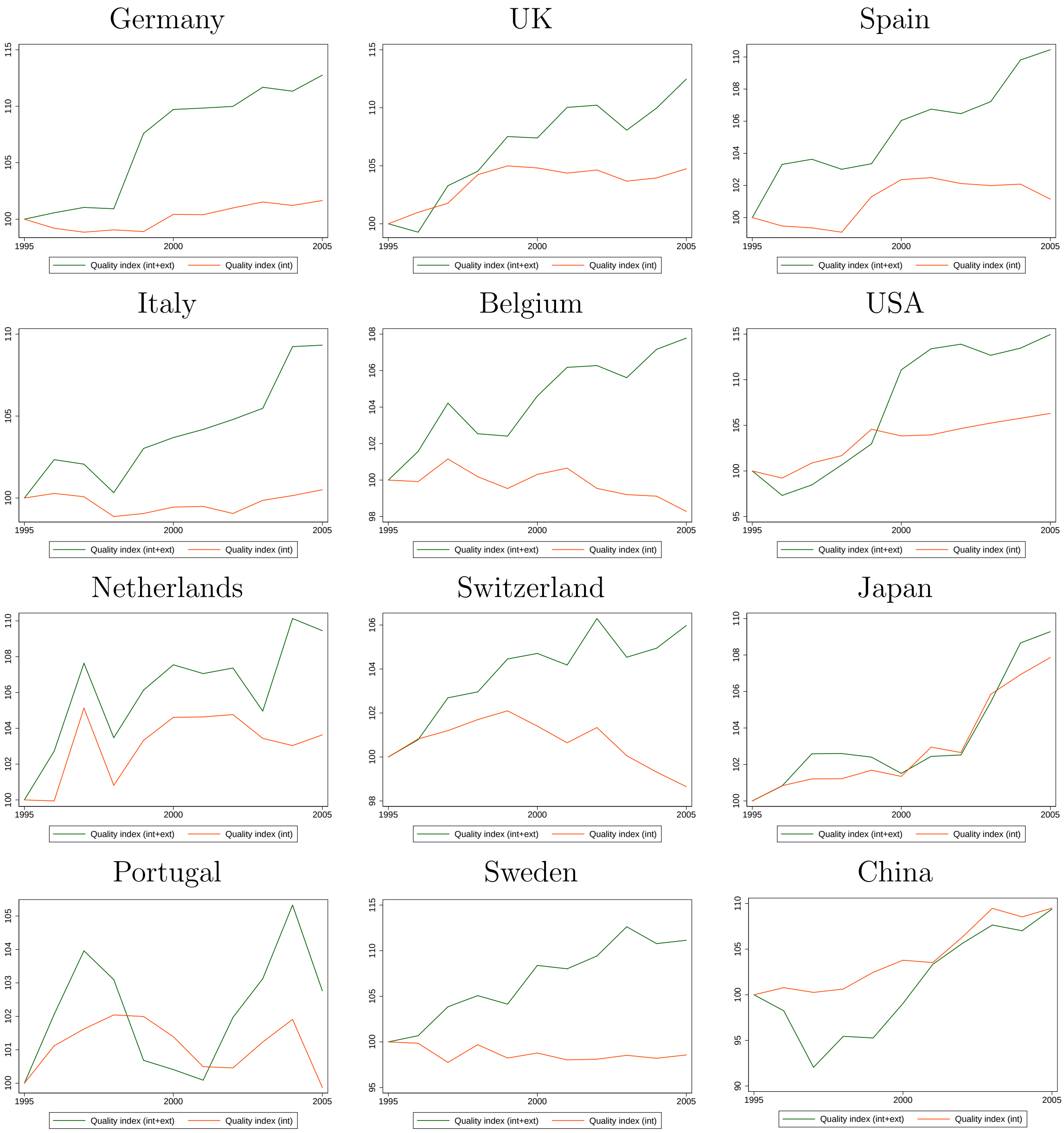


Figure B.3: Evolution of quality, by destination country



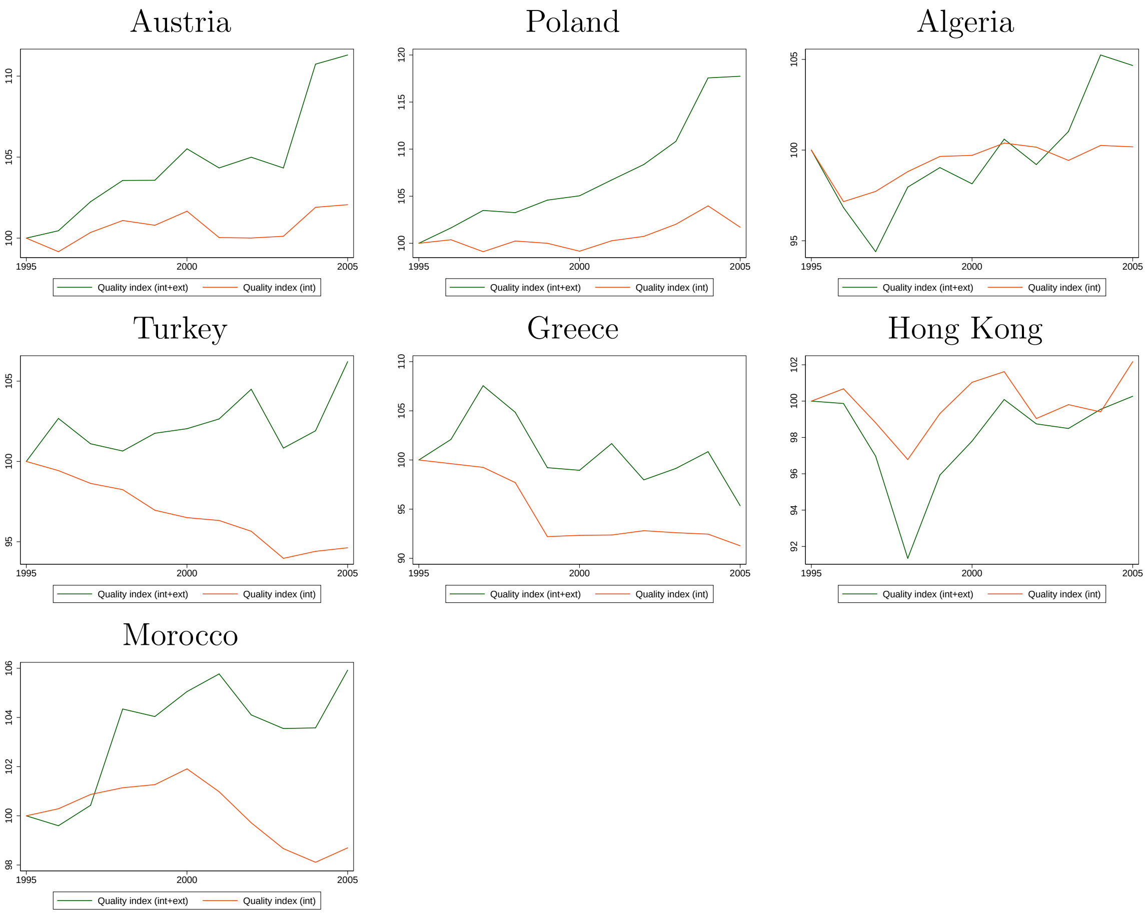
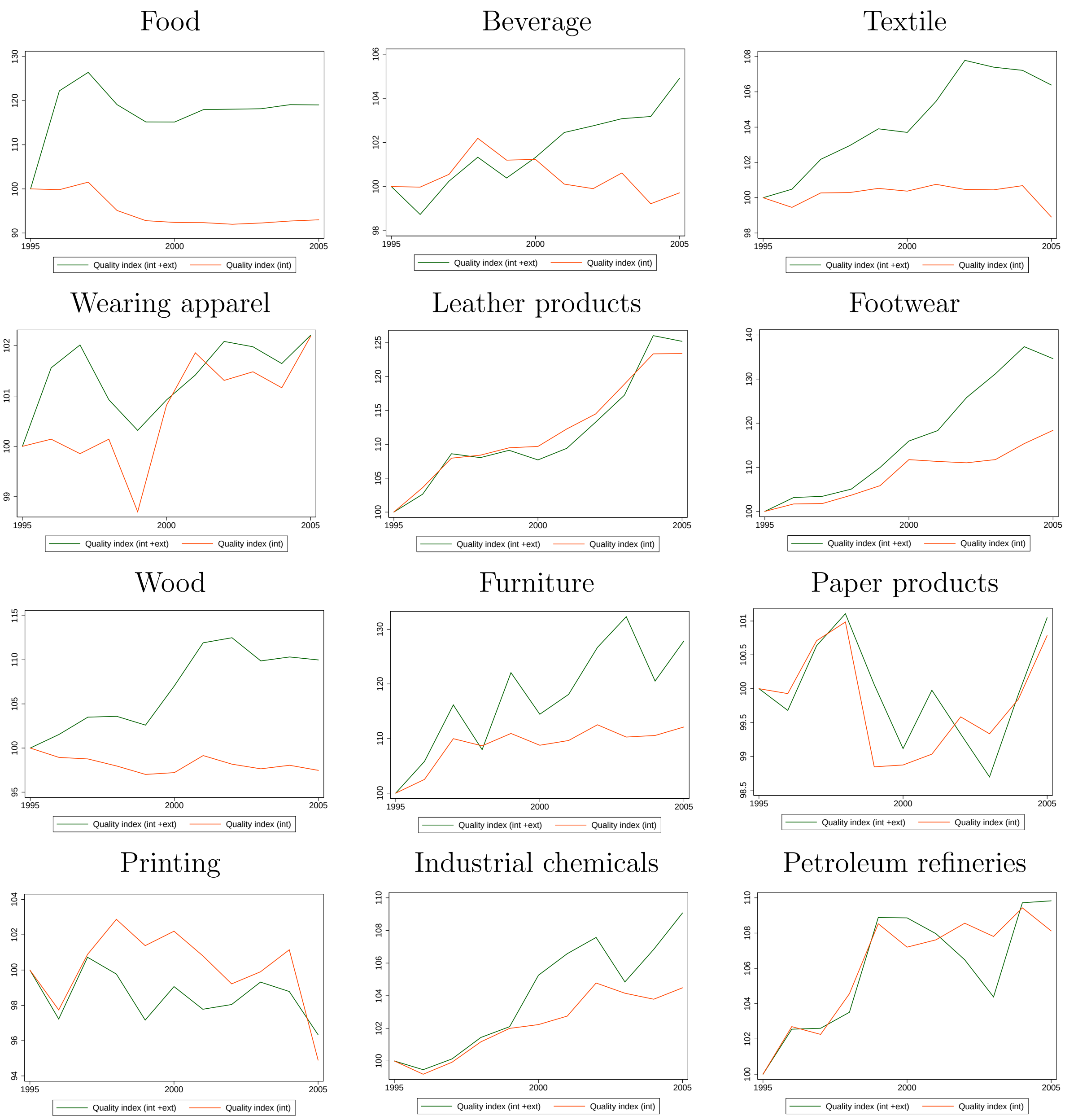
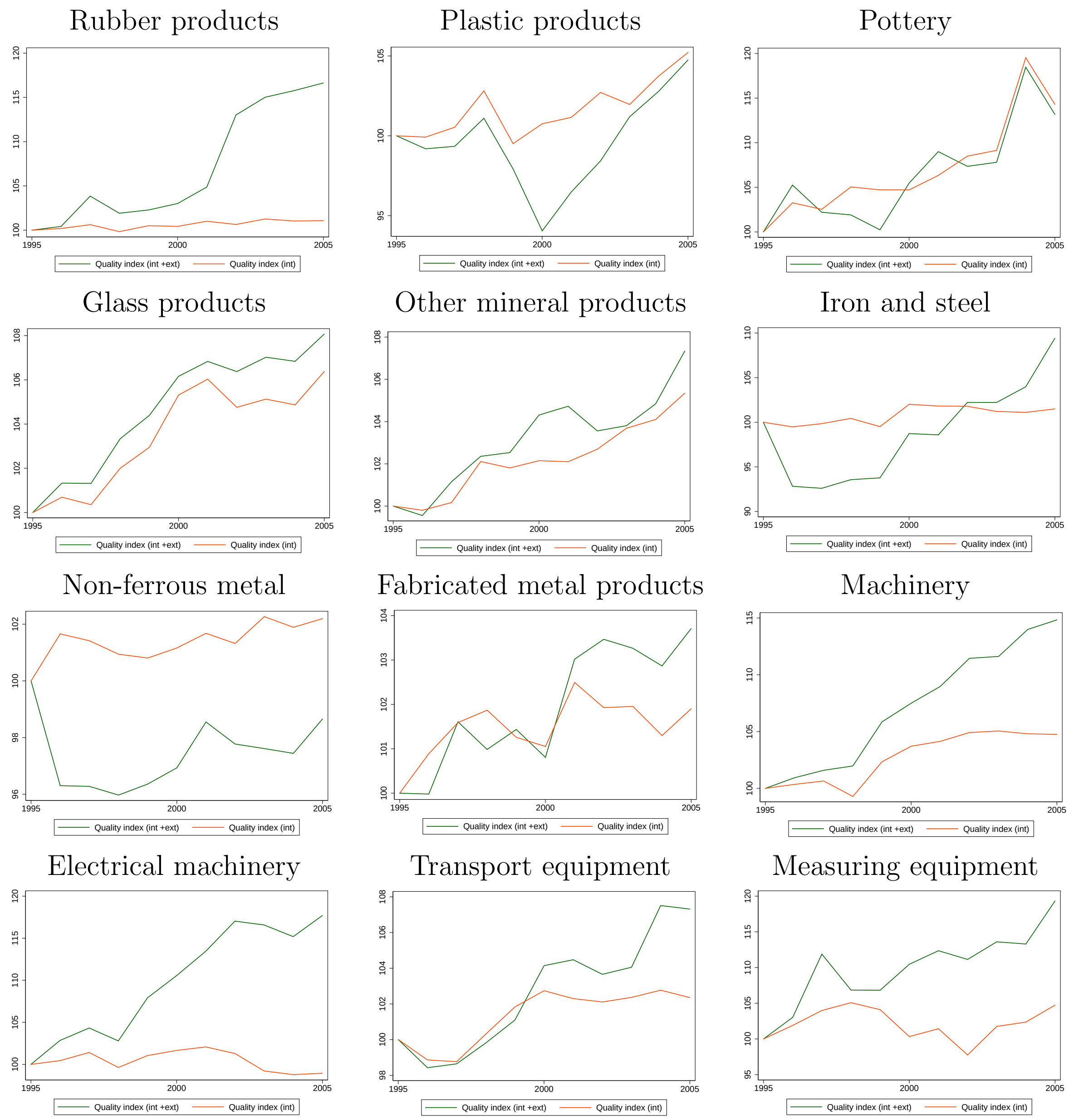

Austria
Poland
Algeria
Turkey
Greece
Hong Kong
Morocco
1995
2000
2005
Quality index (int+ext)
Quality index (int)

Figure B.4: Evolution of quality, by sector




Rubber products
Plastic products
Pottery
Glass products
Other mineral products
Iron and steel
Non-ferrous metal
Fabricated metal products
Machinery
Electrical machinery
Transport equipment
Measuring equipment
1995
2000
2005
Quality index (int +ext)
Quality index (int)