Export Quality Dynamics

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Abstract

Country export quality (measured by unit values) is correlated with income level suggesting that studying quality dynamics potentially offers insights into the development process. This paper uses highly disaggregated trade data to explore the export quality (unit value) dynamics of goods exported to the United States over the 1990–2000 period. In addition to finding considerable heterogeneity in the relative quality of exports across countries and across goods within countries, the authors find that the rate of quality growth varies substantially across countries, as well. Specifically, the fastest growth is seen in exports from the richer (OECD) countries, implying an evolving divergence in product quality across regions. This divergence obtains despite evidence of conditional convergence in quality over time—goods with lower initial relative quality levels experience faster growth in quality. The data suggest that part of this divergence is driven by the product mix itself—OECD exported products experience intrinsically higher growth rates. This is consistent with the argument of Hausmann, Hwang and Rodrik (2007) that what countries export does matter for growth. However, it is partly driven by a higher growth rate of quality in the richer countries independent of convergence effects, suggesting that other country-specific factors impeding overall convergence are at work. Finally, there is very limited technological “leap-frogging” by countries across product lines as the relative quality of new exports, on average, is roughly the same as incumbent exports, both in richer countries and elsewhere.

This paper is a product of the Macroeconomics and Growth Team, Development Research Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at wmaloney@worldbank.org.
Export Quality Dynamics*

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I. Introduction

In two important recent contributions, Schott (2004) and Hummels and Klenow (2005) study cross-country differences in the unit values of exports to the United States and find that, within narrowly defined product categories, richer countries tend to export varieties with higher unit values. Interpreting varieties with higher unit values as varieties of higher quality, these authors suggest an important pattern of specialization and trade in the global economy – the tendency for richer countries to produce and export higher quality varieties of goods.¹

How will this pattern of specialization evolve over time? This is the question that lies at the core of a variety of academic and policy debates concerning the shifting location of global production activity and the rapid change in the nature and volume of exports by countries in recent decades. Yet, it is a question that is difficult to answer on purely theoretical grounds. On the one hand, innovation in richer countries could lead them to export varieties of ever higher quality. On the other hand, technological diffusion to other countries may narrow the gap in quality over time. The relative strength of these different forces will determine whether countries converge or diverge in their export quality. Technological diffusion, and thus convergence, is itself driven by a range of factors and is far from automatic (see Keller, 2004, for a survey). For instance, technological spillovers may decrease with distance, to the

¹In principle, a number of factors may cause a gap between the quality of a product and the economic rents earned by its exporter. For instance, we may imagine a product of high quality competing in price with a close substitute of equally highly quality, so that exporters of both goods earn (nearly) zero profits on their sales, while a different product of low quality earns higher rents because of a lack of competition in its market. Thus, the finding of a robust association between export unit values and the level of development of the exporting country, although intuitive, is nevertheless noteworthy.
The evolution of export quality also appears associated with that of country income. Figure 1 plots the median (across goods) change in the unit values of a country’s exports to the United States against the change in its per capita GDP over the 1990-2000 time period and shows a positive and statistically significant association between these two variables. Studying export quality dynamics thus potentially offers a new lens through which to understand elements of the development process.

Our analysis is, in fact, related to a separate body of work that argues that economic growth and the convergence in per capita incomes may be understood through countries’ production and export choices. Specifically, Hausmann, Hwang and Rodrik (2007) argue that the extent of the overlap of a country’s export basket with those goods that are exported by richer countries is a significant predictor of the country’s growth rate, implying that “what you export matters for growth”. One potential mechanism underlying this association has been explored by Hwang (2006) who argues that the extent of vertical differentiation in goods, and

While we follow much of the earlier literature in referring to goods with higher “unit values” as goods of higher “quality”, it should be noted that an innovative recent literature has recognized and examined the reasons for the divergence between these two concepts. See, for instance, the framework developed by Hallak and Schott (2008) which decompose countries’ observed export prices into quality versus quality - adjusted-price components using information contained in their trade balances and the analysis by Khandelwal (2010) which exploits both price and quantity information to estimate product quality and the magnitude of quality differentiation (quality “ladders”) in United States’ imports.
the extent of specialization in vertically differentiated goods, will determine a country’s rate of economic growth. Finding convergence between countries within a good (i.e. countries which produce at a quality level that is further away from the frontier quality will see faster improvements over time in the quality of their output), he argues that countries producing goods with little differentiation (for instance, commodities), will grow more slowly than those producing goods with a higher degree of differentiation.\textsuperscript{3}

With these issues in mind, this paper studies empirically the dynamic evolution of the quality of exports across countries using highly disaggregated data on their trade with the United States over the time period 1990-2001. Our main findings are as follows. To begin, we find evidence of unit value divergence. That is, non-OECD countries, on average, experience lower growth rates in the unit values of their exports compared to OECD countries. Since OECD exports are characterized by higher unit values to begin with, there is divergence in quality taking place over time. Furthermore, this occurs despite a pattern of conditional convergence in quality over time, i.e., \textit{ceteris paribus}, within product categories, varieties with lower initial quality levels experience faster growth in quality. The data suggest that the divergence in quality between OECD and non OECD countries is partially driven by the product mix (i.e., the fact that products exported by the OECD experience intrinsically higher growth rates), consistent with the argument of Hausmann, Hwang and Rodrik (2007) that what you export does matter for growth. However, it is also driven by the higher average quality growth rate in OECD countries, controlling for product mix, suggesting that other country-specific factors impeding convergence are at work. Finally, we see that there is very little technological “leap-frogging” by countries. The quality of new exports, on average,

\textsuperscript{3}Furthermore, he argues that this is an important explanation for the differences in economic growth rates across developing countries; countries that were producing in sectors where the technological frontier was not far ahead grew slowly while others that were in goods where the frontier was much further ahead grew faster because of the greater ”impact from convergence”.
is about the same as incumbent exports both in OECD countries and elsewhere. Taken together, these findings firmly suggest a lack of convergence in export quality between rich and poor countries.

Our approach here is an entirely atheoretical one. That is to say, we conduct our analysis of the dynamics of unit values by neither imposing any structure derived from theory nor by looking for consistency with any particular theoretical models of trade, innovation and growth in the global economy. A impressive recent literature has begun to explore the determinants and implications of product quality in the domestic economy and in trade. For instance, Waugh (2008) develops a general equilibrium theory of product quality and international trade in which producers make choices regarding the quality of their intermediate inputs given the set of endowments to they have access, Hallak and Sivadasan (2007) study the export patterns when firms vary in their productivity as well as in their ability to produce quality, Verhoogen and Kugler (2010) propose a theory of endogenous input and output quality choices to explain a variety of empirical observations concerning the relationship between plant size and prices. We hope that the empirical findings presented in this paper will serve to inform and stimulate further contributions along these lines. The rest of this paper is organized as follows. Section II describes the data. Section III discusses our empirical framework and results. Section IV concludes.

II. Data Sources and Description

The data used in this study come primarily from data compiled by Feenstra, Romalis and Schott (2002) using official customs records from the U.S. Census Bureau. This dataset records U.S. imports annually at the 10-digit HS level by source country. It contains import values and quantities as well as entries for tariffs and transportation costs. Several filters are applied to clean the data. First, all imports under 25,000 dollars are dropped as are
observations with zero quantities. Furthermore, we exclude products with detailed product
descriptions corresponding to more than one HS10 code (i.e., which appear to have changed
their HS10 code over time or are entered as different HS10 codes when coming from different
source countries). We also exclude HS10 codes with more than one product description.
Additionally, we eliminate all goods belonging to the “Not Elsewhere Specified or Indicated”
(NESOI) categories as they may possibly contain non-homogeneous goods across time. With
these filters in place, we retain over 95 percent of the observations in the full sample. Data
on GDP per capita were obtained from the World Development Indicators (WDI) and the
Global Development Finance (GDF) databases of the World Bank. They are adjusted for
Purchasing Power Parity (PPP) and are recorded in constant 2005 U.S. dollars.

III. Results

We begin by characterizing the relative unit values of imports. As in Schott (2004), unit val-
ues were calculated simply as the quotient of general imports values and quantities. Within
any 10-digit good for any given year, we then have a distribution of unit values of imports
from the different source countries. For each good $i$ and exporting country $c$, in time period
$t$, we generate a measure of relative quality $R$ as:

$$R_{itc} = \frac{u_{itc}}{u_{90it}}$$  \hspace{1cm} (1)

where $u_{itc}$ denotes the unit value of the good and $u_{90it}$ denotes the value at the 90th percentile
of the unit value distribution across countries for that HS 10 good. $R_{itc}$ denotes the relative
quality of the country’s export of that good, i.e., quality relative to other countries exporting
the same good. We obtain the time average for a given country-good pair as:

$$\bar{R}_{ic} = \frac{1}{T} \cdot \sum_{t} R_{itc}$$  \hspace{1cm} (2)
In general, we may expect a great deal of heterogeneity in the relative qualities $\tilde{R}_{ic}$ across goods within a country’s export basket. To evaluate the central tendency of the relative quality of a country’s export basket, while minimizing the role of outliers, we take the median of the values of $\tilde{R}_{ic}$ for that country:

$$\tilde{R}_c = \text{Median}(\tilde{R}_{ic})$$ (3)

### III.1 Quality Differences across Countries

For most of our analysis, we compare the relative unit value distributions of OECD (pre-1995 definition) with non-OECD countries, with the two groups denoted by the index $G$. For any group (OECD/Non-OECD)’s export basket we have

$$\tilde{R}_G = \text{Median}(\tilde{R}_c) \ \forall c \in G$$ (4)

where $\tilde{R}_G$ denotes the median relative quality of the basket of exports by the group. Values of $\tilde{R}_G$ may be obtained as coefficients in a median regression of the group-good averages described above on group fixed effects:

$$\tilde{R}_{ic} = \alpha + \beta \cdot D_{OECD} + \epsilon_{ic}$$ (5)

where $D_{OECD}$ is an indicator variable denoting membership in the OECD. The first column of Table 1 presents these regression results. As expected, OECD countries are at the higher end of the relative quality distribution, $\tilde{R}_G = 0.58$, compared to non-OECD countries, $\tilde{R}_G = 0.37$ (results raised to $10^2$ in the table for clarity). This is not too surprising and is consistent with earlier work, including Schott (2004). Quantitatively, however, the median
value of the OECD’s export basket being only 0.58 suggests that in many HS 10 products, OECD exports to the US are not bunched at the high end of the quality spectrum. This, in turn, suggests an overlap in export quality between countries of quite different levels of development that is, in fact, observed. For instance, Algeria, Angola, Cameroon, Indonesia and Tunisia top the relative quality spectrum for HS 2710000000 (No. 6-type Fuel Oil under 25 degrees API) while Canada, Norway and the UK lie below; for HS 7107000000 (Silver Bullion, Unwrought), Nicaragua, China, Chile and Brazil all lie above Canada, Germany, Switzerland and the UK; while for HS 6403999060 (Women’s Footwear with Leather Uppers), Hungary lies above New Zealand, and Spain.

These examples raise a concern about how different characteristics of exported goods and, in particular, their degree of vertical differentiation may affect the interpretation of quality comparisons. For example, almost by definition, commodities show a much smaller degree of vertical differentiation than manufactures. This implies that any commodity exporter is more likely to be close to the frontier and show high levels of relative quality: the lowest value of $\tilde{R}_{ic}$ for HS 2710000000 (Number 6-Type Fuel Oil under 25 Degrees API) is 0.7; for HS 7107000000 (Silver Bullion Unwrought), 0.75; and for HS 7108121013 (Gold Bullion not under 99.5 Pure Gold), 0.8. That is, these commodities show relatively little vertical differentiation. By contrast, vertical differentiation in manufactures is often much higher. For example, the lowest value of $\tilde{R}_{ic}$ for HS 8703000000 (Passenger Motor Vehicles with Spark Ignition, 4 Cylinders, 1500-3000 CC) is 0.3; for HS 6403999060 (Women’s Footwear with Leather Uppers), 0.2; for HS 6105100010 (Men’s Shirts of Cotton, Knit), 0.15; and for HS 8542138068 (32 Bit Micro Processors), 0.025. That said, many natural resource based products that might be thought of as “commodities” show relatively high degrees of vertical differentiation. For instance, $\tilde{R}_{ic}$ of HS 901110010 (Coffee, Arabica, not Roasted, not Decaffeinated) shows a low value of 0.4 and HS 306130040 (Shrimps and Prawns), 0.35.
Such differences in products suggest the need for controls capturing the product composition in different export baskets. We therefore introduce product fixed effects, denoted by $I$, to equation (5):

$$\bar{R}_{ic} = \alpha + \beta \cdot D_{OECD} + \beta_I \cdot I + \epsilon_{ic}$$

The inclusion of product fixed effects in the median regression changes the picture in important ways. Specifically, as indicated in the second column of Table 1 and consistent with the previous results, the negative coefficient on the constant implies that, within products, non-OECD exporters supply a quality lower than that of the median quality exported by the full set of exporters. However, of greater interest, the gap between the median OECD and Non-OECD relative quality levels shrinks by roughly half – from 0.208 to 0.123, indicating that some of the difference in median relative qualities between OECD and non-OECD countries is explained by the nature of the goods that they produce. More specifically, it suggests that poorer countries are, on average, producing goods with greater vertical differentiation and are at the lower end of the relative quality spectrum.

III.2 Quality Growth

The preceding discussion has analyzed export unit values in a “static” sense. We turn next to the evolution of unit values over time – looking in particular to see whether the non-OECD and OECD countries are converging or diverging in their relative export quality. As we have discussed earlier, there are a variety of possibilities. One the one hand, innovation in richer countries could lead them to export goods of ever higher quality. One the other hand, technological diffusion to other countries may narrow the gap in quality. The relative
strength of these competing factors (among others) will determine whether the difference across countries in the quality of their exports is rising or falling over time.

We measure first the differential rate of unit value growth across OECD and non OECD:

\[
\bar{u}_{ic} = \alpha + \beta \cdot D_{OECD} + \epsilon_{itc}
\]  

(7)

where \(\bar{u}_{ic}\) denotes the mean annual rate of growth of the unit values of a given good from a given exporting country over time (with the mean taken over growth rates calculated for each available pair of contiguous year observations). As the results of the median regression reported in third column of Table 1 indicate, the high-income OECD countries experience a higher rate of unit value growth on average than the rest of the world. Since the OECD countries have both higher initial quality level and higher median quality growth rate, this implies that we do not see a catch-up dynamic, but rather, divergence.

Controlling for product characteristics by introducing product fixed effects changes the picture substantially, as indicated by the results reported in the fourth column of Table 1. While the OECD continues to have the highest quality growth rates, the gap between OECD and non OECD countries, while still positive, shrinks considerably. This suggests that the median unit value growth rate of the export basket is significantly determined by the composition of the export basket. As discussed earlier, the economics literature has recently begun to emphasize the role of the production and export choices of countries in understanding the process of economic growth. Our findings indicating the importance of the export basket in determining unit value growth, are consistent with this literature and with the primary conclusion of the paper by Hausmann, Hwang and Rodrik (2007) that “what you export matters for growth”.

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III.3 Quality Convergence

Next, to explore convergence in export quality, we regress the growth rate of product quality over the 1990-2001 period on the initial (1990) level of quality:

$$\bar{u}_{itc} = \alpha + \beta I \cdot I + \gamma \cdot \ln(u_{itc1990}) + \epsilon_{itc}$$ (8)

The first column of Table 2 presents the results for the combined sample of both OECD and non-OECD countries and offers support for the existence of a convergence dynamic. The negative coefficient on the initial quality level indicates that for a given product, the lower the initial quality level, the higher is the growth rate. Columns 2 and 3 allow for separate convergence and mean growth rate terms for OECD and non OECD countries. Two findings merit note. First, the rate of convergence is higher for the non-OECD countries (1.394) than for the OECD (0.593), suggesting that improvements in quality may be harder to achieve as one gets closer to the technology frontier (non-linearity in the rate of convergence).

Second, given that non-OECD countries are on average even further away from the technology frontier than OECD countries (with median relative quality at 0.4 for the non-OECD countries in contrast with 0.6 for OECD countries), the finding of a significant convergence effect suggests that we should, ceteris paribus, see higher rates of unit value growth in non-OECD countries. This is, however, not the case as shown in the preceding section: the OECD countries experience a substantially higher conditional mean growth rate as indicated by the constant term in the OECD (0.913) compared to that in the non-OECD countries (-0.369). This difference dominates the differential convergence effects.

To the extent that, as suggested by Figure 1, export unit value growth is related to the growth rate of GDP per capita, our findings are potentially related to an important debate in the
literature concerning the patterns of economic convergence across countries. While economic theory often predicts convergence in per-capita incomes between rich and poor countries over time, a large empirical literature has observed that this predicted pattern of convergence has not generally been observed in the data. Several explanations have been offered for this. It has been suggested, for instance, that poor countries with low levels of physical and human capital may also lack the incentives for rapid accumulation of these factors, thus perpetuating their low income levels. In turn, low rates of return to accumulable factors of production are explained by the lack of important economic and political institutions such as a system assuring property rights and mechanisms for the efficient enforcement of contracts (See Barro and Sala-i-Martin (2003) and Acemoglu (2008)). Our view of convergence through the lens of export quality growth and, in particular, the finding that the difference in mean growth rates of quality between OECD and non-OECD countries is large and dominates any differential convergence effects, is in line with these arguments.

III.4 Entry-Exit Patterns

The preceding analysis has concerned itself entirely with the dynamics of incumbent (already existing) products. However, in the sample period we see significant changes in export baskets in several regions, and in particular Asia (China) South Asia (India) and Eastern Europe. It is clearly possible that changes in the quality of a country’s exports occur through a leap-frogging process whereby new products are of a higher relative quality level than those of incumbent products. To study this possibility, we now examine the relative quality of entering goods in relation to existing goods.

We define “Entries” as goods not exported by a country during the first half of the sample period: 1990-1995 but exported at least three times (years) from 1996-2001 and “incumbent” goods as goods exported at least three times in each of the two periods. Table 3 presents
the average relative quality of entering goods generated by quantile regressions of entering
goods on the OECD regional dummy, with the non-OECD countries captured together by
the constant term. To the extent that we expect newly entering goods to be higher quality
goods, the median values for both OECD and non-OECD groups are surprisingly low; the
median value for the non-OECD countries is 0.35 and for OECD countries is 0.55. This is
consistent with our earlier discussion concerning the high levels of heterogeneity in relative
product quality in goods in both OECD and non-OECD baskets. However, it does not
appear to be the case that the low quality goods in the OECD basket are merely reflecting
inertial persistence of products fundamentally now out of their cone of specialization. Even
at entry, there appears to be a very high level of heterogeneity. As Table 3 also indicates,
the distribution of relative quality of entering goods in the OECD dominates that of the
non-OECD countries at all levels, that is to say that at every quantile, the quality levels of
entering goods in the OECD is higher than in the non-OECD countries.

This does not imply that the quality of incoming goods is not higher, on average than
incumbent goods. Table 4 repeats the previous analysis, but using the ratio of the relative
quality of entering goods to the median relative quality of the incumbent goods. The median
ratio for the non-OECD regions is 1.03 and the median ratio for the OECD is equal to 1.05.
This implies that new goods enter at only slightly higher level as existing goods for both
the OECD and the non OECD regions. Given that OECD goods are of higher relative
quality to begin with, this also tells us that new goods enter at higher quality levels in the
OECD than in the poorer regions. However, at the upper end of the distribution, the quality
ratio of entering to incumbent goods is larger for the non-OECD region suggesting a degree
of convergence at the top end of the quality distribution between OECD and non-OECD
countries.4

4The range of goods found at this end of the distribution is large and includes HS 7213990060 (Bars
and Rods/non-alloy Steel Hot-Rolled 19mm) from Taiwan, HS 3808305000 (Herbicides) from China, HS
IV. Summary and Conclusions

Our analysis of the data on exports to the United States over the period 1990-2000 yields several stylized facts regarding export quality. In addition to the considerable initial heterogeneity in the relative quality of exports across countries and across goods within countries, we find that countries vary substantially in the rate at which they improve the unit values of their exports. Specifically, the fastest rise in unit values is seen in exports from the richer (OECD) countries, implying an evolving divergence in product quality across regions. This divergence obtains despite evidence of conditional convergence in quality over time (with goods with lower initial relative quality levels experiencing faster growth in quality). The data suggest that the divergence in quality between OECD and non-OECD countries is partially driven by the product mix (i.e., the fact that products exported by the OECD experience intrinsically higher growth rates), consistent with the argument of Hausmann, Hwang and Rodrik (2007) that what you export does matter for growth. However, it is also driven by the higher average growth rate in OECD countries, controlling for product mix, suggesting that other country-specific factors impeding convergence are at work. Finally, there is very limited technological “leap-frogging” by countries across product lines as the relative quality of new exports, on average, is roughly the same as incumbent exports, both in OECD countries and elsewhere.

2403914390 (Hammers and Sledge Hammers) from Turkey, HS 5205121000 (Cotton Yarn and Sewing thread) from Turkmenistan, HS 8506500000 (Primary batteries, Lithium) from Russia and HS 7209270000 (Flat and Cold Rolled Iron/Steel) from India.
References


Figure 1: GDP Growth vs. Unit Values Growth
Table 1: Export Unit Values: OECD vs Non-OECD

<table>
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<tr>
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<th>Relative Quality</th>
<th>Growth UV</th>
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<tr>
<td></td>
<td>Base PFE</td>
<td>Base PFE</td>
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<tr>
<td>$D_{oced}$</td>
<td>20.848***</td>
<td>4.034***</td>
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<tr>
<td></td>
<td>(0.215)</td>
<td>(0.104)</td>
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<td>Constant</td>
<td>37.132***</td>
<td>3.571***</td>
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<tr>
<td></td>
<td>(0.148)</td>
<td>(0.075)</td>
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Observations: 245804 245804 155541 155541

Notes: All coefficients in the table have been scaled up by a factor of $10^2$. PFE: Product fixed effect. Standard errors in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Growth and Convergence: OECD vs Non-OECD

<table>
<thead>
<tr>
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<th>ALL OECD</th>
<th>Non-OECD</th>
<th>ALL</th>
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<tr>
<td>$u_{1990}$</td>
<td>-0.329***</td>
<td>-1.394***</td>
<td>-1.394***</td>
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<tr>
<td></td>
<td>(0.023)</td>
<td>(0.048)</td>
<td>(0.067)</td>
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<td>$D_{oced}$</td>
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<td></td>
<td>(0.080)</td>
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<tr>
<td>$u_{1990} \times D_{oced}$</td>
<td>0.801***</td>
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<tr>
<td></td>
<td>(0.081)</td>
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<tr>
<td>Constant</td>
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<td>-0.369***</td>
<td>-0.369***</td>
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<tr>
<td></td>
<td>(0.023)</td>
<td>(0.044)</td>
<td>(0.061)</td>
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Observations: 66680 38803 27877 66680

Notes: Dependent variable in all models: Growth in unit values. All coefficients in the table have been scaled up by a factor of $10^2$. Product fixed effect are in use in all specifications. Standard errors in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Table 3: Relative Quality of New Goods: OECD vs Non-OECD

<table>
<thead>
<tr>
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<th>Qreg 0.25</th>
<th>Qreg 0.50</th>
<th>Qreg 0.75</th>
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<td>$D_{oecd}$</td>
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<td>0.202***</td>
<td>0.224***</td>
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<td>(0.005)</td>
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<td>(0.007)</td>
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<td>Constant</td>
<td>0.170***</td>
<td>0.351***</td>
<td>0.610***</td>
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<td>(0.004)</td>
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Notes: Non-OECD (high-income) is the excluded category. Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: New Goods vs Incumbent Goods

<table>
<thead>
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<th>Qreg 0.25</th>
<th>Qreg 0.50</th>
<th>Qreg 0.75</th>
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<tr>
<td>$D_{oecd}$</td>
<td>0.067***</td>
<td>0.027*</td>
<td>-0.187***</td>
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<tr>
<td></td>
<td>(0.011)</td>
<td>(0.013)</td>
<td>(0.014)</td>
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<tr>
<td>Constant</td>
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<td>1.031***</td>
<td>1.764***</td>
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Notes: Non-OECD (high-income) is the excluded category. Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$