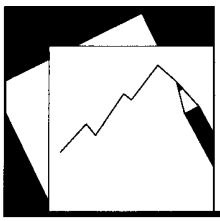
WP/13/108



IMF Working Paper

Export Quality in Developing Countries

Christian Henn, Chris Papageorgiou, and Nikola Spatafora

INTERNATIONAL MONETARY FUND

 WP/13/108

IMF Working Paper

Strategy, Policy, and Review Department and Institute for Capacity Development

Export Quality in Developing Countries

Prepared by Christian Henn, Chris Papageorgiou, and Nikola Spatafora[1]

Authorized for distribution by Catherine Pattillo and Marc Quintyn

May 2013

Abstract

This paper develops new, far more extensive estimates of export quality, covering 178 countries and hundreds of products over 1962–2010. Quality upgrading is particularly rapid during the early stages of development, with quality convergence largely completed as a country reaches upper middle-income status. There is significant cross-country heterogeneity in quality growth rates. Within any given product line, quality converges both conditionally and unconditionally to the world frontier; increases in institutional quality and human capital are associated with faster quality upgrading. In turn, faster growth in quality is associated with more rapid output growth. The evidence suggests that quality upgrading is best encouraged through a broadly conducive domestic environment, rather than sector-specific policies. Diversification is important to create new upgrading opportunities.

JEL Classification Numbers: F14, L15.

Keywords: Exports; Product Quality; Upgrading; Developing Countries.

Authors' E-Mail Addresses: chenn@imf.org, cpapageorgiou@imf.org, nspatafora@imf.org.

[1] This work benefited from the financial support of the U.K.'s Department for International Development. We thank Irena Asmundson, Andy Berg, Hugh Bredenkamp, Era Dabla-Norris, Ricardo Hausmann, Amit Khandelwal, Camelia Minoiu, Cathy Pattillo, Fidel Perez-Sebastian, Michele Ruta, Romain Wacziarg, and participants in seminars at the EBRD and at Oxford University, as well as in the IMF-DFID Conference on "Diversification and Structural Transformation for Growth and Stability in Low-Income Countries," Washington DC, February 2013, for useful comments. Lisa Kolovich, Freddy Rojas, and Jose Romero provided outstanding research assistance.

Contents **Page**

I. INTRODUCTION

Economic development requires the transformation of a country's economic structure. This involves diversifying into new sectors; it implies reallocating resources towards more productive firms; and, critically, it relies on improvements in the *quality* of goods produced. Higher-quality varieties of existing products help build on existing comparative advantages to boost productivity and export revenues. Yet the potential for quality upgrading varies by product (Khandelwal, 2010), and tends 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.

The ongoing process of trade globalization has increasingly led policy-makers to focus on export-oriented growth policies. As countries looked beyond their domestic economies, aiming to tap into regional and global supply chains and to capture newly emerging markets, they realized the importance of upgrading product quality. But while some countries successfully reallocated resources towards more skilled activities and moved up the value chain, for others the transformation proved more challenging. What sort of export-oriented policies are most effective, and through what mechanisms, remains an open and critical question.

This paper makes three contributions to the debate on quality upgrading. First, we develop new estimates of export quality. This dataset is far more extensive than previous efforts, covering 178 countries and hundreds of products over 1962–2010. Second, we present a series of stylized facts relating to export quality. In particular, we illustrate changes over time in quality, 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 versus manufactures, and disaggregate manufacturing into different sectors. Finally, we begin the task of harvesting this dataset to analyze the determinants of quality upgrading.

The literature on quality upgrading is growing rapidly. 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 rich countries.[2] However, LICs are producing low-quality or low-end products within these industries; as a result, this diversification has not led to a big boost in GDP per capita.[3] Put differently, diversification and quality upgrading should be viewed as

[2] While rich 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.

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

Export quality cannot be directly observed and needs to be estimated. Only 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. This sparked an interest in estimating export quality, for which unit values are at best a noisy proxy, being driven also by a series of other factors, including production cost differences. The strategies recently developed for quality estimation (including Khandelwal, 2010, Hallak and Schott, 2011, and Feenstra and Romalis, 2012) 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.

Moreover, much work remains to be done in establishing stylized facts about quality and in linking growth in quality to development. Existing work computed estimates of quality mainly to answer other questions. 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), from whom we adapt our estimation strategy, focuses on showing that rich countries import more from countries producing high-quality goods. Hallak and Schott (2011) and Feenstra and Romalis (2012) are mainly concerned with decomposing changes in unit values into changes in quality and pure trade-price changes. Consequently, they devote little space to discussing stylized facts about export quality.

This paper yields a series of interesting results, many of them worthy of further research. Quality upgrading is particularly rapid during the early stages of development, with quality convergence largely completed as a country reaches upper middle-income status. There is significant cross-country heterogeneity in the growth rate of quality. Finally, determinants of export quality are investigated. Within any given product line, quality converges both conditionally and unconditionally to the world frontier; increases in institutional quality and

---

[3] Schott (2004) finds dramatic cross-country, within-product quality differences, based on shipment-level U.S. customs data. For instance, unit values for cotton shirts imported from Japan are 30 times higher than those from the Philippines. He also finds that unit values within products vary systematically with exporter relative factor endowments and exporter production techniques and argues that intra-industry trade is indeed trade in goods of different quality.

[4] Starting production of higher-quality varieties need not imply abandoning production of lower-quality varieties, particularly if there are destination markets suited for the latter. Mukerji and Panagariya (2009) note that the U.S. produces goods at a huge variety of quality levels suggesting that exporting low-quality goods to certain markets is profitable as well.

human capital are associated with faster quality upgrading. In turn, faster growth in quality is associated with more rapid output growth.

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, 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.[5] Second, unit values may reflect production costs, or pricing strategies (i.e., firms' choice of mark-up). Third, changes over time in unit values may reflect changes in quality-adjusted prices (owing to supply or demand shocks), rather than changes in quality.[6] The quality estimates presented in this section address the last two shortcomings; the first 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 are needed. These are only available for few countries and for limited time periods. Hallak and Schott (2011) require extensive data on tariffs, which is unavailable even for many relatively large countries before 1989.[8] Feenstra and Romalis (2012) 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 LIC exports, especially for early years, limiting their analysis to the 1984–2008 period. Consequently, a reduced-form approach, which sidesteps 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

---

[5] Similarly, quality measures at higher levels of aggregation than SITC 4 digit 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.

[6] 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.

[7] Other papers that focus exclusively on U.S. data (e.g. Khandelwal, 2012) can address this first issue better by starting from the HS 10-digit data. These data, however, are not well suited for our purpose given their limited coverage of developing countries.

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

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:

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

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:

$$\ln(Imports)_{mxt} = ImFE + ExFE + \alpha Dist_{mx} + \beta I_{mxt} + \delta \ln\theta_{mxt} \ln y_{mt} + \varepsilon_{mxt} \quad (2)$$

ImFE and *ExFE* 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 is θ_{mxt}, which enters interacted with the importer's income per capita y_{mt}. If $\delta > 0$, then greater income increases the "demand for quality".

---

[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".

[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 U.S. instead of distance to the importer, because it only focuses on prices of exports to the U.S. 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. We will examine the robustness of the conclusions to adding time effects; the data are in general insufficient to allow for a full set of country-pair effects.

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:

$$\ln(Imports)_{mxt} = ImFE + ExFE + \alpha Dist_{mx} + \beta I_{mxt} + \zeta_1' \ln p_{mxt} \ln y_{mt} + \zeta 2' \ln yxt \ln ymt + \zeta 3' \ln Distmx \ln ymt + \xi' mxt \quad (3)$$

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 products 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 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 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 by exporter-reported data where former does not exist.[14] 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-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.[15] Information on preferential trade agreements was taken from the World Trade Organization's Regional Trade Agreements database, and other gravity variables are

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

[14] The only exceptions to this methodology are export flows as reported by the U.S., which take precedence over importer-reported flows.

[15] 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 95th or below the 5th percentile in 1989 prices within any given product.

taken from CEPII (Head and Mayer, 2013). Data on income per capita was taken from the Penn World Tables, version 7.1.

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.[16]

The regression 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:

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

As is standard, quality θ_{mxt} and importers' taste for quality δ are not separately identified.[17]

The quality estimates are then 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 their 90th percentile in the relevant product-year combination. The resulting quality values typically range between 0 and 1.2. 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 for 3 broad sectors

[16] Hallak (2006), using U.S. data only, computes Fisher price indices 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.

[17] 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.

[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. 15).

[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.

(agriculture, non-agricultural commodities, and manufactures). To allow for easy 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, contrarily, 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 developments in product quality at the regional level. Finally, we highlight the large cross-country heterogeneity in quality upgrading trajectories and provide some tentative evidence that countries with faster export quality upgrading may also have grown faster.

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 85 percent of the world frontier value, quality and unit values are no longer correlated. Thus, quality increases beyond that level tend to not to drive prices higher, possibly because higher efficiency in production may keep prices stable. This last fact can be observed across exports as a whole, as well as across manufactures and agricultural goods; however, it does not hold for non-agricultural commodities.

Quality evolves gradually. Figure 2 divides the sample into an early (1962–80), middle (1980–95), and most recent (1995–2010) period. In all periods, changes in quality were quite gradual, with changes of more than 20 percent rare during any of these periods. Changes in quality also tend to be much lower than changes in volatile 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, as is common 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 LICs, 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 slightly below the world frontier, but has displayed considerable fluctuations over time (Figure 3). Quality stood at or close to the world frontier in the early 1980s, but then fell significantly, whereas prices remained relatively stable vis-à-vis other exporters. As a result, market share fell sharply. A reversal commenced only in the late 1990s, when quality increased considerably, allowing for increases in both prices and market share. German car exports have featured high quality and high prices throughout.

Some countries boosted the quality of their car exports as they developed. For instance, Japanese cars experienced strong quality upgrading through most of the sample period, surpassing German quality in the 2000s. Meanwhile, prices rose only moderately, allowing for increases in market share. Quality of Korean cars was low until the mid–1980s. Then, there were two periods of significant quality upgrading, at the beginning of the 1990s and 2000s. 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 per cent 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 per cent of the world frontier. Bangladesh also recorded a strong increase in its market share, but given that quality increases were not as large as 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 stable prices. Subsequently, however, these countries have been diversifying away from the textile sector. They now seem to 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 2009. It is notable that the length of quality ladders varies considerably by sectors, and likewise a country's relative position may vary considerably across sectors.

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

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 is an example of a country having already experienced considerable quality upgrading, particularly in the important miscellaneous manufactures sector, which includes apparel and footwear. However, there is still much potential for further quality upgrading.

Some of the more mature Asian countries may require horizontal diversification to enable more quality upgrading. Malaysia is heavily specialized in electronics exports, a subcategory of the machinery and transport equipment sector, but has already reached the world frontier in this sector. To enable further quality upgrading, it will first need to diversify. This diversification could occur across SITC1 sectors, as well as within the machinery and transport equipment sector. China's position in electronics is similar to Malaysia's, although more quality upgrading potential may remain in other sectors, including miscellaneous manufacturing. 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. Among high income countries, average export quality levels only vary within a narrow band.

There is scope for quality upgrading in not just manufacturing, but also agriculture. As countries develop, the quality of both agricultural products and commodities increases

[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 exports.

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

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 7). 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 LICs a large share of the labor force remains concentrated in agriculture.

Wide variations in average quality among developing countries, even when controlling for income, suggest that some economies could reap particularly large gains from quality upgrading, while for others diversification may be a priority. Quality estimates show wide variation among middle- and particularly low-income exporters. 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 given their low incomes this is likely 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 and Figure 8). 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 exporters, there still appears to be potential for quality upgrading, although it may be more limited by exogenous factors (such as the grade of available minerals) than in manufacturing.[24]

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 8).

[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 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 *Word Economic Outlook*, if commodities on average exceed 50 percent of total exports.

E. Quality Upgrading by Income Group and Region

MICs have been experiencing increases in manufacturing export quality for many decades, whereas agriculture has lagged behind. In manufacturing, MICs have been steadily converging toward the world quality frontier since the 1970s (Figure 9). Quality convergence in agriculture only commenced later, in the mid–1990s; indeed, during the 1980s quality deteriorated relative to other countries.

Quality upgrading in LICs may follow a similar pattern: thus far, it has been largely limited to manufacturing. The improvement in manufacturing export quality started in the mid–1990s, and coincides with the growth takeoff noted in many LICs around that time. Before this, manufacturing quality had deteriorated relative to the rest of the world. The quality of LICs' agricultural exports, however, has not yet taken off, suggesting that there often exists a time lag between quality upgrading in manufactures and in agriculture. In non-agricultural commodities, LICs' average quality has deteriorated substantially relative to the world frontier since the 1980s. This suggests that LICs 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 both overall and for commodities increased further from already high levels.

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 lag, with quality starting to increase only in the late 1980s; this partly reflected the already high initial quality of regional agricultural exports.

Sub-Saharan Africa and South Asia are still lagging behind, but there are now tentative signs of quality convergence, including in agriculture. Manufacturing export quality has increased sharply in sub-Saharan Africa since the late 1990s, and in South Asia since the early 2000s. Particularly in South Asia, agricultural export quality may already be starting to take off, with only a brief delay relative to manufacturing. In the Middle East and North Africa (MENA), manufacturing quality increased from the 1960s through the 1980s, but stagnated thereafter; in agriculture, no sustained quality increases have occurred, perhaps reflecting difficult climate and soil conditions. In Latin America, export quality has stagnated for several decades, which may be related to its lack of income convergence.[25]

[25] In a similar vein, Lederman and Maloney (2012) argue that both Latin America and MENA 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.

Even within regions, there is considerable cross-country heterogeneity in the pace of quality upgrading. Within Asia, we can identify several countries, such as Japan, Korea, China, and Vietnam, which have converged or are converging fast towards the world quality frontier (Figure 11). In contrast, in countries including Malaysia, Thailand, India, Indonesia, and Bangladesh, quality convergence has slowed since the mid–1990s. Likewise, within Africa, quality has grown rapidly since the mid-1990s in countries such as Uganda, Nigeria, Tanzania, and South Africa. In contrast, export quality has remained stagnant—as in previous decades—in Ghana, Kenya, and Cameroon.

IV. Determinants of Quality Upgrading

This section begins the task of harvesting the quality dataset to analyze the determinants of quality upgrading. Specifically, we estimate a series of cross-country, product-level panel regressions to examine the relationship between the growth rate of product quality and a set of potential determinants:

$$Growth\_Quality_{ijt} = \alpha_i + \beta_j + \gamma_t + \delta_1 \ln Initial\_Quality_{ijt} + \delta_2 Other_{ijt} + \varepsilon_{ijt}, \quad (5)$$

where *i*, *j*, and *t* index, respectively, the country, product, and time period; *Initial_Quality* denotes the initial product quality level; and *Other* denotes a vector of other controls, including initial income per capita, initial institutional quality, and initial human capital. Institutional quality is measured here using the "constraints on the executive variable" from the Polity IV dataset, but similar results obtain using the Kaufmann-Kraay-Mastruzzi indicators. Human capital is measured using the secondary-school completion rate, from the *World Development Indicators*. All variables are expressed as averages over 10-year non-overlapping periods (see Table 2 for summary statistics).

The quality of individual products tends to converge across countries over time. Specifically, the growth rate of product quality depends negatively on its initial level (Table 3). This convergence can be observed unconditionally, and is robust to the inclusion of other controls. The speed of convergence, at about 5 percent per annum, is stable across specifications. Quality convergence for individual products need not imply quality convergence for countries' overall export baskets, owing for instance to the presence of country-level 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.

Quality tends to converge even more rapidly within manufacturing. The speed of convergence within manufacturing is about 7 percent per annum, and is again stable across specifications (Table 4). This increased rate of convergence may reflect greater scope for flows of quality-enhancing knowledge within this sector.

Both institutional quality and human capital are positively associated with the growth rate of product quality. The relationships are significant both statistically and economically (Table 3 and Table 4). A one standard deviation increase in institutional quality or in human capital is associated with, respectively, a 0.3 and a 0.2 standard deviations increase in the pace of quality upgrading.

Developing countries' potential for quality upgrading does not appear to be limited by low demand for quality in their destination markets. Lower-income countries do tend to serve markets that import lower-quality products (Figure 12). However, the differences are not substantial enough to act as a constraint on quality upgrading. On average, the poorer the exporter, the greater the gap between its export quality and the average quality of its trade partners' imports. Likewise, in slow-converging countries, 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 at 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.

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. Overall, those countries and time periods that have witnessed faster growth in quality have also experienced faster growth in GDP per capita.

Substantial cross-country and regional 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 Tanzania 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 China, may now have little 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 sectors.

Removing barriers to entry into new sectors could boost growth in 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 "frontier" over time. In this sense, diversification and quality upgrading can be thought of as complementary. Importantly for LICs, there is also substantial potential for quality upgrading in agriculture, where large parts of their labor force are concentrated.

The evidence suggests that quality upgrading is best encouraged through horizontal rather than sector-specific policies. Preliminary analysis indicates that both institutional quality and human capital are significantly associated with the pace of quality upgrading. In contrast, there is no evidence that lack of demand for quality in a country's existing destination markets on average constrains quality upgrading. An emphasis on horizontal policies is consistent with the unpredictability of export successes: for instance, Easterly et al. (2009) document that relatively few 'big hit' products account for a large share of many developing countries' exports. It is therefore important to shape a domestic environment broadly conducive to quality upgrading, as well as create new upgrading opportunities through diversification.

REFERENCES

Asmundson, I., forthcoming, "More World Trade Flows: An Updated Dataset," (Washington: International Monetary Fund).

Baldwin, R., and F. Robert-Nicoud, 2010, "Trade-in-goods and Trade-in-tasks: An Integrating Framework," CEPR Discussion Paper No. 7775.

Cadot, O., C. Carrere, and V. Strauss-Kahn, 2011, "Export Diversification: What's Behind the Hump?" *Review of Economics and Statistic,* Vol. 93, pp. 590–605.

Easterly, W., A. Reshef, and J. Schwenkenberg, 2009, "The Power of Exports," World Bank Policy Research Working Paper No. 5081.

Feenstra, R., and J. Romalis, 2012, "International Prices and Endogenous Quality," NBER Working Paper No. 18314.

Grossman, G., and E. Rossi-Hansberg, 2008, "Trading Tasks: A Simple Theory of Offshoring," *American Economic Review*, Vol. 98, pp. 1978–97.

Hallak, J. C., 2006, "Product quality and the direction of trade," *Journal of International Economics,* Vol. 68, pp. 238–65.

Hallak, J. C., and P. Schott, 2011, "Estimating Cross-country Differences in Product Quality," *Quarterly Journal of Economics,* Vol. 126, pp. 417–74.

Harrigan, J., X. Ma, and V. Shlychkov, 2011, "Export Prices of U.S. Firms," NBER Working Paper No. 17706.

Hausmann, R., J. Hwang, and D. Rodrik, 2007, "What You Export Matters," *Journal of Economic Growth*, Vol. 12, pp. 1–25.

Head, K., and T. Mayer, 2013, "Gravity Equations: Toolkit, Cookbook, Workhorse," in *Handbook of International Economics*, ed. by Gopinath, Helpman, and Rogoff.

Heston, A., R. Summers, and B. Aten, 2012, Penn World Table Version 7.1, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

Hummels, D., and P. Klenow, 2005, "The Variety and Quality of a Nation's Exports," *American Economic Review,* Vol. 95, pp. 704–723.

Hwang, J., 2007, "Introduction of New Goods, Convergence and Growth," Job Market Paper, Department of Economics, Harvard University.

Imbs, J., and R. Wacziarg, 2003, "Stages of Diversification," *American Economic Review,* Vol. 93, pp. 63–86.

Khandelwal, A., 2010, "The Long and Short (of) Quality Ladders," *Review of Economic Studies*, Vol. 77, pp. 1450–1476.

Klinger, B., and D. Lederman, 2004, "Discovery and Development: an Empirical Exploration of "New" Products," World Bank Policy Research Working Paper Series No. 3450.

Klinger, B., and D. Lederman, 2006, "Diversification, Innovation, and Imitation Inside the Global Technological Frontier," World Bank Policy Research Working Paper No. 3872.

Lederman, D., and W. Maloney, 2012, *Does What You Export Matter? In Search of Empirical Guidance for Industrial Policies* (Washington: World Bank).

Mukerji, P., and A. Panagariya. 2009, "Within- and Across-Product Specialization Revisited," Columbia University, New York.

Schott, P., 2004, "Across-product Versus Within-product Specialization in International Trade," *Quarterly Journal of Economics,* Vol. 119, pp. 646–677.

Sutton, J., and D. Trefler, 2011, "Deductions from the Export Basket: Capabilities, Wealth and Trade," NBER Working Paper No. 16834.

World Development Indicators (Washington: World Bank).

World Trade Organization, Regional Trade Agreements Database (Geneva, Switzerland: WTO).

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 for Data

Variable	*Mean*	*Standard Deviation*	*Maximum*	*Minimum*
Growth Rate of Quality	0.00121	0.03703	1.95781	-3.60544
Ln Initial Quality	-0.22553	0.12213	0.00097	-0.63778
Ln Initial GDP per capita	6.86541	1.17895	10.79187	4.64996
Institutional Quality	2.03812	6.83642	7.00000	-45.08594
Human Capital	18.45108	12.91274	64.15278	0.53906

Notes: The annualized growth rate of (product) quality is expressed in annualized natural units. Institutional quality is proxied by the "constraints on the executive" variable, from the Polity IV dataset. Human capital is proxied by the secondary-school completion rate.

Table 3. Quality Upgrading: Panel Regressions, for All Products

Growth in Product Quality				
	(1)	(2)	(3)	(4)
Ln Initial Quality	-0.049 ***	-0.049 ***	-0.046 ***	-0.046 ***
	(4.2e-4)	(4.4e-4)	(5.0e-4)	(5.1e-4)
Ln Initial GDP per capita		1.5e-4	1.1e-4	-1.5e-4
		(1.9e-4)	(2.3e-4)	(2.3e-4)
Initial Institutional Quality			3.8e-5 **	5.2e-5 ***
			(1.6e-5)	(1.7e-5)
Initial Human Capital				2.9e-5 ***
				(7.2e-6)
Memo Items				
Observations	237,689	224,139	191,704	181,877
Countries	174	173	137	127
Products	851	851	851	851
Time Period	1962–2008	1962–2008	1965–2008	1965–2008
R^2	0.070	0.068	0.062	0.063

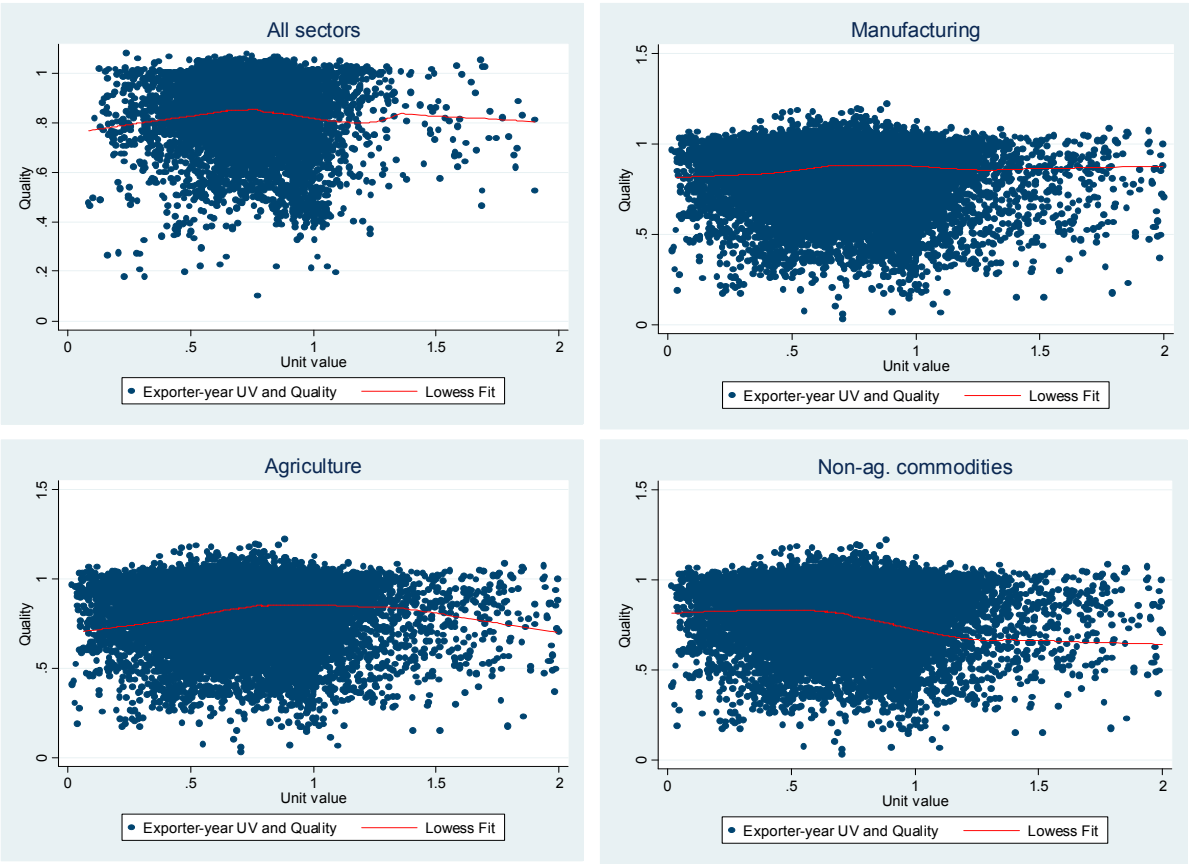
Notes: All equations estimated using observations averaged over 10-year non-overlapping periods. The dependent variable is the annualized growth rate of product quality. Institutional quality is proxied by the "constraints on the executive" variable, from the Polity IV dataset. Human capital is proxied by the secondary-school completion rate. Other controls include a full set of country, product, and time-period fixed effects. *, **, and *** denote statistical significance at the, respectively, 10 percent, 5 percent, and 1 percent level.

Table 4. Quality Upgrading: Panel Regressions, for Manufacturing Alone

Growth in Product Quality				
	(1)	(2)	(3)	(4)
Ln Initial Quality	-0.071 ***	-0.072 ***	-0.066 ***	-0.065 ***
	(5.9e-4)	(6.2e-4)	(6.8e-4)	(7.0e-4)
Ln Initial GDP per capita		8.9e-4***	8.9e-4 ***	7.6e-4 ***
		(2.1e-4)	(2.4e-4)	(2.5e-4)
Institutional Quality			3.3e-5 *	4.2e-5 **
			(1.7e-5)	(1.7 e-5)
Human Capital				1.7e-5 **
				(7.7e-6)
Memo Items				
Observations	156,260	147,907	127,561	121,029
Countries	174	173	137	127
Products	568	568	568	568
Time Period	19623–2008	19623–2008	1965–2008	1965–2008
R^2	0.103	0.104	0.089	0.089

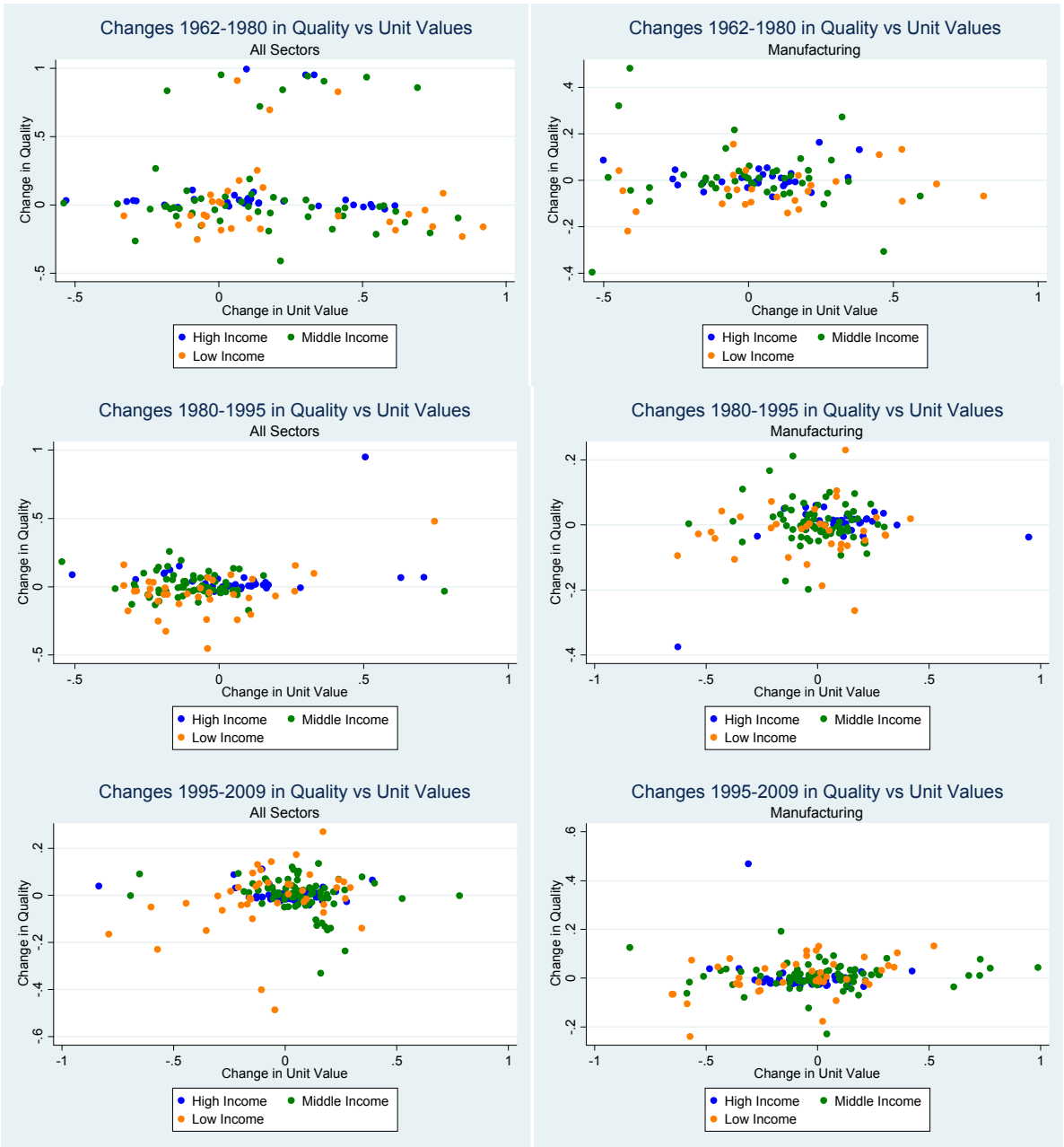
Notes: All equations estimated using observations averaged over 10-year non-overlapping periods. The dependent variable is the annualized growth rate of product quality. Institutional quality is proxied by the "constraints on the executive" variable, from the Polity IV dataset. Human capital is proxied by the secondary-school completion rate. Other controls include a full set of country, product, and time-period fixed effects. *, **, and *** denote statistical significance at the, respectively, 10 percent, 5 percent, and 1 percent level.

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)

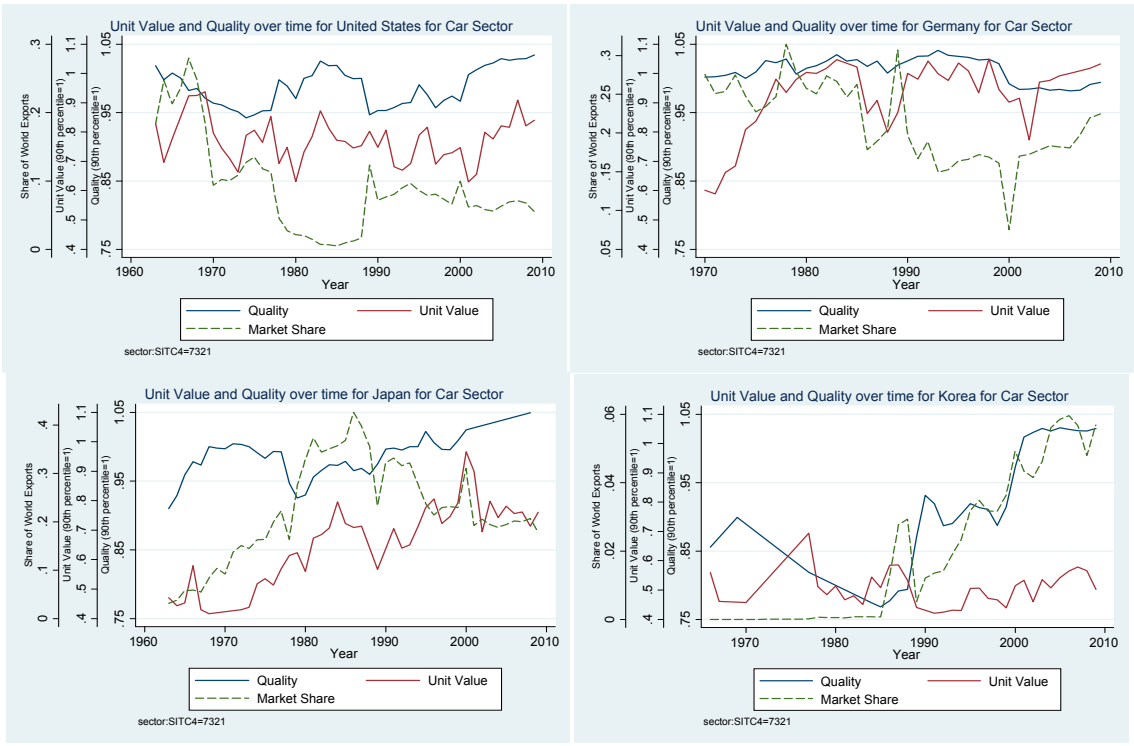


Figure 4. Quality and Unit Values for Apparel Exports (SITC 84)

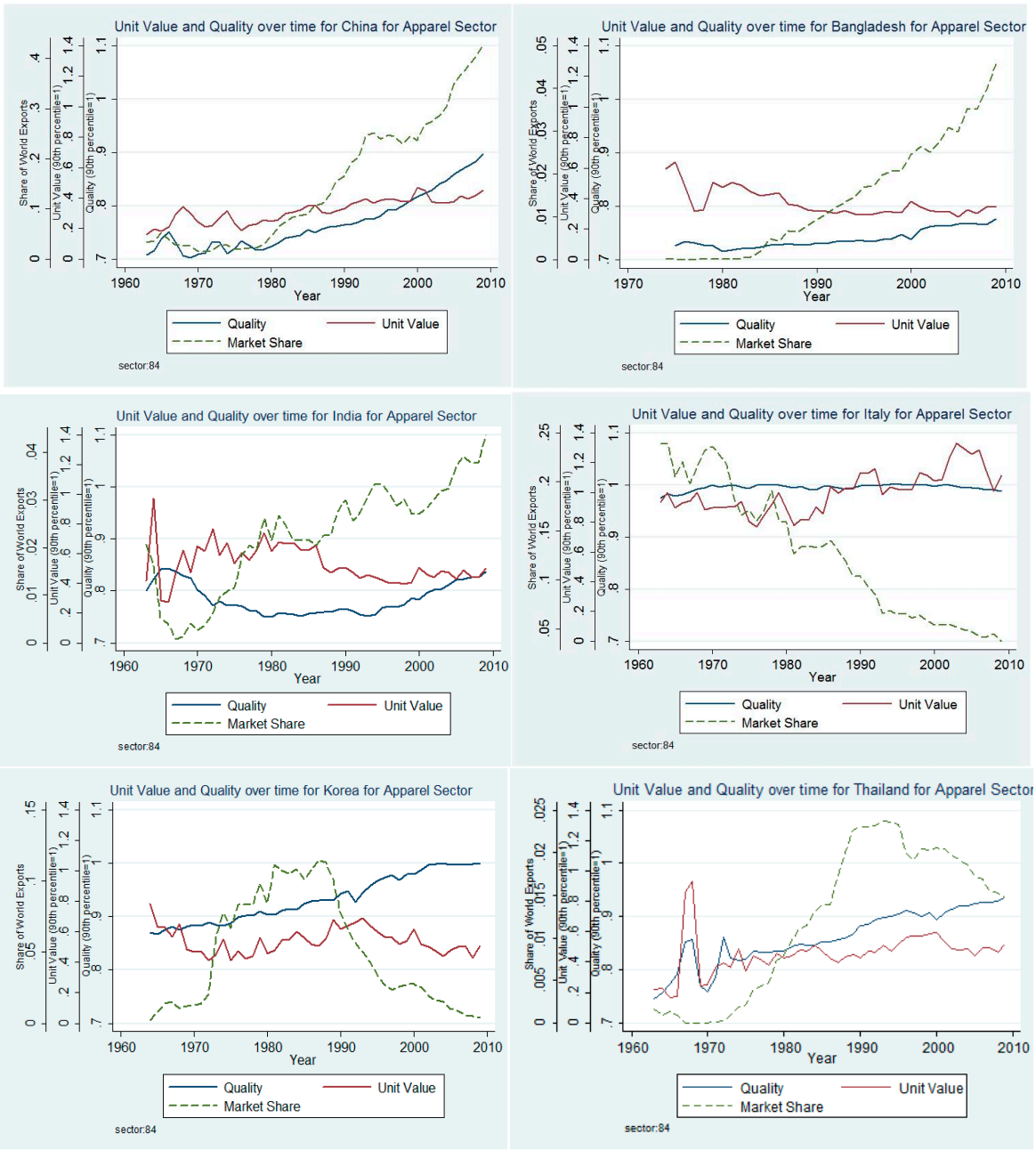


Figure 5. Quality Ladders

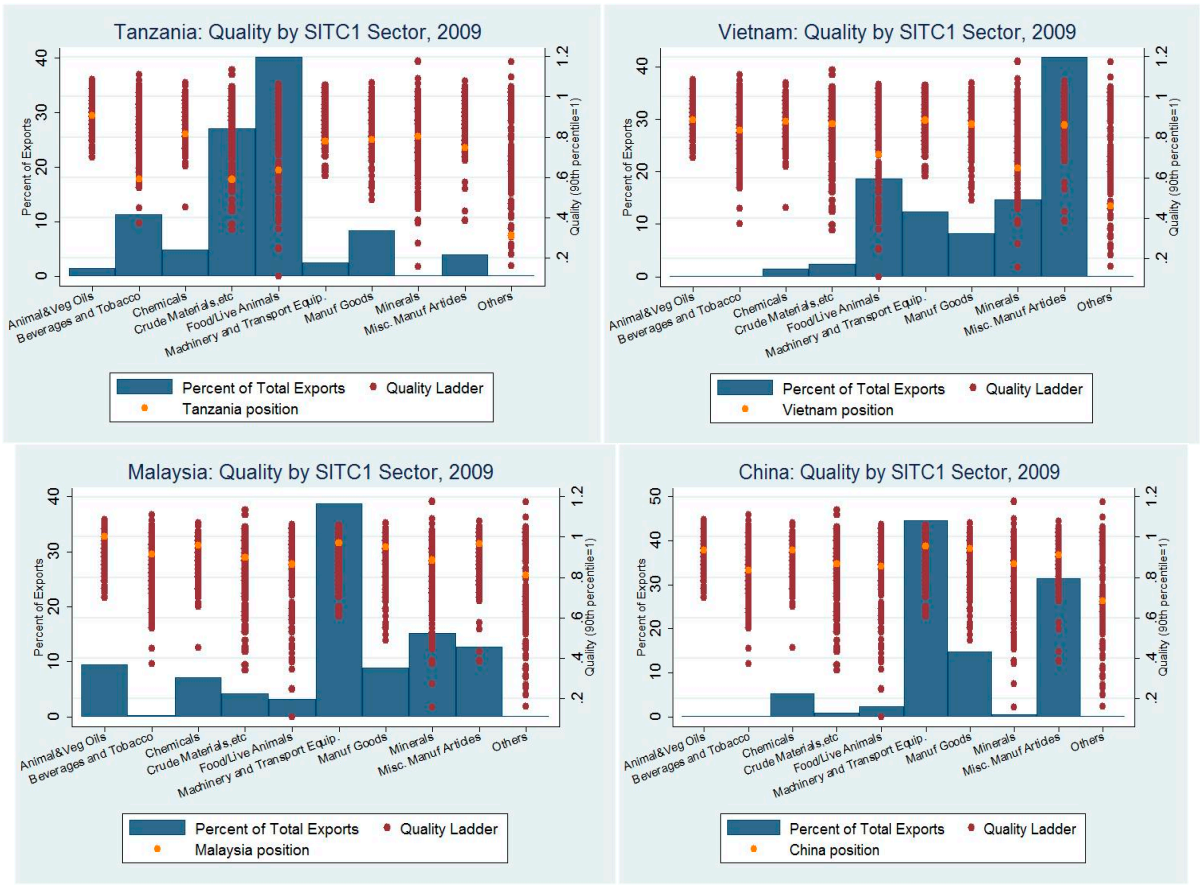


Figure 6. Quality, Unit Values, and GDP per capita

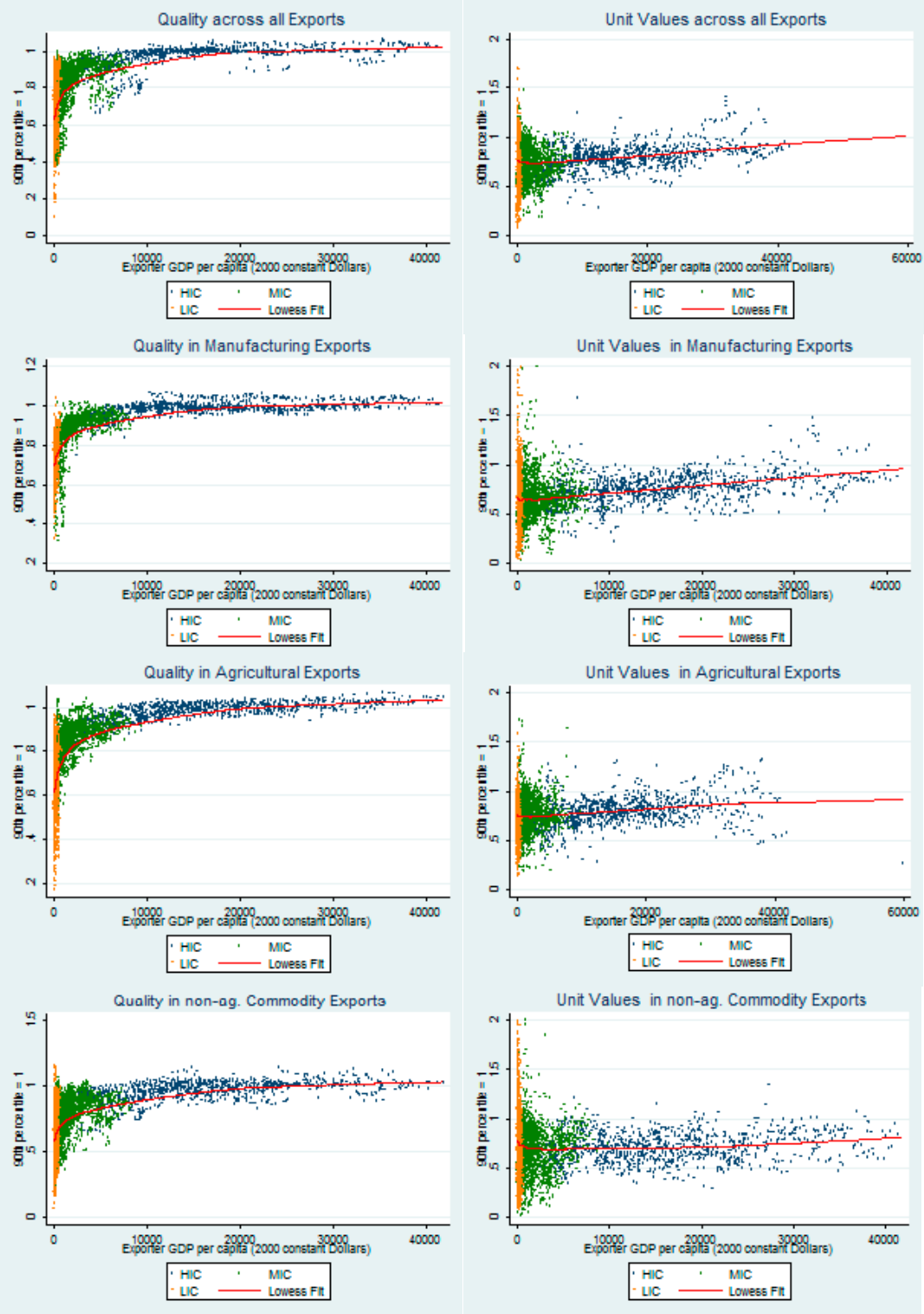


Figure 7. Quality in Agriculture and Manufacturing

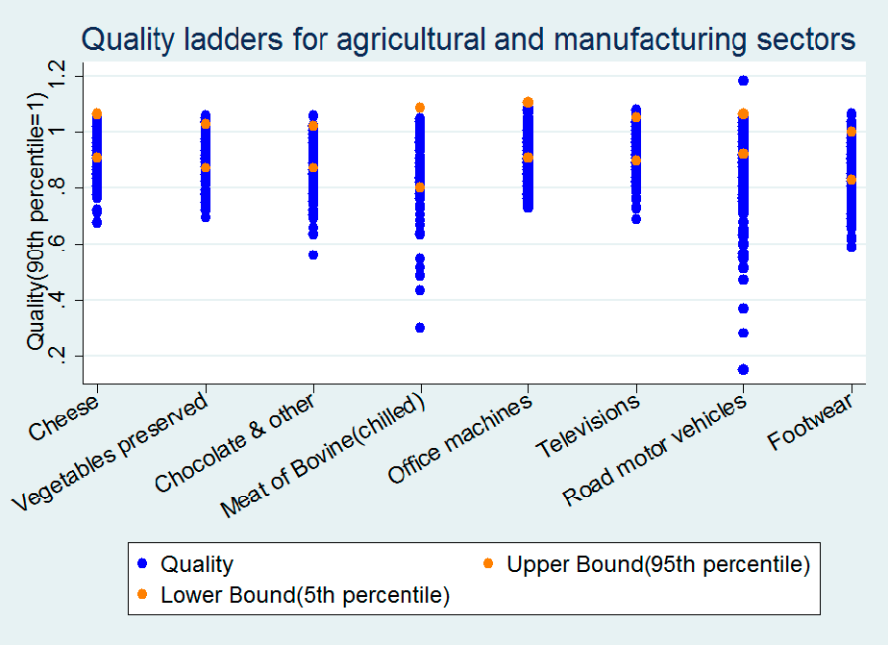
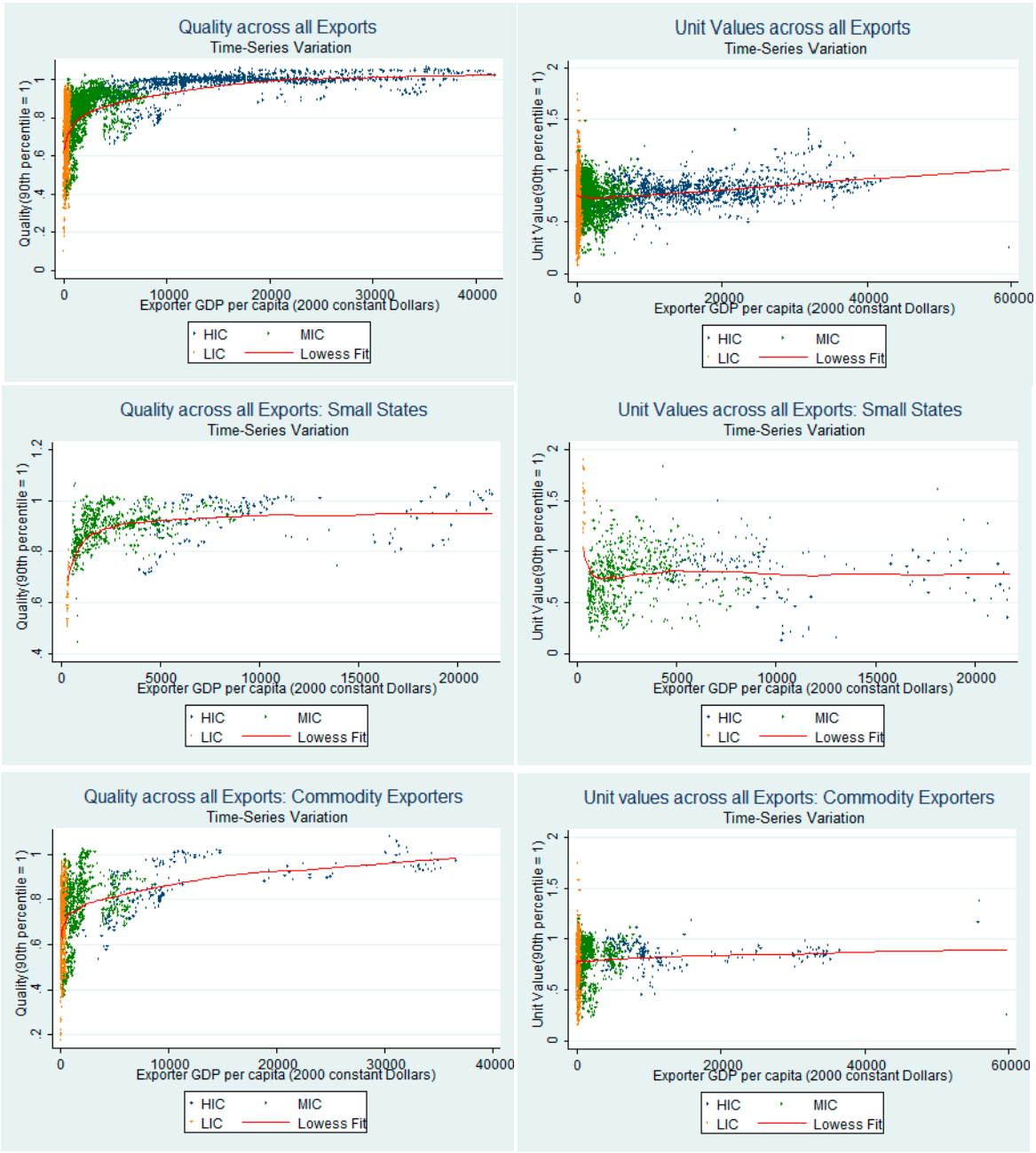


Figure 8. Quality, Unit Values, and GDP per capita: Within-Country Variation



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

Figure 9. Export Quality by Income Group over Time

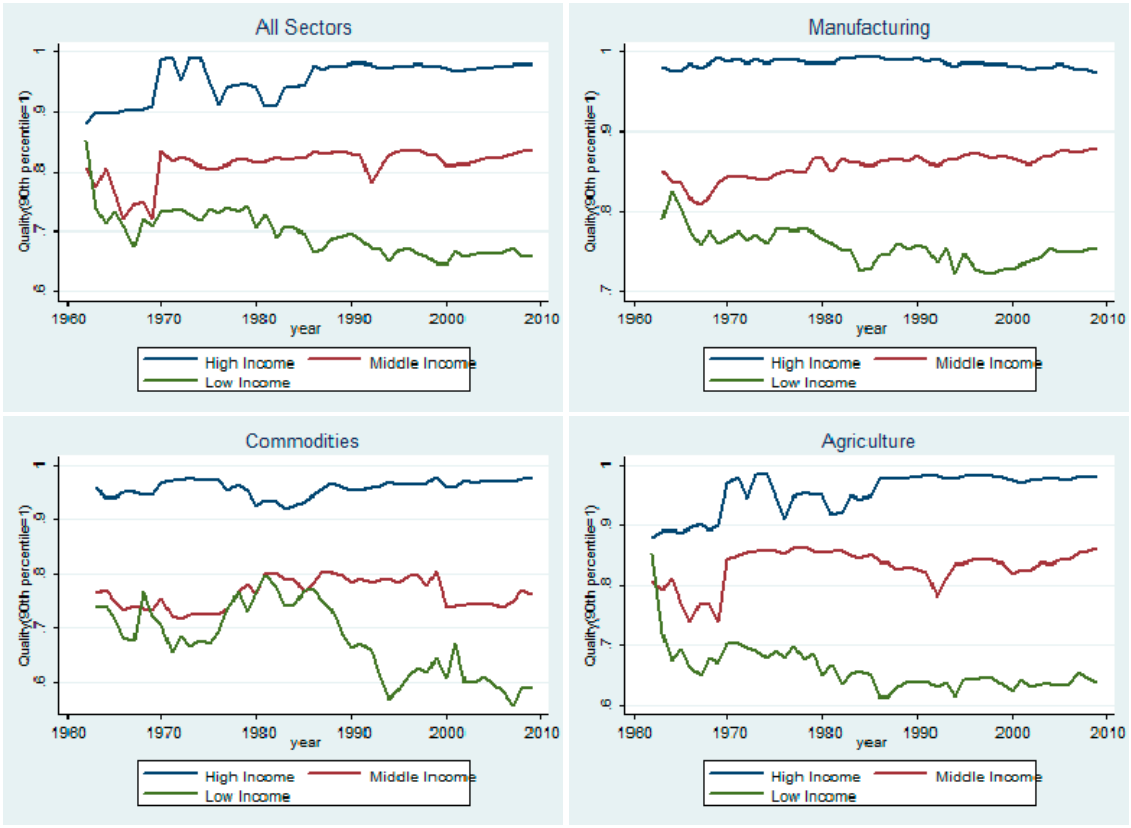


Figure 10. Quality Upgrading by Region

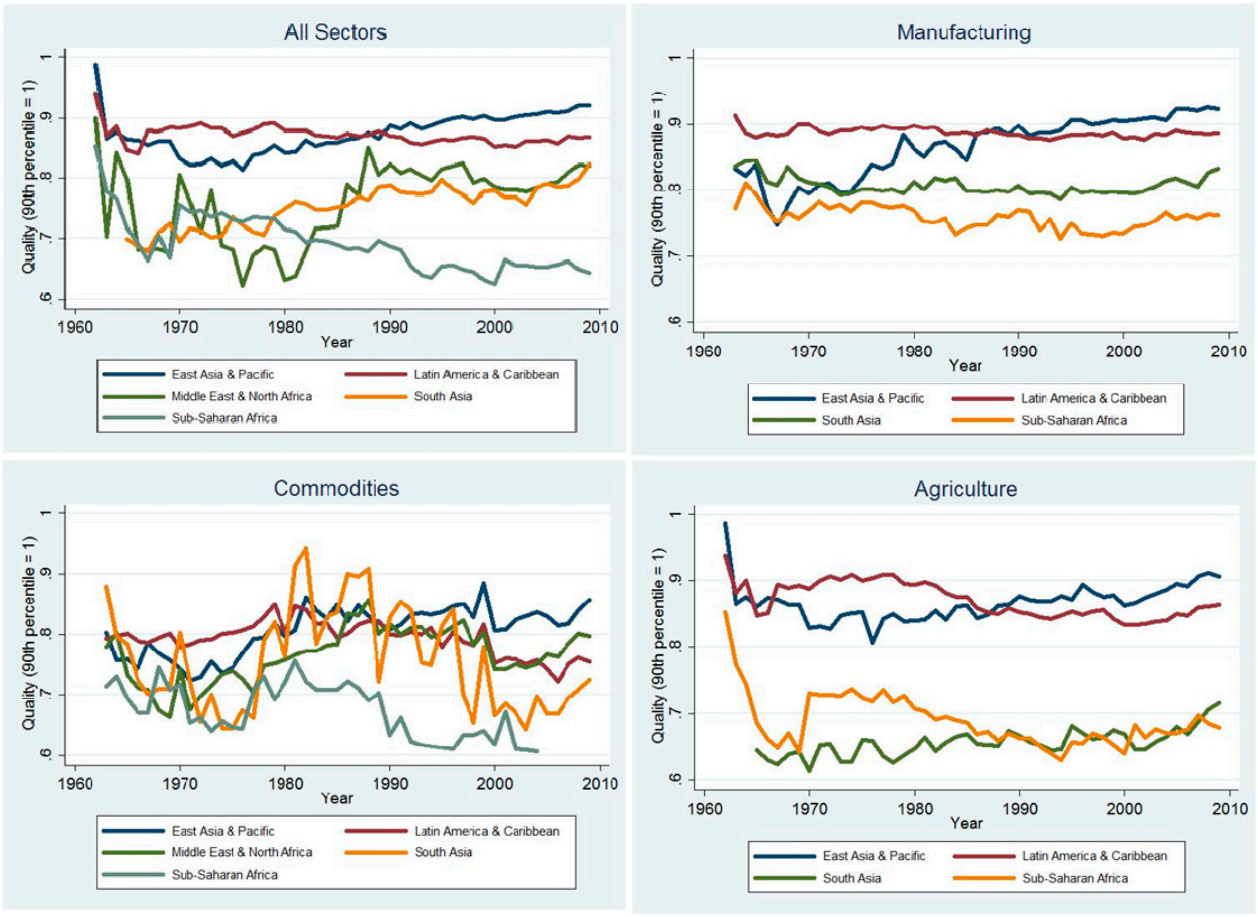


Figure 11. Country-level Heterogeneity in Quality Upgrading in Asia and Africa

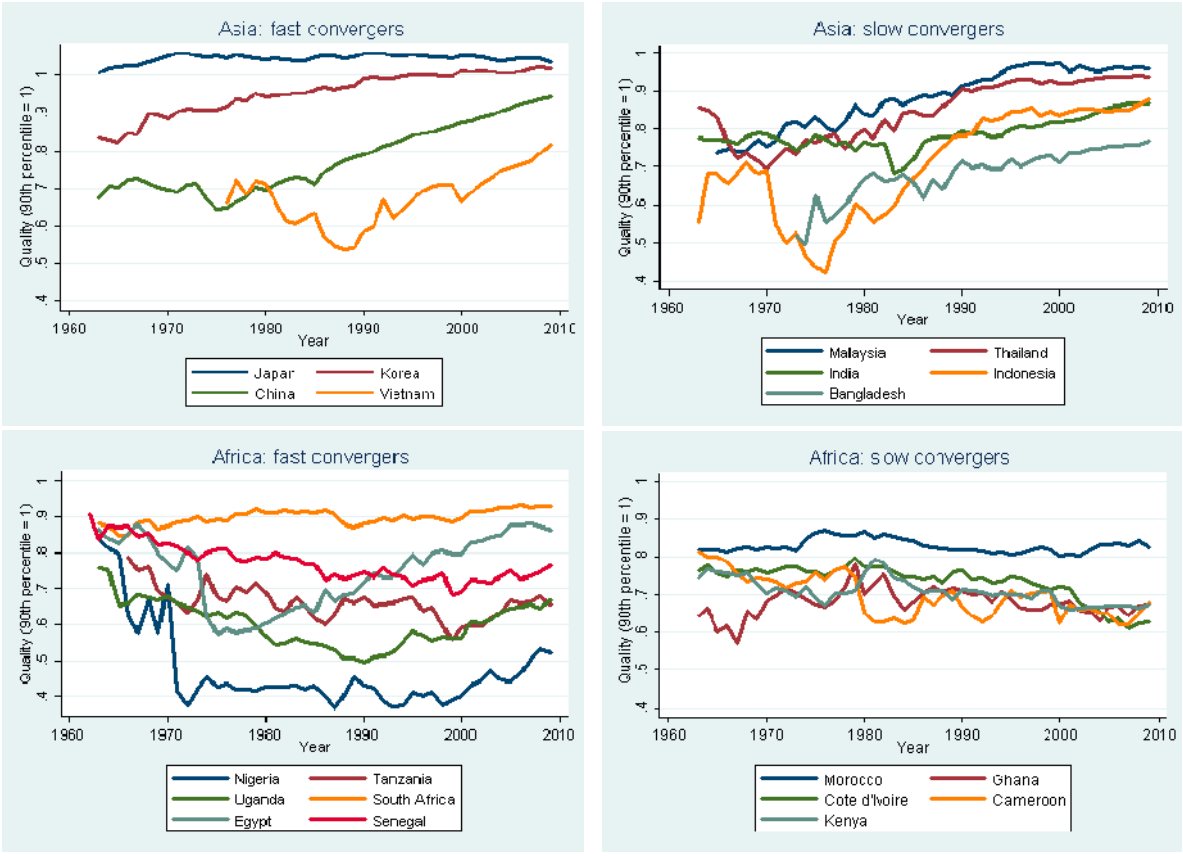


Figure 12. Quality Upgrading and Destination Markets