Reallocation across firms and aggregate quality upgrading [*]

Julien Martin[†]   Isabelle Méjean[‡]

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Abstract

What is the impact of low-wage countries' competition on the quality of high-wage countries' exports? To answer this question, we use a new method that identifies changes in the quality of sectoral exports induced by a reallocation of market shares across different qualities of the same good. Using French firm-level data covering the 1995-2005 period, we measure a 10% increase in the mean quality of the aggregate export basket. Quality upgrading is explained by a reallocation of demand in favor of higher quality producers, at the intensive and the extensive margins. The reallocation is more pronounced in markets where the penetration of developing countries has increased. This suggests that low-wage countries' competition has a heterogeneous impact on French exporters, with lower quality producers being more strongly hurt. This phenomenon is consistent with within-product specialization along the vertical dimension. Finally, we quantify the impact that quality upgrading has had on France's export performances. Over the period, more than 20% of the growth in the value of French exports is attributable to the reallocation of demand in favor of higher quality, more expensive varieties.

Keywords: Firm-Level Data, Quality Heterogeneity, Low-Wage Countries' Competition, Within-product specialization.

JEL Classification: F12, F14.

1 Introduction

One of the most discussed phenomenon in international trade is the growing share of emerging countries in world exports, and its impact on developed countries' export patterns. According to the neo-classical theory of international trade, the increasing participation of developing countries in international markets should lead rich countries to specialize in the production of capital-intensive goods. However, recent empirical evidence suggests that emerging economies are now becoming competitive not only in labor-intensive sectors, as theory would predict, but also in capital-intensive sectors (see Amiti & Freund, 2010, on Chinese data). If their goods substitute the ones traditionally produced in developed countries, it may well be that low-wage countries are going to concentrate most of the world production of manufacturing goods in the near future.

This scenario has not yet been realized, however, as high income countries continue exporting manufacturing goods. Schott (2004) shows that the US now imports the same products from *both* developed and developing countries, and that the reason why these varieties can coexist is that they are vertically differentiated. Hence, 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* industries but suggest specialization occurs *within* industries (Schott, 2004, 2008). International trade leads countries to specialize in vertically differentiated goods. Thus, developed economies continue exploiting their comparative advantage by producing better qualities.

This paper develops a new method to test whether increased competition from low-wage countries induces such a shift in the specialization of rich nations in favor of better qualities. Our methodology identifies aggregate quality upgrading explained by a biased reallocation of market shares in favor of high-quality exporters. While the rest of the literature uses ex-post measures of aggregate quality to test whether countries specialize along the quality dimension, we use firm-level panel data, which allows us to capture the dynamic aspect of these specialization patterns. In particular, we provide evidence of quality upgrading driven by the reallocation of exports towards high-quality varieties and show that the phenomenon

is stronger in sectors and markets in which competition from low-wage countries is tougher.

We start the analysis with an illustrative model describing the conditions under which changes in the competitive environment modify the quality composition of a country's export basket. Our framework borrows from the industrial organization literature, notably Gabszewicz & Thisse (1979). We consider a highly simplified economy in which two firms located in a high-income country compete with a low-wage country's producer to sell goods in the same import market. Firms are differentiated along the quality dimension and the low-wage country is assumed to offer the lowest quality.[1,2] In this setting, increased competitive pressures from the low-wage country's producer are disproportionately felt by the lowest quality produced in the rich country. This asymmetry triggers a reallocation of market shares in favor of the high quality firm, and an improvement in the mean exported quality. [3]

This example 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, increased competition from low-quality producers in emerging countries should induce a quality upgrading in rich countries' exports. In the words of Schott (2008), developed countries respond to competition from low-wage countries by "moving out, that is, by [...] dropping the least-sophisticated varieties from their export bundle." In the empirical exercise, we use the heterogeneity across sectors in the degree of vertical differentiation, 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

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[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]Results in Schott (2004), Hallak (2006), Hallak & Schott (2010) and Khandelwal (2010) suggest it is indeed the case that low income countries tend to export goods of worse quality.

[3] In our example, quality adjustments occur at the intensive margin - the low quality firm loses market shares - and through extensive adjustments - the low quality eventually exits export markets. This differentiates us from previous models of trade with quality heterogeneity, e.g. Baldwin & Harrigan (2010), Helbe & Okubo (2008), Johnson (2008), Verhoogen (2008), Kugler & Verhoogen (2010), Hallak & Sivadasan (2009). In these models, quality upgrading is solely driven by the selection of firms into export markets. Beyond these extensive margin adjustments, our model shows changes in the competitive environment is likely to rebalance sales between firms that are different in terms of the quality they produce. Our methodology captures quality upgrading induced by both adjustment margins.

of quality relies on the methodology proposed by Aw & Roberts (1986) and 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 this methodology to our data. In firm-level data, particular attention has to be paid to entry and exit of firms from the export markets. We thus disentangle quality improvements due to a reallocation of market shares toward high-quality producers from those caused by a net entry of better qualities in the export market. Our estimates suggest that, over the 1995-2005 period, the overall 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 exhibit 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 that this heterogeneity is related 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 important 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 inequality and employment rates. This may help explain the increased wage premium between skilled and unskilled workers observed in a number of developed countries.[4]

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[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 that the lion's share of the rise in wage premia comes

A change in the mix of exported products could also affect growth potential, as discussed in Hausmann, Hwang & Rodrik (2007). If high 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 2010).

Based on Khandelwal's argument, we conduct a counterfactual exercise that quantifies the impact of quality upgrading on France's export performances. Namely, we compare the actual evolution in the value of exports to the one that would have prevailed without any reallocation of demand across heterogeneous qualities. In our data, more than 20% of the increase in France's exports (in value) is explained by quality upgrading. This means that, absent the reallocation of demand towards high quality producers, France would have lost more than twice the market share it actually lost during the period we consider.

This paper is related to an important literature analyzing the impact that competition from low-wage countries has on developed countries' performance. In particular, a number of recent papers study North-South trade and its heterogeneous impact on firms located in developed countries. Bernard, Jensen & Schott (2006) show that competition from low-wage countries reallocates production towards capital-intensive plants while labor-intensive ones are pushed out of the market. This is consistent with evidence discussed in this paper if the production of better quality goods is more capital intensive.[5] Our results allow us to go one step further and interpret the reallocation in terms of the quality differentiation of traded goods. Another strand of the literature focuses on *within-firm* technology upgrading induced by Chinese competition (see Bloom, Draca & Van Reenen 2009, Mion, Vandenbussche & Zhu 2009). Complementary to these works, our paper analyzes aggregate quality upgrading driven by a reallocation of sales *across firms*.

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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]Verhoogen (2008) and Kugler & Verhoogen (2010) provide evidence of a positive link between the capital intensity of a firm and the quality of its output.

Our work is also related to the literature on the impact of quality heterogeneity in international trade. While the theoretical dimension of the problem has been extensively discussed, testing these models 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 strategy is based on revealed preferences. It uses the information on consumed quantities and observed prices to infer measures of quality. This approach has been used in Boorstein & Feenstra (1987), Hallak & Schott (2010) and Khandelwal (2010). To our knowledge, we are the first ones to use a similar revealed preference method to infer information on quality heterogeneity at the firm-level.

The paper the most closely related to ours is Khandelwal (2010). Using estimates of the relative quality of products exported by different countries in the US, he shows Chinese competition is more painful - in terms of employment in the US - in sectors with less quality heterogeneity (shorter "quality ladders"). This suggests that vertical differentiation protects the most developed economies against competition from low-wage countries. We go one step further and argue quality upgrading is a natural consequence of competition from emerging countries. In our example, the mean quality of a country's exports increases when firms face competitive pressures from low-quality producers. Countries thus climb the quality ladder which in turn should reduce their sensitivity to competitive pressures.

The rest of the paper is organized as follows. Section 2 describes the mechanism we have in mind to explain the link between low-wage countries' competition and the aggregate quality of exports. Section 3 presents the strategy and data we use to test the prevalence of this mechanism at the firm-level. We discuss the results in Section 4. Finally, Section 5 concludes.

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[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."

2 An illustrative model

We present a stylized model illustrating how increased competition from low wage countries can affect the quality composition of developed countries' exports. Our logic is based on the assumption that low-wage countries have a comparative advantage in the production of low quality goods. If this is indeed the case, competitive pressures coming from emerging markets should be felt disproportionately by low-quality producers in developed countries. One may thus observe a redistribution of market shares in favor of high-quality varieties when competition from low-wage countries becomes more intense.

Our example builds upon a model of quality differentiation based on Gabszewicz & Thisse (1979) and Tirole (1988). There are three firms in the economy that compete in prices to sell goods in the same import market. Two firms are located in a rich country, called North, while the third one is in a low-wage country, called South. Firms are assumed to be endowed with a quality level, while they are able to choose their prices strategically. In the following, we use L, M and H to denote the low, medium and high quality, respectively. We assume the Southern firm offers the lowest quality L.[7]

In this framework, we consider what happens to the relative sales of Northern firms when competition from the low-wage country becomes more intense. Stronger competition is modeled as an exogenous reduction in the export price of the Southern firm. The relative price shock can come from the Southern firm becoming more productive, from its cost of exporting reducing, from Southern wages decreasing, or from the country's currency depreciating. The nature of the shock is irrelevant from our standpoint. We do not try to explain why emerging markets represent an increasing share in world markets but what consequence this has on the mean quality and price of developed countries' exports.

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 substi-

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[7] Appendix A considers the other two possibilities, namely that the Southern firm offers an intermediate, or a high quality.

tution between income and quality. This assumption is equivalent to supposing income is heterogeneous across consumers: a higher marginal rate of substitution has the same impact as the consumer being poorer.

The utility of the consumer, with marginal rate of substitution $1/\theta$, is equal to $U = s_i - \frac{1}{\theta}\tau_i p_i$ if she consumes the quality s_i. With $s_L < s_M < s_H$, utility is increasing in quality. The price $\tau_i p_i$ of the variety is the product of an ad-valorem cost τ_i (> 1) and the optimal mark-up p_i. In the following, τ_i is assumed country-specific: $\tau_M = \tau_H = \tau_N$, $\tau_L = \tau_S$ where τ_N (respectively τ_S) is the exogenous cost faced by Northern (resp. Southern) firms.

There is a mass one of consumers with marginal rates of substitution uniformly distributed over $[\underline{\theta}, \overline{\theta}]$. Following Tirole (1988), it is assumed that i) the market is covered, i.e., all consumers consume the differentiated good, and ii) all qualities are sold in equilibrium.[8] 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 $U(\tilde{\theta}_{LM}, s_M, \tau_N p_M) = U(\tilde{\theta}_{LM}, s_L, \tau_S p_L)$. Similarly, the consumer with a θ just equal to $\tilde{\theta}_{MH}$ is indifferent between consuming the medium and the high quality.

The demand faced by each producer can be expressed as a function of the distribution of incomes and the previously defined income thresholds. For the high, medium and low quality producers, respectively, we have

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

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

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

$$\text{with} \quad \tilde{\theta}_{LM} = \frac{\tau_N p_M - \tau_S p_L}{s_M - s_L}, \quad \tilde{\theta}_{MH} = \frac{\tau_N p_H - \tau_N p_M}{s_H - s_M}.$$

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[8]In analytical terms, the first condition is fulfilled as long as there exists at least one variety i the poorest consumer is willing to buy. This occurs if $\underline{\theta} s_i > \tau_i p_i$. The second condition is met when the delivered price per unit of quality increases in quality:

$$\frac{\tau_S p_L}{s_L} < \frac{\tau_N p_M}{s_M} < \frac{\tau_N p_H}{s_H}.$$

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.[9] 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: $s_H - s_L = 1$. We further call: $s_H - s_M = \alpha$ and $s_M - s_L = 1 - \alpha$.

The profit function of firm i is given by

$$\pi_i = (p_i - c_i)D_i(\tau_S p_L, \tau_N p_M, \tau_N p_H).$$

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

$$
\begin{aligned}
BR_H &= \frac{c_H}{2} + \frac{1}{2\tau_N}\left[\tau_N p_M + \alpha\overline{\theta}\right] \\
BR_M &= \frac{c_M}{2} + \frac{1}{2\tau_N}\left[\alpha\tau_S p_L + (1-\alpha)\tau_N p_H\right] \\
BR_L &= \frac{c_L}{2} + \frac{1}{2\tau_S}\left[\tau_N p_M - (1-\alpha)\underline{\theta}\right].
\end{aligned}
$$

This implicitly defines optimal mark-ups as a function of the firm and its competitors' marginal and ad-valorem costs (see details in the Appendix).

Relative price shock: Using the optimal price strategies just derived, it is easy to show how Northern firms react to a change in the Southern relative competitiveness. Here, we model the shock as a drop in the Southern ad-valorem cost τ_S. The shock is exogenous from all firms' standpoint. It increases the relative price of Northern firms and induces a strategic reaction. In particular, the response of Northern firms is

$$\frac{dp_H}{d\tau_S} = \frac{\alpha c_L}{6\tau_N} > 0 \quad \text{and} \quad \frac{dp_M}{d\tau_S} = \frac{\alpha c_L}{3\tau_N} > 0.$$

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[9]We do not seek to endogeneize quality choices since our empirical strategy assumes that, at the firm-level, quality is constant over time.

Both Northern firms reduce their price following the shock. However, the price adjustment is more pronounced for the firm producing the medium quality: $\frac{dp_H}{d\tau_S} < \frac{dp_M}{d\tau_S}$. This firm is directly hurt by increased competitive pressures induced by the Southern shock and must reduce its mark-up. On the other hand, the highest quality producer is only indirectly impacted, through the price adjustment of its local competitor.

Despite price adjustments, the demand faced by Northern firms diminishes following the shock:

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

Once again, the medium-quality firm is more strongly affected than its high-quality competitor. As a consequence, its market share loss is more pronounced: $\frac{dD_H}{d\tau_S} < \frac{dD_M}{d\tau_S}$. In some circonstances, the medium quality can even be pushed out of the market. This happens if the shock is large enough (see details in Appendix).

When the Southern firm produces the lowest quality in the market, our example thus shows that an improvement in the South competitiveness reduces the aggregate market share of Northern firms in foreign markets. In the meantime, market shares within the North are redistributed in favor of the high-quality firm, as the medium-quality producer is more vulnerable to competitive pressures exerted by the Southern low quality. This is true in real and 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: when Southern costs continue to go down, the medium-quality producer is the first one to exit the market.

All in all, these results suggest that stronger competition from low-quality producers induces an improvement in the mean quality exported by the rich country.[10] The quality upgrading is induced by intensive margin adjustments, a redistribution of market shares in favor of high-quality producers, and by extensive margin adjustments, the exit of the lowest

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[10]Results in Appendix A allow to refine this conclusion, by considering the possibility that the Southern firm produces a medium or even a high quality. When she produces the highest quality available in the market, the mechanism is reversed, and the mean quality of Northern exports goes down following a competitiveness loss. When the South produces the medium quality, the shock still induces a quality upgrading in the North when the low and the medium quality are close enough.

qualities from export markets. Finally, quality upgrading is more pronounced in sectors with a larger scope for quality differentiation (a longer "quality ladder").

3 Measuring Quality in the Data

3.1 Definition of Quality

In our example, 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 phenomenon in the data. First, one obviously needs firm-level data to capture reallocations of demand *across* heterogeneous firms. Second, one needs a method that measures aggregate quality changes induced by a reallocation of market shares across firms producing vertically differentiated varieties.

Because we want to have a method that is general enough and covers the whole set of exporting firms, we choose to measure quality changes 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 revealed preferences and considers a variety that induces more utility to consumers, conditional on the quantity consumed, as being of better quality.[11]

A nice 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

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[11] The method has been applied to product-level data by Aw & Roberts (1986), Boorstein & Feenstra (1987) and more recently Harrigan & Barrows (2009).

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 $\Delta \ln(\pi(p_t))$ denotes changes in the ideal price index.[12] 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.

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.

3.2 Data

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

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[12]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.

however restricted to France's main partners, namely Germany, UK, Spain, Italy, Belgium (and Luxembourg), the US, the Netherlands, Switzerland, Japan, Portugal, Sweden, Austria, Poland, and Greece. The restriction insures that our sample contains destination markets that are served by a large enough number of French firms, even at the disaggregated sectoral level. Together, those markets represent 65% of French exports.

We also drop exports in non-manufacturing industries that are less likely to be vertically differentiated, as well as the tobacco industry, which is very concentrated in France, and the industries of "Other food products, not elsewhere classified" and "Miscellaneous products of petroleum and coal." These restrictions leave us with a sample of 14 countries and 24 ISIC sectors that covers 55% of French exports. In this sample, observations are identified by a firm ID (f), a product category (p) defined at the 8-digit level of the combined nomenclature (cn8), a destination market (c) and a time period (t). We call "variety" a firm $\times$ product $\times$ destination triplet and assume the quality of each variety is constant over time. The dataset is a panel describing how the value and quantity of French exports in these varieties evolve between 1995 and 2005.

The time-series can be aggregated 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 and/or products). As the 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 (hs6). A "good" is thus a hs6 sector, while a variety is the product sold by a particular firm in that sector.[13] Since the analysis uses the time dimension of the panel, particular attention has to be paid to potential changes

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[13]It may be that the same firm serves the same market with several cn8 varieties within the same hs6 "sector". These varieties are assumed as substitutable from each other as two varieties produced by different firms. These "multi-product" companies represent a very small share of our sample, however. More than 90% of the firms we consider produce a single product within a given hs6 category.

in the cn nomenclature. Before computing the quality indices, product data are 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 cover 171,753 firms producing goods in 7,737 cn8 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 us to compute the unit value index for good k, defined as

$$
\begin{aligned}
\Delta \ln(UV_{kct}) \quad &= \quad \Delta \ln \frac{\sum_{(p,f)\in I_{kct}} v_{fpct}}{\sum_{(p,f)\in I_{kct}} q_{fpct}} \\
&= \quad \underbrace{\Delta \ln \frac{\sum_{(p,f)\in I_{kc}} v_{fpct}}{\sum_{(p,f)\in I_{kc}} q_{fpct}}}_{\text{Intensive component}} + \underbrace{\Delta \ln \tilde{\lambda}_{kct} - \Delta \ln \lambda_{kct}}_{\text{Extensive component}}
\end{aligned}
\tag{5}
$$

$$
\text{where} \quad \lambda_{kct} \equiv \frac{\sum_{(p,f)\in I_{kc}} v_{fpct}}{\sum_{(p,f)\in I_{kct}} v_{fpct}}
$$

$$
\text{and} \quad \tilde{\lambda}_{kct} \equiv \frac{\sum_{(p,f)\in I_{kc}} q_{fpct}}{\sum_{(p,f)\in I_{kct}} q_{fpct}},
$$

where I_{kct} is the set of varieties of good k exported in country c in year t. The unit value index can be decomposed into an intensive and an extensive components as in (5). The intensive component is computed from the sub-sample covering firms that export in a given market over two consecutive periods ($I_{kc} = I_{kct} \cap I_{kct-1}$). The extensive component is the difference between the value and the volume shares of new varieties in the overall sample of bilateral trade flows.

As in Harrigan & Barrows (2009), the ideal price index for good k is built using the Sato-Vartia-Feenstra formula, which assumes $g()$ has a CES form:[14]

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

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

$$\text{where} \quad w_{fpct}(I_{kc}) \equiv \frac{\left(\frac{s_{fpct}(I_{kc}) - s_{fpct-1}(I_{kc})}{\ln s_{fpct}(I_{kc}) - \ln s_{fpct-1}(I_{kc})}\right)}{\sum_{(p,f) \in I_{kc}} \left(\frac{s_{fpct}(I_{kc}) - s_{fpct-1}(I_{kc})}{\ln s_{fpct}(I_{kc}) - \ln s_{fpct-1}(I_{kc})}\right)}$$

$$\text{with} \quad s_{fpct}(I_{kc}) \equiv \frac{v_{fpct}}{\sum_{(p,f) \in I_{kc}} v_{fpct}}.$$

The first component of equation (6) is the ideal price index computed over the sub-sample of intensive trade flows. The second part of equation (6) corrects the price index for 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/dropped varieties in consumption is high. This is what the λ ratio of equation (6) captures. Moreover, a lower elasticity of substitution between varieties, σ_k, implies a larger utility effect of these virtual price adjustments.[15]

This decomposition of price adjustments into intensive and 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 an alternative form of preferences would neglect the impact that extensive margin adjustments have on 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.[16]

The ideal price index (6) aggregates price adjustments observed at the variety (firm)

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[15]In the empirical part, 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.

[16]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.

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. Given the very high level of disaggregation, however, we expect these measurement errors to be small. At least in the medium run, most quality adjustments should occur between rather than within firms. Unit values may however be polluted by other measurement errors, notably misleading reports 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 by less than 3% as a consequence.

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 components of the unit value and ideal price indices (i.e., from the first terms in 5 and (6)). 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 entering/exiting 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.[17] Finally, we measure quality changes on a year-by-year

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[17]Whether we use a Tornqvist or a Sato-Vartia formula to aggregate sector-specific quality indices is irrelevant. The main difference between these indices is due to the aggregate impact of extensive margin

basis. We then chain-weight 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 364 (market- and sector-specific) time-series. Table 1 gives summary statistics on 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.[18] At the intensive margin, the quality index has increased by about 4%. In the meantime, firm-level export prices grew by 7% on average.[19]

These summary statistics do not account for the composition of the French export basket across sectors and destinations. Figure 1 aggregates the 364 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 entries and exits (panel (b)). The figure confirms that quality adjustments mainly come from the extensive margin. 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, which are correlated with exchange rate fluctuations (see Figure A.2 in the Appendix).[20]

These aggregate evolutions hide a strong degree of heterogeneity, however, as shown by

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adjustments. But since most *hs*6 sectors are present in the data over the whole period, these extensive margin effects are almost zero and the Tornqvist and Sato-Vartia formula give very similar results. See the discussion in Harrigan & Barrows (2009).

[18]The evolution in the number of French flows is depicted in Figure A.1.

[19]Note that the unit value index, which the literature uses as an indicator of either price or quality competitiveness has increased by 12% over the period. This is consistent with Khandelwal (2010) whose results suggest sectoral unit values are poor indicators of either prices or qualities.

[20]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%).

the large distribution of quality growth rates around the mean (first row of Table 1). Despite the average upward tendency, the quality of the French export basket reduces in about one third of the 364 destination markets we consider. The heterogeneity is strong in both the geographic and sectoral dimensions. This is illustrated in Figures A.3 and A.4 which compare the evolution of quality across export destinations and sectors, respectively. Together, these additional pieces of evidence illustrate the double dimension of heterogeneity the analysis has to account for.

At the geographical dimension, Figure A.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 Greece and Portugal. At the sectoral dimension, quality upgrading is on average stronger for textile, leather products, footwear, machinery and measuring equipment while almost zero for food, wood, paper products, printing and metal products. But the sectoral differences are not homogeneous across countries. For furniture for instance, the mean quality of exports to Sweden, UK and Japan has decreased between 1995 and 2005 while it has increased for sales to Germany, Portugal and Italy. In fact, a variance decomposition based on the sector- and country-specific quality indices reveals that more than 75% of the total sum of squares is due to determinants that have the double geographic *and* sectoral dimension (see Table A.2). The important role of sector-specific determinants is consistent with the IO literature, which explains vertical differentiation by structural features related to the production technology. However, our results suggest that quality changes are also affected by determinants that are market-specific within a given sector.

4.2 Quality improvements and export performance

The previous section has documented an aggregate quality upgrading in French exports. We now ask how this "flight-to-quality" affects France's aggregate export performance, by running a counterfactual exercise. Specifically, we ask what would have been the change in the value of France's exports if aggregate quality had stayed constant over the sample period. Given our definition of the quality index, the growth rate in the value of France's

exports can be written as:

$$\Delta \ln V_t = \Delta \ln Q y_t + \Delta \ln \pi(p_t) + \Delta \ln Q_t, \tag{7}$$

where $\Delta \ln V_t$, $\Delta \ln Q y_t$, $\Delta \ln \pi(p_t)$ and $\Delta \ln Q_t$ denote the growth rates of the export value, the export quantity, the price of exports and the quality of exports, respectively. In our framework, an increase in the value of French exports can be explained by French firms exporting a larger quantity, by their prices increasing, or by demand being reallocated in favor of more expensive, better qualities. We first use our data to measure this evolution in the value of French exports. We then compute what would have happened if the mean quality had stayed constant, i.e., we compute:[21]

$$\Delta \ln \tilde{V}_t = \Delta \ln Q y_t + \Delta \ln \pi(p_t). \tag{8}$$

Since aggregate quality increases in our data, the counterfactual growth rate is going to be smaller than the observed one (i.e., $\Delta \ln \tilde{V}_t < \Delta \ln V_t$). The difference will be particularly pronounced in tose markets where quality upgrading is stronger.

It has to be noted that this is a *ceteris paribus* exercise, which implicitly assumes observed changes in prices and the quantity of exports to be independent from the evolution of quality. In that sense, our measure of the impact of quality changes on the value of exports is conservative. Indeed, the aggregate growth rates in the volume and price of exports that we observe are probably lowered by the reallocation of demand in favor of high-quality firms. In a world of within-industry specialization, those low quality firms which market share decreases are also the ones that suffer the most from increased international competitive pressures. Their market share losses are larger and they are forced to compress their mark-up more strongly. The downward pressures on the quantity and price of exports are however attenuated at the aggregate level because of the drop in the weight of low-quality producers. This suggests that the growth rate of exports we would have observed if demand were not

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[21]Consistent with the empirical strategy described in Section 3, the counterfactual is measured at the lowest level of aggregation. We then aggregate across hs6 products and countries using a Tornqvist formula.

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reallocated in favor of high-quality producers would be even lower than the one we compute based on equation (8).

Aggregate results for the counterfactual exercise are displayed in Figure 2. Over the 1995-2005 period, the aggregate value of French exports increases by almost 60% (panel (a), solid line).[22] This fairly large number has to be compared to the overall increase in world trade over the period. Panel (b) in Figure 2 thus corrects the index for the growth rate of overall imports in each destination market (expressed in euros). Despite the general increase in the value of its exports, France loses almost 6% of its market share in foreign countries. The market share loss would be substantially larger, however, absent the rebalancing of French exports in favor of high quality goods. Around 20% of the observed increase in the value of France's exports is indeed due to quality upgrading. Without the reallocation of market shares, French firms would have lost almost 20% of their market share in foreign markets over the 1995-2005 period.

The impact of quality changes on export performances is thus large. However, it is not homogeneous across countries and sectors. Figure 3 uses equation (7) to decompose the 1995-2005 growth of exports (in value) by destination country (panel a) and by sector (panel b). The relative size of the quality component with respect to the overall growth rate of exports provides us with information on the contribution of quality to export performances. This contribution is especially important for richer countries, notably Germany, Japan and Switzerland. At the other side of the spectrum, quality is relatively less important in explaining France's export performance in poorer countries like Poland, Spain, Portugal and Greece. For these countries, the growth of exports is mainly due to French firms increasing the quantity they export. At the industry level, quality growth is especially important in explaining the growth of French exports in electrical machineries, other machineries, footwear and glass products. In these sectors, quality explains more than 50% of export growth.

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[22]This number is calculated using the sub-sample of export flows that is considered in the rest of the analysis. The corresponding growth rate based on the whole universe of French exporters is equal to 69%.

4.3   Impact of low wage countries' competition

In a world of within-industry specialization, the previously described increase in the quality of French exports is driven by changes in the competitive environment French firms face in international markets. To test whether this mechanism prevails in the data, we now use the heterogeneity in the intensity of quality changes across sectors and destination countries to ask whether it can be related to measures of the quality competition. If countries indeed specialize within industries, it must be true that quality upgrading is stronger in those markets in which France faces stronger competitive pressures from low-quality producers.

Our first measure of "quality competition" relies on the growing penetration of goods produced in low-wage countries in France's export markets. As mentioned in the introduction, the share of low-wage countries in world trade has dramatically increased over the last two decades. Figure 4 compares the evolution in the aggregate market share of low wage countries in world exports with the evolution of France's market share.[23] The market share of low-wage countries has strongly increased, from less than 8% of world exports in 1995 to more than 16% in 2005. alone. China accounts for more than two thirds of this increase. If low wage countries produce lower qualities on average, it must be true that the increased penetration of their products into French exporters' destination countries exert competitive pressures that induce French quality upgrading.

As preliminary evidence, Figure 5 plots the change in the quality of French sectoral exports (averaged across destination markets) against the change in low-wage countries' market share. It shows a positive relationship between quality upgrading and increased competition from low-wage countries, for the whole sample (panel (a)), as well as for the sub-sample of intensive trade flows (panel (b)). This suggests that the mean quality of French exports increases more over the period in those industries that are more exposed to low-wage countries.

We now use regression analyses to ask whether the previous correlation is explained by

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[23]We follow Bernard et al. (2006) and define low-wage countries as countries which GDP per capita is less than 5% of the US one. Market shares data are averaged over France's export markets considered in the empirical exercise. They are computed using the information on bilateral trade flows of the UN-ComTrade database.

a causal impact from changes in competitive pressures exerted by low wage countries on the quality of French exports in each destination market. Our baseline estimated equation is

$$\Delta_{95-05} \ln Qlty_{kc} = \sum_{i \in lwc} \alpha_i \, \Delta_{95-05} Msh_{kc}^i + X_{kc} + \epsilon_{kc}, \tag{9}$$

where k and c refer to the sector and the destination country, respectively, and Δ_{95-05} denotes the first difference between 1995 and 2005. $\Delta_{95-05} \ln Qlty_{kc}$ is the log change in the quality of French exports toward country c in sector k over the period 1995-2005. $\Delta_{95-05} Mks_{kc}^i$ is the variation in country i's market share, where i is one particular low-wage country. Finally, X_{kc} is a vector of controls. The most basic regression uses country-specific fixed effects to control for all macroeconomic evolutions that may explain an aggregate improvement in the demand for quality expressed by market c. For instance, these effects capture the possibility that the country becomes richer, which tends to increase its aggregate demand of high-quality goods. However, the variance decomposition of Table A.2 underlines the impact of sector-specific and, above all, sector *and* market-specific determinants in explaining the heterogeneity in quality changes. We account for these sectoral determinants using various control variables detailed below.

We start by assuming that the impact of competition from low-wage countries is the same whatever the particular country we consider within that group. We thus constrain the α_i coefficients to be equal ($\alpha_i = \alpha$, $\forall i$). Since most of the rise in low-wage countries' market share displayed in Figure 4 is attributable to China, this country may be an outlier, however. We thus investigate whether competition from China has a specific impact on the quality of French exports, i.e., we allow the α_i coefficient to be different for China than for other low wage countries.

A potential caveat of the previous regression framework is that changes in market shares may be endogenous to the evolution in the mean quality of French exports because of reverse causality or omitted variables. Reverse causality may arise if positive changes in the quality composition of French exports allow low-wage countries' firms to increase their market shares in foreign markets. Omitted variables may also create endogeneity if these determinants of

quality changes are also correlated with low wage countries' market shares.

To address endogeneity issues, we first compute low wage countries' market shares in a country's imports excluding sales from French firms:

$$Mks_{kct}^{i} \equiv \frac{IMP_{ikct}}{\sum_{l \neq France} IMP_{lkct}},$$

where IMP_{lkct} is the value of good k country c imports from l at time t. Based on the assumption that the evolution of these market shares is exogenous to France's quality changes, we estimate equation (9) using OLS.

Changes in low-wage countries' market shares may still be endogenous, however. We thus run a set of 2SLS estimations. Namely, we estimate predicted values for changes in low-wage countries' market shares using two instruments. The first one measures the overall evolution of the country's market share in sector k, computed over all destination markets except for country c. This instrument conveys some information about the aggregate "performance" of the low-wage country in sector k over the period under consideration. Since the variable does not use information on sales in country c, it is independent from changes in the market structure of that country, notably due to France increasing the quality of its exports. The second instrument we use measures the relative proximity of the low-wage country to the destination market, in comparison with its competitors. It is constructed as

$$RelDist_{ick} = \frac{Dist_{ic}}{\frac{1}{N_{ck}} \sum_{l=1}^{N_{ck}} Dist_{lc}},$$

where i and c are the low-wage country and the destination market we consider, respectively. $Dist_{ic}$ is the distance between i and c and N_{ck} is the number of countries serving country c in good k.[24] In comparison with the first one, this instrument adds variance in the country dimension of predicted market shares. The exporter's proximity to the destination country is a good predictor of its initial market share. Since the level increase of low-wage countries' market shares is negatively correlated to their initial market share, this instrument should

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[24]The distance variable is a population weighted mean of city-to-city bilateral distances, downloaded from the CEPII's website ($http://www.cepii.fr/anglaisgraph/bdd/distances.htm$).

be negatively correlated with the instrumented variable.

Our main results are presented in Table 2.[25] Whatever the specification, estimated coefficients suggest that low-wage countries increasing their market share has a positive impact on the quality of French exports. This result is consistent with Schott (2008)'s argument suggesting that the increasing penetration of low-wage countries in world trade induces developed countries to specialize in higher qualities. The estimated effect of low-wage countries' competition is stronger in the IV regressions (column (2)) than with OLS (column (1)). A one standard deviation in market shares increases the quality index by 2.7% according to the OLS estimate (column 1) and by 3.3% in the IV estimation (column 2). This suggests that, if any, the endogeneity bias tends to underestimate the effect that quality competition has on French exports.

In column (3), we consider the possibility that competition from China has a different impact than competition from other low-wage countries. Results of the IV estimation suggest that it is indeed the case. Once China is considered separately, the impact of other low-wage countries increasing their market share is no longer significant. This explains from the variance of this variable being much lower than changes in China's market shares.

The descriptive statistics on quality changes presented in section 2.1 underlined a strong impact of the extensive margin on the magnitude of quality adjustments. We now ask whether these extensive margin adjustments also play a role in explaining the relationship between competition from low-wage countries and quality upgrading. Namely, we introduce a measure of changes in the number of firms serving a given destination market (called "$\Delta\#$ varieties" in Table 2, columns (4) and (5)). As expected, the impact of extensive adjustments is strongly positive. This is consistent with the descriptive statistics suggesting that most of the quality improvement in French exports is due to the net entry of better qualities.

Controlling for extensive margin adjustments does not change the main result, however. The impact of Chinese firms increasing their market share is still positive and significant (column (4)). In column (5), we interact the previous measure of extensive margin adjustments to our proxy for quality competition. The coefficient associated to the interaction

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[25]Results for the first-stage regressions are presented in Table A.1.

turns out non-significant. The impact of competition from Chinese firms is not more intense in those sectors in which extensive margin adjustments are larger. This result is confirmed in Table 3 that replicates regressions displayed in columns (1)-(3) of Table 2 on the sub-sample of intensive flows. Estimates are very similar to the ones obtained on the whole sample. Together, these results suggest that the impact of low-wage countries' competition on the aggregate quality of French exports works through intensive and extensive adjustments. This is consistent with the model presented in section 2.

Table 4 tests the robustness of the previous results to the inclusion of additional control variables. In particular, since the results presented in Tables 2 and 3 are identified between sectors within a destination market, it is important for us to check that the significance of the estimated coefficients is not due to omitted sectoral variables.

A potential omitted candidate is related to the extent of vertical differentiation: by definition, quality upgrading cannot be observed in homogeneous sectors. Not controlling for the extent of vertical differentiation may induce spurious correlation in Table 2 if those sectors that are more differentiated are also the ones where market shares for Chinese firms increased the most. We control for this possibility in Column (1) of Table 4 using as control the indicator of vertical differentiation estimated by Khandelwal (2010). Khandelwal uses a cross-country identification method to estimate the mean quality of a country's exports in the US, at the highly disaggregated product-level. He then assimilates the maximum quality gap across exporting countries within a given sector to a measure of quality differentiation. A longer "quality ladder" thus corresponds to a sector that is more prone to vertical differentiation.

We interact this measure of vertical differentiation with our proxy for competitive pressures exerted by low-wage countries. As expected, quality upgrading is estimated to be larger in industries with longer quality ladders, even though the effect is very close to zero and not statistically significant. On the other hand, the impact of competitive pressures from low-wage countries is less pronounced in long-ladder sectors, as shown by the negative coefficient obtained on the interaction term. A possible interpretation is that, in long-ladder sectors, French firms are already isolated from price competition thanks to vertical differen-

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tiation. The coefficient associated to the interaction is not significant, however. The only robust result in this regression concerns the positive effect of competition from China on the quality of French exports.

Table 4 considers two other potential omitted variables, namely the change in the destination country's production of the considered good (column (2)) and the initial market share of French firms (columns (3)-(5)). The change in domestic production accounts for local competitive pressures that French firms face in each destination market. Until now, we have indeed assumed that quality upgrading was driven by competitive pressures coming from other foreign firms. It may well be, however, that French exporters have to face increased competition from local firms, which should trigger additional quality upgrading if these firms produce relatively low qualities. Unfortunately, we are unable to measure the quality of local products. Column (2) of Table 4 thus tests the possibility that any increase in sectoral production exerts competitive pressures that induce quality changes. The coefficient associated to this variable is not significant. Moreover, controlling for changes in local production does not affect the conditional correlation between competition from China and quality upgrading.

Changes in the quality of French exports may also be related to the initial comparative advantage that France has in some sectors and destinations. This is what the use of France's initial market share is meant to capture (columns (3)-(5) in Table 4). Interestingly, we observe that quality upgrading is more pronounced in markets in which France has a lower initial market share. Once again, this does not change our main result, however. The impact of competition from China remains positive and significant. And it is homogeneous whatever the initial market share of French firms (column (4) of Table 4).

These results suggest that the quality upgrading in French exports is in part due to competition from low-wage countries. This is consistent with within-industry specialization when low-wage countries produce low quality goods. In the data, however, it is not always true that the quality of French exports upgrades: in around one third of the sample, we measure quality downgrading. In a model of within-industry specialization, such quality downgrading is due to France facing relatively more competition from firms that produce

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relatively higher qualities.

To consider this possibility, we build a second measure of "quality competition" that accounts for the whole set of competitors French firms face in foreign markets. This quality competition indicator increases in markets where France faces tougher competitive pressures from developing countries, but goes down if competition is induced by the increased penetration of developed countries' producers. The indicator is defined as:

$$\Delta_{95-05}QComp_{kc} = 100 * \left(\sum_{j \in N_{kc}} \frac{\Delta_{95-05}Mks_{kc}^{j}}{GDPc_{j95}} \right), \quad (10)$$

where N_{kc} is the set of exporting countries serving market c in goods k (excluding France). $GDPc_{j95}$ is country j's 1995 GDP per capita (in current US dollars). Finally, $\Delta_{95-05}Mks_{kc}^{j}$ is the change in country j's share of market c for product k (excluding French sales from the computation).[26] The index increases if less developed countries increase their market share/enter the market. In the following, we use $\Delta_{95-05}\ln QComp_{kc}$ as an approximation of changes in the mean quality of products France is competing with 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).

We use this index to estimate the following equation:

$$\Delta_{95-05}\ln Qlty_{kc} = \alpha\Delta_{95-05}QComp_{kc} + X_{kc} + \epsilon_{kc}. \quad (11)$$

Results are presented in Table 5. Column (1) shows the regression with country fixed effects as controls. It emphasizes a positive and significant relationship between quality competition and changes in the quality of French exports. The magnitude of the effect is similar to what we found with the first indicator of quality competition: A one standard deviation shock in the quality competition indicator increases the quality of French exports by 3%, on average. Columns (2)-(4) show that the result is robust to other control variables. It is slightly reduced but still significant when we account for extensive margin adjustments (column (2))

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

or for the negative relationship between France's initial market share and quality changes (column (4)). Controlling for the degree of vertical differentiation does not change the result either. But we again find the impact of quality competition to be (marginally) smaller in more vertically differentiated sectors. All in all, results obtained using the second proxy for quality competition confirms what we found before, namely that quality upgrading is stronger in those sectors in which France faces increased competitive pressures from low quality producers.

5 Conclusion

In a world of within-product specialization along the quality dimension, competition in international markets has an heterogeneous impact on vertically differentiated producers located in a given country. Low-quality producers in rich countries are more strongly affected by increased competitive pressures from standardized good producers in low-wage countries than firms producing high quality goods. This asymmetry induces a reallocation of demand within countries between producing firms.

Our paper discusses the impact that the asymmetry has on the quality composition of a country's exports. Using a simple model of vertical differentiation, we show that increasing competition from low-quality producers should induce a quality upgrading in rich countries' aggregate exports. We evaluate the pertinence of this mechanism using bilateral export data covering the universe of French manufacturing firms.

We show that the quality of the French export basket has increased by more than 10% between 1995 and 2005. Quality upgrading is particularly pronounced in sectors and countries where French firms face increasing competitive pressures from low-quality producers. The flight to quality is consistent with within-industry specialization along the vertical dimension.

The quality upgrading identified in the data has important consequences. In particular, it allows maintaining high-income countries' exports in a world of increased competition from low-wage countries. Our estimates suggest that at least 20% of the growth of French exports between 1995 and 2005 is due to the recomposition of its export basket in favor

of high-quality producers. Absent any reallocation, the share of French products in foreign markets would have reduced at least twice as much as what we observe in the data.

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A   Solution of the Model

The best response functions for the high, medium and low quality producers are defined as

$$
\begin{aligned}
BR_H &= \frac{c_H}{2} + \frac{1}{2\tau_H}\left[\tau_M p_M + \alpha\bar{\theta}\right] \\
BR_M &= \frac{c_M}{2} + \frac{1}{2\tau_M}\left[\alpha\tau_L p_L + (1-\alpha)\tau_H p_H\right] \\
BR_L &= \frac{c_L}{2} + \frac{1}{2\tau_L}\left[\tau_M p_M - (1-\alpha)\underline{\theta}\right].
\end{aligned}
$$

The Nash equilibrium yields the following optimal prices:

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

Prices equal marginal cost plus a markup. Markups positively depend on the costs of the firm's competitors as well as the size of the market (implicitly defined by $\bar{\theta}$ and $\underline{\theta}$). Markups negatively depend on the own cost of the firm: Firms incompletely pass their cost through prices. The magnitude of cost pass-through depends on the market power the firm benefits from thanks to vertical differentiation.

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:

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

Case 1: The Southern firm produces the lowest quality: Consider the case in which the lowest quality (L) is produced by the Southern firm while the two Northern firms respectively produce the medium and high qualities. Starting from a situation in which both demands are strictly positive, one can show that a reduction in the ad-valorem cost faced by the Southern firm ($\Delta \tau_S = \Delta \tau_L < 0$)) reduces the demand addressed to each Northern firm, but the demand loss is stronger for the medium quality producer:

$$0 < \frac{dD_H}{d\tau_S} = \frac{c_L}{6} \quad < \quad \frac{dD_M}{d\tau_S} = \frac{c_L}{3(1-\alpha)}.$$

Under some circonstances, one or both firms can even be pushed out of the market. This happens if the trade cost drop is large enough in which case ex-post sales are negative. Calling $\Delta \tau_S$ the absolute drop in the South ad-valorem cost, this means, respectively for the medium- and the high-quality firms:

$$D_M(\tau_S - \Delta \tau_S, \tau_N, c_L, c_M, c_H, \bar{\theta}, \underline{\theta}, \alpha) \quad < \quad 0$$
$$D_H(\tau_S - \Delta \tau_S, \tau_N, c_L, c_M, c_H, \bar{\theta}, \underline{\theta}, \alpha) \quad < \quad 0.$$

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

$$\bar{\Delta \tau_S}^M = \tau_S - \frac{\tau_N c_M}{\alpha c_L} + \frac{(1-\alpha)\tau_N c_H}{\alpha c_L} + \frac{(1-\alpha)(\bar{\theta} - \underline{\theta})}{c_L},$$

while the high-quality firm exits if the drop exceeds

$$\bar{\Delta \tau_S}^H = \tau_S + \frac{2\tau_N c_M}{\alpha c_L} - \frac{(2+\alpha)\tau_N c_H}{\alpha c_L} + \frac{(1-\alpha)(\bar{\theta} - \underline{\theta})}{c_L} + \frac{3\bar{\theta}}{c_L}.$$

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

$$\bar{\Delta\tau_S}^H > \bar{\Delta\tau_S}^M$$

$$\Leftrightarrow \quad \tau_N(c_H - c_M) < \alpha\bar{\theta},$$

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

Case 2: The Southern firm produces the medium quality: Consider now the situation in which the Southern firm is endowed with the median quality and benefits from a trade cost reduction ($\Delta_S = \Delta\tau_M < 0$). Once again, both Northern firms suffer from a sales drop as a result of the Southern firm becoming more competitive:

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

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

$$\frac{dD_H}{d\tau_S} < \frac{dD_L}{d\tau_S}$$

$$\Rightarrow \quad \alpha > \frac{1}{2}.$$

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

$$D_L(\tau_S - \Delta\tau_S, \tau_N, c_L, c_M, c_H, \bar{\theta}, \underline{\theta}, \alpha) \quad < \quad 0$$

$$D_H(\tau_S - \Delta\tau_S, \tau_N, c_L, c_M, c_H, \bar{\theta}, \underline{\theta}, \alpha) \quad < \quad 0.$$

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

$$\bar{\Delta\tau_S}^L = \tau_S - \frac{(3-\alpha)\tau_N c_L}{2c_M} + \frac{(1-\alpha)\tau_N c_H}{2c_M} + \frac{\alpha(1-\alpha)}{2c_M}(\bar{\theta} - \underline{\theta}) - \frac{3(1-\alpha)}{2c_M}\underline{\theta},$$

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

$$\bar{\Delta\tau_S}^H = \tau_S - \frac{(2+\alpha)\tau_N c_H}{2c_M} + \frac{\alpha\tau_N c_L}{2c_M} + \frac{\alpha(1-\alpha)}{2c_M}(\bar{\theta} - \underline{\theta}) + \frac{3\alpha}{2c_M}\bar{\theta}.$$

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

$$\bar{\Delta\tau_S}^H > \bar{\Delta\tau_S}^L$$
$$\Leftrightarrow \quad \tau_N(c_H - c_L) < \alpha\bar{\theta} + (1-\alpha)\underline{\theta}$$
$$\Leftrightarrow \quad \alpha > \frac{\tau_N(c_H - c_L) - L}{\bar{\theta} - \underline{\theta}}.$$

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

<u>Case 3: The Southern firm produces the high quality:</u> Following the price shock ($\Delta_S = \Delta\tau_H < 0$), both Northern firms suffer from a drop in their sales:

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

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

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

$$D_L(\tau_N, \tau_S - \Delta\tau_S, c_L, c_M, c_H, \bar{\theta}, \underline{\theta}, \alpha) \quad < \quad 0$$
$$D_M(\tau_N, \tau_S - \Delta\tau_S, c_L, c_M, c_H, \bar{\theta}, \underline{\theta}, \alpha) \quad < \quad 0.$$

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

$$\bar{\Delta\tau_S}^M = \tau_S - \frac{\tau_N c_M}{(1-\alpha)c_H} + \frac{\alpha\tau_N c_L}{(1-\alpha)c_H} + \frac{\alpha}{c_H}(\bar{\theta} - \underline{\theta}).$$

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

$$\bar{\Delta\tau_S}^L = \tau_S + \frac{2\tau_N c_M}{(1-\alpha)c_H} - \frac{(3-\alpha)\tau_N c_L}{(1-\alpha)c_H} + \frac{\alpha}{c_H}(\bar{\theta} - \underline{\theta}) - \frac{3}{c_H}\underline{\theta}.$$

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

$$\bar{\Delta\tau_S}^L > \bar{\Delta\tau_S}^M$$

$$\Leftrightarrow \quad \tau_N(c_M - c_L) > (1-\alpha)\underline{\theta}.$$

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

Table 1: Summary statistics

| Variable	Mean	Std. Dev.	pctle 5	pctle 95	N
Quality (Intensive + Extensive)	111.35	21.94	86.4	149.7	364
Quality (Intensive)	104.09	14.51	83.1	132.5	364
Price (Intensive + Extensive)	101.97	24.81	75.9	136.5	364
Price (Intensive)	107.46	25.05	84.7	141.2	364
Unit Value (Intensive + Extensive)	112.68	32.86	79.7	163.5	364
Unit Value (Intensive)	111.55	28.67	83.9	156.4	364

Notes: These summary statistics are computed over the distribution of sector- and destination-specific indices for 2005 ($Q_{kc,05}$ with $Q_{kc,1995} = 100$). Sectors are defined in the ISIC revision 2 nomenclature. The decomposition is either performed on the whole sample ("Intensive + extensive" rows) or on the subsample of intensive flows ("Intensive" rows). Interpretation: Over 1995-2005, the mean growth rate of quality, averaged across markets and sectors, is equal to 11.35%. The corresponding average price increase is equal to 1.97%. In the meantime, unit values were increasing by 12.68%.

Figure 1: Evolution of the aggregate quality of French exports

(a) Whole sample
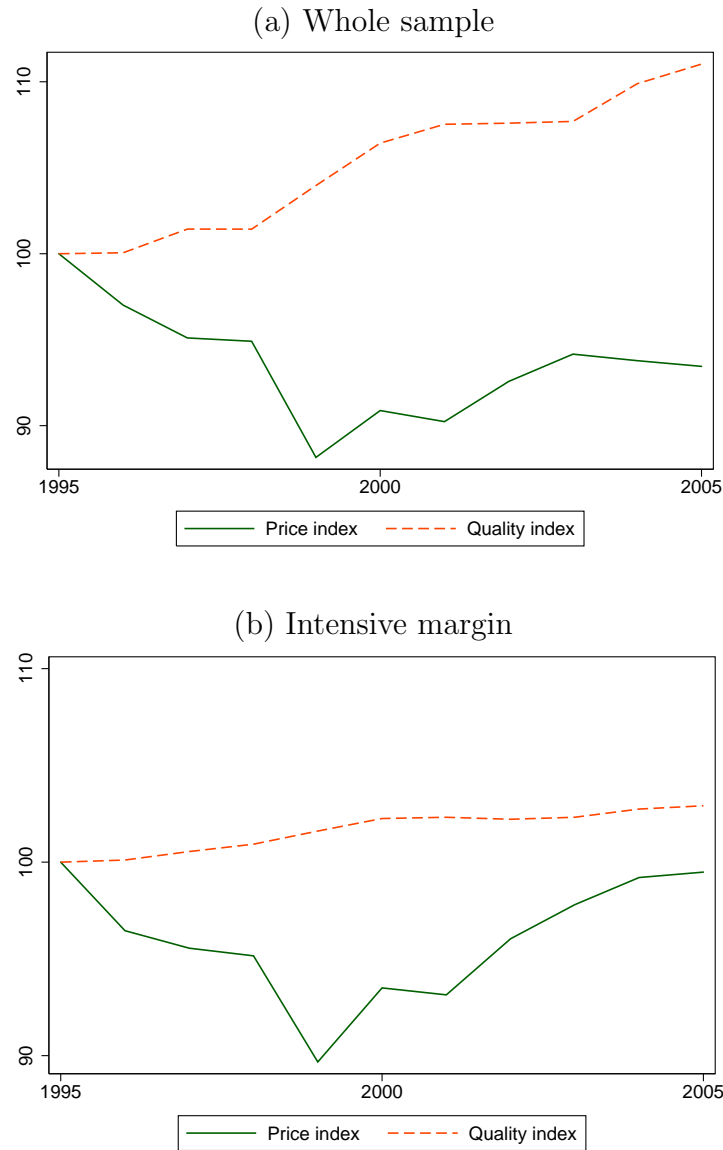
(b) Intensive margin

Notes: The multilateral quality index is obtained from a Tornqvist aggregation of sectoral and country-specific quality indices (Q_{kct}). The multilateral price index aggregates the corresponding ideal price indices. The "Intensive margin" sample is defined has the set of firms present in the considered market over two consecutive years. Price indices are corrected from exchange rate fluctuations affecting the price of French products in the destination market (source: *IMF-IFS*).

Figure 2: Impact of quality upgrading on export performances

(a) Exported value

(b) Market shares
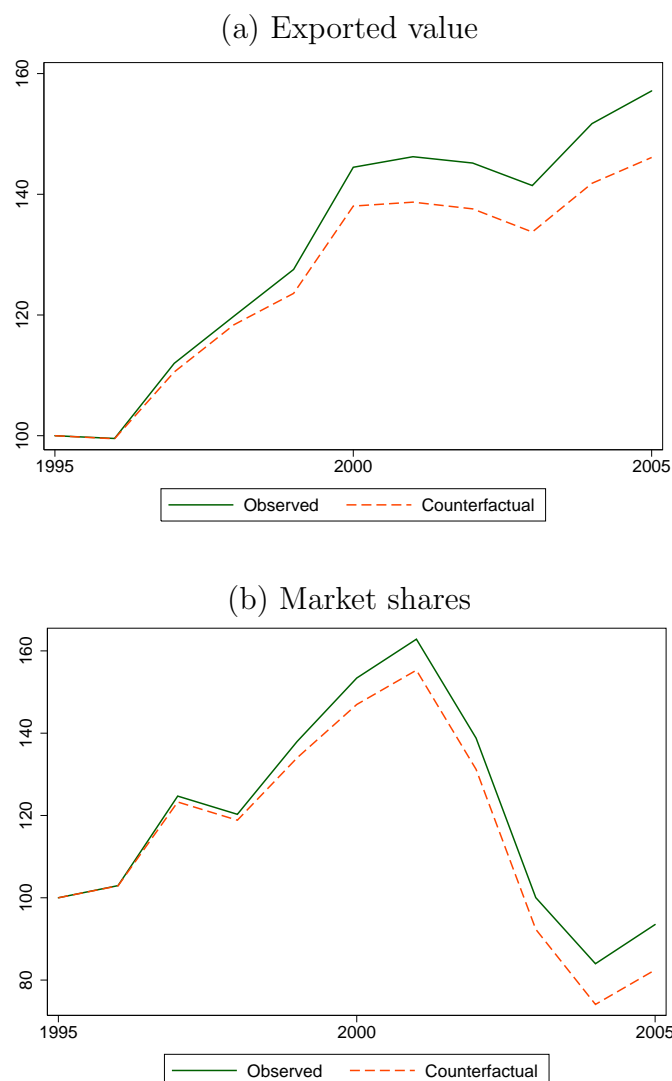
Notes: Panels (a) and (b) compare the observed behavior of the value of French exports (solid line) to the one that would prevail absent any quality adjustment (dashed line). The "counterfactual" is computed as the sum of the price and quantity growth rates of French exports while the "observed" serie is the counterfactual plus the growth rate of aggregate quality. Panel (a) uses as reference the total value of French exports. Panel (b) corrects the series from changes in the total value of each destination's sectoral imports (Source: *UN-ComTrade*). The corresponding figures thus reflect changes in the market share of French products. These decomposition are performed at the sectoral and destination-country level and are then aggregated using a Tornqvist index.

Figure 3: Decomposition of the value of exports

(a) By country
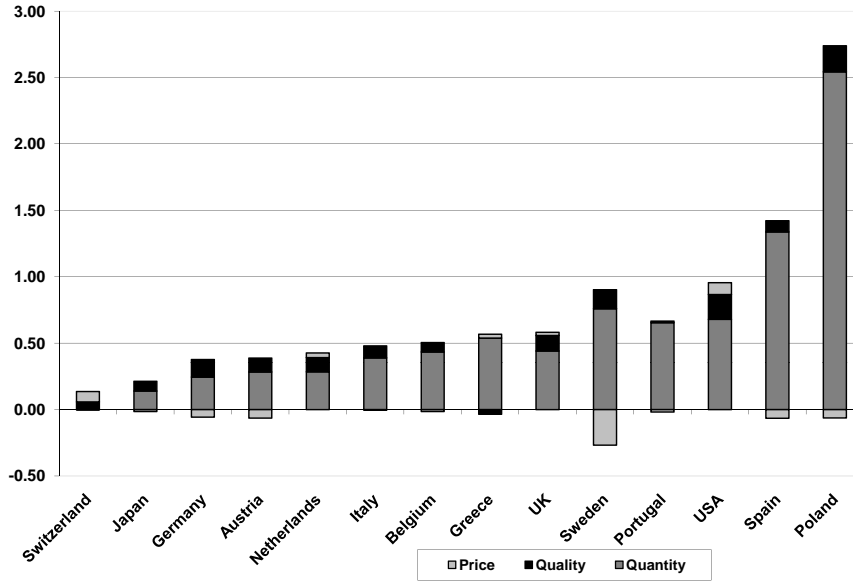
(b) By sector
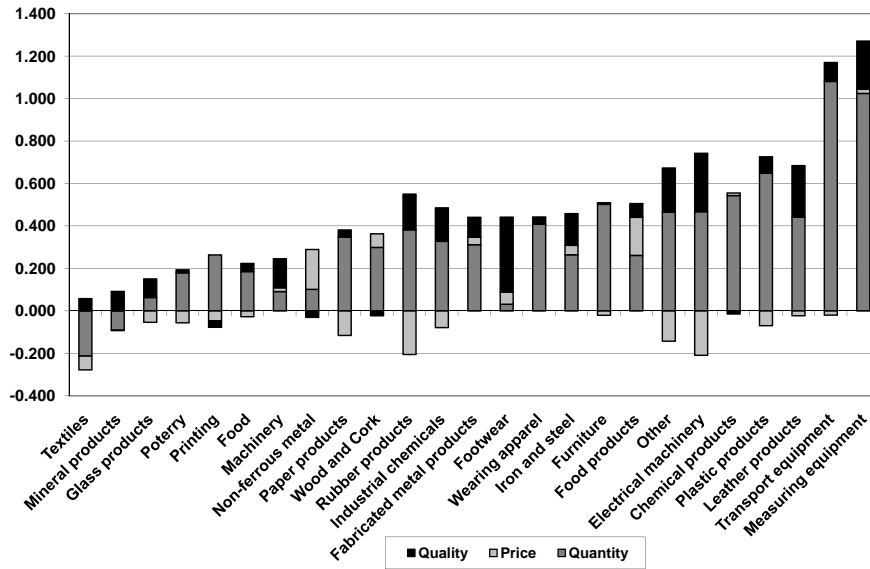
Notes: The decomposition is based on equation (7), computed at the hs6 level for each destination market. Data are then aggregated at the country level (panel (a)) and at the sectoral level (panel (b)) using Tornqvist weights. Each bar measures the growth rate of French exports (in value) between 1995 and 2005. The growth rate is decomposed into a price, a quantity and a quality components. The relative size of the quality component conveys information on the importance of quality upgrading in explaining French export performances.

Figure 4: Evolution in the market shares of low wage countries and France
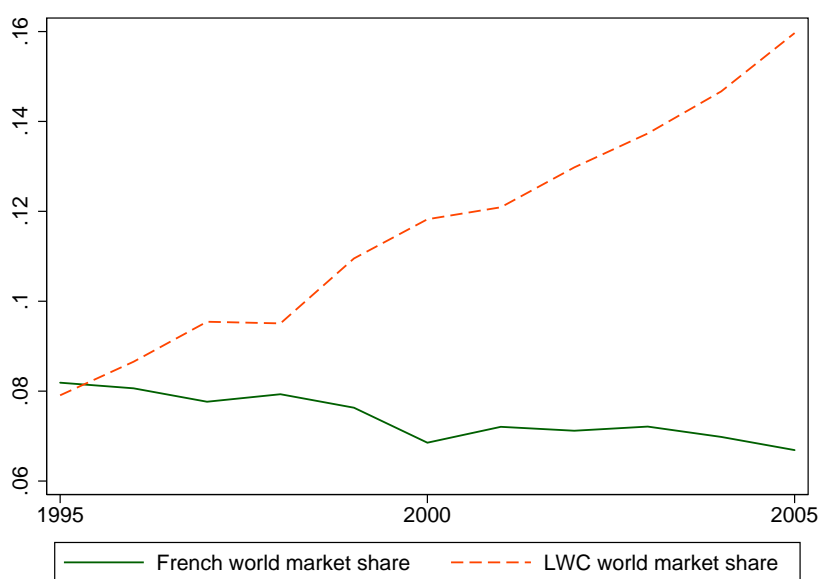
Notes: The solid line displays the evolution in the market share of France in those foreign markets that are considered in the empirical analysis. The dashed line corresponds to the market share of low-wage countries (LWC). The definition of LWC is taken from Bernard et al. (2006): it is a country which GDP per capita is less than 5% of the US one. The trade data are taken from the *UN-ComTrade* database.

Figure 5: Quality & low-wage countries' competition, across industries

(a) Whole sample

(b) Intensive sample
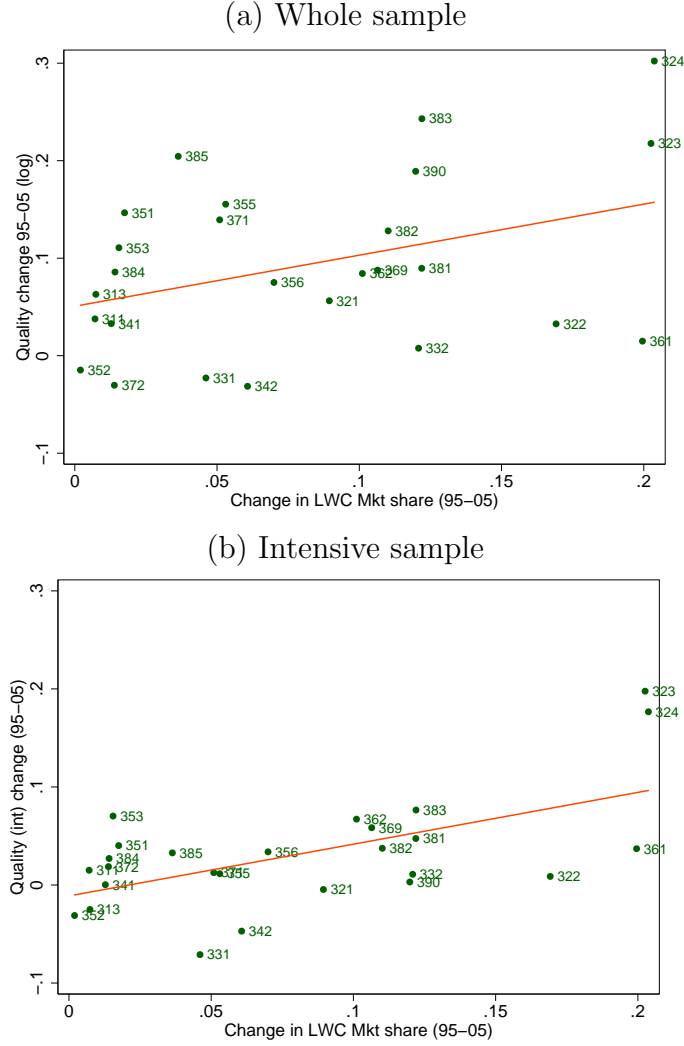
Notes: The change in low-wage countries' market shares is a weighted average that reflects the composition of France's trade. It is computed as $\Delta_{95-05}Mks_k^{lwc} = \sum_c w_{kc}^{fra}\Delta_{95-05}Mks_{kc}^{lwc}$ where w_{kc}^{fra} is the weight of country c in French exports for sector k and $\Delta_{95-05}Mks_{kc}^{lwc}$ is the change in low-wage countries' market share in sector k and country c. For the whole sample an OLS estimation gives

$$\Delta_{95-05}lnQlty_k = \underset{(0.26)}{0.52^b}\Delta_{95-05}Mks_k^{lwc} + \underset{(0.03)}{0.05^b}$$

with a R^2 of 0.14. For the intensive sample we obtain

$$\Delta_{95-05}lnQlty_k = \underset{(0.14)}{0.53^a}\Delta_{95-05}Mks_k^{lwc} - \underset{(0.02)}{0.01}$$

with a R^2 of 0.34. ^{a} and ^{b} denote significance at the 1 and 5% level, respectively.

Table 2: Quality and Low-Wage Countries' Market Shares

	(1)	(2)	(3)	(4)	(5)
	Dep. var: Δ_{95-05} ln Quality				
Δ_{95-05} LWC Market share	0.306^a	0.611^a			
	(0.115)	(0.205)			
Δ_{95-05} LWC Market sh (w/o China)			0.881	1.361	-0.171
			(1.133)	(1.189)	(1.786)
Δ_{95-05} Chinese Market share			0.585^a	0.522^a	0.451^c
			(0.199)	(0.194)	(0.254)
$\Delta\#$ varieties				0.554^a	0.317
				(0.167)	(0.267)
$\Delta\#$ var$\times\Delta_{95-05}$ Ch. Mks					0.674
					(2.054)
$\Delta\#$ var$\times\Delta_{95-05}$ LWC Mks					22.111
					(14.952)
Observations	349	349	349	349	349
R^2	0.044	0.050	0.050	0.087	0.100
Country FE	Yes	Yes	Yes	Yes	Yes
Estimation Method	OLS	IV	IV	IV	IV

Notes: Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$.
The dependent variable is the log difference of the quality index between 1995 and 2005, computed at the ISIC (revision 2) level for each destination country. "Δ_{95-05} LWC Market share", "Δ_{95-05} LWC Market sh (w/o China)" and "Δ_{95-05} Chinese Market share" denote the 1995-2005 change in market shares for low wage countries, low wage countries excluding China and China, respectively. $\Delta\#$ *varieties* is the variation in the number of varieties composing the sectoral export basket which quality is measured. The IV procedure uses as instruments for the change in market shares the country's relative distance to the destination country and the change in its world share of sectoral exports. All market shares are computed excluding France.

Table 3: Quality and Low-Wage Countries' Market Shares, Intensive sample

	(1)	(2)	(3)
	Dep. var: Δ_{95-05} ln Quality		
Δ_{95-05} LWC Market share	0.306^a	0.464^a	
	(0.100)	(0.171)	
Δ_{95-05} LWC Market sh (w/o China)			0.374
			(0.818)
Δ_{95-05} Chinese Market share			0.473^a
			(0.176)
Observations	349	349	349
R^2	0.093	0.073	0.074
Country FE	Yes	Yes	Yes
Estimation Method	OLS	IV	IV

Notes: Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$. The dependent variable is the log difference of the quality index between 1995 and 2005, computed at the ISIC (revision 2) level for each destination country. "Δ_{95-05} LWC Market share", "Δ_{95-05} LWC Market sh (w/o China)" and "Δ_{95-05} Chinese Market share" denote the 1995-2005 change in market shares for low wage countries, low wage countries excluding China and China, respectively. The IV procedure predicts the change in market shares using the country's distance to the destination country and the change in its world share of sectoral exports as instruments. All market shares are computed excluding France.

Table 4: Robustness Checks

	(1)	(2)	(3)	(4)	(5)
	Dep. var: Δ_{95-05} ln Quality index				
Δ_{95-05} Chinese Market share	1.042^b	0.604^a	0.429^b	0.475^c	0.386^c
	(0.456)	(0.199)	(0.211)	(0.286)	(0.207)
Quality ladder	0.001				
	(0.003)				
Ladder $\times$ Δ_{95-05} Chn Mks	-0.060				
	(0.053)				
Δ_{95-05} Domestic Prod.		-0.006			
		(0.033)			
French Market share 1995			-8.145^a	-7.565^a	-8.010^a
			(2.675)	(2.679)	(2.458)
Fr Mks 95 $\times$ Δ_{95-05} Chn Mks				-12.559	
				(45.171)	
Δ# varieties					0.509^a
					(0.152)
R^2	0.053	0.047	0.063	0.063	0.094
Observations	349	349	349	349	349
Country FE	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV

Notes: Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$.
The dependent variable is the log difference of the quality index between 1995 and 2005, computed at the ISIC (revision 2) level for each destination country. The explanatory variables are i) the difference in Chinese market shares between 1995 and 2005 (source: UN-ComTrade), ii) the quality ladder estimated at the ISIC level by Khandelwal (2010), iii) the interaction between the change in market shares and the quality ladder, iv) the change in the destination country's sectoral output (Source: TradeProd), v) the French market share in 1995 (source: UN-ComTrade), vi) the interaction between the change in market shares and the French market share in 1995 and vii) the change in the number of varieties aggregated in the quality index.

Table 5: Quality Upgrading and the Quality of Competition

	(1)	(2)	(3)	(4)
	Dep. var: Δ_{95-05} ln Quality index			
Quality competition	0.204^a	0.184^a	0.305^a	0.161^b
	(0.061)	(0.060)	(0.115)	(0.064)
$\Delta\#$ varieties		0.494^a		
		(0.152)		
Quality ladder			0.001	
			(0.003)	
Ladder $\times$ Quality competition			-0.018	
			(0.016)	
French Market share 1995				-7.871^a
				(2.731)
Obs.	350	350	350	350
R^2	0.055	0.085	0.059	0.070
Country FE	Yes	Yes	Yes	Yes
Method	OLS	OLS	OLS	OLS

Notes: Robust standard errors in parentheses. ^{a} $p < 0.01$, ^{b} $p < 0.05$, ^{c} $p < 0.1$. The dependent variable is the log difference of the quality index between 1995 and 2005, computed at the ISIC (revision 2) level for each destination country. The explanatory variables are i) the quality of competition, ii) the change in the number of varieties aggregated in the quality index ("$\Delta\#$ *varieties* "), iii) the quality ladder estimated at the ISIC level by Khandelwal (2010), iv) the interaction of the quality ladder and the quality competition indicator, v) the French market share in 1995 (source: UN-ComTrade). The Quality of Competition in country j is measured as

$$\Delta_{95-05}QComp_{kc} = 100 \times \left(\sum_j \frac{\Delta_{95-05}Mks_{kc}^j}{GDPc_{j95}} \right)$$

where k is the sector, c the destination country, j an exporting country, $GDPc_{j95}$ the GDP per capita of the exporting country in 1995, and $\Delta_{95-05}Mks_{kc}^j$ the 1995-2005 change in country j's market share in country c's imports of good k.

Table A.1: First stage regressions

	(1) Δ oLWC mks	(2) Δ CHN mks
Δ LWC mks global	0.625^a	
	(0.016)	
Relative distance	-0.0002^c	-0.065^a
	(0.000)	(0.007)
Δ CHN mks global		0.779^a
		(0.060)
Observations	6381	387
R^2	0.194	0.402
F-stat	765.2	129.3

Notes: Robust standard errors in parentheses with ^{a} $p < 0.01$, ^{b} $p < 0.05$ and ^{c} $p < 0.1$

The change in low wage countries' market shares for sector k and destination c is explained by the total change in the country's market share in sector k, computed over all destination countries but c, and the distance between the country and c, in relative term with respect to the "mean" exporter to that destination. The regression is run separately for China and for other low-wage countries.

Table A.2: Variance Decomposition

Source	Partial SS	dof	MS	F	Prob > F
Model	741026.7	38	1079.7	2.63	.000
Country FE	6449.3	13	496.1	1.21	.273
Sector FE	34577.4	25	1383.1	3.36	.000
Residual	133643.8	325	411.2		
Total	174670.5	363	481.2		

Notes: 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.

Figure A.1: Evolution in the number of French export flows
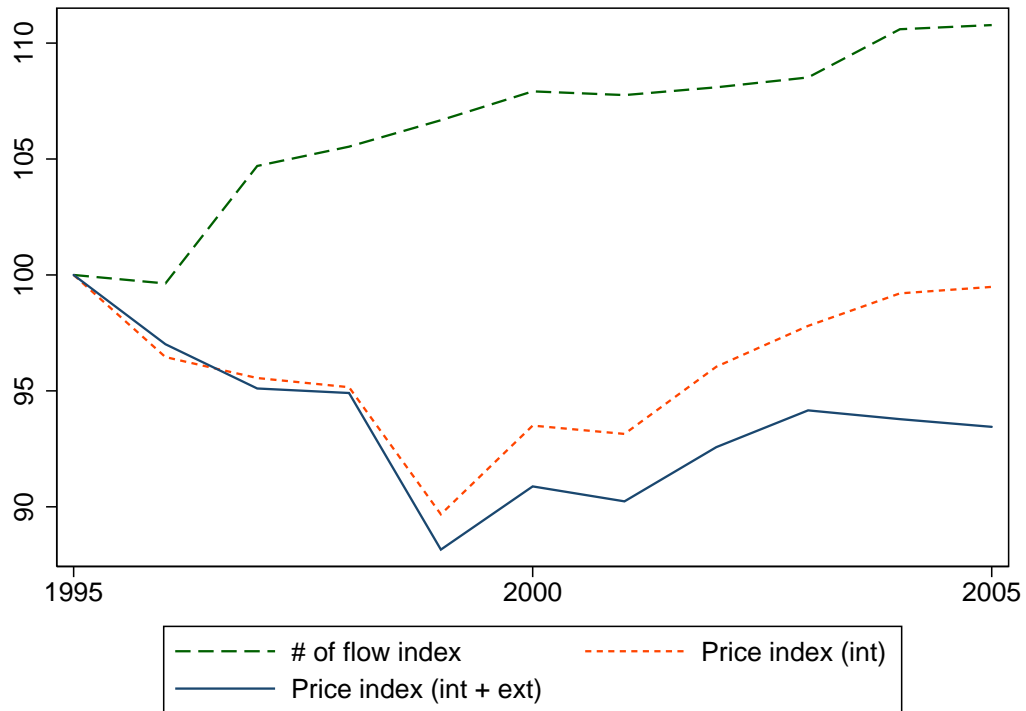
Notes: The solid and dotted lines correspond to the measured evolution of prices, computed over the whole sample (solid line) and the intensive sample (dotted line). The difference between both series comes from entries and exits. The (net) flow of entries (normalized to 100 in 1995) is depicted as well (dashed line).

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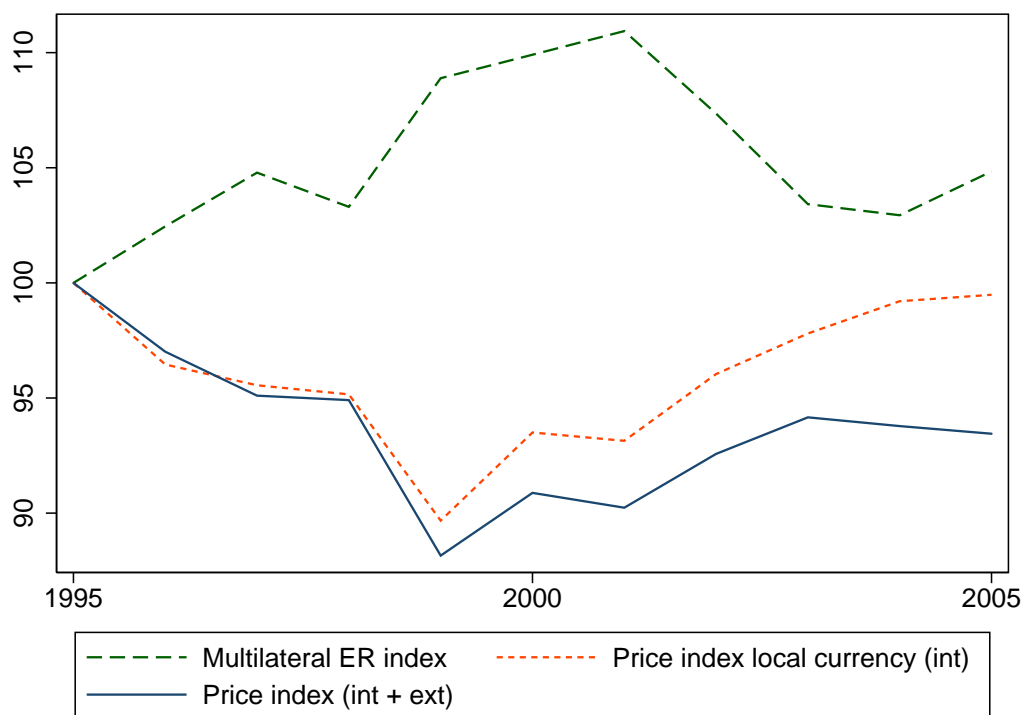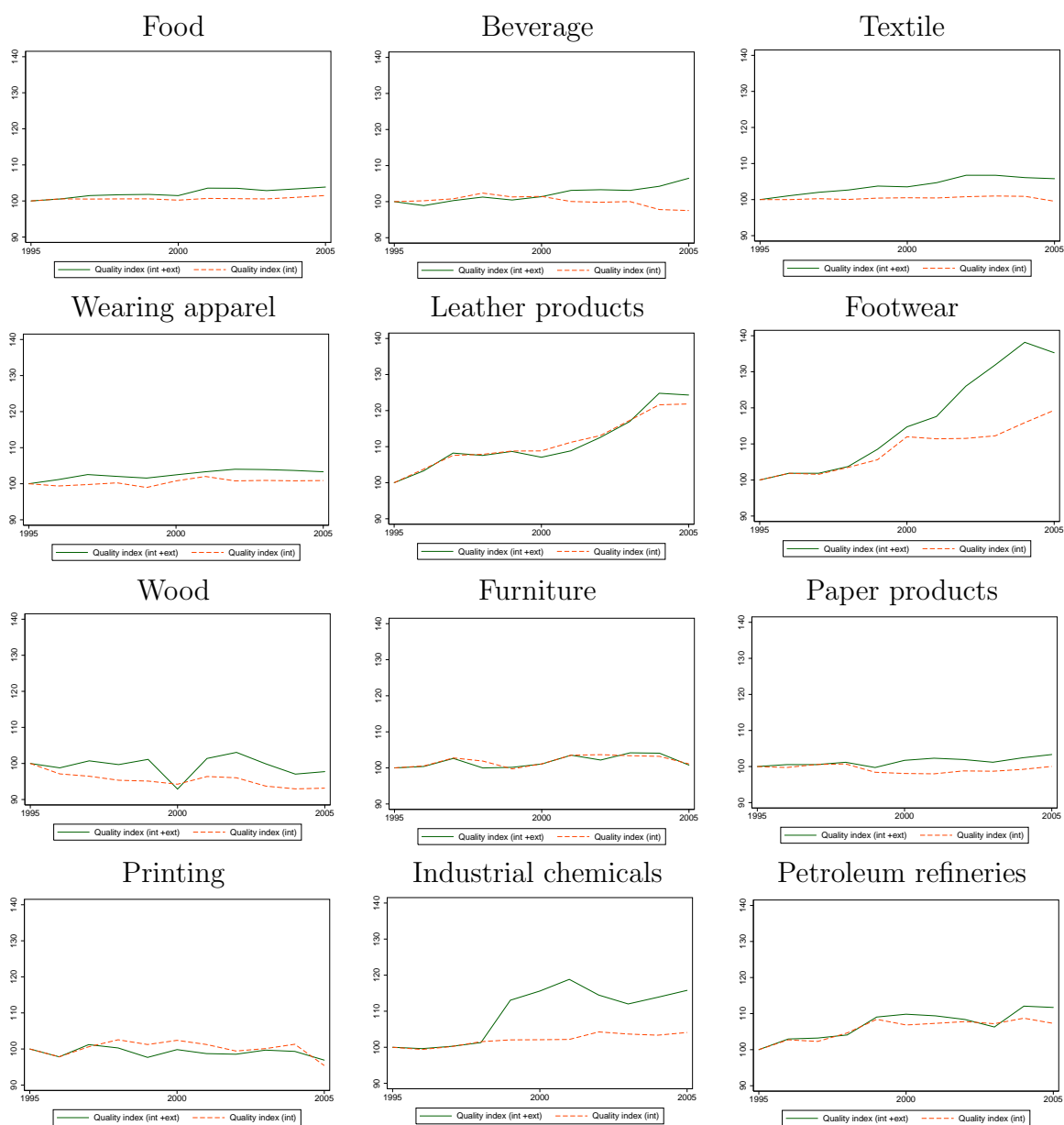

Notes: The solid and dotted lines correspond to the measured evolution of prices, computed over the whole sample (solid line) and the intensive sample (dotted line). They are compared to the evolution in France's effective nominal exchange rate. The effective exchange rate is computed using bilateral exchange rates taken from the *IMF-IFS* database and trade weights from *UN-ComTrade*.
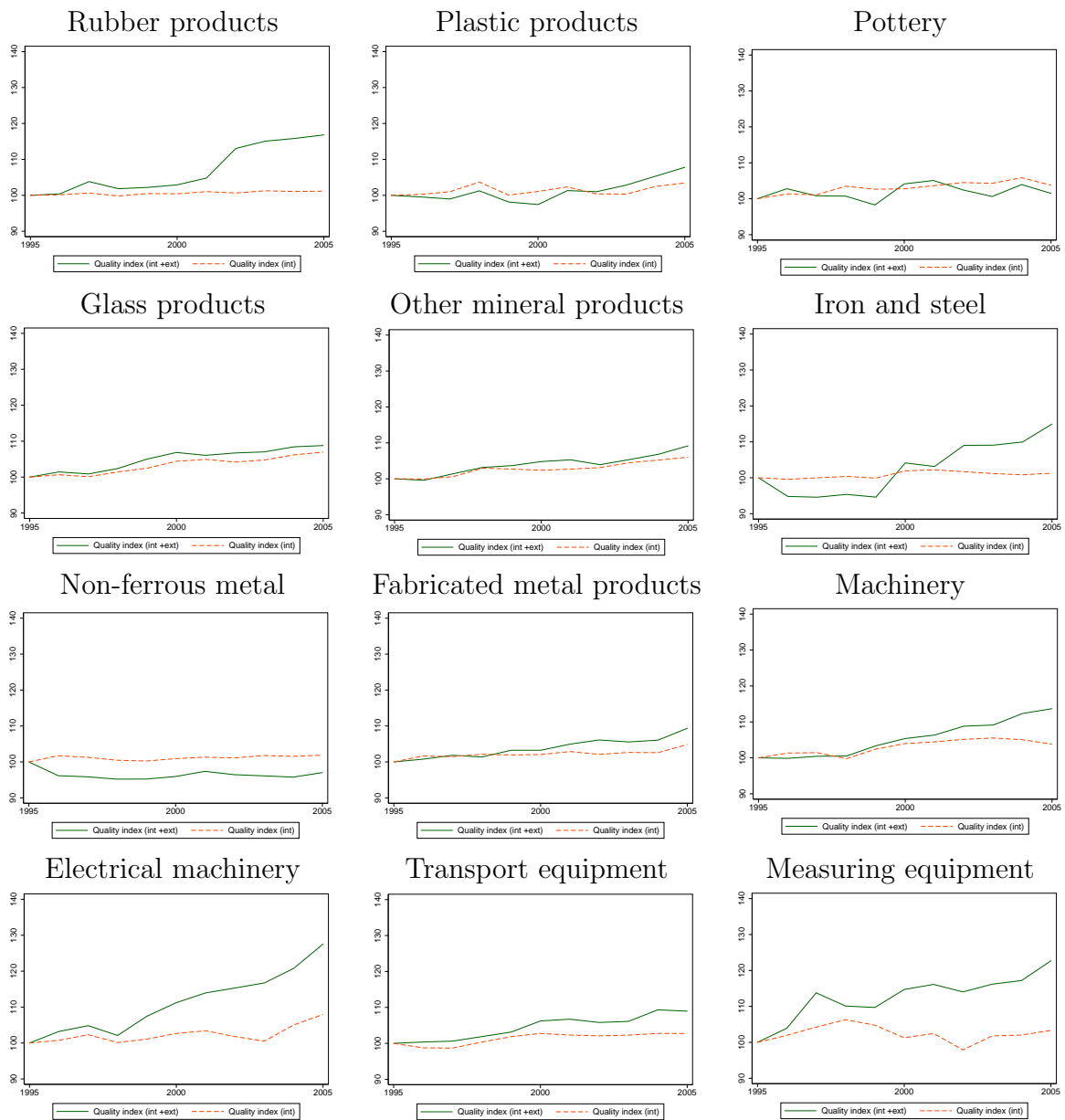
Figure A.3: Evolution of quality, by destination country
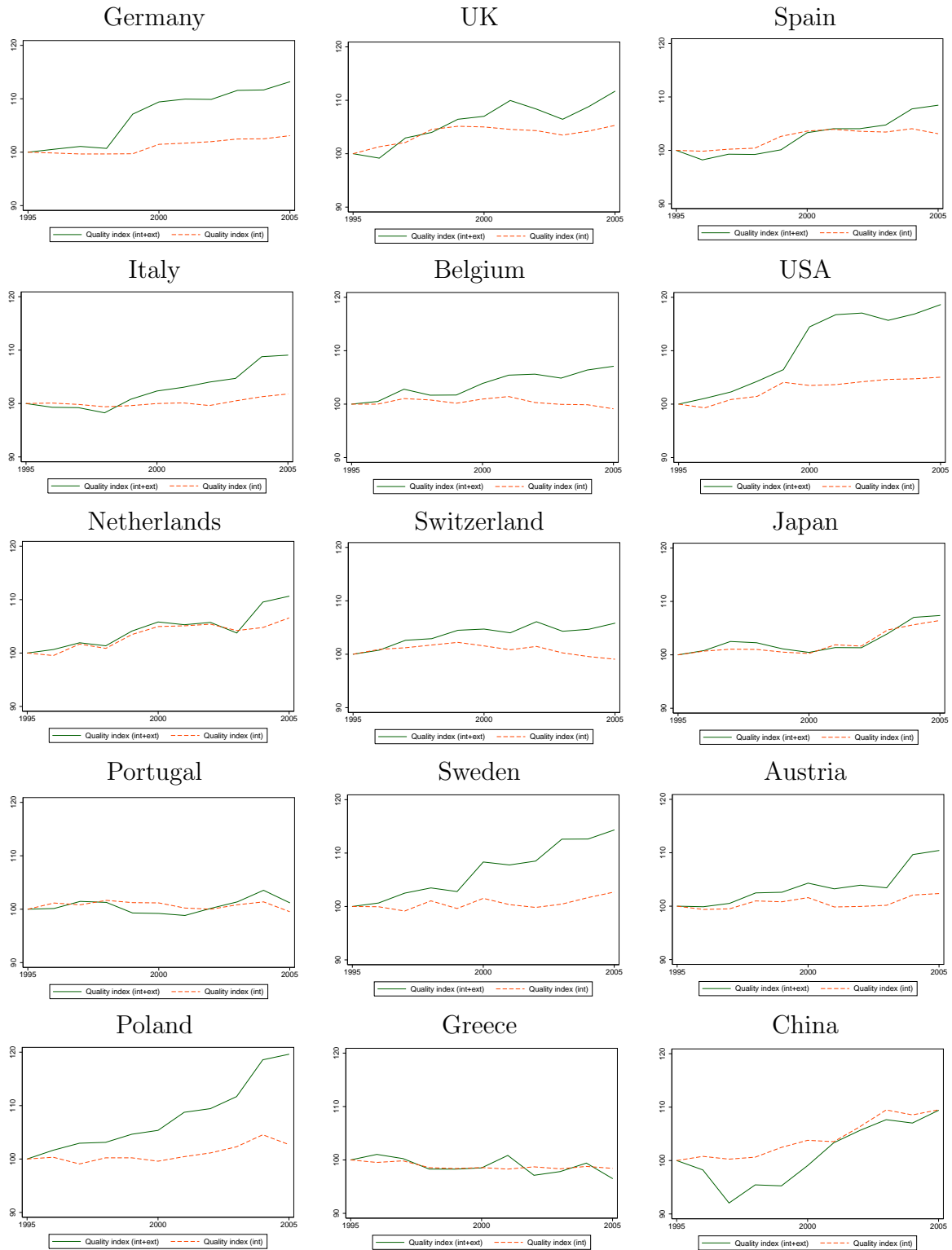
Notes: Quality indices calculated, by country, over the whole sample of export flows (solid line) and the sub-sample of intensive flows (dashed line).

Figure A.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

Notes: Quality indices calculated, by sector, over the whole sample of export flows (solid line) and the sub-sample of intensive flows (dashed line).

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