Export Quality in Advanced and Developing Economies: Evidence from a New Dataset

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Abstract

This paper develops new estimates of export quality, far more extensive than previous efforts, covering 178 countries and hundreds of products during the period 1962–2010. It finds that quality upgrading is particularly rapid during the early stages of development, with the process largely completed as a country reaches upper middle-income status. There is significant cross-country heterogeneity in the growth rate of quality. Within any given product line, quality converges over time to the world frontier. Institutional quality, liberal trade policies, FDI inflows, and human capital all promote quality upgrading, although their impact varies across sectors. The results suggest that reducing barriers to entry into new sectors can allow economies to benefit from rapid quality convergence over time.

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I. INTRODUCTION

Economic development requires the transformation of a country's economic structure. This involves diversifying into new sectors; reallocating resources towards more productive firms; and, critically, improving the *quality* of goods produced. Producing higher-quality varieties of existing products helps build on existing comparative advantages to boost export revenues and productivity. Yet the potential for quality upgrading varies by product (Khandelwal, 2010), and has been found to be higher in manufactures than in agriculture and natural resources. For countries at an early stage of development, diversification into new products may therefore be a precondition to reaping large gains from quality improvement.

This paper makes three contributions to the debate on quality upgrading. First, we develop new estimates of export quality. These estimates are far more extensive than previous efforts, covering 178 countries and hundreds of products during the period 1962–2010. Second, we present a series of stylized facts about export quality and how it varies along the development path. In particular, we illustrate changes in quality over time, both for the entire sample and for selected countries of interest, and we discuss the relationship between quality and income. Throughout, we examine separately the quality of primary goods and of manufactures, and we disaggregate manufacturing into several sub-sectors. Finally, we begin the task of harvesting this dataset to analyze the determinants of quality upgrading.

The paper is related to a rapidly expanding literature on quality upgrading. Schott (2004) finds dramatic cross-country within-product quality differences, based on shipment-level U.S. customs data.[2] In particular, quality varies systematically with exporters' relative factor endowments and production techniques. He also argues that intra-industry trade is largely trade in goods of different quality. Sutton and Trefler (2011), elaborating on Hausmann et al. (2007), find that between 1980 and 2005 low-income countries (LICs) have moved into more "sophisticated" products, defined as those products predominantly produced by high-income economies.[3] However, LICs are producing low-quality products within these industries; as a result, diversification has not led to a big boost in GDP per capita. Put differently, diversification and quality upgrading should be viewed as complementary in the development process. In a related

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[2] For instance, unit values for cotton shirts imported from Japan are 30 times higher than those from the Philippines.

[3] While higher-income countries also tend to produce higher-quality varieties, the concepts of quality and sophistication are quite different. Quality refers to the relative price of a country's varieties *within* their respective product lines. Product sophistication, as in Hausmann et al. (2007), assesses the composition of the aggregate export basket.

vein, Hwang (2007) argues that, to achieve rapid income convergence, countries need to enter sectors with long "quality ladders" that they can climb.[4]

This literature, however, faces a key challenge: export quality cannot be directly observed and needs to be estimated. Unit values (that is, average trade prices for each product category) are observable. Schott (2004) and Hummels and Klenow (2005) showed that these unit values increase with GDP per capita. However, unit values are at best a noisy proxy for export quality, being driven also by other factors, including production cost differences. The strategies recently developed for quality estimation (including Khandelwal, 2010; Hallak and Schott, 2011; and Feenstra and Romalis, 2014) typically model demand, and in some cases also supply, using explicit microeconomic foundations. However, these methodologies do not allow calculation of a set of quality estimates with large country and time coverage, owing to their significant data requirements.

As a result, much work remains to be done in establishing stylized facts about product quality and, in particular, in linking growth in quality to economic development. Existing work has focused mainly on other questions. For instance, Khandelwal's (2010) primary aim in calculating quality ladders is to show that U.S. sectors with short quality ladders are exposed to larger employment and output declines resulting from low-wage competition. Hallak (2006) focuses on showing that higher-income economies import more from countries producing high-quality goods. Hallak and Schott (2011) and Feenstra and Romalis (2014) are mainly concerned with decomposing changes in unit values into changes in quality and pure trade-price changes.

This paper yields a series of important results, many of them worthy of further research. Quality upgrading is particularly rapid during the early stages of development, with the process largely completed as a country reaches upper middle-income status. There is significant cross-country heterogeneity in the growth rate of quality. Within any given product line, quality converges over time to the world frontier. Institutional quality, liberal trade policies, FDI inflows, and human capital all promote quality upgrading, although their impact varies across sectors. The results suggest that reducing barriers to entry into new sectors can allow economies to benefit from rapid quality convergence over time.

II. ESTIMATING PRODUCT QUALITY: METHODOLOGY AND DATA

Much of the existing literature measures export quality using unit values. Unit values are the trade prices, defined as the ratio of export value over quantity for any given product category. Unit values are readily observable, but suffer from three serious shortcomings. First, unit values

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[4] Starting production of higher-quality varieties need not imply abandoning production of lower-quality varieties, particularly if the latter are better suited to some destination. Mukerji and Panagariya (2009) note that the United States produces goods at a large variety of quality levels. Nonetheless, the *average* quality within 4-digit product categories, which is the focus of our study, tends to be higher in higher-income economies.

may reflect production costs, or pricing strategies (that is, firms' choice of mark-up). Second, changes over time in unit values may reflect changes in quality-adjusted prices (owing to supply or demand shocks), rather than changes in quality.[5] Finally, if the composition of goods within a given product category varies across exporters, then cross-country differences in unit values may reflect these differences in composition, rather than quality differences.[6] The quality estimates presented here address the first two shortcomings; the last one cannot be addressed if one is to maintain broad country and time coverage.[7]

The remaining literature does not provide a set of quality estimates well suited to analyzing developments in developing countries. Khandelwal (2010) requires data on market shares of imports relative to corresponding domestic varieties. These are only available for few countries and for limited time periods. Hallak and Schott (2011) require extensive data on tariffs, which are unavailable even for many relatively large countries before 1989.[8] Feenstra and Romalis (2014) require for each product two different unit-value observations, one derived from importer-reported (CIF) and one from exporter-reported (FOB) data. However, exporter-reported data are not available for many developing-country exports, especially for early years, limiting their analysis to the 1984–2008 period. Consequently, a reduced-form approach, which circumvents data constraints, is more suitable for our purposes.

Our methodology estimates quality based on unit values, but with two important adjustments. The methodology is a modified version of Hallak (2006), which sidesteps data limitations to achieve maximum country and time coverage.[9] As a first step, for any given product, the trade price (equivalently, unit value) p_{mxt} is assumed to be determined by the following relationship:

$$\ln p_{mxt} = \zeta_0 + \zeta_1 \ln\theta_{mxt} + \zeta_2 \ln y_{xt} + \zeta_3 \ln Dist_{mx} + \xi_{mxt}, \qquad (1)$$

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[5] Hallak and Schott's (2011) results suggests for instance that Malaysia continually upgrades quality, but this does not show in unit values because of falling world prices for electronics, the country's main export.

[6] Similarly, quality measures will be affected by introduction of new products, if the initial quality level produced in these new products varies substantially from the average quality of existing products in the category.

[7] Other papers that focus exclusively on U.S. data (such as Khandelwal, 2012) can address this last issue by using HS 10-digit data. However, data at such a high level of disaggregation are not widely available for developing countries.

[8] Also, data on tariffs in the Long Time Series TRAINS database, which goes back to the 1970s, do not cover LICs well.

[9] The key difference is that we directly use unit values at the SITC 4-digit level, whereas Hallak gathers unit values at the 10-digit level and then normalizes them into a price index for each 2-digit "sector".

where the subscripts m, x, and t denote, respectively, importer, exporter, and time period. Prices reflect three factors. First, unobservable quality θ_{mxt}. Second, exporter income per capita y_{xt}; this is meant to capture cross-country variations in production costs systematically related to income. With high-income countries typically being capital-abundant, we expect $\zeta_2 < 0$ for capital-intensive sectors and $\zeta_2 > 0$ for labor-intensive sectors.[10] Third, the (great circle) distance between importer and exporter, $Dist_{mx}$. This accounts for selection bias: typically, the composition of exports to more distant destinations is tilted towards higher-priced goods, because of higher shipping costs.[11]

Next, we specify a quality-augmented gravity equation. This equation is specified separately for each product, because preference for quality and trade costs may vary across products:

$$\text{Ln}(Imports)_{mxt} = FE_m + FE_x + \alpha \ln Dist_{mx} + \beta I_{mxt} + \delta \ln\theta_{mxt} \ln y_{mt} + \varepsilon_{mxt} \qquad (2)$$

FE_m and FE_x denote, respectively, importer and exporter fixed effects. Distance is as defined above. The matrix I_{mxt} is a set of standard trade determinants from the gravity literature.[12] The exporter-specific quality parameter θ_{mxt} enters interacted with the importer's income per capita y_{mt}. If $\delta > 0$, then greater income increases the "demand for quality".

The estimation equation is obtained by substituting observables for the unobservable quality parameter in the gravity equation. Rearranging (1) for $\ln \theta_{mxt}$, and substituting into (2), yields:

$$\begin{aligned} \ln(Imports)_{mxt} = {} & FE_m + FE_x + \alpha \ln Dist_{mx} + \beta I_{mxt} + \zeta_1' \ln p_{mxt} \ln y_{mt} + \\ & \zeta_2' \ln y_{xt} \ln y_{mt} + \zeta_3' \ln Dist_{mx} \ln y_{mt} + \xi'_{mxt} \qquad (3) \end{aligned}$$

where $\zeta_1' = \frac{\delta}{\zeta_1}$, $\zeta_2' = -\frac{\delta\zeta_2}{\zeta_1}$, $\zeta_3' = -\frac{\delta\zeta_3}{\zeta_1}$, and $\xi'_{mxt} = -\frac{\delta\zeta_0' + \delta\xi_{mxt}}{\zeta_1} \ln y_{mt} + \varepsilon_{mxt}$.

This equation is estimated separately for each of the 851 product categories in the dataset, yielding 851 sets of coefficients. We obtain estimates by two stage least squares. ξ_{mxt} is a component of p_{xmt}, so that the regressor $\ln p_{xmt} \ln y_{mt}$ is correlated with the disturbance term

[10] This approach builds on Schott (2004), who showed that unit values for any given product vary systematically with exporter relative factor endowments, as proxied by GDP per capita.

[11] Hallak (2006) uses distance to the United States instead of distance to the importer, because it only focuses on prices of exports to the United States. Harrigan, Ma, and Shlychkov (2011) find that the correlation between export prices and distance is due to a composition, or "Washington apples", effect. They also find that U.S. firms charge higher prices to larger and richer markets.

[12] It includes indicator variables for a common border, a common language, the existence of a preferential trade agreement, a colonial relationship, and a common colonizer.

ξ'_{mxt}. We therefore use $\ln p_{xmt-1} \ln y_{mt}$ as an instrument for $\ln p_{xmt} \ln y_{mt}$. Where a unit value for the preceding year is not available (for instance, because the good was not traded), we use the unit value in the closest available preceding year, going back up to 5 years.[13]

The results are used to calculate a comprehensive set of quality estimates. Rearranging (1) and using the estimated coefficients, quality is calculated as the unit value adjusted for differences in production costs and for the selection bias stemming from relative distance:

$$Quality\ estimate_{mxt} = \delta \ln \theta_{mxt} = \zeta_1{}' \ln p_{mxt} + \zeta_2{}' \ln y_{xt} + \zeta_3{}' \ln Dist_{mx} \quad (4)$$

As is standard, quality θ_{mxt} and importers' taste for quality δ are not separately identified.[14]

The dataset is a significantly extended version of the UN–NBER dataset. Starting with the COMTRADE database, we construct a trade dataset for 1962–2010 by supplementing importer-reported data with exporter-reported data where the former do not exist.[15] We ensure consistency over time and in aggregating to broader categories by using the methodology of Asmundson (forthcoming). This dataset is analogous to the UN–NBER dataset, but provides longer time coverage. The dataset contains 45.3 million observations on bilateral trade values and quantities at the SITC 4-digit (Revision 1) level. Any given importer-exporter-product-year combination will have more than one observation for the same 4-digit category whenever import quantities are reported for more than one set of units. In this case, the two sets of import quantities are considered distinct "SITC 4-digit-plus" products, so that comparable unit values can be obtained within each product category. The total number of products based on this procedure is 851.[16] Information on preferential trade agreements is drawn from the World Trade Organization's Regional Trade Agreements database, and other gravity variables are drawn from CEPII (Head and Mayer, 2013). Data on income per capita is drawn from the Penn World Tables, version 7.1.

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[13] If unit values are not available in any of the preceding 5 years, the observation is excluded from the estimation.

[14] The preference for quality parameter δ will also vary across sectors. Therefore, when we later aggregate quality estimates across sectors, the procedures necessarily also aggregates across these heterogeneous preferences for quality.

[15] The only exceptions to this methodology are export flows as reported by the United States, which take precedence over importer-reported flows.

[16] SITC 4-digit-plus products were dropped if they met either of two criteria for smallness. First, the product comprised less than 1 percent of total observations or trade value of the corresponding SITC 4-digit product. Second, the product had less than 1000 observations, and comprised less than 25 percent of total observations or trade value of the corresponding SITC 4-digit product. In addition, outliers were eliminated by excluding any observation with: (i) a quantity of 1; or (ii) a total trade value of less than $7,500 at 1989 prices; or (iii) a unit value above the 95^{th} or below the 5^{th} percentile in 1989 prices within any given product.

Reassuringly, estimation results mirror closely those of Hallak (2006). All coefficients have the expected sign, and are statistically significant in the majority of specifications (Table 1). Moreover, the coefficients are closely comparable to those in Hallak (2006), except for those on the price-importer income interaction, which is as expected because our trade price vector is defined differently.[17]

The resulting quality estimates are aggregated into a multi-level database. The estimation yields quality estimates for more than 20 million product-exporter-importer-year combinations.[18] To enable cross-product comparisons, all quality estimates are first normalized by the "world frontier", defined as the 90th percentile in the relevant product-year combination. The resulting quality values typically range between 0 and 1.2. As a corollary, changes in quality over time are all defined relative to the world frontier, rather than in an absolute sense.

The quality estimates are then aggregated, using current trade values as weights, to higher-level sectors (SITC 4-, 3-, 2-, and 1-digit, as well as country-level totals).[19] At each aggregation step, the normalization to the 90th percentile is repeated. Aggregations are also produced based on the BEC classification, as well as on 3 broad sectors (agriculture, non-agricultural commodities, and manufactures). To enable comparisons with unit values, the latter are also normalized with the 90th percentile set equal to unity.

III. EXPORT QUALITY: STYLIZED FACTS

This section illustrates some stylized facts about export quality and provides a flavor of the richness of the dataset. First, we compare our quality estimates with standard unit value measures. Second, we focus on a couple of specific sectors to highlight how informative it is to examine jointly developments in quality, unit values, and market share. Third, we turn to "quality ladders" and show how a country's position on these ladders may indicate large quality upgrading potential or, conversely, an increased need for horizontal diversification. Fourth, we discuss how our measure of quality varies along the development path, again establishing a comparison with unit values. Fifth, we analyze changes in product quality over time, highlighting the significant heterogeneity across regions and countries.

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[17] Hallak (2006), using U.S. data only, computes Fisher price indexes for each SITC 2-digit sector starting from 10-digit sectors. In this paper, we use directly unit values of SITC 4-digit-plus products.

[18] This number is smaller than the 45.3 million in the original dataset because of: (i) missing observations for other regressors, primarily per capita income; and (ii) elimination of outliers (see fn. 16).

[19] Changes in the higher-level (including country-level) quality estimates will in general reflect both quality changes *within* disaggregated sectors, and reallocation *across* sectors with different quality levels. If the composition of exports is shifting toward product lines characterized by low quality levels, it is quite possible for the quality of any given product to be rising sharply, but country-level quality to rise slowly (or indeed decline). We will examine the robustness of the conclusions to using constant weights, or a chain-weighted quality measure.

A. Comparison of Quality Estimates with Unit Values

Unit values are much more dispersed than quality. This is the case even after eliminating extreme values (Figure 1). Quality and unit values are correlated, but only at lower quality levels. Once a country's quality level reaches about 80–85 percent of the world frontier value, quality and unit values are no longer correlated. Thus, quality increases beyond that level do not tend to be associated with price increases, possibly because higher efficiency in production reduces costs. Quality increases are particularly strongly correlated with price increases in agricultural goods.

Quality evolves gradually. Focusing on the early (1962–80), middle (1980–95), and most recent (1995–2010) periods, changes in quality within each period of more than 20 percent relative to other countries are rare (Figure 2). Changes in quality also tend to be much smaller than changes in unit values. Moreover, for all sectors as well as manufacturing alone, increases in quality are in many cases not accompanied by increases in unit values. Some countries have seen considerable increases in quality accompanied by stable unit values: here, quality increases offset price declines on constant-quality products, for instance in the computer and electronics sectors.

B. Export Quality over Time: Examples from Specific Sectors

We now illustrate our export quality estimates using examples drawn from the car and apparel sectors. We focus on cars because most readers are likely to recognize the brands and have some intuition as to their relative quality. We consider apparel because it is a key export for many developing countries, particularly during the early stages of development, and typically constitutes one of the first beachheads in the manufacturing sector.

Results on quality are intuitive and, together with the evolution of prices, help explain developments in market shares.[20] In the passenger motor cars sector (SITC 7321), the quality of U.S. exports has on average been at the world frontier, but has displayed some slight fluctuations over time (Figure 3). Meanwhile, prices oscillated around 90 percent of the world frontier and the U.S. world export market share has been stable since the early 1990s after a long-term decline up to this point. German car exports have featured high quality and high prices throughout since the late 1970s. During the 2000s, German car exports regained much of the market share that they lost during the 1980s.

Some countries boosted the quality of their car exports as they developed. For instance, Japanese cars experienced strong quality upgrading through 1990, reaching world frontier levels. Meanwhile, prices rose only moderately during this period, allowing for increases in market share. Since then prices have risen slightly higher with constant quality, possibly explaining some loss of market share to competitors. Quality of Korean cars was low until the early 1980s.

[20] Market share is measured as a country's exports as a percentage of total world exports of that product.

Since then Korean autos have experienced ongoing and substantial quality upgrading. As Korean prices remained relatively low, their market share increased.

Analysis of the apparel sector (SITC 84) provides additional insights. China increased its relative quality of apparel exports substantially, from 70 to 90 percent of the world frontier since 1980 (Figure 4). This was accompanied by a similarly drastic increase in export market share, and also allowed prices to rise slightly, although they remain low, at 40 percent of the world frontier. Bangladesh also recorded a strong increase in its market share, but given that quality increases were much less than in China, no price increases could be realized. India mirrors Bangladesh closely. Italy maintained world frontier quality throughout the sample period, but its market share declined as prices rose. Finally, Korea and Thailand are examples of countries which in the past increased their market shares against a backdrop of rising quality and mostly stable prices. Subsequently, however, these countries have been diversifying away from the textile sector. They now retain higher-quality segments of the apparel market, as quality remains stable or continues to increase, but record falling market shares.

C. Quality Ladders: Potential for Quality Upgrading

A country's position on sectoral quality ladders indicates the potential for further quality upgrading in its existing product basket. Figure 5 illustrates such sectoral quality ladders at the relatively aggregate SITC 1 level for four selected countries, alongside the composition of their export baskets in 2010. Overall, the length of a quality ladder, as well as a country's relatively position on the ladder, varies considerably across sectors.

Tanzania and Vietnam are examples of countries with considerable quality upgrading potential within existing export sectors. Tanzania has experienced strong growth during the last decade. Yet, Tanzania's exports are concentrated in primary and agricultural exports, and within those sectors the country is near the bottom of the quality ladder, suggesting large potential for quality upgrading. Horizontal diversification, for instance towards manufactures, may create additional opportunities for quality upgrading. Vietnam's exports, on the other hand, are already heavily tilted towards manufactures, particularly the miscellaneous manufactures sector, which includes apparel and footwear. However, as in Tanzania, there is still much potential for further quality upgrading in these sectors.

Some of the more mature Asian countries may require horizontal diversification to enable further quality upgrading. Malaysia is heavily specialized in exports of electronics, a subcategory of the machinery and transport equipment sector, but is already coming close to the world frontier in this sector. To enable further quality upgrading, it may first need to diversify. This diversification could occur across SITC 1-digit sectors, as well as within the machinery and transport equipment sector. China's position in most sectors lies between Vietnam and Malaysia. Some quality upgrading potential has already been realized, but more remains. These countries may also be able to increase the value added in their existing exports by engaging in more sophisticated tasks than, say, assembly, as highlighted by a growing literature on offshoring (see, for instance, Baldwin and Robert-Nicoud, 2010).[21]

D. Export Quality along the Development Path

Overall, income per capita is correlated with export quality. This holds both at the aggregate level, and for manufacturing, agriculture, and non-agricultural commodities separately (Figure 6).[22] These finding are consistent with Hummels and Klenow (2005) and Sutton and Trefler (2011).

Quality increases with income particularly sharply during the early stages of development. Quality upgrading is particularly rapid until GDP per capita reaches $10,000. Quality convergence then continues at a diminishing rate, and is largely complete by the time GDP per capita reaches $20,000. In contrast, unit values increase with income at a relatively constant rate. The slope of the non-parametric best-fit curve linking income and unit values is quite constant across different income levels, particularly for manufacturing (Figure 6 and Figure 7).

Among high income countries, average export quality levels only vary within a narrow band. In contrast, among and within developing countries, and in particular low-income countries, average quality levels vary widely, even when controlling for income. This suggests that some economies could reap particularly large gains from quality upgrading, while for others diversification may be a priority. Those countries with low average quality have considerable scope to upgrade quality even within existing export sectors. Other developing countries may already enjoy relatively high export quality, but consistent with their low incomes this is in sectors with short quality ladders or low productivity. These economies could benefit from diversification into sectors with new opportunities for quality upgrading.

These stylized facts hold also when focusing on within-country changes over time, or on small states and commodity exporters (Figure 7). Even controlling for country fixed-effects, so as to focus purely on within-country changes, export quality still increases as countries grow richer. We also examine robustness of our baseline results by considering two alternative subsamples: small states and commodity exporters. Small states follow similar patterns to other countries: quality rises with income particularly sharply for income levels below $10,000.[23] In commodity

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[21] Our quality measure can only evaluate the quality of a good exported by a country, not how much domestic input it includes. It may thus prove misleading for cases where a country combines low-value assembly services and high-quality imported intermediates to generate (high-quality) exports.

[22] The correlation between income and unit values for non-agricultural commodities is relatively weak.

[23] Countries are classified as small states if their population is smaller than 1.5 million in either 2010 or 2011, using Penn World Tables (2010) and *World Development Indicators* (2011) data. This classification does not include fuel

(continued…)

exporters, there still appears to be potential for quality upgrading, although it is more limited by exogenous factors (such as the grade of available minerals) than in manufacturing.[24]

The results also indicate significant scope for quality upgrading in not just manufacturing, but also agriculture. As countries develop, the quality of both agricultural products and commodities increases substantially. The latter likely reflects countries shifting toward more processed products within each commodity category. And lengths of quality ladders vary substantially across subsectors in both agriculture and manufacturing (Figure 8). All this suggests that early development need not be driven by the establishment of a manufacturing base. Although soil and climate may impose some limitations, the finding that sharp increases in quality can be registered in agricultural and commodity exports is particularly important since in many developing countries a large share of the labor force remains concentrated in agriculture.

E. Quality Upgrading by Income Group and Region

In middle-income countries, export quality in manufacturing has been increasing for several decades; these countries have converged toward the world quality frontier since the 1980s (Figure 9). Quality convergence in agriculture only commenced later, in the 2000s, after a prolonged period of divergence.

In low-income countries as a whole, export quality in manufacturing has stagnated during the last three decades. In agriculture, there have been signs of quality upgrading during the last decade, after a prolonged gradual decline. In non-agricultural commodities, average quality has deteriorated substantially relative to the world frontier since the 1980s. This suggests that low-income countries have increasingly focused on raw material exports, as opposed to developing processing activities in the context of vertically integrated industries. In contrast, in high-income countries, export quality increased further from already high levels, both for all products and for commodities.

At the regional level, East Asia has exhibited particularly fast quality upgrading (Figure 10). The quality convergence was particularly impressive in manufactures. Quality of commodities also increased, particularly in the 1970s and 1980s, as a result of the development of vertically-integrated industries engaged in elementary processing. Again, agriculture only followed with a substantial lag, with quality starting to increase only since 2000.

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exporters that are high income (as per World Bank definition), including in particular Bahrain, Brunei, and Equatorial Guinea.

[24] Countries are classified as commodity exporters, following the IMF *World Economic Outlook* classification, if commodities on average exceed 50 percent of total exports.

Sub-Saharan Africa is still lagging behind, but there are now tentative signs of quality convergence. Manufacturing export quality has increased sharply since the late 1990s, and prolonged quality divergence in agriculture has seemingly halted. In contrast, in South Asia, there are no strong signs of quality convergence in any large sector. In the Middle East and North Africa, manufacturing quality increased from the 1960s through the 1980s, but stagnated thereafter; in agriculture, no sustained quality increases have occurred, although there are signs of some upgrading since 2000. In Latin America, export quality has stagnated for several decades.[25] That said, during the last decade some signs of convergence have appeared in both manufacturing and agriculture.

Even within regions, there is considerable cross-country heterogeneity in the pace of quality upgrading. Within Asia, several countries, such as Japan, Korea, China, and Vietnam, have converged or are converging fast towards the world quality frontier (Figure 11). India, Indonesia, and Bangladesh are converging at a slower pace, although with some acceleration during the last decade. Meanwhile, in countries such as Malaysia and Thailand, quality convergence has slowed since the mid–1990s.

In Africa, the patterns of convergence are even more heterogeneous, with particularly large fluctuations in quality indexes in countries whose exports are strongly driven by a few products. Upward trends in quality can be noted since the early 2000s in a series of countries including Senegal, Ghana, Uganda, Nigeria, and South Africa. In Egypt, quality increased over an extended period, but more recently stagnated. In many countries, including Morocco, Cote d'Ivoire, and Cameroon, quality has largely stagnated throughout the sample period.

IV. Determinants of Quality Upgrading

A. Estimation Strategy and Data

This section analyzes the determinants of the growth rate of product quality through product-level cross-country panel regressions. We estimate separate regressions for manufacturing, agriculture, and other natural resources, since determinants can be expected to vary by sector. The estimation equation is:

$$Growth\_Quality_{ipt} = \text{FE} + \delta_1 \ln Initial\_Quality_{ipt} + \delta_2\, Determinants_{ipt} + \varepsilon_{ipt}, \qquad (5)$$

where *i*, *p*, and *t* index, respectively, the exporting country, product, and time period. $Growth\_Quality$ stands for the annualized growth rate of quality calculated as the difference

[25] In a similar vein, Lederman and Maloney (2012) argue that both Latin America and the Middle East & North Africa are already near the quality frontier for many of their exports, consisting largely of natural-resource based goods, and thus benefit little from quality upgrading in existing exports.

between (the logarithms of) quality levels in the initial and final years of 10-year non-overlapping periods.[26] FE relates to different sets of fixed effects, discussed below.

Other explanatory variables relate to initial conditions and are observed in the first year of any 10-year non-overlapping period. *Initial_Quality* denotes the initial product quality level. *Determinants* denotes the vector of potential determinants, which includes in our baseline specification initial GDP per capita, initial FDI inflows, initial institutional quality, initial human capital, and indexes measuring the levels of initial trade and agricultural liberalization (see Table 2 for all summary statistics).

GDP per capita is drawn from the World Bank's *World Development Indicators*. FDI inflows are measured as a percentage of GDP, and the data are drawn from the IMF's *International Financial Statistics*. Institutional quality is measured using the "Constraints on the Executive" variable from the Polity IV dataset.[27] Human capital is measured using the secondary-school completion rate from the World Bank's *World Development Indicators*. The indexes measuring initial trade and agricultural liberalization are de jure indicators drawn from Prati et al. (2013).[28]

To contain any omitted variable bias, we include sets of fixed effects to control for any other observables or unobservables that may drive quality growth. The basic specification includes fixed effects for country, product, and time. Country fixed effects control for quality growth being faster in some countries, for instance owing to unobserved institutional circumstances, such as the quality of business organizations or other mechanisms to exploit knowledge spillovers. Product fixed effects allow for quality improvements being easier to attain in some products. Time fixed effects detect changes over time in the global average speed of quality growth, for instance reflecting advances in information and communications technology or reductions in transportation costs.

The extended specification instead includes country-product and product-time fixed effects.[29] Country-product effects account, for instance, for unobserved institutional circumstances in a specific country favoring quality upgrading, but only in some types of products. Similarly,

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[26] These 10-year non-overlapping periods are 1962–71, 1972–81, 1982–91, 1992–2001, and 2002–2010.

[27] Similar results are obtained if the Kaufmann-Kraay-Mastruzzi indicators are used.

[28] Both indexes vary between zero and unity. The trade liberalization measure is based on average tariff rates: zero means the tariff rates are 60 percent or higher, while unity means the tariff rates are zero. The agricultural liberalization index measures the extent of public intervention in the market of each country's main agricultural export commodity; it includes the presence of export marketing boards and the incidence of administered prices. Both indexes are available from 1960 onwards.

[29] We do not include country-time fixed effects, because the determinants we are primarily interested in only vary along the country-time dimension.

product-time fixed effects allow global developments to have different impacts on average quality growth in different products.

B. Results

We present results from both the basic specification (with country, product, and time fixed effects) and the extended specification (with country-product and product-time fixed effects), for each of the three broad sectors (Table 3).[30] We strongly prefer the extended specification, and focus our discussion on it unless otherwise stated. The reason is that, when moving from the basic to the extended specification, the goodness of fit increases significantly (the R^2 increases from 11–15 percent to around 84 percent). This indicates significant country-product– and product-time–specific heterogeneity in the quality data, which cannot be explained by our determinants given that—aside from the initial quality level—they only vary along the country-time dimension. Reflecting this, for all sectors the basic specification is statistically rejected at very high significance levels in favor of the extended, preferred specification, based on both F and Hausman tests.[31]

A key finding is that the quality of individual products converges across countries over time. Specifically, the growth rate of product quality depends negatively on its initial level. This convergence is robust to which set of determinants is included.[32] Quality convergence for individual products need not imply quality convergence for countries' overall export baskets, owing for instance to the presence of country or country-product fixed effects. The result does imply, however, that new entrants into a sector on average see their quality rise over time towards the world frontier.

The speed of quality convergence is high. In the preferred specification, it equals 13–14 percent per year, in all sectors. In the basic specification, it drops to a still considerable 6.5 percent per year, again with little difference across sectors. This suggests the presence of significant, persistent, country-product–specific obstacles to quality upgrading—obstacles that, in the preferred specification, are neutralized by the country-product fixed effects. In both specifications, the initial quality level is the single most important observable determinant of quality growth: since it varies across country-product combinations, it can explain some of the large heterogeneity across this dimension.

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[30] Results vary considerably across sectors, limiting the usefulness of regressions on the full sample covering all three sectors. We nonetheless include these latter results in Appendix Table A.1.

[31] Appendix Table A.2 introduces country-product and product-time fixed effects separately, and shows that country-product heterogeneity is especially important.

[32] This is demonstrated in more detail in an earlier working paper version of this paper (see Henn et al., 2013, Table 3).

Quality upgrading is easier to achieve in higher-income economies, after controlling for their higher initial quality levels. This is true in both manufacturing and agriculture, although not in other natural resources (and only when using the fuller controls of the extended specification). One interpretation is that advanced economies, given their more advanced communication technologies and favorable network effects,[33] can reap greater knowledge spillovers and implement quality improvements more easily. However, the magnitude of this effect, in both manufacturing and agriculture, is small relative to the impact of convergence: a one standard deviation increase in GDP per capita only increases quality growth by 0.5 percent per year.

For lower-income economies, the (positive) effect on quality upgrading of low initial quality will therefore generally dominate the (negative) effect of low income. This provides additional intuition for the earlier finding that most quality convergence happens before countries reach a per capita income of $20,000.

Institutional quality, which also tends to be greater in higher-income countries, again matters for quality upgrading in both manufacturing and agriculture, but not in other natural resources. The impact of institutions increases in magnitude and statistical significance in the preferred specification. Even then, the magnitude of the impact is quite small: a one standard deviation improvement in institutions leads to a 0.1 percent additional quality convergence per year.

Increasing human capital by one standard deviation also accelerates quality convergence by 0.1 percent per year, but only in manufacturing. An increase in FDI inflows of 1 percentage point of GDP is associated with a 0.05 percent per year increase in export quality in the other natural resource sector.[34] This effect can be economically significant in resource-dependent developing countries, where natural-resources FDI is high relative to GDP. In manufacturing, the effect is also statistically significant but economically negligible.

Trade liberalization leads to faster quality upgrading, particularly in agriculture but also in manufacturing, in both the preferred and basic specifications. A one standard deviation increase in trade liberalization accelerates quality convergence by 0.2 percent per year in agriculture and 0.1 percent per year in manufacturing. Agricultural liberalization leads to faster agricultural quality upgrading only in the basic specification (a one standard deviation increase boosts quality convergence by 0.1 percent per year).

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[33] For instance, an advanced economy's economic size may sustain larger agglomerations of industry, which can bring benefits including more specialized and deeper labor markets, or cheaper and more direct shipping and air travel options.

[34] The effects of both human capital and FDI inflows are only observed after country-product heterogeneity is controlled for.

Finally, we note that fixed effects account for most of the observed sample variation in the pace of quality upgrading. This fact, while challenging to interpret, suggests that unobservable dimensions of institutional & policy performance may have important implications. Related, a country moving into a new product line should not automatically expect rapid quality growth.

C. Robustness

We now present two robustness checks. The first varies the time period over which quality growth is calculated. The second includes financial openness variables as additional determinants of quality upgrading.

We start by adopting a single cross section from the beginning to the end of the sample (Table 4, left half). Since this drops the time dimension, only country and product fixed effects can be included. The results are therefore most appropriately compared with the earlier basic specification. These cross-sectional results again highlight the importance of unconditional convergence in quality levels. Initial quality levels are the only determinant that retains statistical significance across all sectors. The speed of convergence toward the world quality frontier is estimated at 5 percent per year; these estimates incorporate the effect of country-product specific barriers, which are not separately controlled for. Agricultural liberalization also has an effect on agricultural quality upgrading; the magnitude of the estimates here is twice as large as in the basic specification with 10-year periods.

We also use observations on 5-year non-overlapping periods, rather than the earlier 10-year periods (Table 4, right half). Here, both country-product and product-year fixed effects are included, as in the earlier preferred specification. The results broadly confirm those of the preferred specification, although with a lower goodness of fit. The main difference is that the speed of unconditional convergence increases to 20–23 percent per year. This likely reflects the greater potential for measurement error when using short time periods. The magnitudes of the other estimated effects change only slightly, with the statistical significance of the coefficients remaining virtually unchanged from the preferred specification. The effects are greater for initial GDP per capita and education, and smaller for trade liberalization, in those sectors where these impacts were previously found to be statistically significant. The effect of institutional quality is greater in agriculture, but lower in manufacturing.

The second robustness check adds to the preferred specification two measures of de jure financial openness: a domestic financial liberalization index, and an external capital account openness index, drawn from Prati et al. (2013).[35] These indexes are only available from 1973

[35] Both indexes are scaled to vary from zero to unity. The domestic financial liberalization index is an average of six sub-indexes. The first five refer to the banking system and cover: (i) credit controls, such as subsidized lending and directed credit; (ii) interest rate controls, such as floors or ceilings; (iii) competition restrictions, such as entry barriers and limits on branches; (iv) the degree of state ownership; and (v) the quality of banking supervision and regulation. The sixth sub-index relates to securities markets: it captures the extent of legal restrictions on the

(continued…)

onwards, and correspondingly reduce our estimation sample.[36] These financial variables have no effect on quality upgrading in agriculture and other natural resources (Table 5). They have a statistically significant negative impact on manufacturing, suggesting that excessively rapid financial liberalization could hamper quality upgrading. However, the economic magnitude of the impact is small: for instance, a one standard deviation increase in domestic financial liberalization only reduces quality growth by 0.1 percent per year.

Inclusion of the financial variables only has a minimal effect on the estimated coefficients for other determinants. The speed of convergence increases marginally, to around 15 percent per year for all sectors. In addition, human capital and trade liberalization have a slightly greater effect on quality upgrading in manufacturing.

D. The Role of Destination Markets

Developing countries' potential for quality upgrading does not appear to be limited by low demand for quality in their destination markets. Data limitations prevent a formal hypothesis test. That said, while lower-income countries do tend to serve markets that on average import lower-quality products, the differences do not seem substantial enough to act as a constraint on quality upgrading (Figure 12). On average, the lower-income the exporter, the greater the gap between its export quality and the average quality demanded by its trade partners in those products that the exporter sells to them). Likewise, in countries with slower convergence, export quality is substantially lower than the average quality of their trade partners' imports. All this suggests that policy should focus on creating a domestic environment broadly conducive to quality upgrading; lowering barriers to entry into higher-quality export markets constitutes a less urgent priority.

V. Conclusion and Policy Implications

We develop a new dataset on export quality. This dataset is far more extensive than previous efforts, covering 178 countries over 1962–2010, and providing breakdowns up to the SITC 4-digit and BEC 3-digit levels, for a total of more than 20 million quality estimates. Our estimates, based on sector-specific quality-augmented gravity equations, explicitly recognize that high product prices are not necessarily an indicator of high quality, but may rather reflect supply-side considerations such as high production costs. The estimates also control for selection bias, such that only higher-priced items are shipped to far-away destinations.

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development of domestic bonds and equity markets, and the existence of independent regulators. The capital account openness index measures a broad set of restrictions on financial transactions for residents and non-residents, as well as the use of multiple exchange rates. See Prati et al. (2013) and Abiad et al. (2010) for details.

[36] In this case the non-overlapping time periods are 1973–81, 1982–91, 1992–2001, and 2002–2010.

Average country-level quality is strongly correlated with income per capita. Further, quality upgrading is particularly rapid during the early stages of development, until a country reaches a GDP per capita of about $10,000. Convergence in export quality continues at a slower pace until GDP per capita reaches $20,000, and levels off thereafter.

Substantial cross-country differences in the pace of quality upgrading suggest that policies may have a significant impact. At the regional level, product quality in sub-Saharan Africa and South Asia is lower, and has been growing more slowly, than in East Asia. But there is considerable heterogeneity within regions, with quality rising far more rapidly in Ghana or Uganda than in Cote d'Ivoire or Cameroon.

Analysis of countries' position on sectoral quality ladders shows that some middle-income countries that have increased quality sharply in the past, such as Malaysia and to a lesser extent China, may now have less scope left to upgrade quality within existing export sectors. These countries may profit from horizontal diversification, which would also enable future upgrading. Other countries, such as Tanzania or Vietnam, still have considerable quality-upgrading potential within existing export sectors.

Diversification and quality upgrading can thus be thought of as complementary. Removing barriers to entry into new sectors could boost growth in many developing countries by increasing the potential for future quality upgrading. Sectors with long "quality ladders" may hold particular potential given our finding that, within any given product line, quality converges to the world frontier over time at a rapid pace of about 13–14 percent per year. Importantly for low-income countries, there is also substantial potential for quality upgrading in agriculture, where large parts of their labor force are concentrated.

Both economies policies and underlying characteristics affect the speed of quality upgrading, with an impact that varies across sectors. Institutional quality and trade liberalization are important for quality upgrading in both manufacturing and agriculture. FDI inflows are associated with quality upgrading in manufacturing as well as in natural resources, while increased education mainly promotes quality upgrading in manufacturing. However, the impact of these policies is quantitatively small relative to the impact of quality convergence. We find no evidence that lack of demand for quality in a country's existing destination markets on average constrains quality upgrading.

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Table 1. Imports: Quality-Augmented Gravity Equations

	In percent of SITC 4-digit-plus sectors				Median coefficient value	
	Positive Coefficients		Negative Coefficients			
	Significant	Insignificant	Significant	Insignificant	This paper	Hallak (2006)
Common preferential trade agreement	82	9	6	3	0.45	0.38
Colonial relationship	80	11	6	3	0.43	0.79
Common colonizer	50	20	16	14	0.20	0.29
Common language	71	14	9	5	0.28	0.53
Common border	82	9	6	3	0.38	0.33
Ln (distance)	6	8	10	76	-1.02	-1.04
Ln (distance) * Ln (importer GDP per capita)	61	14	10	16	0.04	-0.02
Ln (exporter GDP per capita)* Ln (importer GDP per capita)	90	5	4	2	0.10	0.08
Ln (unit value) * Ln (importer GDP per capita)	238	82	438	93	-0.01	0.19

Notes: All equations estimated using two stage least squares.

Table 2. Quality Upgrading: Summary Statistics of Data

Variable	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
Growth Rate of Quality	0.001268	0.089368	-5.608547	5.964081
Ln Initial Quality	-0.201023	0.280277	-8.454018	1.044727
Ln Initial GDP per capita	7.723025	1.585803	3.565800	11.626510
Initial Institutional Quality	2.080978	14.636410	-88	7
Initial Human Capital	19.153060	13.310290	0.027734	69.751091
Initial Trade Lib. Index	0.715041	0.231503	0	1
Initial Agricultural Lib. Index	0.471090	0.382185	0	1
FDI inflows as % of GDP	2.362129	4.948364	-34.756802	136.193100
Initial Domestic Fin. Lib. Index	0.520379	0.298308	0	1
Initial Ext. Capital Account Lib.	0.599943	0.373698	0	1

Notes: The annualized growth rate of (product) quality is expressed in annualized natural units. The indexes of liberalization of trade, agriculture, the domestic financial sector, and the external capital account are *de jure* indicators that range between 0 and 1, with higher values corresponding to greater liberalization (see Prati et al., 2013, and Abiad et al., 2010). Institutional quality is proxied by the "Constraints on the Executive" variable from the Polity IV dataset. GDP per capita and human capital, as proxied by the secondary-school completion rate, are drawn from the World Bank's *World Development Indicators*. Foreign Direct Investment as a percentage of GDP is drawn from the IMF's *International Financial Statistics*.

Table 3. Determinants of Quality Growth: Panel Regressions

	Basic specification 1/			Preferred specification 2/		
	Manufacturing	Agriculture	Natural Res.	Manufacturing	Agriculture	Natural Res.
Ln(Initial Quality)	-7.22***	-6.62***	-5.72***	-13.9***	-13.9***	-13.4***
	(0.07)	(0.11)	(0.20)	(0.12)	(0.17)	(0.34)
Ln(Initial GDP p.c.)	0.0508	-0.0059	-0.167	0.319***	0.355***	-0.0626
	(0.0400)	(0.0011)	(0.190)	(0.0305)	(0.0877)	(0.1560)
Initial Institutional Quality	0.0018	0.0056*	0.0087	0.0048***	0.0077***	0.0048
	(0.0013)	(0.0031)	(0.0058)	(0.0009)	(0.0023)	(0.0046)
Initial Human Capital	0.0000	0.0000	-0.0070	0.0059***	0.0053	-0.0071
	(0.0027)	(0.0071)	(0.0127)	(0.0018)	(0.0050)	(0.0094)
Initial FDI inflows	0.0076***	0.0145**	-0.0131	0.0062**	0.0070	0.0596***
	(0.0027)	(0.0071)	(0.0134)	(0.0028)	(0.0073)	(0.0152)
Initial Trade Lib.	0.2090**	0.7360***	-0.0351	0.3950***	0.8000***	0.2390
	(0.0009)	(0.2490)	(0.4230)	(0.0657)	(0.1890)	(0.3440)
Initial Agric. Lib.		0.3220*			0.0435	
		(0.179)			(0.1380)	
Observations	98,746	29,802	8,365	98,746	29,802	8,365
R-squared	0.115	0.144	0.146	0.838	0.839	0.834

Notes: All equations estimated using observations averaged of 10-year non-overlapping periods. The dependent variables is the annualized growth rate of product quality. *, **, and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level, respectively. All coefficients and standard errors are multiplied by 100 for presentation purposes.
1/ Includes country, product and time fixed effects.
2/ Includes country-product and product-time fixed effects.

Table 4. Robustness I: Varying the time window for calculating quality growth

	Cross-section 1/			5-year non-overlapping windows 2/		
	Manufacturing	Agriculture	Natural Res.	Manufacturing	Agriculture	Natural Res.
Ln(Initial Quality)	-5.04***	-5.02***	-4.67***	-20.3***	-22.6***	-22.2***
	(0.12)	(0.16)	(0.47)	(0.11)	(0.19)	(0.35)
Ln(Initial GDP p.c.)	0.0933	-0.0103	0.1640	0.4940***	0.6880***	0.0778
	(0.0598)	(0.1610)	(0.3440)	(0.0317)	(0.1070)	(0.1780)
Initial Institutional Quality	0.0012	0.0027	-0.0047	0.0017**	0.0140***	-0.0002
	(0.0022)	(0.0055)	(0.0105)	(0.0007)	(0.0025)	(0.0041)
Initial Human Capital	0.0011	0.0215	0.0327	0.0106***	0.0104	-0.0136
	(0.0064)	(0.0164)	(0.0375)	(0.0020)	(0.0064)	(0.0113)
Initial FDI inflows	0.0033	-0.0078	-0.0127	-0.0059**	0.0021	-0.0011
	(0.0052)	(0.0097)	(0.0249)	(0.0026)	(0.0081)	(0.0140)
Initial Trade Lib.	0.0458	0.3500	-0.6120	0.2020***	0.7890***	0.6090*
	(0.162)	(0.4040)	(0.9080)	(0.0628)	(0.2180)	(0.3640)
Initial Agric. Lib.		0.7340**			0.1830	
		(0.2850)			(0.1610)	
Observations	17,632	4,138	1,479	152,022	46,126	12,798
R-squared	0.147	0.282	0.292	0.739	0.717	0.724

Notes: The dependent variable is the annualized growth rate of product quality. *, **, and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level, respectively. All coefficients and standard errors are multiplied by 100 for presentation purposes.
1/ Includes country and product fixed effects.
2/ Includes country-product and product-time fixed effects.

Table 5. Robustness II: Adding financial openness variables

	Manufacturing	Agriculture	Natural Res.
Ln(Initial Quality)	-14.9***	-14.4***	-15.1***
	(0.13)	(0.19)	(0.40)
Ln(Initial GDP p.c.)	0.3400***	0.3540***	-0.1080
	(0.0378)	(0.1030)	(0.1940)
Initial Institutional Quality	0.0049***	0.0059**	0.0036
	(0.0011)	(0.0028)	(0.0051)
Initial Human Capital	0.0107***	0.0040	0.0033
	(0.0021)	(0.0058)	(0.0106)
Initial FDI inflows	0.0087***	-0.0082	0.1270***
	(0.0319)	(0.0079)	(0.0173)
Initial Trade Lib.	0.6870***	1.0300***	0.5530
	(0.0818)	(0.2290)	(0.4240)
Initial Agric. Lib.		-0.0479	
		(0.1740)	
Initial Dom. Financial Lib.	-0.2510**	0.2640	-0.3630
	(0.1020)	(0.2960)	(0.5240)
Initial Ext. Capital Account Lib	-0.1270***	0.1230	-0.2030
	(0.0489)	(0.1430)	(0.2570)
Observations	80,076	25,501	6,802
R-squared	0.858	0.846	0.835

Notes: All equations estimated using observations averaged of 10-year non-overlapping periods and include country-product and product-time fixed effects. The dependent variables is the annualized growth rate of product quality. *, **, and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level, respectively. All coefficients and standard errors are multiplied by 100 for presentation purposes.

Appendix Table A.1. Full sample regressions covering all sectors

Sets of Fixed Effects	Country, Product, and Time	Country and Product-Year	Country-Product and Year	Country-Product and Product-Year
Ln(Initial Quality)	-6.56***	-5.49***	-15.5***	-13.8***
	(0.06)	(0.05)	(0.11)	(0.09)
Ln(Initial GDP p.c.)	0.0050	-0.0800**	0.4490***	0.3220***
	(0.0471)	(0.0399)	(0.0452)	(0.0354)
Initial Institutional Quality	0.0028**	0.0017	0.0068***	0.0058***
	(0.0013)	(0.0011)	(0.0012)	(0.0009)
Initial Human Capital	-0.0015	0.0028	0.0034	0.0064***
	(0.0029)	(0.0024)	(0.0027)	(0.0020)
Initial FDI inflows	0.0076**	0.0088***	0.0105***	0.0108***
	(0.0030)	(0.0029)	(0.0033)	(0.0031)
Initial Trade Lib.	0.4650***	0.4240***	0.6660***	0.5670***
	(0.1040)	(0.0877)	(0.0995)	(0.0768)
Initial Agric. Lib.	0.1000	0.1660**	-0.1080	-0.1090*
	(0.0759)	(0.0646)	(0.0740)	(0.0579)
Observations	112,010	112,010	112,010	112,010
R-squared	0.123	0.545	0.610	0.847

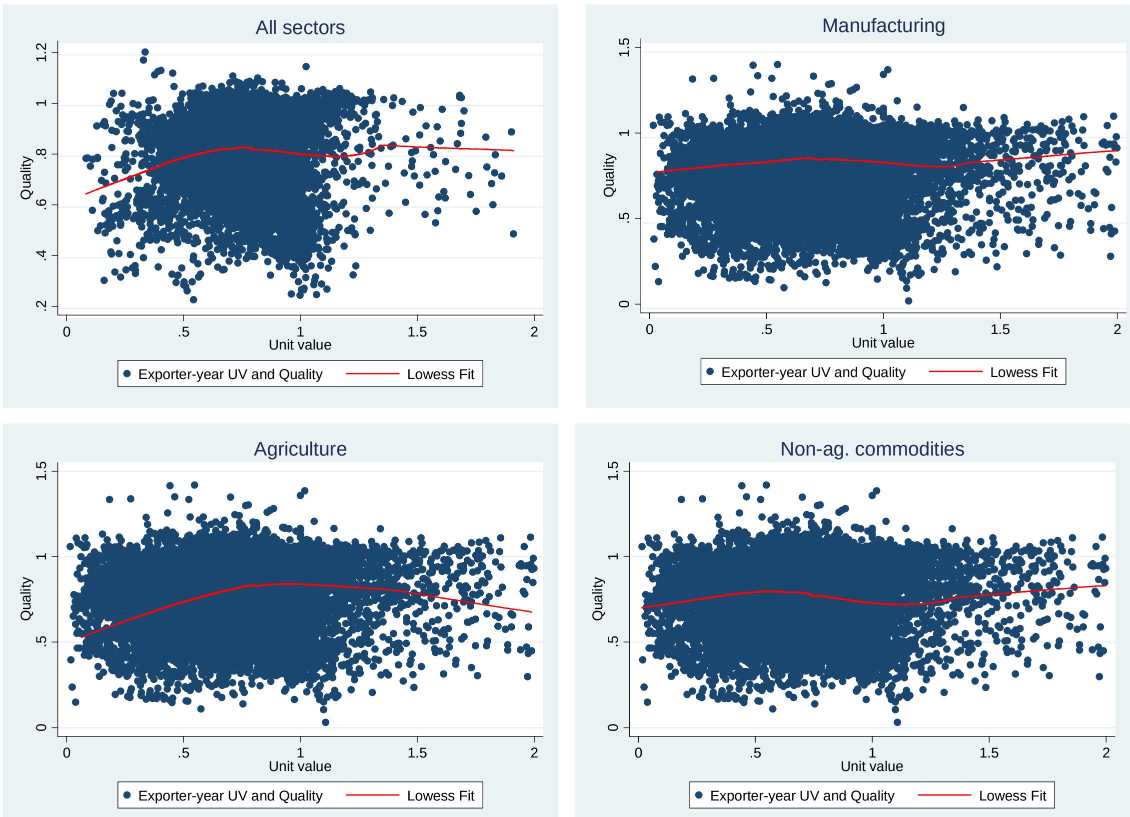
Notes: All equations estimated using observations averaged of 10-year non-overlapping periods. The dependent variables is the annualized growth rate of product quality. *, **, and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level, respectively. All coefficients and standard errors are multiplied by 100 for presentation purposes.

Appendix Table A.2. Intermediate sets of fixed effect controls

	Country-Product and Year Fixed Effects			Country and Product-Year Fixed Effects		
	Manufacturing	Agriculture	Natural Res.	Manufacturing	Agriculture	Natural Res.
Ln(Initial Quality)	-17.2***	-15.0***	-13.5***	-5.70***	-5.65***	-5.29***
	(0.13)	(0.18)	(0.36)	(0.06)	(0.09)	(0.20)
Ln(Initial GDP p.c.)	0.5080***	0.4990***	0.0116	-0.0649*	-0.1170	-0.2210
	(0.0399)	(0.1070)	(0.1810)	(0.0337)	(0.1000)	(0.1880)
Initial Institutional Quality	0.0061***	0.0092***	0.0142***	0.0091	0.0037	0.0005
	(0.0012)	(0.0028)	(0.0053)	(0.0011)	(0.0027)	(0.0058)
Initial Human Capital	0.0042*	0.0056	-0.0123	0.0017	0.0031	-0.0037
	(0.0025)	(0.0064)	(0.0113)	(0.0021)	(0.0060)	(0.0122)
Initial FDI inflows	0.0072**	0.0148*	-0.0129	0.0072***	0.0057	0.0409**
	(0.0031)	(0.0077)	(0.0129)	(0.0026)	(0.0070)	(0.0164)
Initial Trade Lib.	0.5530***	0.9320***	0.2080	0.1730**	0.5930***	-0.0378
	(0.0884)	(0.2320)	(0.4000)	(0.0741)	(0.2180)	(0.4200)
Initial Agric. Lib.		0.1970			0.3080**	
		(0.1700)			(0.1570)	
Observations	98,746	29,802	8,365	98,746	29,802	8,365
R-squared	0.577	0.634	0.656	0.540	0.510	0.380

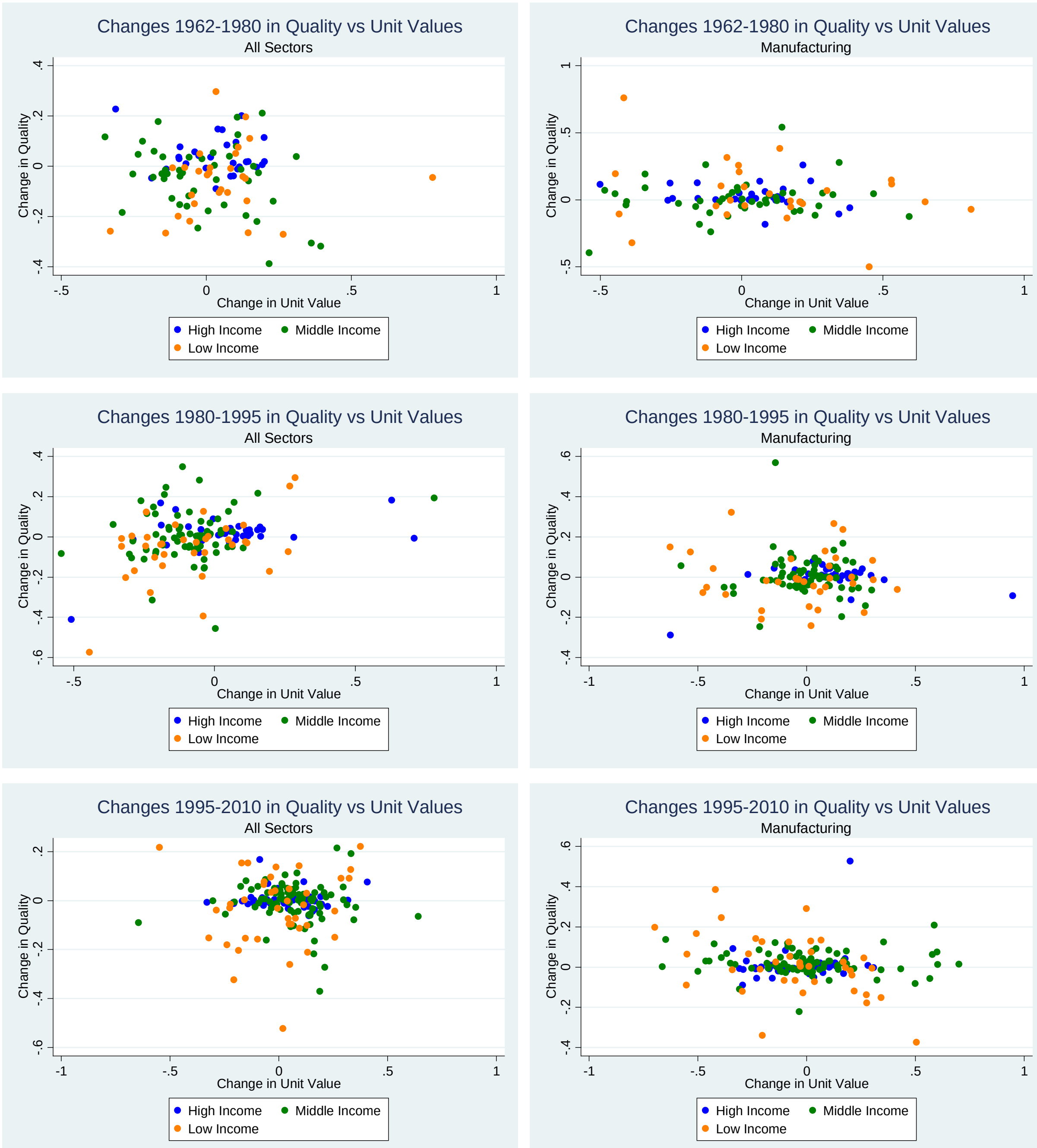
Notes: All equations estimated using observations averaged of 10-year non-overlapping periods. The dependent variables is the annualized growth rate of product quality. *, **, and *** denote statistical significance at the 10 percent, 5 percent and 1 percent level, respectively. All coefficients and standard errors are multiplied by 100 for presentation purposes.

Figure 1. Quality and Unit Values



Notes: Each dot depicts an exporter-year combination. The 90th percentile is set to unity for both unit values and quality observations.

Figure 2. Changes in Quality and Changes in Unit Values



Notes: Each dot depicts one exporter.

Figure 3. Quality and Unit Values for Passenger Motor Cars Exports (SITC 7321)

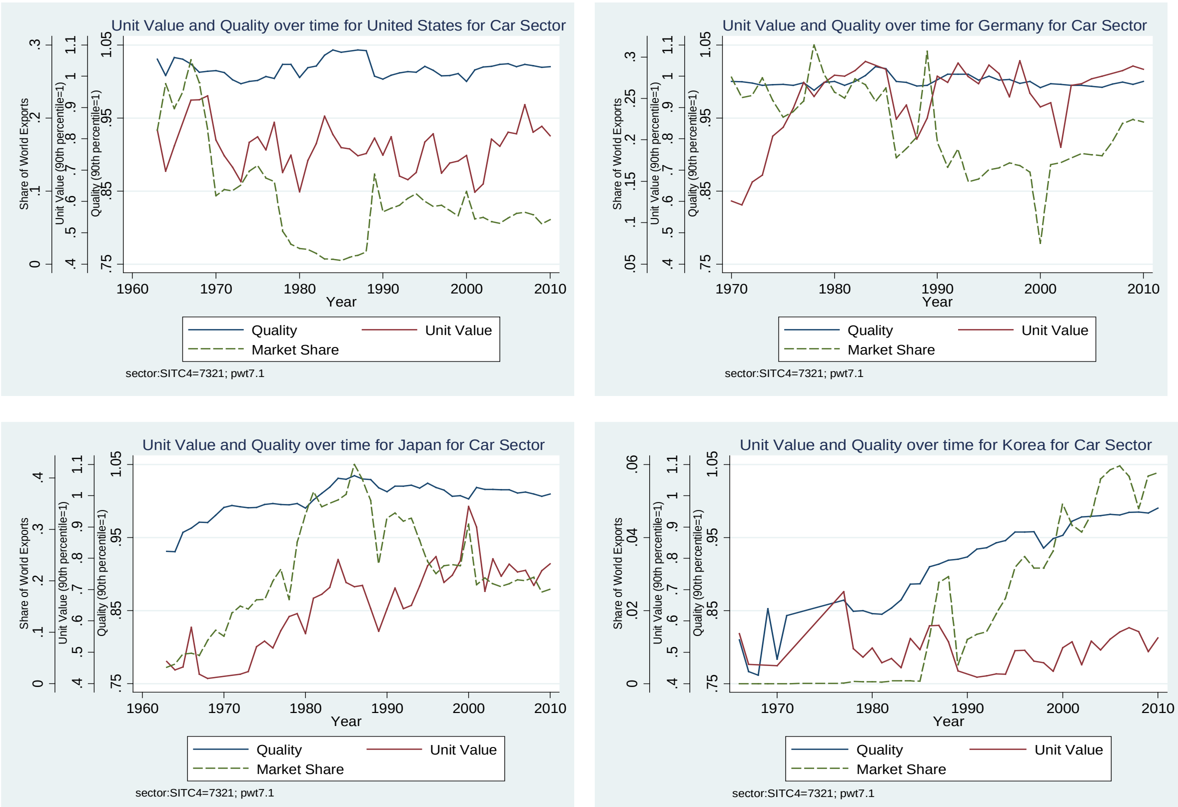


Figure 4. Quality and Unit Values for Apparel Exports (SITC 84)

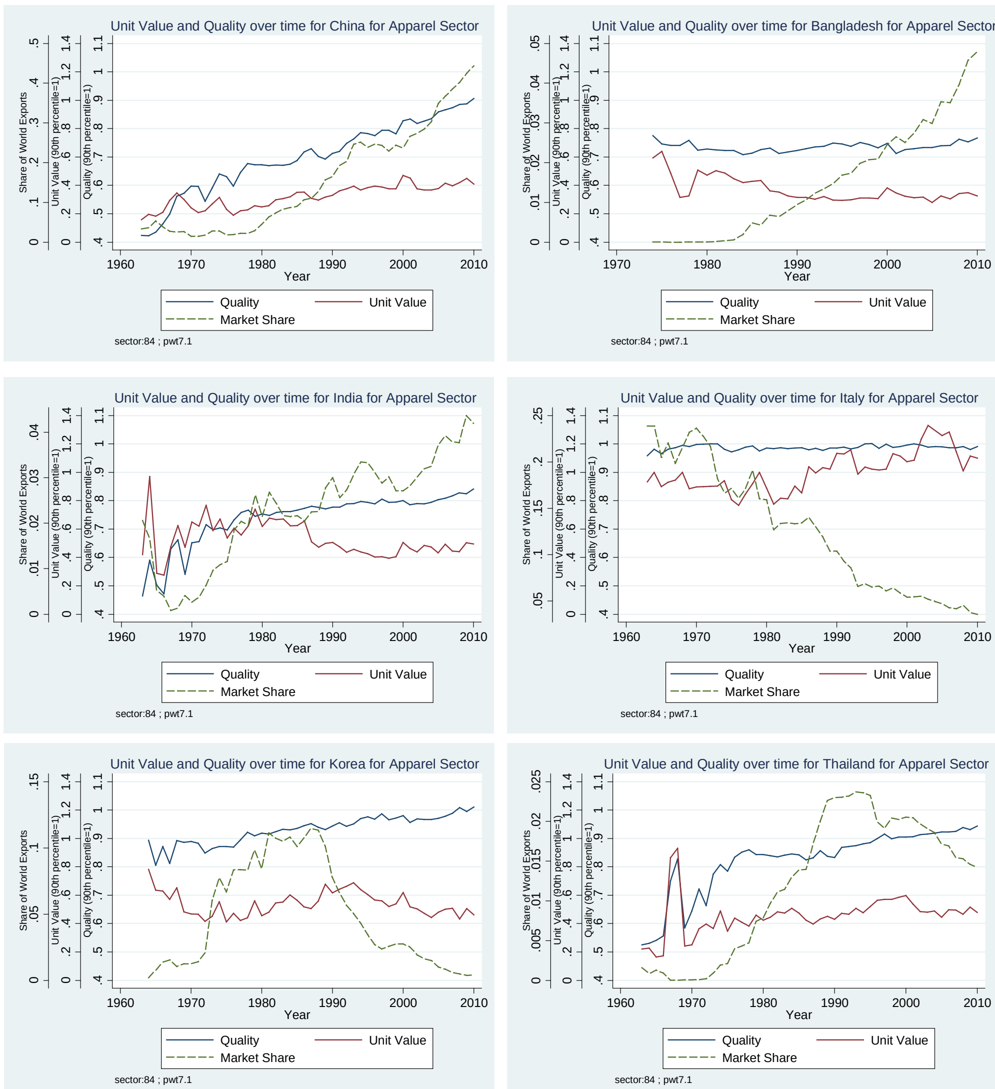


Figure 5. Quality Ladders

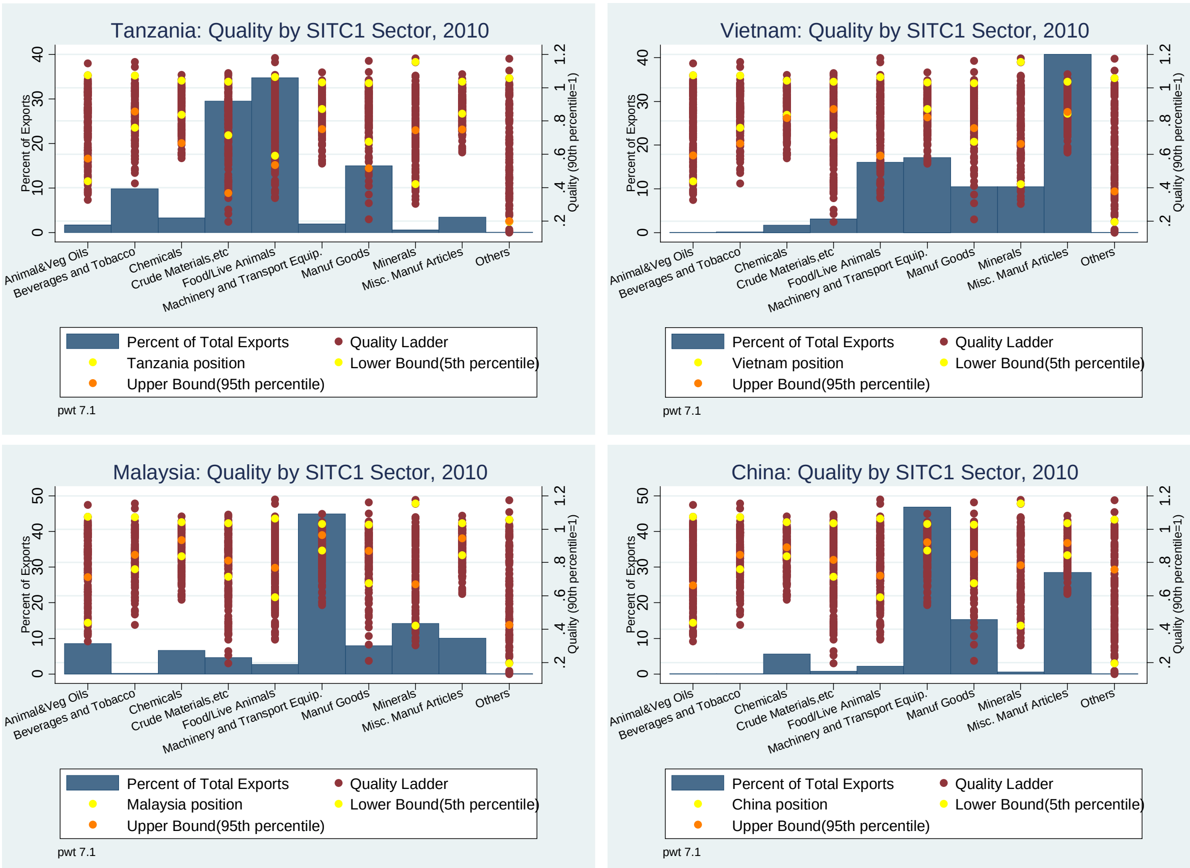


Figure 6. Quality, Unit Values, and GDP per capita

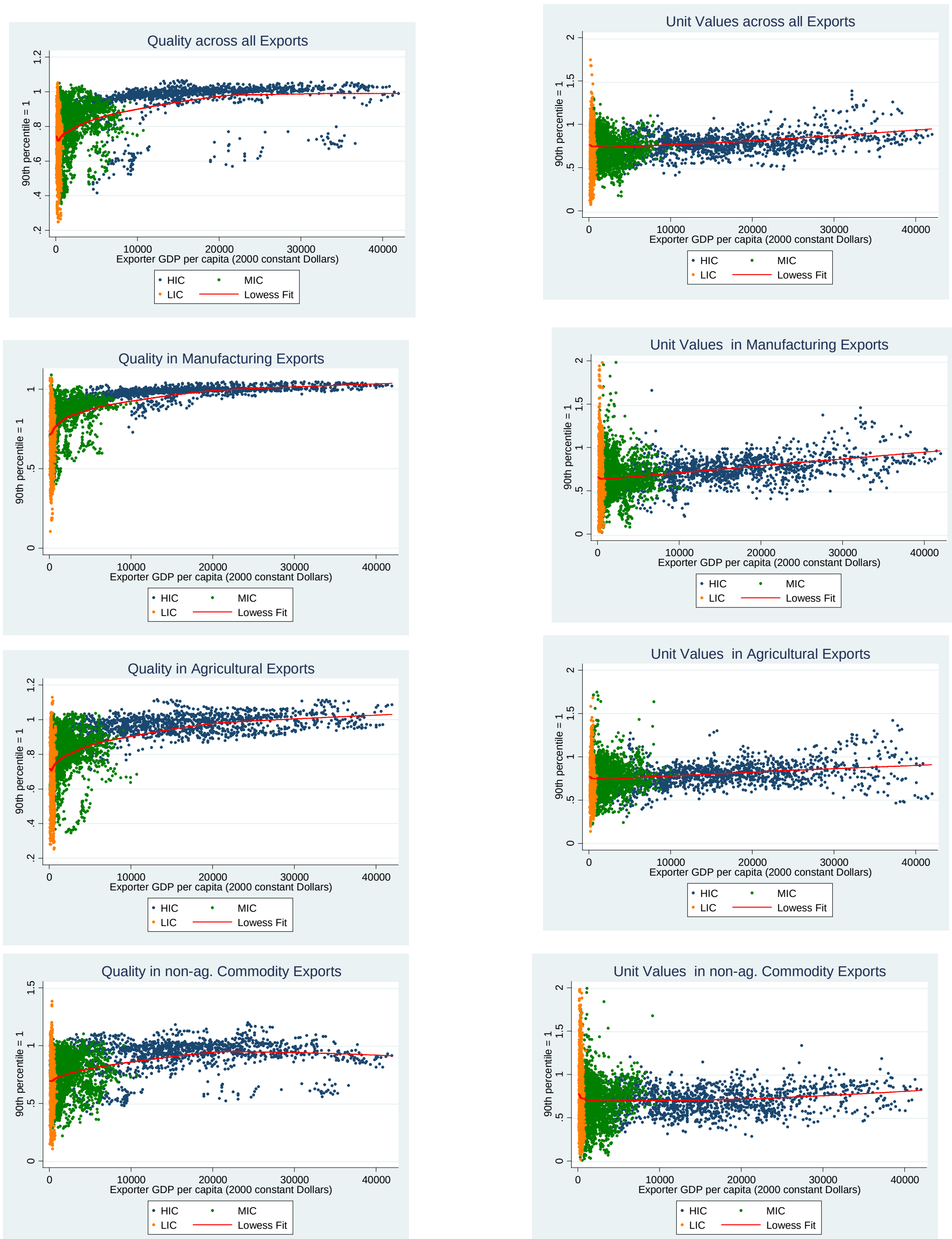
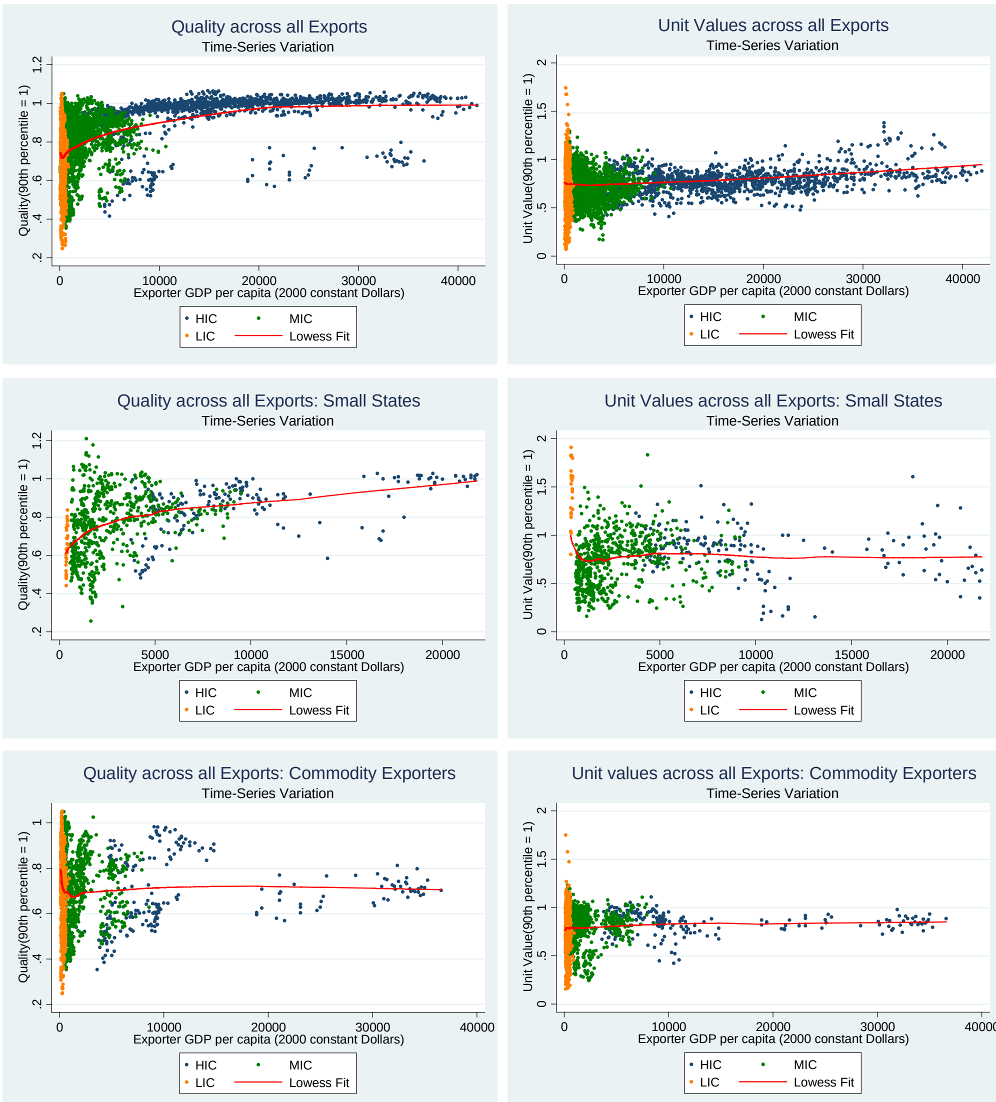


Figure 7. Quality, Unit Values, and GDP per capita: Within-Country Variation



Notes: Figures for small states and commodity exporters use both within- and cross-country variation.

Figure 8. Quality in Agriculture and Manufacturing

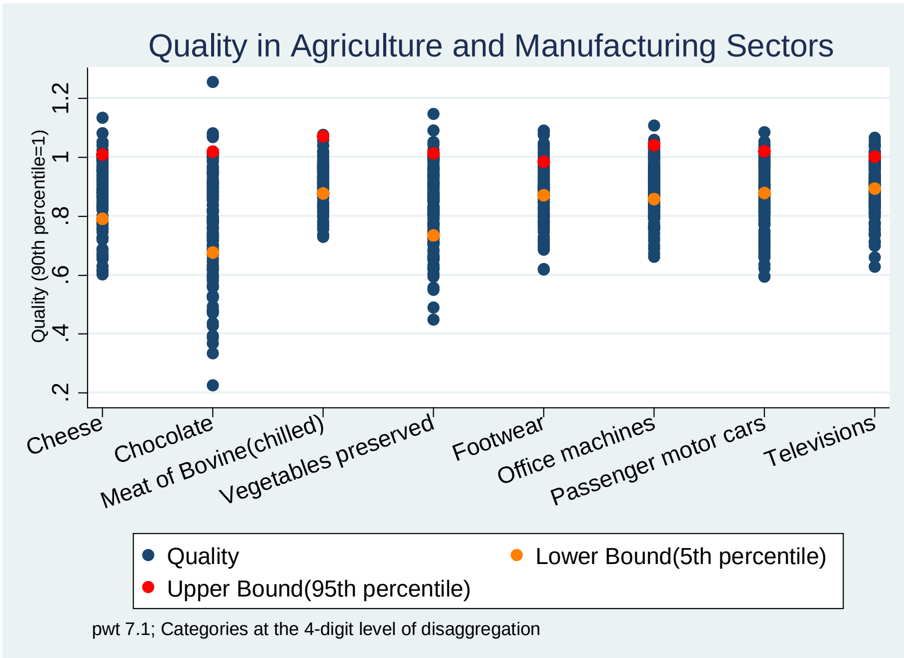


Figure 9. Export Quality by Income Group over Time

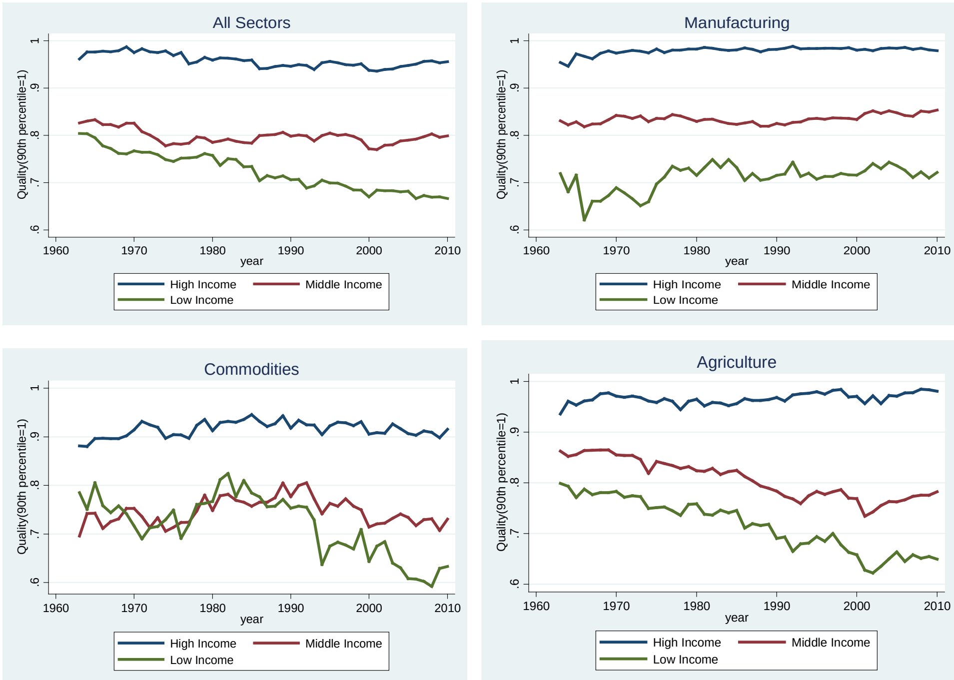


Figure 10. Quality Upgrading by Region

Figure 11. Country-level Heterogeneity in Quality Upgrading in Asia and Africa

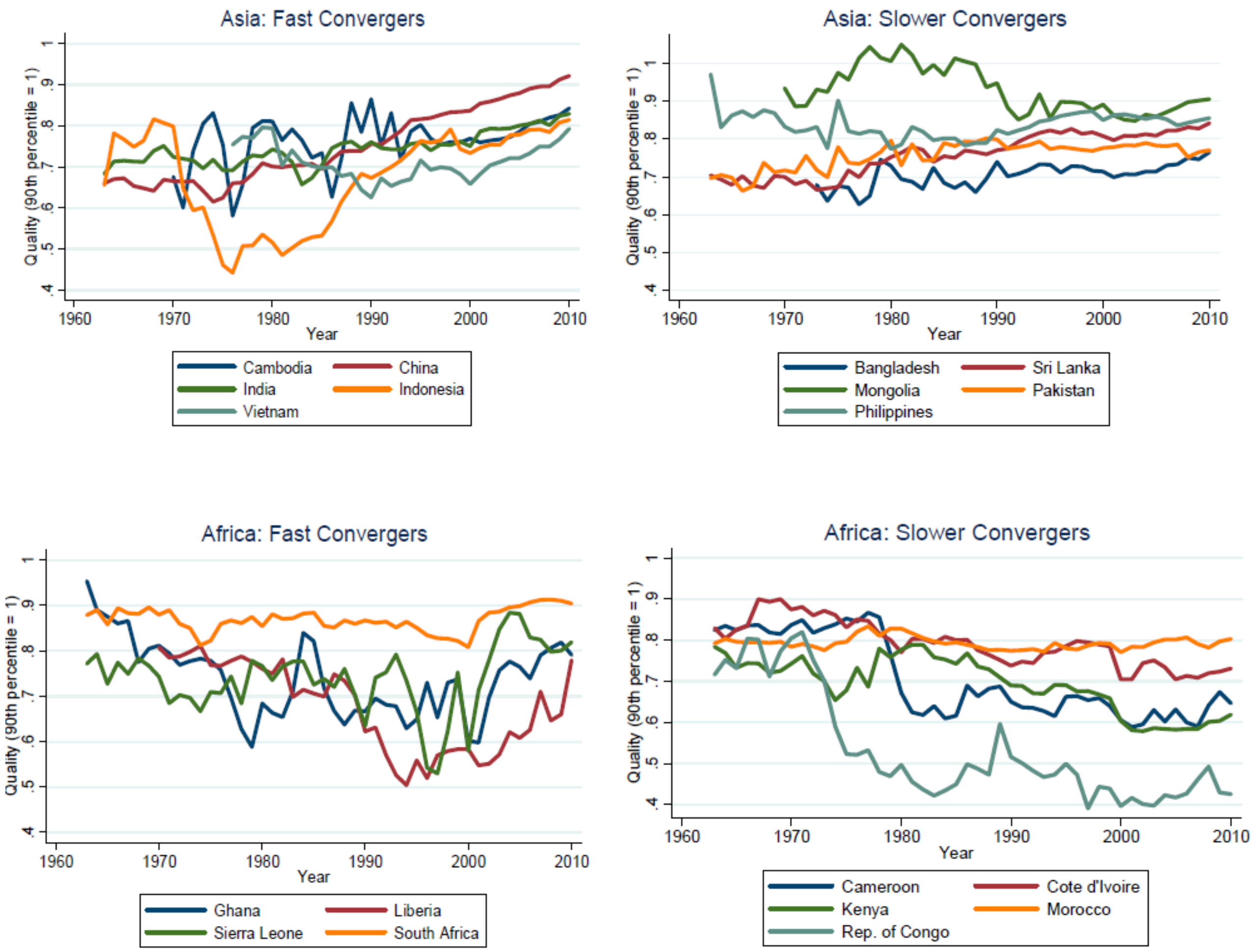


Figure 12. Quality Upgrading and Destination Markets