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A Panel Study of Factor Accumulation and Export Quality

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Abstract: Cross-sectional data show Global North countries export higher quality products at a point in time. Product-level panel data can address if countries improve their export quality over time. The literature has addressed this practically relevant panel question only in small samples over the short term. We addressed it for a large sample, over the long run, focusing on the hitherto overlooked endogeneity between export quality and factor accumulation and the role of export composition. We utilized a two-tiered panel: the panel of countries and the panel of products each country trades. We found some evidence that middle-income countries often upgrade export quality within the same product, but that high- and low-income countries do this less often. Our results appear to support product cycle theory: some countries climb the value ladder, others are competed off from the ladder's top, and new countries enter markets. Technology appears to be a potential basis for consolidating trade competitiveness over time, as skill accumulation becomes more widespread across countries and loses significance as an explanatory variable. Our results provide some explanation of why Global North countries might resist sharing technology. This research is timely with deadlocked multilateral trade negotiations and looming trade wars. It attempts to contribute to an evidence-based guide to trade policy.

Keywords: export quality; factor accumulation; trade competition; economic development; technology competition

JEL Classification: F10; F14

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1. Introduction

We intuitively expect the process of development to be reflected in the increasing sophistication of exports. Extant literature (e.g., Balassa 1979; Romalis 2004; Hallak 2006; Chor 2010; Hallak 2010; Costinot et al. 2011) has mostly utilized cross-sectional data to investigate this, thus shedding light only on what happens at a point in time. The only exception is a very brief panel section in Schott (2004). Also, studies of a single or a handful of countries over shorter periods exist in the literature (Schott 2002; Romalis 2004; Fabrizio et al. 2007; Verhoogen 2008; Khandelwal 2010).

Typically, we expect the increase in per capita income or rising capital and skill abundance, viz. the development process, to be reflected in the increasing sophistication of exports. This process may be driven by different factors depending on the level of an economy's development. Rising income levels may create a demand for more sophisticated products, encouraging their production and sale domestically and abroad (Linder 1961). In addition, product cycle theory (Vernon 1966; Flam and Helpman 1987; Grossman and Helpman 1989; Grossman and Helpman 1991a) suggests that the process of increasing sophistication can arise from the transfer of technology into Global South countries. Transfer of technology leads to increasing competition among countries and further innovation. This implies rising sophistication of exports for all countries, no matter what their stage of development. Understanding the process could contribute to our understanding of how international competition among countries evolves at different stages of development.

In this paper, we add to the literature by asking a timely question of practical relevance. Specifically, with the availability of detailed product-level data (e.g., Feenstra et al. 2005), we can ask whether countries would improve their export quality over time as they develop and accumulate capital/skills/technology. Its timeliness arises from the current deadlock in negotiations of multilateral trade liberalization and the prospect of protracted trade wars (Regan and Barrett 2019; Baldwin 2016). The answers we seek will clarify how countries compete with each other over time as they develop. Greater clarity on this front will contribute to an evidence-based guide to trade policy, which is sorely needed in the current distrust of the multilateral system.

To study the long-term relationship between export quality and factor accumulation, we undertook a two-tiered analysis using a panel of countries first and then delved into the products that each country exports. We allowed the relationship to change with countries' income and export composition because existing empirical results indicate that trade competitiveness depends on their position in the product value ladder and their income (Schott 2002; Khandelwal 2010). Moreover, the composition of exports changes countries' trade competition strategies (Fabrizio et al. 2007). Trade competition strategy impacts the quality of exports that a country chooses to produce. Finally, we addressed the hitherto overlooked endogeneity between export quality and factor accumulation and proposed appropriate instruments.

Our findings indicated some interesting patterns. For example, middle-income countries most often upgrade export quality within the same product. In contrast, high-income countries do this less frequently, and low-income countries are the least likely to upgrade within the same product. Therefore, our results present evidence for product cycle theory. Middle-income production climbs up the product value ladder. High-income leaves as imitators compete them off the top of the value ladder, and low-income are new entrants into product markets.

Among our findings from the panel of countries is that factor accumulation's role appears to change over time both in terms of significance and direction of influence. We find some evidence of the growing importance of technology as a means of successful participation in global markets, particularly in the manufacturing sector. We see that low-income countries often absorb technology from Global North countries (e.g., Barro and Lee 2001). Global North countries view this as a threat to their competitiveness (Alper et al. 2019; Jin and Takenaka 2019), leading to acrimonious trade relations: stalemates in multilateral negotiations (Payosova et al. 2018) and even trade wars. Our research provides an analysis of underlying trends that might provide a basis for understanding practical issues in international trade today. Our findings attempt to offer a nuanced guide to competitiveness considerations based on a country's factor accumulation level. Thus we attempt to provide an alternative to trade policy based on politics (Mason 2019) by informing trade policy with economic fundamentals-based research.

The rest of the paper is organized as follows. Section 2 contains a brief review of the most relevant literature. Section 3 presents stylized facts on the product export values. Section 4 presents our estimation procedure and data. Section 5 discusses our results, and Section 6 concludes.

2. Literature Review

Previous work has investigated the association of export quality and economic development at a point in time in a cross-sectional sample of countries (e.g., Schott 2004; Romalis 2004; Aiginger 1998) or they have pooled data across countries to find the average association of unit values of exports and measures of development over time (e.g., Schott 2004). The contribution of this paper is to investigate this question at the level of each country over time. Our approach thus allows us to make distinctions among countries based on their level of development.

Balassa (1979) estimated that the relative export performance of countries within individual product categories was significantly determined by the countries' physical and human capital endowments. He contends that if these results are used to predict the future export structure given projected future values of countries' physical and human capital, then as physical and human capital grow, Global South countries' exports could supplant the exports of countries that graduated to a higher level. Relative export performance in Balassa (1979) is based on a measure of market share in a product as a ratio of average market share in other products involving the total exports of a country in each four-digit SIC category of manufactured products (resulting in 184 product categories) in the year 1972.

Romalis (2004) found similar results using 1998 data on U.S. imports categorized into four-digit SIC product categories. Specifically, he found that the market share of the rich trade partners of the U.S. rises within each product category with increasing factor intensity of capital and skilled labor.

The two above studies thus provide indirect evidence of a potentially changing pattern of cross-country participation in trade as countries grow and graduate to higher skill and capital endowments. There is some evidence of this in studies such as Khandelwal (2010), which found that the U.S. can continue to compete in products with low-wage countries where there is a scope for upgrading into more sophisticated versions, i.e., products with longer quality ladders. In products with shorter ladders, the U.S. industry is hurt by import penetration. Schott (2002) found more direct evidence of the process of countries graduating to higher levels of quality within a product using U.S. export and import data at the product level. He found that, during the 1990s, U.S. exports declined in product categories with the rise of competition from low-wage countries. He also found that U.S. intra-product trade with low-wage countries typically involves the U.S. selling a significantly higher unit value of the same product than it buys from low-wage countries. Schott (2002) contends that taken together, this provides evidence of a product cycle theory process where Global North countries invent and Global South countries copy (real world examples are in Radjou et al. 2012). This forces Global North countries to either innovate further through vertical differentiation in the same product or exit the market. Firm-level data confirm this sort of adjustment in U.S. manufacturing from 1977 to 1997 (Bernard et al. 2006).

Schott (2004) contends that countries predominantly specialize within products (defined as H.S. 10-digit classification) with a positive relationship between the product's unit value and relative factor endowments of the exporting country. Taking this train of reasoning forward, in Balassa's (1979) fashion, this would imply that over time as countries graduate to higher levels of skill and capital endowment, we could expect to see corresponding graduation to higher unit value levels.

This paper investigates the relationship between the unit value of exports of countries and their changing skill and capital endowments over time. It would be interesting to see if the type of vertical differentiation that the U.S. is found to practice in the face of low-wage foreign competition (e.g., Bernard et al. 2006; Khandelwal 2010; Schott 2002) is also practiced by countries in the process of their development. Vertical differentiation could be the result of competition from still lower-wage producers, as implied by, e.g., Bernard et al. (2006), Khandelwal (2010), and Schott (2002), and the natural evolution of production processes shaped by changing endowments, as implied by, e.g., Romalis (2004) and Balassa (1979).

The predictions of the Heckscher–Ohlin model indicate that the product using the abundant factor in a given country will be exported. As countries develop, human and physical capital increases (Barro 1991; Mukerji and Struthers 2021), implying that the relatively abundant factors will produce more technologically sophisticated output. With this change, we expect countries that develop to capture a greater share of the world markets in products that reflect their changing factor abundance at home (Romalis 2004).

Romalis (2004) deals with the quasi-Heckscher–Ohlin effect: countries will capture a larger share of production and trade in products that use their abundant factor more intensively. The quasi-Heckscher–Ohlin effect thus relates to our aim of testing whether changing factor abundance over time leads to changes in trade composition. This paper looks for evidence to corroborate this shift of factor abundance to a change in export unit values within products.

With changing factor abundance, we may expect many related changes. For instance, countries could climb up the value ladder in products they already export, thus utilizing their growing endowments of skill and capital. Alternatively, countries could migrate to the production of new products that are more skill- and capital-intense in production (e.g., Romalis 2004; Balassa 1979). Thus, while there are many issues involved in changing factor abundance and its impact on trade, this paper focuses only on whether changing factor abundance is associated with changes in unit values exported within product categories.

In addition to the above evidence, empirical analyses of changing technology sophistication of exports based on Global South country case studies have corroborated the link between economic development and growing export sophistication. For example, Verhoogen (2008) found that exporting firms in Mexico pay their workers higher wages, and takes that as indirect proof that exporters are upgrading the quality of their output. Fabrizio et al. (2007) studied eight central and east European countries (CEE-8) between 1994 to 2004, as they transitioned from centrally planned economies through privatization and restructuring. They found that exports increased in products where these countries increased quality of output. They also found that the composition of the export basket changed in favor of more technology-intensive products. For seven countries that rapidly grew from 1960 to 1998, Romalis (2004) calculated a shifting pattern of market share, with these countries' market shares exhibiting the positive correlation with capital and skill intensity after they had grown and graduated to the club of the "North" countries.

We found that less than a third of countries made the transition up the unit value ladder in their exports during the sample period (1972–2001), while the proportion is somewhat larger in the later years of the sample. The lowest proportion of products exported by low-income countries made this transition compared to those in the high- or middle-income categories.

For low-income countries, the increasing sophistication of exports might show up in the export of new goods instead of a rising price of existing imports. This paper focuses on within-product changes of real unit value experienced by a given country. While the increase in the real unit value of a product exported by a country could signify an increase in its export sophistication, it need not be the only avenue through which improved production capability manifests itself. The export of entirely new products is, in fact, another common manifestation of rising sophistication. New products trade is called the extensive margin of trade and is consistent with product cycle theory. For instance, low-income countries might start exporting new goods based on technology transfer from abroad. Mukerji (2013) found evidence of the greater importance of the extensive margin in trade growth among low-income countries related to technology transfer. In addition, competition, resulting innovation, and technology-driven cost saving might all drive down the price of existing exports (Helpman and Krugman 1985). Lower export prices would result in observed negative relationships over time.

One potential implication of the literature outlined above is that countries' exports will change with growing capital/skill/technology abundance, i.e., the factor accumulation that accompanies economic development. Our paper aims to provide a direct test of this implication in a large sample of countries between 1972–2001.

We have chosen our period of analysis to capture the steepest acceleration in world trade as a percentage of world GDP since the Second World War (Fouquin and Hugot 2016). A mix of repeated rounds of multilateral trade liberalization through the General Agreement on Tarriffs and Trade (GATT) and the expansion of participation by countries at all levels of income led to the acceleration gathering steam in this period. Therefore, the sample starts in the early 1970s. The end time of 2001 is specifically chosen to restrict the sample to the period before China entered the WTO. We hope by doing so to capture the trade competition, especially among Global South countries, before this significant change. This paper aims to capture the impact of changing fundamentals of a country, represented by factor accumulation, on its trade. However, China's entry had a considerable impact on trade in Global South countries which was not directly related to the fundamentals of these economies. For example, Brambilla et al. (2010) illustrate China's outsize impact in competition faced by Global South countries.

3. Trends in Product-Level Export Unit Values

To estimate the relationship between exporting countries' quality of exports and their factor accumulation over time, we used the unit values of product exports from the rest of the world to the U.S. to measure product quality; and capital per worker, education, and technology to measure factor accumulation. Table 1 details the definitions and sources of the data.

Table 1. Data definitions and sources.

Variable	Definition	Source
Labor skill	Population share attaining secondary or higher education	World Development Indicators, World Bank andGlobal Development Finance
Capital per worker	Capital stock per worker in constant international dollars	Penn World Tables (Mark 5.6)
Per capita gross domestic product	In constant dollars	World Development Indicators, World Bank http://data.worldbank.org/data-catalog/world-development-indicators (accessed on 20 December 2020)
Unit value of exported products	Nominal dollars	Center of International Data UC Davis http://cid.econ.ucdavis.edu/ (accessed on 20 December 2020)
Income level dummy variable (methodology based on Schott (2004))	The income category is evaluated in the last year of the sample period: 1988 for subsample period 1972–1988 and 2001 for subsample period 1989–2001. Countries at and above the 80th percentile of per capita gross domestic product at constant prices are classified as high income, between the 20th and 80th percentile are classified as middle income and below the 20th percentile as low income.	World Development Indicators, World Bank http://data.worldbank.org/data-catalog/world-development-indicators (accessed on 20 December 2020)
Exporter category dummy variable	The dummy variable for exporter equals one if a single category of exports accounts for 50% or more of total exports of the country. The categories considered are: nonfuel primary (SITC 0, 1, 2, 4, plus 68), fuels (SITC 3), manufactures (SITC 5 to 9, less 68), and services (factor and nonfactor service receipts plus workers' remittances).	Global Development Network Growth Database

Using exports to the U.S. has the advantage of being available in product-level detail for a long time and spanning a vast majority of countries globally, thus allowing the study of export unit values at a practically helpful level of disaggregation. Moreover, since the U.S. accounts for a substantial share of world commerce, we can be confident in capturing a reasonable representation of each country's exports. Trade with the U.S. is assumed to be fairly representative of trade for a given country because the U.S. figures among the top ten trading partners for close to 80% of all countries listed in the WITS trade database of the World Bank. Appendix C presents top ten trade partners of all countries in the World Bank database in along with an analysis of the role of the U.S. It is therefore not surprising that there are several prominent precedents in the literature of using trade with the U.S. as representative of a country's overall trade, due to its high quality and detailed nature. See, for example, Schott (2004).

Table 2 presents the average percentage of products that have increased in real unit value (unit value deflated by the consumer price index) over the sample period. We categorized our findings based on income levels. For example, during 1972–1988, 29% of products that a high-income country exported in 1972 exhibited rising real unit values. As discussed in the introduction to this paper, changes in factor accumulation might improve the output quality and move production towards more capital/skill/technology-intensive products. Thus, Table 2 captures improvements in the quality of both existing and new exports.

Table 2. Change in real unit values by country categories.

Countries	Percentage with Increasing Unit Value	
	1972–1988	**1989–2001**
High	29	30
Middle	21	29
Low	18	26

Note: The income category is evaluated in the last year of the sample period: 1988 for subsample period 1972–1988 and 2001 for subsample period 1989–2001. Countries at and above the 80th percentile of per capita gross domestic product at constant prices are classified as high income, between the 20th and 80th percentile are classified as middle income and below the 20th percentile as low income.

Table 3 presents the trends in real unit values by SITC classification. During 1972–1988, among manufacturing products (SITC 5 through 8), which most closely reflect exporter capital, skill, and technology abundance (Schott 2004), the trend of rising real unit values is present, on average, among 25% of products. It is 31% among the rest of the products. During 1989–2001, they rise in 32% and 26% of the cases, respectively. Given differences across SITC products, we realize that the composition of exports will play a role in the relationship between factor accumulation and export quality as measured by its unit value. We incorporate this finding in our analysis in the next section by controlling for differences in export composition.

Table 3. Change in real unit values by SITC categories.

Products	Percentage with Increasing Unit Value	
	1972–1988	**1989–2001**
All	29	30
SITC 0	32	20
SITC 1	9	22
SITC 2	47	31
SITC 3	31	36
SITC 4	34	38
SITC 5	45	37
SITC 6	26	30
SITC 7	25	34
SITC 8	18	27
SITC 9	33	9

Both Tables 2 and 3 illustrate that unit values are not increasing for all products as one might expect. The extant literature provides some basis for why this might be the case: price competition might be eroding the gains from quality improvement in the unit value of exports. For example, in calculating pure price indices that abstract from the changing quality over time, Hallak and Schott (2011) found that a flat unit value might hide a rising quality and falling prices, e.g., in the case of south-east Asian economies in the early 2000s.

This raises the broader question of the difficulty of capturing changes in export quality over time when economic forces manifest themselves in changes in competition, cost of production, inflation, exchange rate fluctuations, etc. This paper attempts to control for these economic forces through our data and estimation strategies. For example, we use appropriate controls in the regressions, we deflate export prices, we conduct robustness checks that account for changing composition of trade, and changing values of the home currency. All this ensures that our results are reasonably robust to these factors.

4. Empirical Analysis

In this Section 4.1 presents the data, the variables used in the regression, and the estimation strategy. Sections 4.2 and 4.3 lay out the formal regression equations that were estimated.

4.1. Estimation

The data-set we used was a panel of countries over the time period 1972 to 2001. In turn, each country's data contained a panel of products exported to the U.S. We utilized the two-tiered structure of our panel data by analyzing the panel of countries and a separate analysis for each country with the panel of products it exports. The regression equations used in these two analyses are presented in Sections 4.2 and 4.3 below, specifically in Equations (4) and (5), respectively. In both analyses, we used a first differenced instrumental variables regression to study the relationship between factor accumulation and export quality.

We used the real unit value of exports as a measure of export quality and included interactions between product-SITC and year dummy variables to control market-specific trends. Hummels and Klenow (2005) contend that export unit value differences predominantly embody quality differences. Indeed, using unit values to measure export quality has considerable precedence (e.g., Aiginger 1998; Hallak 2006; Schott 2004). However, Hallak and Schott (2011) have pointed out potential problems with this approach due to differences in production cost and possible currency valuation problems. We address these issues with an additional estimation using the exporting country's domestic currency as units instead of the U.S. dollar. The unit values are deflated by the exporter country's wholesale price index[1] in this case.

The explanatory variables are exporter characteristics that capture factor accumulation: real capital per worker, education level of labor (to measure skill), and real per capita gross domestic product (to measure technology). We included interaction terms between factor accumulation and composition of exports to allow factor accumulation's relation to export quality to change based on the composition of exports. For example, Schott (2002, 2004) and Khandelwal (2010) show countries compete in export markets by upgrading export quality. Fabrizio et al. (2007) investigated changing export composition among eight central and eastern European countries in the decade leading up to their entry into the E.U. in 2004.

A discussion of causality is relevant for our regressions because extant literature (e.g., Verhoogen 2008; Baldwin and Gu 2003) provides a theoretical and empirical basis for the potential of upgrades in export quality (which is our dependent variable) leading to future spillovers to the rest of the economy. Therefore, factor accumulation, which is our independent variable, may be correlated with past export quality. For example, other sectors learn from exporters, leading to technology upgrades to the rest of the economy in the future. Here, we have a potential for reverse causality from our dependent variable to future values of our independent variables. At the same time, the current factor accumulation determines the current period's export quality. Our data could thus be reasonably assumed to be sequentially exogenous (Wooldridge 2010). It is useful to illustrate our assumption of sequential exogeneity in a simple panel data setting, where x_{it} are the independent variables, y_{it} is the dependent variable, u_{it} is the error term, and c_i is the unobserved panel effect (in our case, the country effect and product effect for the panel of countries and the product effect for the panel of products):

$$y_{it} = x_{it}\beta + c_i + u_{it} \quad (1)$$

where $t = 1,2,\ldots T$ and $i = 1,2,\ldots,n$

$$E(u_{it}|x_{it}, x_{it-1}, x_{it-2}, \ldots) = 0 \tag{2}$$

When (2) holds, we say, x_{it} are sequentially exogenous conditional on the unobserved effect c_i. Given the model in (1), we write assumption (2) as:

$$\begin{aligned} &E(y_{it}|x_{it}, x_{it-1}, \ldots, x_{i1}, c_i) \\ &= E(y_{it}|x_{it}, c_i) = x_{it}\beta + c_i \end{aligned} \tag{3}$$

From (3) we see that sequential exogeneity implies that after we control for x_{it} and c_i, no past values of x_{it} affect the expected value of y_{it}. This assumption allows for the practical possibility that future values of x_{it} (factor accumulation variables) are correlated with the current y_{it} (export quality) due to spillover from upgrades from the export sector to the rest of the economy. Sequential exogeneity leads to inconsistent estimation of (1), thus we used differencing combined with an instrumental variable approach for consistent estimation (Wooldridge 2010). Equation (2) implies that lagged values of the independent variables are valid instruments for contemporaneous independent variables. We used two lags of independent variables as instruments.

4.2. Data

Export data are taken from the Bureau of Census of the U.S. and are compiled by Feenstra et al. (1997) and updated in Feenstra et al. (2005). The data cover the period 1972–2001. In 1972–1988, U.S. imports are measured according to the Tariff Schedule of the United States Annotated (TSUSA) classification. Between 1989 and 2001, imports are measured by the Harmonized System of Commodity Classification (HTS 10-digit product data). Thus our analysis is separate for the two subsample periods: 1972–1988 and 1989–2001.

The data provide the quantity (for example, meters of cloth, tons of steel, or the number of shirts) and the dollar value of the United States trade with partner countries for each of the thousands of TSUSA and HTS classified products. Using the quantity and value associated with a product's trade, we calculated each product's unit value and used it to measure quality.

We used three measures for a country's factor accumulation (similar to extant literature, e.g., Balassa 1979; Romalis 2004; Schott 2004). Capital abundance was measured by real capital per worker taken from the Penn World Tables (Mark 5.6), compiled by Summers (1995). Skill was measured as the population share attaining secondary or higher education, and the level of technology was measured using real per capita gross domestic product. Both the skill and technology measures were from the World Development Indicators of the World Bank. Table 1 details the definitions and sources of the data.

4.3. Panel of Countries: Empirical Analysis and Data

We estimated the relationship between factor accumulation and export quality using the panel of countries. One of the benefits of this estimation is that we can control for unobserved factors that vary over time across product markets, for example, trends in consumption that might make the demand for a product change. The sample comprised a maximum of 122 and 152 trading partners of the U.S., respectively, during 1972–1988 and 1989–2001. The data were annual, and we estimated separately for the two time periods since the product classifications are TSUSA in 1972–1988 and H.S. 10 in 1989–2001. The countries included in the regression depended upon data availability of factor accumulations, and we list them in Appendix A.

We estimated the following first differenced regression, using pooled two-stage least squares and two lags of factor accumulation as instruments. The estimated equation is:

$$\begin{aligned}\Delta\ln(u_{cmt}) = \chi_t + \beta_1\Delta\ln(Z_{ct}) + \beta_2[\Delta\ln(Z_{ct}) * \textbf{Low inc}] + \beta_3[\Delta\ln(Z_{ct}) * \textbf{High inc}] + \\ \beta_4[\Delta\ln(Z_{ct}) * \textbf{Manf. exp}] + \beta_5[\Delta\ln(Z_{ct}) * \textbf{Serv exp}] + \beta_6[\Delta\ln(Z_{ct}) * \textbf{Fuel exp}] + \\ \beta_7\textbf{Low inc} + \beta_8\textbf{High inc} + \beta_9\textbf{Manf. exp} + \beta_{10}\textbf{Serv exp} + \beta_{11}\textbf{Fuel exp} + \Delta\varepsilon_{cmt}\end{aligned} \quad (4)$$

where $\boldsymbol{\Delta}$ is the first difference, **ln** is the natural log following the literature (e.g., Balassa 1979; Schott 2004; the coefficients thus are interpreted as elasticities), $\boldsymbol{u_{cpt}}$ is the real unit value of export of product m, for country c, in year t, $\boldsymbol{Z_{ct}}$ stands for the particular measure of country c's factor accumulation in period t for which we use the following, one at a time to avoid multicollinearity issues: real capital per worker, education level of labor (to measure skill), and real per capita gross domestic product (to measure technology), Low inc stands for low income, and $\boldsymbol{\varepsilon_{cpt}}$ is the corresponding error term. $\boldsymbol{Z_{ct}}$ is interacted with dummies for low- and high-income countries (Low inc and High inc, respectively) and predominant exporters of manufacturing, services, or fuel (Manf. exp, Serv exp and Fuel exp, respectively). These interactions formally test the hypothesis we presented in Section 4.1, namely, that the impact of changing factor accumulation might be differentiated by export composition. In estimating Equation (4), we included time and product category (SITC) dummies. Finally, to control for unobserved factors that vary over time across product markets, we included interactions of time and product-SITC dummies. $\boldsymbol{\Delta \ln Z_{ct}}$ is sequentially exogenous, leading to inconsistent estimates, so we use $\boldsymbol{\ln Z_{ct-1}}$ and $\boldsymbol{\ln Z_{ct-2}}$ as instruments to ensure consistency.

The panel estimation yields two vectors of $\boldsymbol{\beta}$ coefficients—one each for 1972–1988 and 1989–2001, respectively. We discuss the results in Section 5. Standard errors are adjusted for serial correlations and heteroscedasticity. Following each panel estimation, the test of overidentifying restrictions was used to test the validity of our assumption of sequential exogeneity. Sequential exogeneity is supported, as we fail to reject the null that the errors are uncorrelated with our instruments.

Measurement error problems might arise in the form of errors in measuring the unit values of U.S. imports (dependent variable) and errors in measurement of country characteristics (independent variables). We considered measurement error in the dependent variable first. Since U.S. authorities collect data on U.S. imports, we can reasonably assume that our dependent variable's measurement error is independent of the country that exports the product to the U.S. Therefore, the estimation is consistent even if such measurement error was present. Measurement error in the independent variables implies that country characteristics are measured with an error. It is likely that country characteristics were measured with greater accuracy in richer, more developed countries. Thus the measurement error is correlated with the true independent variables; the more advanced the country, the lower the measurement error, and uncorrelated with the observed independent variable. Accordingly, the classical-errors-in-variables model does not apply to our estimation, and therefore our estimation will produce consistent results (Wooldridge 2010).

4.4. Panel of Products: Empirical Analysis and Data

The sample comprised 122 and 152 exporting countries in 1972–1988 and 1989–2001, respectively. The estimation was then undertaken for each country separately, utilizing the panel of products over time that each country exports to the U.S.

The estimated equation for each country c is:

$$\boldsymbol{\Delta}\textbf{ln}(u_{mt}) = \beta\boldsymbol{\Delta}\textbf{ln}(Z_t) + \boldsymbol{\Delta}\varepsilon_{mt} \quad (5)$$

where $\boldsymbol{\Delta}$ stands for taking the first difference, **ln** is the natural log, $\boldsymbol{u_{mt}}$ is the real unit value of export of product m, for country c, in year t, $\boldsymbol{Z_t}$ stands for measures of country c's factor accumulation in period t for which we use: real capital per worker, education level of labor (to measure skill), and real per capita gross domestic product (to measure technology), and $\boldsymbol{\varepsilon_{mt}}$ is the corresponding error term. In estimating Equation (5), we included product category (SITC) dummies. Additionally, to control for unobserved factors that vary over time across product markets, we included interactions of time and product-SITC dummies.

Similar to our previous estimation strategy, the regression in (5) was estimated for a given country's panel of products by pooled two-stage least squares using two lags of the independent variables as instruments. Specifically, $\Delta \ln Z_t$ is sequentially exogenous, leading to inconsistent estimates, so we use $\ln Z_{t-1}$ and $\ln Z_{t-2}$ as instruments to ensure consistency. This estimation yielded 122 and 152 coefficients for 1972–1988 and 1989–2001, respectively. Standard errors were adjusted for serial correlation and heteroskedasticity.

We presented our data and estimation strategy in this section. We will interpret our results in the next section.

5. Results

5.1. Panel of Countries

The results of estimating the regression in Equation (4) are in Tables 4–8. Tables 4–6 present the results for 1972–1988, and Tables 7 and 8 present the results for 1989–2001. Table 4 presents the results of 1972–1988 of the panel of countries when skill and its interaction with country income and export composition are the independent variables. Rising skill level is associated negatively with real export unit value growth; the elasticity is −0.51. Thus a two standard deviations increase in skill level is associated with a 32% decrease in unit values. This is fairly significant from a practical standpoint. However, there are two exceptions—low-income countries with an elasticity of 0.23, and service exporting countries with elasticity 0.58—where improvement in skill has a positive impact. Simply being a high-income country positively impacts, while at the average level of skill accumulation, being a service exporter has a negative effect, albeit these are not economically significant at elasticities of 0.02 and −0.01, respectively.

Table 4. Panel regression of countries, estimating Equation (4). Dependent variable: first difference of log real unit value of exports. Measure of factor accumulation: skill (log population share attaining secondary or higher education). Years: 1972–1988.

	Dependent Variable: Δ Log Real Unit Value of Exports
Δ Log skill level	−0.51 (−1.85) *
Δ [Log skill level × low income dummy]	0.74 (2.22) **
Δ [Log skill level × high income dummy]	0.30 (0.81)
Δ [Log skill level × manufacturing exporter]	−0.15 (−0.51)
Δ [Log skill level × services exporter]	1.09 (2.74) ***
Δ [Log skill level × fuel exporter]	−0.82 (−1.11)
Low income dummy	−0.01 (−0.97)
High income dummy	0.02 (3.04) ***
Manufacturing exporter dummy	0.004 (0.68)

Table 4. *Cont.*

	Dependent Variable: Δ Log Real Unit Value of Exports
Services exporter dummy	−0.03 (−2.84) ***
Fuel exporter dummy	0.002 (0.06)
Observations	527,441
R-squared[2]	0.02
F-stat of joint significance of instruments	9906.92
Prob. > F	0.00

Notes: 1. *t*-Statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are corrected for heteroskedasticity and serial correlation; 2. regression includes year and interaction of product-SITC and year dummies; 3. list of countries in the sample is in Appendix A. 4. First stage regressions in Appendix F.

Table 5. Panel regression of countries, estimating Equation (4). Dependent variable: first difference of log real unit value of exports. Measure of factor accumulation: capital (log capital per worker). Years: 1972–1988.

	Dependent Variable: Δ Log Real Unit Value of Exports
Δ [Log capital per worker]	0.42 (2.75) ***
Δ [Log capital per worker × low income dummy]	−0.53 (−1.99) **
Δ [Log capital per worker × high income dummy]	−0.20 (−1.16)
Δ [Log capital per worker × manufacturing exporter]	−0.21 (−1.13)
Δ [Log capital per worker × services exporter]	−0.04 (−0.13)
Δ [Log capital per worker × fuel exporter]	0.91 (1.45)
Low income dummy	0.02 (2.49) **
High income dummy	0.03 (3.72) ***
Manufacturing exporter dummy	0.01 (1.41)
Services exporter dummy	0.01 (0.56)
Fuel exporter dummy	−0.03 (−1.33)
Observations	786,584
R-squared	0.02
F-stat of joint significance of instruments	310,000
Prob. > F	0.00

Notes: 1. *t*-Statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are corrected for heteroskedasticity and serial correlation; 2. regression includes year, and interaction of product-SITC and year dummies; 3. list of countries in the sample is in Appendix A. 4. First stage regression in Appendix F.

Table 5 presents the results of 1972–1988 of the panel of countries when the independent variable is capital and its interaction with income and export composition. Overall capital growth was positively correlated with growth in real export unit values with an elasticity of 0.42, which translates to an approximately 50% rise in unit values with a two standard deviation change in capital stock per worker from its mean. However, rising capital was associated negatively with real unit value growth for low-income countries with an elasticity of −0.11. At the average capital accumulation, being a low- or high-income country adds positively to the growth of unit values. Here, too, the elasticities were too small in magnitude to be of practical significance at 0.01 and 0.03, respectively.

Table 6 presents the results of 1972–1988 when the independent variable is technology, and its interaction with income level and export composition. Technology improvement was positively correlated with real unit value with an elasticity of 0.9, which implies a rise in unit values of 120% with a two standard deviation change in technological improvement from its mean. Interestingly, this relationship was even stronger in high-income countries where the elasticity was 1.6, while it is smaller in magnitude in low-income countries where the elasticity was 0.07. In contrast, service exporter countries saw a negative correlation with technological improvement where the elasticity was −0.32. Being a low-income country or a service exporter adds positively to the growth of unit values. However, the elasticity was not economically significant at only 0.01 for both.

Table 6. Panel regression of countries, estimating Equation (4). Dependent variable: first difference of log real unit value of exports. Measure of factor accumulation: technology (log per capita gross domestic product (PCGDP)). Years: 1972–1988.

	Dependent Variable: Δ Log Real Unit Value of Exports
Δ [Log PGDP]	0.90 (5.39) ***
Δ [Log PCGDP × low income dummy]	−0.83 (−4.34) ***
Δ [Log PCGDP × high income dummy]	0.70 (3.78) ***
Δ [Log PCGDP × manufacturing exporter]	−0.27 (−1.59)
Δ [Log PCGDP × services exporter	−1.22 (−4.65) ***
Δ [Log PCGDP × fuel exporter]	−0.84 (−1.11)
Low income dummy	0.02 (2.59) ***
High income dummy	0.01 (1.26)
Manufacturing exporter dummy	0.01 (0.91)
Services exporter dummy	0.03 (3.41) ***
Fuel exporter dummy	−0.02 (−0.82)
Observations	899,688
R-squared	0.02
F-stat of joint significance of instruments	46,654.39
Prob. > F	0.00

Notes: 1. *t*-Statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are corrected for heteroskedasticity and serial correlation; 2. regression includes year, and interaction of product-SITC and year dummies; 3. list of countries in the sample is in Appendix A. 3. First stage regression is in Appendix F.

Tables 7 and 8 present the results for 1989–2001. Table 7 shows results of 1989–2001 when the independent variable is skill, and its interaction with income and export composition of countries. None of the variables had any significant impact here. Table 8 presents the results of 1989–2001 when the independent variables are technology, and its interactions with countries' income and export composition. Technology seemed to have a negative relation with the growth of unit value as the elasticity was −0.25, which represents a fall in unit value of 37% for a change in technology of two standard deviations from its mean. For manufacturing exporters, improving technology was associated with a smaller negative impact with an elasticity of −0.14. The impact for fuel exporters was the largest in magnitude and positive with an elasticity of 0.29. Being a high- or low-income country has a slight negative impact on real unit value growth.

In summary, in the sample period 1972–1988: skill growth decelerated growth of real export unit values. Low income and service exporters were exceptions here, as skill growth led to accelerated growth of unit values in such countries. Capital growth accelerated growth of real export unit values except in low-income countries where it was associated with deceleration. Technology growth accelerated the growth of real export unit values, most especially in high-income countries. There was much less acceleration in low-income countries, while there was a deceleration in service exporters.

In summary, in the sample period 1989–2001: technology growth was associated negatively with unit value deceleration, although much less so in manufacturing exporters, and accelerated it in fuel exporters. Skill no longer had any significant impact.

Table 7. Panel regression of countries, estimating Equation (4). Dependent variable: first difference of log real unit value of exports. Measure of factor accumulation: skill (log population share attaining secondary or higher education). Years: 1989–2001.

	Dependent Variable: Δ Log Real Unit Value of Exports
Δ [Log skill level]	−0.17 (−0.70)
Δ [Log skill level × low income dummy]	−0.42 (−1.37)
Δ [Log skill level × high income dummy]	−0.20 (−0.74)
Δ [Log skill level × manufacturing exporter]	−0.23 (1.00)
Δ [Log skill level × services exporter]	−0.44 (−1.49)
Δ [Log skill level × fuel exporter]	0.50 (0.56)
Low income dummy	0.01 (0.44)
High income dummy	0.01 (0.52)
Manufacturing exporter dummy	0.01 (0.95)
Services exporter dummy	0.004 (0.32)
Fuel exporter dummy	−0.02 (−0.50)
Observations	647,161
R-squared	0.01
F-stat of joint significance of instruments	24,975.01
Prob. > F	0.00

Notes: 1. *t*-Statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are corrected for heteroskedasticity and serial correlation; 2. regression includes year, and interaction of product-SITC and year dummies; 3. List of countries in the sample is in Appendix A. 4. First stage regressions are presented in Appendix F.

Table 8. Panel regression of countries, estimating Equation (4). Dependent variable: first difference of log real unit value of exports. Measure of factor accumulation: technology (log per capita gross domestic product (PCGDP)). Years: 1989–2001.

	Dependent Variable: Δ Log Real Unit Value of Exports
Δ Log PCGDP	−0.25 (−3.07) ***
Δ [Log PCGDP × low income dummy]	0.05 (0.82)
Δ [Log PCGDP × high income dummy]	−0.08 (−1.29)
Δ [Log PCGDP × manufacturing exporter]	0.11 (2.10) **
Δ [Log PCGDP × services exporter]	0.11 (1.25)
Δ [Log PCGDP × fuel exporter]	0.54 (2.37) **
Low income dummy	−0.02 (−4.65) ***
High income dummy	−0.02 (−4.68) ***
Manufacturing exporter dummy	0.004 (1.16)
Services exporter dummy	0.01 (0.89)
Fuel exporter dummy	−0.02 (−1.23)
Observations	1,589,264
R-squared	0.01
F-stat of joint significance of instruments	22,057.92
Prob. > F	0.00

Notes: 1. *t*-Statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors are corrected for heteroskedasticity and serial correlation; 2. regression includes year, and interaction of product-SITC and year dummies; 3. list of countries in the sample is in Appendix A. 4. The first stage regression is in Appendix F.

Over time it appears that skill accumulation has receded in importance as a significant differentiator. While in the earlier time period, at least low income countries saw gains in unit value from skill improvement. This is no longer significant in the latter time period. One reason could be the spread of education across all countries. For example, Global South countries in general and particularly countries in Sub-Saharan Africa and the Middle East/North Africa have shown robust progress in education skills in the latter time period (Barro and Lee 2001). Higher education levels the playing field and reduces the differences based on skill although it can have profound effects on competition based on technology (Grossman and Helpman 1991b), which we discuss next.

We saw that technological improvement was associated with growing real export unit values in the earlier period while this trend was reversed in the later period. Our results also indicate that manufacturing exporters' real unit values decelerated much less. It appears that being a manufacturing exporter leads to benefits from technological advancement. One explanation could be that manufacturing has shifted from the high income countries, and middle- and low-income countries are benefitting from the transfer of technology in manufacturing. This supplanting of lower income countries in areas of higher income production was predicted by Balassa (1979). It is also supported by the findings of Khandelwal (2010) that higher income countries are competed off the value ladders in products where these ladders might be short. Finally, it is in line with evidence of innovations being copied across borders in Schott (2002). Certainly the skill gains from education could have helped in this technology transfer, as highlighted in Barro and Lee (2001).

Thus, our findings provide potential support for the product cycle theory where lower income countries catch up with higher income countries through technology transfer. This catch-up can be alarming as it cascades into large leap-frogging by lower income countries. Interestingly, much of the discord in international relations comes from Global North countries resisting sharing their technology. Our results provide some clues to the underlying mechanism for this emerging discord.

5.2. Panel of Products

The results of estimating Equation (5) are in Tables 9–12. Each table's cell gives the proportion of countries with a significant regression coefficient on the factor accumulation variable. For example, in the first cell, six out of 23—approximately 25%—of high-income countries, in 1989–2001, have a significant positive coefficient on skill-accumulation. In this case, our measure of export quality is the dollar unit value deflated by the United States consumer price index in Table 9. The rest of the table covers the entire range of income levels, factor accumulation measures, time periods.

Table 9. Results summary *—panel regression of products, estimating Equation (5) with an unrestricted sample of products.[3]

Dependent Variable: Real Unit Value of Exports ($ Deflated by CPI)							
Year	Independent Variable	Positive Significant/Total			Negative Significant/Total		
		High Inc.	Low Inc.	Middle Inc.	High Inc.	Low Inc.	Middle Inc.
1989–2001	Skill	6/23	5/29	10/39	8/23	12/29	12/39
	PCGDP	10/30	14/65	23/57	12/30	20/65	19/57
1972–1988	Skill	6/22	11/37	12/38	8/22	15/37	10/38
	Capital	15/18	13/19	18/21	2/18	1/19	1/21
	PCGDP	8/25	13/48	18/49	9/25	19/48	17/49

* detailed regression results are presented in Appendix B.

Table 10. Results summary—panel regression of products, estimating Equation (5) with an unrestricted sample of products.

Dependent Variable: Real Unit Value of Exports (Home Currency Deflated by WPI)							
Year	Independent Variable	Positive Significant/Total			Negative Significant/Total		
		High Inc.	Low Inc.	Middle Inc.	High Inc.	Low Inc.	Middle Inc.
1989–2001	Skill	7/21	2/8	5/22	4/21	4/8	6/22
	Technology	12/25	6/11	20/37	5/25	2/11	9/37
1972–1988	Skill	7/18	3/10	7/19	5/18	4/10	6/19
	Technology	14/17	3/11	13/22	0/17	3/11	7/22

Table 11. Results summary—panel regression of products, estimating Equation (5) with sample restricted to products that were traded in the first year of the sample.

Dependent Variable: Real Unit Value of Exports ($ Deflated by CPI)							
Year	Independent Variable	Positive Significant/Total			Negative Significant/Total		
		High Inc.	Low Inc.	Middle Inc.	High Inc.	Low Inc.	Middle Inc.
1989–2001	Skill	7/23	5/25	15/36	9/23	8/25	12/36
	Technology	7/29	8/51	15/57	8/29	12/51	16/57
1972–1988	Skill	8/22	8/34	10/35	7/22	8/34	10/35
	Capital	8/17	2/19	1/22	7/17	10/19	13/22
	Technology	7/22	6/41	15/52	6/22	13/41	16/52

Table 12. Results summary—panel regression of products, estimating Equation (5) with products restricted to those that belong to SITC 5–8 only.

Dependent Variable: Real Unit Value of Exports ($ Deflated by CPI)							
Year	**Independent Variable**	**Positive Significant/Total**			**Negative Significant/Total**		
		High Inc.	**Low Inc.**	**Middle Inc.**	**High Inc.**	**Low Inc.**	**Middle Inc.**
1989–2001	Skill	6/25	6/23	9/34	7/25	6/23	12/34
	Technology	8/30	13/61	20/55	9/30	16/61	13/55
1972–1988	Skill	6/22	8/34	12/38	7/22	14/34	10/38
	Capital	15/19	13/20	15/19	1/19	1/20	1/19
	Technology	7/27	7/47	34/44	12/27	12/47	14/44

Table 10 presents the regression results when the home currencies value exports. Tables 11 and 12 present two robustness checks of the estimation of Equation (5). Table 11 estimates Equation (5) while restricting the products for each year to only those exported by the country in the first year of the sample. We aimed to abstract from the changing composition of trade due to entry into new markets or the invention of new products, and focused exclusively on the evolution of export quality within each existing product market. Table 12 contains the results of estimating Equation (5) while we restrict the exported product sample to SITC categories 5–8 only. These products are manufacturing exports, and hence they are most likely to be influenced by capital, skill, and technology accumulation of the exporter country (Schott 2004).

That unit values did not necessarily rise with improving factor abundance might be explained by innovation, falling prices, and technology-driven cost saving. We would see less positive relationships as unit values would not necessarily keep pace with factor accumulation. Hallak and Schott (2011) found that a flat or declining unit value might hide rising quality and falling prices, thus appearing to show that price competition might be eroding the gains from quality improvement in the unit value of exports. Therefore, we focused on the positive coefficients as a more precise measure of quality improvements over time.

We used graphs 1 through 5 to bring out the variations in results based on the different income levels. The statistical significance[4] of the difference is below each chart. Figures 1 and 2 show the percentage of countries with a positive significant coefficient on skill accumulation. Similarly, Figures 3 and 4 plot the share of countries with a positive significant coefficient on technology accumulation. Figure 5 presents the capital accumulation results. The results are grouped based on the sample of products: all, manufacturing only, or those exported in the first year.

Comparing Figures 1 and 2 we see that the proportion of countries with positive significant coefficients has fallen over time and, in most cases, statistically significantly for skill accumulation. Interestingly, the one exception is middle income countries where the proportion has risen significantly when we consider products continuously exported throughout the entire sample period. The average magnitude of the positive significant coefficient (for detailed regression results, see Appendix B) has fallen to less than half in the 1989–2001 time period. The coefficient was 2.5 in 1989–2001 compared to 6 in 1972–1988. Since both skill levels and export unit values are log changes, the coefficient is an elasticity. So a 1% change in skill level will lead to a 6% increase in real unit value of exports in the earlier period and 2.5% in the latter period.

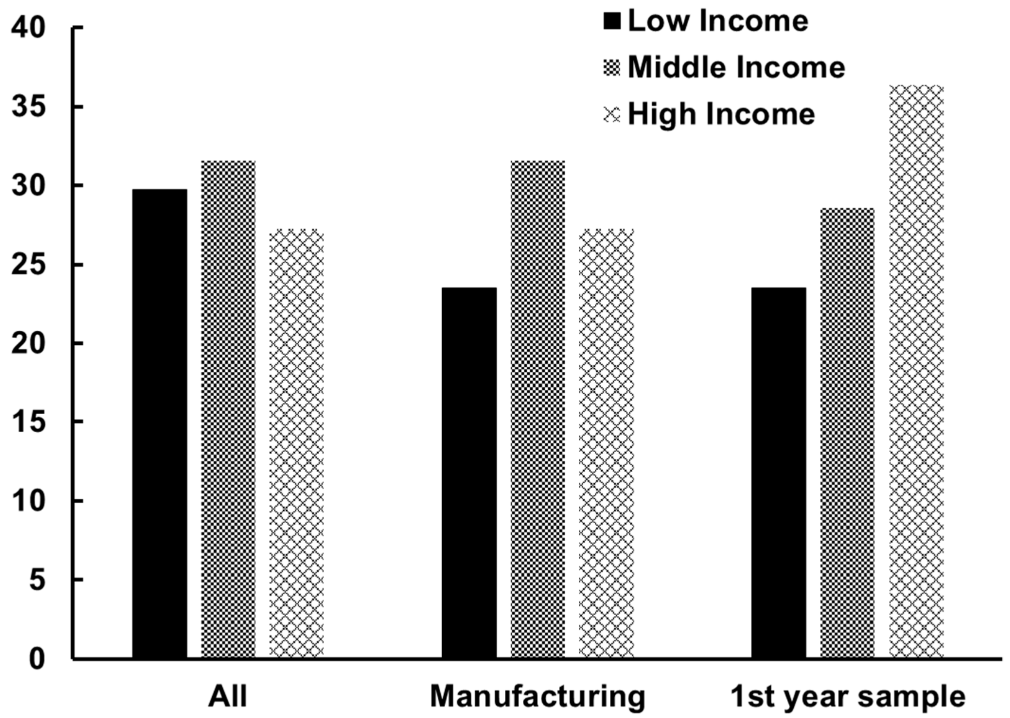

Figure 1. Panel regression of products, estimating Equation (5). Percentage of countries with positive significant coefficient on skill-level: 1972–1988. The difference between income levels' results, are statistically significant in all three categories of All, Manufacturing, and 1st year sample.

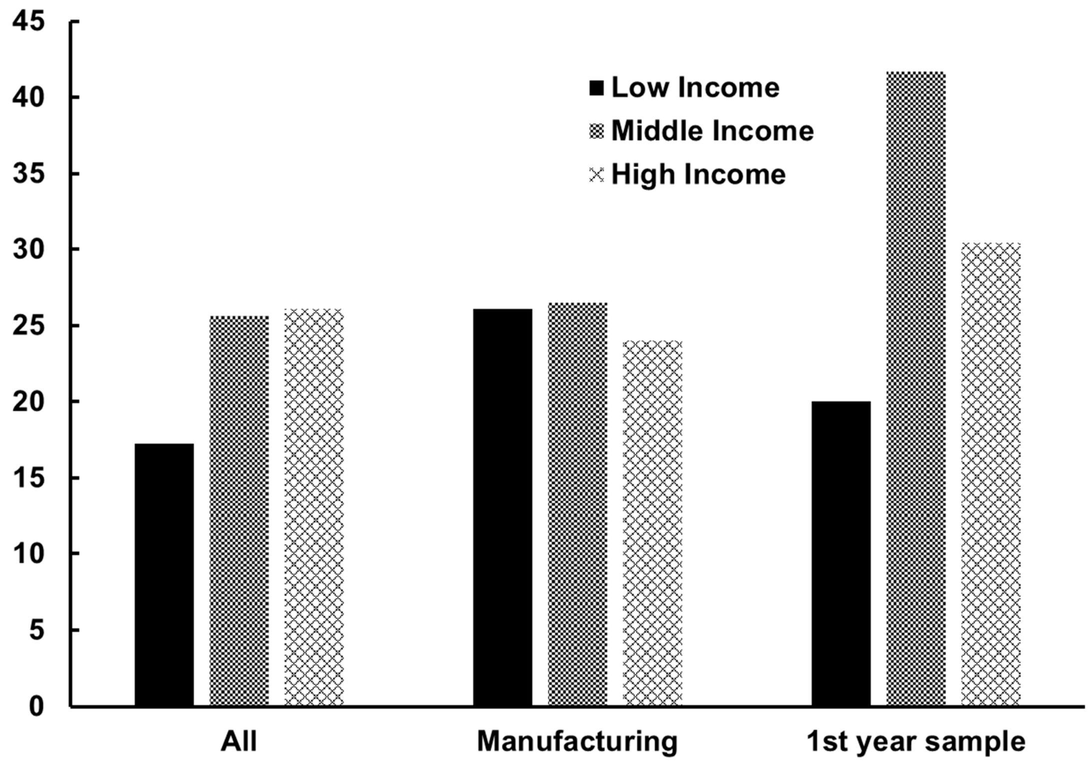

Figure 2. Panel regression of products, estimating Equation (5). Percentage of countries with positive significant coefficient on skill-level: 1989–2001. The differences between middle- and high-income countries in the All and Manufacturing categories are not statistically significant. All other differences are statistically significant in all categories.

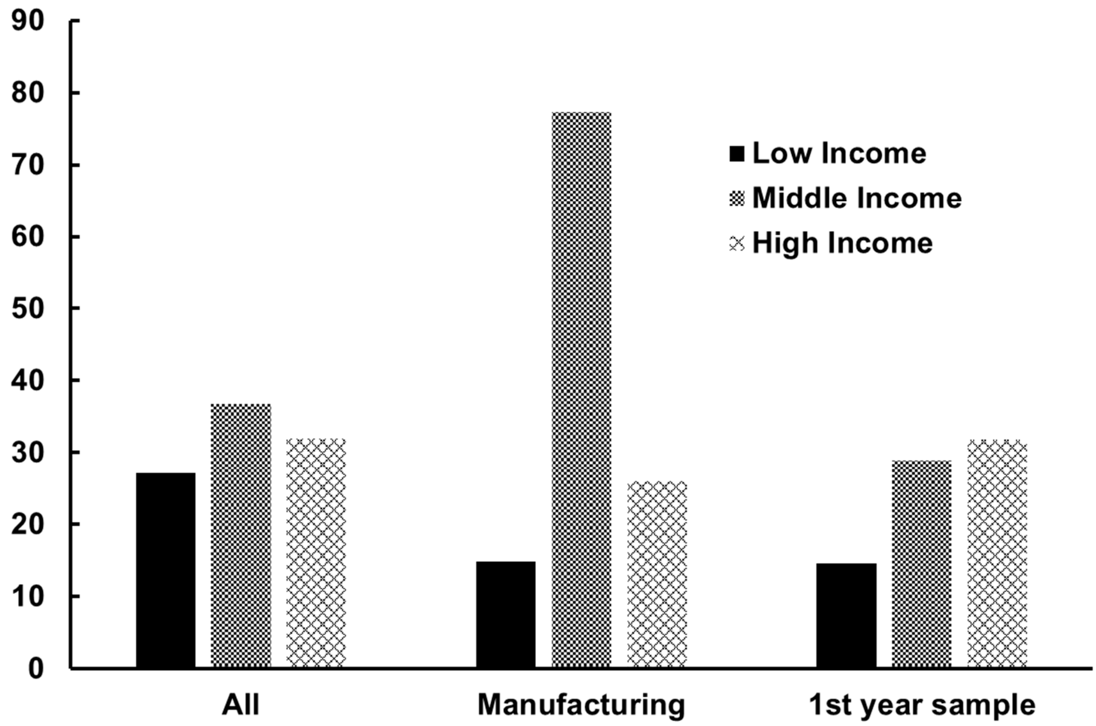

Figure 3. Panel regression of products, estimating Equation (5). Percentage of countries with positive significant coefficient on technology: 1972–1988. The differences between income levels' results are statistically significant in all three categories of All, Manufacturing, and 1st year sample.

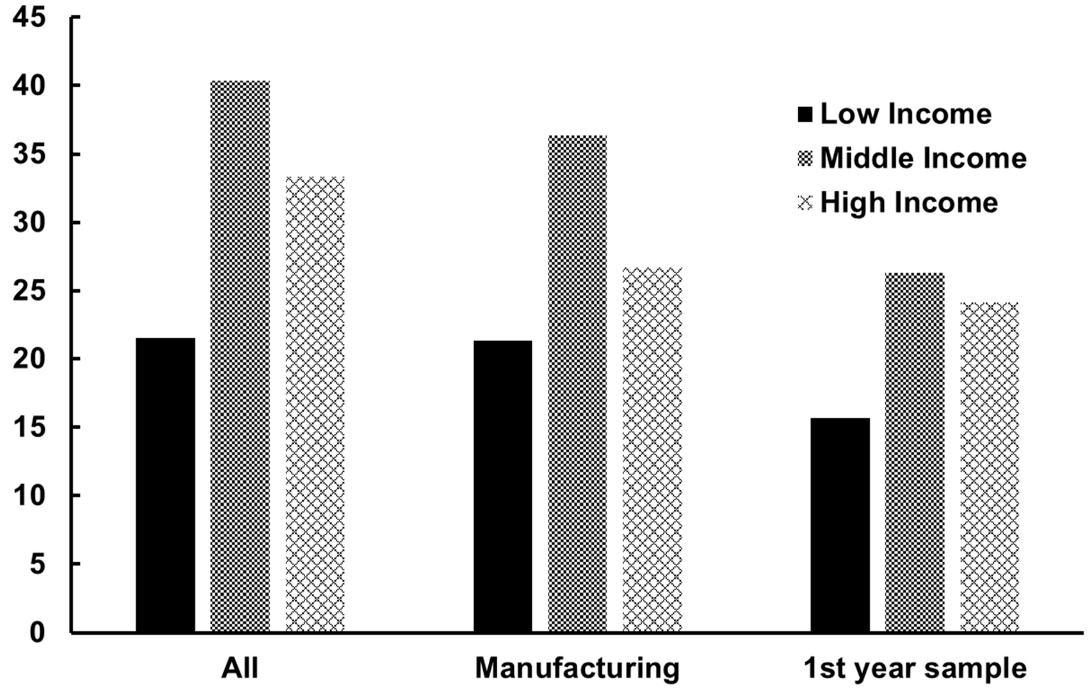

Figure 4. Panel regression of products, estimating Equation (5). Percentage of countries with positive significant coefficient on technology: 1989–2001. The difference between income levels' results are statistically significant in all three categories of All, Manufacturing, and 1st year sample.

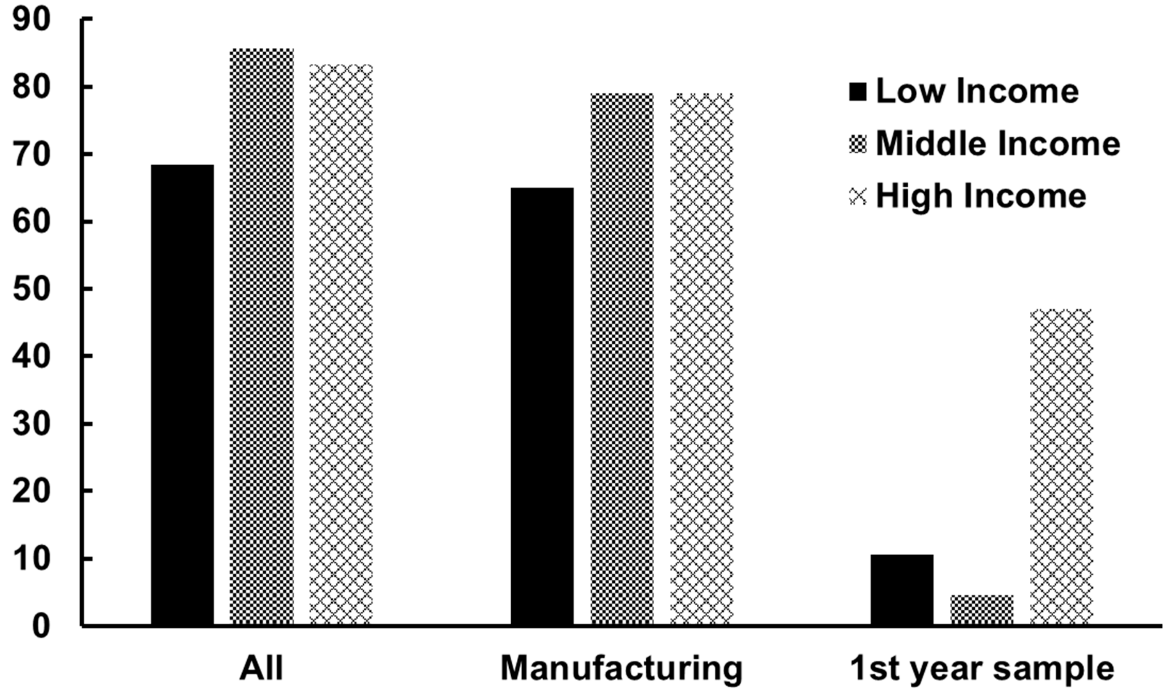

Figure 5. Panel regression of products, estimating Equation (5). Percentage of countries with positive significant coefficients on capital: 1972–88. The differences between middle- and high-income countries in the All and Manufacturing categories, which are not statistically significant. All other differences are statistically significant in all categories.

By contrast, in Figures 3 and 4 we see that the proportion of countries with a positive coefficient for technology has remained steady, and the average significant positive coefficient—around 3.5 in both time periods—is also steady. There is a notable exception to this steadiness across time periods, and that is in the case of manufacturing products. Within manufacturing there is a significant and large shift where low-income countries rise and middle-income countries fall in the proportion of positive coefficients.

Figure 5 shows the proportion of countries with positive significant coefficients on capital accumulation. The proportions are the highest here compared to all graphs presented so far. Additionally, we find that the average magnitude of the positive significant coefficients on capital accumulation is the largest at 7. It is important to note that low-income countries have the lowest proportion of positive coefficients and there is no statistically significant difference among high- and middle-income countries in the proportion of positive coefficients. However, when products are limited to only those exported in the first year capital accumulation accelerates the growth of export quality (unit values) in the largest proportion of countries with high income. Among low- and middle-income countries, the proportion is statistically significantly smaller. There appears to be a core group of products which were exported throughout the sample period, where a large proportion of high-income countries have continued to enjoy rising unit values related to capital accumulation. On the other hand, middle- and low-income countries do not exhibit this feature. This finding is an interesting clue indicating that the nature of variety of goods exported by high-income versus other countries at the start of the sample period might be giving high-income countries a certain first mover advantage. It also provides an interesting question for future research that uses firm level data to disentangle the export baskets in these countries in the manner of Bernard et al. (2006).

Among other general patterns evident from the graphs is that middle-income countries have the highest proportion of positive coefficients. The graphs show where the differences among countries are statistically significant.

Product cycle theory offers some explanation for why middle-income countries might be expected to lead in the proportion of positive coefficients. On average, middle-income countries are in the middle of the unit value spectrum (Schott 2004) and have room to climb up the value ladder in their export products. Therefore, skill accumulation might manifest itself most clearly in increasing unit values of already exported products among middle-income countries. High-income countries are at the top of many of these ladders. When faced with competition, they might choose to abandon some of them (Schott 2002) and invest instead in developing new goods based on innovative technology. Low-income countries might also start exporting new products (new to them) in the natural process of growth, development, and technology diffusion from abroad (Grossman and Helpman 1991a). Mukerji (2013) demonstrated the relatively more substantial growth of exports along the extensive margin in Global South countries than Global North countries. Therefore, for low- and high-income countries, increasing skill abundance might also manifest itself through the beginning of new product exports, rather than only climbing up the value ladder in existing exports.

6. Conclusions

6.1. Discussion

Among the results with respect to skill accumulation, both the results in country panel and product panel by individual countries seem to indicate diminishing importance as a source of trade competitiveness in the form of being able to command higher unit values in exports. In the earlier sample period, low-income countries were reaping the benefit of higher skills-related growth in unit values; however, over time, even this was eroded away. One potential explanation we have offered is that growing education levels in Global South countries in the latter time period have led to a more level playing field among countries in this regard and removed the edge in trade competitiveness that can be gained from skill improvement. We have also related worldwide skill accumulation to growing capacity for technology absorption by lower income countries, potentially shifting the focus of trade competition to the frontier of technology.

In the country panel regressions results (Section 5.1), capital accumulation has been associated with positive unit value of export growth, except in the case of low income countries. This country panel result is supported by the product panel results (Section 5.2) as the proportion of countries with positive coefficients with respect to capital accumulation is the lowest among low-income countries. The final piece of evidence that helps to tie these results together is that among products exported throughout the time sample by countries, high-income countries have the highest proportion of positive coefficients and other countries have remarkably low proportions. One explanation could be differences in the variety of goods that high-income countries sold at the start of the sample period compared to other countries. Firm level analysis could delve into this rich source of variation among countries in future studies.

Both country and product panels (in Sections 5.1 and 5.2, respectively) indicate an overall positive impact of technology on unit values. However, there is a change in the latter time period in both types of analysis, which seems to indicate a notable aspect of the relationship of manufacturing to capital accumulation. In the country regression results, when the association with capital accumulation becomes negative, manufacturing is less negative than the general trend. In the product regressions, manufacturing sees the biggest shift between the two periods as low-income countries gain and middle-income countries lose in the proportion of positive coefficients. As mentioned in Section 5.1, the outcome of these shifts in manufacturing could be the potential reason behind the discord in multilateral international trade.

Our findings thus provide a potentially interesting explanation of the latest round of disputes centered around Global North countries' reluctance to share technology. Examples are the disputes between China and the U.S. (Alper et al. 2019) and between Japan and South Korea (Jin and Takenaka 2019).

6.2. Overall Conclusions

This paper adds to the literature by utilizing product-level trade data to estimate the relation between export quality and factor accumulation. It accounts for the hitherto neglected endogeneity between these two variables. Adding to the extant literature dominated by cross-sectional studies, we ask whether factor accumulation is accompanied by improving export quality over time. The aim was to understand how countries at various stages of development compete in international markets over the long term. We found that, unlike cross-sectional studies, a positive association between export quality and factor accumulation is not a consistent pattern in panel data. The findings can be partly explained with the aid of the product cycle theory and price and technology-based competition. Moreover, the accelerated growth in high-level education across the world might play a role.

Our estimation based on considering the panel of products exported by each country separately indicates a steady and important role of technology in determining unit value of exports, and therefore trade competitiveness. Our estimation based on the panel of countries where all their exports are pooled together gives a more nuanced picture of how technology has benefited certain types of producers in trade more than others.

This paper attempts to contribute towards a more nuanced guide for policymakers by relating trade competitiveness to export characteristics. Understanding factor accumulation's impact on a country's trade and its competitors' trade clarifies what a country can expect in international markets—thus providing a guide for trade policy based on economic fundamentals and not just political considerations.

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Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: This data is publicly available. All data sources and links to the data are provided in Table 1.

Conflicts of Interest: The author declares no conflict of interest.

Appendix A

Table A1. Countries included in regression presented in Table 4.

Algeria
Argentina
Australia
Austria
Belize
Belgium
Benin
Bangladesh
Brazil
Burkina Faso
Burundi
Cameroon
Canada
Chile
China
Colombia
Congo
Costa Rica
Central African Republic
Denmark
Dominican Republic

Table A1. *Cont.*

Ecuador
Egypt
Fiji
Finland
France
Gabon
Gambia
Ghana
Greece
Guatemala
Guyana
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Cote d'Ivoire
Jamaica
Japan
Jordan
Kenya
South Korea
Kuwait
Malawi
Malaysia
Mali
Malta
Mauritania
Mexico
Morocco
Mauritius
Nepal
Netherlands
Papua New Guinea
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Paraguay
Peru
Philippines
Portugal
Romania
Rwanda
El Salvador
Saudi Arabia
Senegal
Sierra Leone
Singapore

Table A1. *Cont.*

Spain
Sri Lanka
Sudan
Suriname
Sweden
Switzerland
Syria
South Africa
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
United Kingdom
Uruguay
Venezuela
Democratic Republic of the Congo
Zambia
Zimbabwe

Table A2. Countries included in the regressions presented in Table 5.

Argentina
Australia
Austria
Belgium
Bolivia
Canada
Chile
Colombia
Denmark
Dominican Republic
Ecuador
Finland
France
Germany
Greece
Guatemala
Honduras
Hong Kong
Iceland
India
Iran
Ireland
Israel
Italy
Cote d'Ivoire
Jamaica
Japan
Kenya
South Korea
Madagascar
Malawi
Mexico
Morocco
Mauritius
Nepal
Netherlands
New Zealand

Table A2. *Cont.*

Nigeria
Norway
Panama
Paraguay
Peru
Philippines
Portugal
Sierra Leone
Spain
Sri Lanka
Sweden
Switzerland
Syria
Thailand
Turkey
United Kingdom
Venezuela
Zambia
Zimbabwe

Table A3. Countries included in the regressions presented in Table 6.

Albania
Algeria
Angola
United Arab Emirates
Argentina
Australia
Austria
Bahamas
Bahrain
Belize
Belgium
Benin
Bangladesh
Bolivia
Brazil
Bulgaria
Burkina Faso
Burundi
Cameroon
Canada
Chad
Chile
China
Colombia
Congo
Costa Rica
Cyprus
Central African Republic
Denmark
Dominican Republic
Ecuador
Egypt
Ethiopia
Fiji
Finland
France

Table A3. *Cont.*

Gabon
Gambia
Germany
Ghana
Greece
Guatemala
Guinea
Guyana
Guinea-Bissau
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Cote d'Ivoire
Jamaica
Japan
Jordan
Kenya
Kiribati
South Korea
Kuwait
Laos
Liberia
Libya
Macau
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritania
Mexico
Mongolia
Morocco
Mozambique
Mauritius
Nepal
Netherlands
New Caledonia
Papua New Guinea
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Paraguay
Peru
Philippines

Table A3. *Cont.*

Portugal
Romania
Rwanda
El Salvador
Samoa
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Singapore
Spain
Sri Lanka
Saint Kitts and Nevis
Sudan
Suriname
Sweden
Switzerland
Syria
South Africa
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
Uganda
United Kingdom
Uruguay
Venezuela
Democratic Republic of the Congo
Zambia
Zimbabwe

Table A4. Countries included in the regressions presented in Table 7.

Algeria
Australia
Austria
Belize
Belgium
Benin
Brazil
Burkina Faso
Burundi
Cameroon
Canada
Chad
Chile
China
Colombia
Congo
Costa Rica
Central African Republic
Denmark
Dominican Republic
Ecuador
Egypt
Fiji
Finland

Table A4. *Cont.*

France
Gabon
Gambia
Georgia
Germany
Ghana
Greece
Guatemala
Guyana
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Cote d'Ivoire
Jamaica
Japan
Jordan
Kenya
South Korea
Kuwait
Latvia
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritania
Mexico
Morocco
Mauritius
Nepal
Netherlands
Papua New Guinea
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Paraguay
Peru
Philippines
Portugal
Romania
El Salvador
Saudi Arabia
Senegal
Singapore
Spain
Sri Lanka

Table A4. *Cont.*

Sudan
Suriname
Sweden
Switzerland
Syria
South Africa
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
United Kingdom
Uruguay
Venezuela
Democratic Republic of the Congo
Zambia

Table A5. Countries included in the regressions presented in Table 8.

Albania
Algeria
Angola
United Arab Emirates
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Belarus
Belize
Belgium
Benin
Bangladesh
Bolivia
Bosnia and Herzegovina
Brazil
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Canada
Chad
Chile
China
Colombia
Congo
Costa Rica
Croatia
Cyprus
Czech Republic
Central African Republic
Denmark
Djibouti
Dominican Republic
Ecuador
Egypt

Table A5. *Cont.*

Equatorial Guinea
Estonia
Ethiopia
Fiji
Finland
France
Gabon
Gambia
Georgia
Germany
Ghana
Greece
Guatemala
Guinea
Guyana
Guinea-Bissau
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Cote d'Ivoire
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Kiribati
South Korea
Kuwait
Kyrgyz Republic
Laos
Latvia
Lebanon
Liberia
Lithuania
Macau
Macedonia
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritania
Mexico
Moldova
Mongolia
Morocco
Mozambique
Mauritius
Nepal
Netherlands

Table A5. *Cont.*

New Caledonia
Papua New Guinea
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Romania
Russia
Rwanda
El Salvador
Samoa
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Spain
Sri Lanka
Saint Kitts and Nevis
Sudan
Suriname
Sweden
Switzerland
Syria
South Africa
Tajikistan
Tanzania
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
United Kingdom
Ukraine
Uruguay
Uzbekistan
Venezuela
Vietnam
Yemen
Yugoslavia
Democratic Republic of the Congo
Zambia
Zimbabwe

Appendix B

Regressions include product dummies and interaction of year and product-SITC dummies.

Regression run:

$$\Delta \ln(u_{pt}) = \chi_t + \beta \Delta \ln(Z_t) + \Delta \varepsilon_{pt}$$

Z_{ct} Measures Technology Years: 1989–2001		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
TAJIKISTAN	3.137	1.654 *
UGANDA	7.993	2.248 **
KYRGYZSTAN	−6.279	−4.754
IVORY COAST	3.005	3.221 ***
GEORGIA	1.010	0.560
EQUATORIAL GUINEA	0.545	0.752
AZERBAIJAN	−0.439	−0.541
TOGO	−1.690	−1.780
BANGLADESH	−0.206	−0.220
INDIA	−0.921	−3.220
CHAD	1.184	0.198
SENEGAL	−4.440	−2.465
ARMENIA	10.651	7.301 ***
BURUNDI	0.511	0.114
CAMEROON	0.961	0.966
KIRIBATI	−1.546	−0.912
NEPAL	−2.289	−3.132
MALI	−6.349	−2.743
SRI LANKA	−0.856	−1.171
PAKISTAN	−1.032	−2.605
UKRAINE	−0.069	−0.242
SUDAN	−1.141	−0.769
RWANDA	−0.557	−0.995
NICARAGUA	−3.566	−4.395
BENIN	36.668	1.853 *
GUYANA	2.828	5.278 ***
GHANA	−16.716	−4.094
TURKMENISTAN	−3.634	−4.408
TANZANIA	−4.703	−1.614
INDONESIA	0.407	4.946 ***
MAURITIAN	−3.654	−0.350

Z_{ct} Measures Technology Years: 1989–2001		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
YEMEN	−1.023	−0.341
PHILIPPINES	0.446	1.710 *
MOLDOVA	−1.711	−3.705
MALAWI	1.850	2.730 ***
KENYA	−4.017	−2.818
ZAIRE	0.722	0.575
LIBERIA	−0.654	−2.102
HONDURA	−1.154	−3.227
LAOS	−31.988	−6.637
GUINEA	−0.067	−0.014
CENTRAL AFRICA	0.582	0.110
ZIMBABWE	−1.276	−3.516
ALBANIA	−2.819	−5.175
UZBEKISTAN	−26.741	−8.080
NIGER	9.397	2.494 ***
BOLIVIA	−1.033	−0.811
CHINA	0.616	4.678 ***
SIERRA LEONE	2.265	2.855 ***
GUINEA BISSAU	−2.078	−1.262
MOZAMBIQUE	−2.163	−0.921
ETHIOPIA	−2.280	−4.120
CAMBODIA	1.144	1.523
NIGERIA	3.264	2.362 ***
BURKINA	−5.359	−1.542
NEW GUINEA	2.853	2.300 ***
MONGOLA	−4.917	−7.411
SYRIA	−0.363	−0.620
HAITI	−0.096	−0.422
ZAMBIA	−1.077	−0.447
BOSNIA AND HERZEGOVINA	1.047	3.081 ***
GAMBIA	−8.251	−1.947
VIETNAM	4.081	3.953 ***
ANGOLA	6.830	5.417 ***
MADAGASCAR	−11.858	−7.857

Z_{ct} Measures Technology Years: 1989–2001		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	t-Stat.
BRAZIL	0.323	1.463
GABON	−9.438	−6.384
COSTA RICA	−1.763	−5.445
PANAMA	1.745	2.819 ***
VENEZUELA	0.614	2.547 ***
POLAND	−3.548	−10.718
URUGUAY	−0.151	−0.361
ECUADOR	1.386	4.768 ***
PARAGUAY	−3.921	−2.411 ***
CZECHOSLOVAKIA	−0.185	−0.625
SOUTH AFRICA	5.386	9.218 ***
ARGENTINA	0.585	3.053 ***
LITHUANIA	1.398	3.709 ***
MOROCCO	−0.610	−2.911 ***
GUATEMALA	−0.113	−0.115
FIJI	2.160	3.416 ***
DOMINICAN REPUBLIC	−2.225	−9.399 ***
BELIZE	−3.114	−6.589 ***
SEYCHELLE	−10.074	−1.507
SLOVAKIA	5.252	3.839 ***
PORTUGAL	−0.322	−0.913
TURKEY	0.576	4.324 ***
CHILE	2.696	9.243 ***
LEBANON	−1.660	−8.249 ***
TUNISIA	−2.783	−2.951 ***
BULGARIA	−1.025	−3.455 ***
MALAYSIA	0.476	3.438 ***
MAURITIUS	7.729	3.191 ***
IRAN	−7.755	−1.318
CONGO	−1.185	−0.753
LATVIA	0.588	0.417
MACEDONIA	2.067	3.927 ***
CROATIA	−2.418	−8.964 ***
MEXICO	−0.028	−0.270
GREECE	−0.531	−0.955
TRINIDAD	−1.899	−2.995 ***

Z_{ct} Measures Technology Years: 1989–2001		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
SAINT KITTS AND NEVIS	2.790	3.228 ***
HUNGARY	−4.466	−17.811 ***
RUSSIA	−0.297	−1.599
KAZAKHSTAN	−0.681	−1.507
SOUTH KOREA	1.014	11.500 ***
SLOVENIA	−6.060	−2.707 ***
BELARUS	−0.653	−1.979 ***
ALGERIA	−6.463	−2.331 ***
EGYPT	−4.104	−4.458 ***
JORDAN	2.059	3.356 ***
THAILAND	1.112	13.954 ***
PERU	1.244	6.336 ***
MALTA	2.911	0.780
ROMANIA	−0.494	−2.304 ***
COLOMBIA	1.455	5.813 ***
SALVADOR	4.512	10.113 ***
JAMAICA	1.477	2.193 **
SURINAME	6.884	4.226 ***
ESTONIA	−0.339	−0.387
SAMOA	−3.933	−1.996 **
OMAN	2.223	4.727 ***
High-Income Countries		
SPAIN	0.366	0.879
MACAU	2.683	15.907 ***
ARAB EMPIRE	−1.109	−3.323 ***
ISRAEL	1.501	2.917 ***
GERMANY	1.810	7.841 ***
ICELAND	−7.411	−10.729 ***
KUWAIT	6.246	4.571 ***
BELGIUM-LUXEMBOURG	−0.618	−1.286
AUSTRIA	0.198	0.342
SINGAPORE	−0.219	−0.894
ITALY	2.622	7.668 ***
NEW ZEALAND	−4.143	−8.708 ***
SAUDI ARABIA	4.067	4.402 ***
NETHERLANDS	−4.055	−6.667 ***
CYPRUS	−1.369	−1.733 *

Z_{ct} Measures Technology Years: 1989–2001		
High-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
JAPAN	1.301	6.291 ***
IRELAND	−0.838	−2.209 **
HONGKONG	−0.107	−0.826
UNITED KINGDOM	−1.283	−4.850 ***
DENMARK	−0.334	−0.530
AUSTRALIA	0.468	4.929 ***
NORWAY	1.533	1.645 *
SWITZERLAND	−1.372	−3.805 ***
BAHAMAS	−10.749	−7.526 ***
NEW CATALONIA	−5.074	−2.215 **
CANADA	−1.724	−13.499 ***
BAHRAIN	2.203	3.620 ***
FRANCE	0.902	2.800 ***
FINLAND	−0.658	−2.202 **
SWEDEN	−1.875	−6.017 ***

* significant at 10%; ** significant at 5%; *** significant at 1%.

Z_{ct} Measures Technology Years: 1972–1988		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
Togo	−0.117	−0.019
Bangladesh	−3.400	−2.650 ***
Nepal	−1.009	−1.198
Zambia	−16.619	−3.549 ***
Congo, Dem. Rep.	−2.595	−1.169
Mozambique	3.656	1.640
Kiribati	−4.474	−4.093 ***
Gambia, The	6.193	1.370
Pakistan	−5.762	−10.129 ***
China	−1.720	−9.088 ***
Morocco	−0.811	−1.841 *
Sri Lanka	0.084	0.226
Central African Republic	1.045	0.117
Cote d’Ivoire	−0.574	−0.490
Rwanda	4.417	0.519

Z_{ct} Measures Technology Years: 1972–1988		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
Mali	0.617	0.404
Sudan	2.800	0.704
Senegal	−1.073	−0.355
Malawi	−5.105	−0.766
Egypt, Arab Rep.	−2.920	−3.812 ***
Papua New Guinea	−0.473	−0.055
Benin	4.855	0.713
Guinea-Bissau	11.400	1.526
Uganda	−6.952	−0.625
Sierra Leone	18.089	4.329 ***
Kenya	−1.677	−0.926
Guyana	0.732	0.710
Liberia	4.168	0.810
Haiti	1.677	5.362 ***
Ethiopia	−1.677	−1.209
Nicaragua	1.630	3.995 ***
Honduras	3.714	4.379 ***
Thailand	−0.826	−2.472 ***
Indonesia	−0.039	−0.070
India	−0.776	−4.345 ***
Congo, Rep.	−3.428	−1.974 **
Niger	8.745	5.232 ***
Zimbabwe	7.038	3.792 ***
Mauritania	8.428	1.295
Madagascar	−0.212	−0.073
Syrian Arab Republic	1.248	1.525
Nigeria	−2.851	−2.392 ***
Cameroon	−2.216	−1.556
Burkina Faso	3.242	1.415
Philippines	−0.552	−3.613 ***
Bolivia	2.680	2.887 ***
Ghana	−4.258	−3.621 ***
Middle-Income Countries		
Mexico	2.970	19.865 ***
Brazil	1.617	10.246 ***
Malta	1.448	1.275
Malaysia	2.020	6.155 ***

Z_{ct} Measures Technology Years: 1972–1988		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
Samoa	0.047	0.010
Peru	0.769	4.132 ***
Panama	0.301	0.910
Belize	5.146	4.834 ***
Venezuela, RB	3.804	6.073 ***
Turkey	−2.903	−6.094 ***
Guatemala	−1.067	−2.034 **
Portugal	−1.408	−6.285 ***
Trinidad and Tobago	−1.084	−1.045
Greece	−1.903	−5.286 ***
Costa Rica	−0.638	−1.939 *
Dominican Republic	0.530	1.469
Uruguay	−2.441	−6.626 ***
Suriname	−1.126	−0.571
Paraguay	−5.956	−5.957 ***
Italy	1.364	6.331 ***
Chile	−1.927	−5.288 ***
Oman	−5.677	−2.577 ***
Seychelles	−10.661	−2.791 ***
Bulgaria	8.717	4.520 ***
Ecuador	−1.300	−2.413 ***
Colombia	0.819	1.316
Cyprus	1.924	1.934 ***
Iran, Islamic Rep.	0.289	0.469
Gabon	−1.336	−0.606
Korea, Rep.	−1.873	−11.940 ***
El Salvador	−0.316	−0.866
Jordan	−2.751	−1.022
Algeria	−13.159	−1.843 **
Spain	−0.611	−1.955 **
Fiji	−0.425	−0.406
Tunisia	−7.002	−5.201 ***
Hungary	−0.920	−1.332
St. Kitts and Nevis	−0.974	−1.145
Romania	−3.123	−5.877 ***
South Africa	1.529	3.075 ***
Libya	4.066	0.682
Argentina	1.125	4.795 ***

Z_{ct} Measures Technology Years: 1972–1988		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
Jamaica	−2.253	−4.558 ***
Mauritius	15.443	9.374 ***
High-Income Countries		
Netherlands	2.711	6.145 ***
Sweden	−0.441	−0.881
Israel	−0.744	−1.538
Bahamas, The	−0.230	−0.412
Finland	−4.717	−7.088
France	0.967	2.662 ***
Kuwait	−1.415	−1.375
Germany	1.803	7.817 ***
Japan	−0.368	−2.265 **
Hong Kong, China	−2.343	−22.567 ***
Saudi Arabia	1.640	1.565
Bahrain	−7.038	−4.690 ***
Austria	2.810	5.923 ***
United Arab Emirates	−2.022	−2.610 ***
New Zealand	−4.124	−5.506 ***
Singapore	−0.734	−2.510 ***
Belgium	2.096	6.003 ***
Iceland	0.150	0.155
Switzerland	−2.139	−8.795 ***
Denmark	−2.325	−5.757 ***
Ireland	1.972	3.971 ***
Macao, China	−0.680	−2.402 ***
New Caledonia	−1.332	−0.991
Australia	−3.980	−7.042 ***
Canada	0.314	1.581
United Kingdom	−2.804	−15.034 ***
Norway	2.447	4.040 ***

* significant at 10%; ** significant at 5%; *** significant at 1%.

Z_{ct} Measures Skill Years: 1989–2001		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
FIJI	2.560	1.723 *
KUWAIT	−0.409	−2.361 ***
INDIA	−0.584	−2.198 **
SYRIA	−7.679	−2.250 **
CHAD	2.152	0.297
NIGER	−14.726	−3.327 ***
SRI LANKA	−3.187	−3.779 ***
MALI	6.471	2.802 ***
NEW GUINEA	6.661	3.069 ***
MADAGASCAR	1.412	0.928
KENYA	−0.201	−0.461
BENIN	−25.948	−4.040 ***
GUYANA	−4.814	−4.401 ***
PHILIPPINES	−1.369	−2.302 ***
NEPAL	0.427	0.662
CHINA	0.229	1.307
MALAWI	2.154	2.469 ***
HONDURA	−14.604	−2.364 ***
TOGO	−4.458	−1.950 *
CAMEROON	−9.174	−7.596 ***
NICARAGUA	1.818	3.655 ***
SENEGAL	−0.080	−0.037
ZAMBIA	−60.834	−2.868 ***
INDONESIA	0.865	4.948 ***
ZIMBABWE	−0.416	−0.706
NIGERIA	2.672	1.735 ***
GAMBIA	2.105	1.564
BURUNDI	−14.180	−4.579 ***
IVORY COAST	0.422	0.267
Middle-Income Countries		
ROMANIA	−4.096	−8.219 ***
TURKEY	−1.588	−2.970 ***
BELIZE	−1.000	−1.548
PANAMA	−11.199	−6.423 ***
CHILE	0.368	1.261
SURINAM	−4.395	−4.120 ***
THAILAND	1.146	7.241 ***
SOUTH AFRICA	11.569	6.419 ***

Z_{ct} Measures Skill Years: 1989–2001		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
IRAN	11.814	0.913
VENEZUELA	1.275	4.128 ***
OMAN	3.379	12.864 ***
EGYPT	1.111	1.805 *
TUNISIA	−3.133	−4.723 ***
ECUADOR	1.646	7.344 ***
CONGO	0.967	0.202
HUNGARY	−1.427	−3.532 ***
DOMINICAN REPUBLIC	−0.574	−1.231
MOROCCO	2.636	3.374 ***
PORTUGAL	1.121	7.033 ***
COLOMBIA	0.750	3.384 ***
URUGUAY	−1.860	−2.492 ***
GUATEMALA	0.376	0.926
PERU	0.532	1.108
LATVIA	7.895	0.555
GABON	1.997	0.701
MEXICO	−2.488	−10.965 ***
SOUTH KOREA	0.257	1.030
ALGERIA	−20.017	−3.252 ***
MALAYSIA	−1.636	−5.721 ***
PARAGUAY	−2.606	−2.940 ***
JAMAICA	2.742	1.061
BRAZIL	−0.459	−1.453
JORDAN	2.556	1.368
GREECE	2.993	3.888 ***
MAURITIAN	−0.922	−0.635
MALTA	4.069	2.390 ***
SALVADOR	−0.502	−2.552 ***
COSTA RICA	−0.161	−0.248
TRINIDAD	−0.445	−0.233
High-Income Countries		
JAPAN	0.608	2.360 ***
NORWAY	−0.609	−2.190 **
AUSTRIA	2.498	2.435 ***
SWEDEN	0.006	0.059
ICELAND	−8.240	−6.706 ***
HONGKONG	0.172	0.949

Z_{ct} Measures Skill Years: 1989–2001		
High-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
AUSTRALIA	0.129	1.939 *
IRELAND	1.067	2.104 **
ITALY	−3.152	−9.361 ***
BELGIUM-LUXEMBOURG	0.062	0.815
GERMANY	0.586	2.446 ***
SAUDI ARABIA	−9.472	−4.218
SPAIN	−0.361	−0.987
SINGAPORE	1.501	3.801 ***
FRANCE	−0.805	−4.122 ***
FINLAND	−2.229	−3.417 ***
SWITZERLAND	1.366	1.416
DENMARK	−3.474	−3.128 ***
CANADA	3.869	6.555 ***
NETHERLANDS	−0.123	−0.796
UNITED KINGDOM	0.076	1.890 ***
NEW ZEALAND	−0.936	−2.071 **
ISRAEL	0.660	1.046

* significant at 10%; ** significant at 5%; *** significant at 1%.

Z_{ct} Measures Skill Years: 1972–1988		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
BARBADOS	−5.158	−2.732 ***
THAILAND	6.209	12.316 ***
PHILIPPINES	−1.468	−5.922 ***
IVORY COAST	−4.696	−2.681 ***
MALI	0.192	0.097
GHANA	1.479	0.430
ZAMBIA	−7.719	−1.368
SUDAN	−27.575	−3.809 ***
EGYPT	14.924	10.351 ***
BURKINA	−2.204	−3.160 ***
KENYA	4.153	4.389 ***
SENEGAL	−2.725	−0.660
CENTRAL AFRICA	−9.965	−2.963 ***
GUYANA	−3.302	−3.297 ***

Z_{ct} Measures Skill Years: 1972–1988		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
NIGER	−8.979	−2.486 ***
NEW GUINEA	−13.545	−1.156
NIGERIA	1.165	2.170 **
NEPAL	−2.759	−3.989 ***
SRI_LKA	−1.085	−1.703 *
MAURITIUS	−1.774	−0.097
BANGLADESH	−0.806	−3.033 ***
HAITI	−0.307	−2.170 **
HONDURA	5.325	7.542 ***
SYRIA	−3.621	−0.818
INDIA	0.730	1.585
TOGO	−10.685	−3.091 ***
CAMEROON	8.878	3.348 ***
INDONESIA	−0.651	−2.115 **
ZAIRE	1.056	0.726
MALAWI	2.215	0.537
MOROCCO	0.133	0.168
SIERRA LEONE	8.621	2.886 ***
ZIMBABWE	1.830	4.071 ***
CHINA	−1.441	−20.933 ***
Middle-Income Countries		
TURKEY	0.115	0.086
ARGENTINA	−2.033	−4.920 ***
MAURITIAN	7.030	6.779 ***
VENEZUELA	1.340	9.814 ***
SPAIN	0.193	0.611
JORDAN	2.775	0.458
OMAN	4.805	0.686
JAMAICA	−1.958	−2.675 ***
MEXICO	−0.285	−0.950
PARAGUAY	18.900	10.715 ***
BRAZIL	0.420	1.623
GUATEMALA	−6.798	−8.810 ***
SOUTH KOREA	1.217	4.632 ***
URUGUAY	−6.334	−4.813 ***
IRAN	5.172	2.584 ***
PANAMA	−12.963	−5.108 ***
COLOMBIA	0.126	0.714

Z_{ct} Measures Skill Years: 1972–1988		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
FIJI	−3.160	−0.912
TRINIDAD	12.753	4.437 ***
GABON	2.759	0.560
PORTUGAL	0.205	1.754 *
ROMANIA	1.343	4.891 ***
SURINAM	−1.160	−0.499
BELIZE	−8.140	−3.610 ***
SALVADOR	3.121	6.969 ***
HUNGARY	−0.673	−0.925
ALGERIA	−7.270	−1.357
MALTA	5.311	2.436 ***
MALAYSIA	−3.372	−6.982 ***
PERU	−1.955	−1.578
GREECE	1.594	2.159 **
NICARAGUA	−3.205	−1.457
CHILE	−3.450	−4.963 ***
CONGO	6.733	2.119 **
COSTA RICA	−5.927	−8.132 ***
DOMINICAN REPUBLIC	0.896	4.832 ***
TUNISIA	−7.520	−5.496 ***
ECUADOR	1.134	1.599
High-Income Countries		
SAUDI ARABIA	2.131	0.952
DENMARK	−5.904	−4.700 ***
ITALY	−5.249	−10.844 ***
NETHERLANDS	0.375	2.159 **
UNITED KINGDOM	6.147	7.352 ***
SWEDEN	0.593	1.363
ISRAEL	−3.353	−4.298 ***
ICELAND	2.836	0.912
HONGKONG	−18.827	−21.670 ***
NORWAY	0.955	0.682
AUSTRIA	−0.064	−0.476
KUWAIT	−2.701	−0.332
BELGIUM−LUXEMBOURG	1.290	2.439 ***
FINLAND	−4.118	−3.744 ***
IRELAND	20.754	10.133 ***
AUSTRAL	−0.187	−0.780

Z_{ct} Measures Skill Years: 1972–1988		
High-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
NEW ZEALAND	2.743	1.830 *
FRANCE	7.980	5.113 ***
SINGAPORE	−0.873	−3.717 ***
CANADA	−4.252	−14.135 ***
JAPAN	−0.432	−0.986
SWITZERLAND	9.509	4.546 ***

* significant at 10%; ** significant at 5%; *** significant at 1%.

Z_{ct} Measures Capital Years: 1972–1988		
Low-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
Name	**Yhat_Estimate**	**Yhat_Tstat**
POLAND	1.700	0.817
YUGOSLAVIA	8.723	12.401 ***
IRAN	4.732	5.710 ***
TAIWAN	3.931	19.311 ***
SYRIA	−6.035	−3.295 ***
KENYA	5.905	4.222 ***
PHILIPPINES	3.558	10.298 ***
HONDURA	3.675	6.812 ***
NEPAL	0.463	0.192
INDIA	14.008	14.399 ***
IVORY COAST	3.564	2.944 ***
SRI LANKA	−0.646	−0.429
BOLIVIA	2.689	3.628 ***
MALAWI	−5.803	−0.886
SIERRA LEONE	−3.428	−0.354
NIGERIA	5.517	4.487 ***
THAILAND	3.413	6.999 ***
ZIMBABWE	9.990	4.000 ***
MOROCCO	1.543	3.042 ***
ZAMBIA	5.651	0.944
Middle-Income Countries		
PARAGUAY	−0.497	−0.651
MAURITIUS	3.935	7.871 ***
CHILE	−1.206	−2.247 **
GUATEMALA	3.557	7.174 ***
PORTUGAL	3.645	10.267 ***

Z_{ct} Measures Capital Years: 1972–1988		
Middle-Income Countries		
	$\hat{\beta}$	
	Estimate	***t*-Stat.**
Name	**Yhat_Estimate**	**Yhat_Tstat**
ITALY	11.851	31.457 ***
SPAIN	3.546	10.095 ***
PANAMA	2.893	2.310 ***
GREECE	11.556	17.877 ***
SOUTH KOREA	4.781	19.208 ***
TURKEY	1.893	2.433 ***
COLOMBIA	14.066	14.470 ***
PERU	0.310	0.628
VENEZUELA	4.560	4.840 ***
ECUADOR	0.846	0.965
JAMAICA	5.064	6.171 ***
ARGENTINA	4.451	6.965 ***
MEXICO	0.615	2.853 ***
DOMINICAN REPUBLIC	7.110	15.766 ***
High-Income Countries		
BELGIUM−LUXEMBOURG	13.003	25.055 ***
GERMANY	17.464	42.090 ***
SWEDEN	2.694	6.127 ***
NORWAY	1.395	1.432
JAPAN	7.794	36.236 ***
SWITZERLAND	6.746	13.022 ***
UNITED KINGDOM	8.121	19.872 ***
NETHERLANDS	12.087	20.589 ***
DENMARK	4.745	6.707 ***
HONGKONG	1.010	7.751 ***
NEW ZEALAND	0.095	0.066
ISRAEL	4.844	8.242 ***
FRANCE	11.056	33.117 ***
CANADA	−11.501	−25.380 ***
ICELAND	−1.827	−0.925
FINLAND	17.792	15.444 ***
AUSTRIA	13.280	21.715 ***
AUSTRALIA	21.066	7.541 ***
IRELAND	10.529	16.306 ***

* significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix C

The source of the information presented here is the WITS trade database of the World Bank. https://wits.worldbank.org/countrystats.aspx (accessed on 5 August 2021).

Countries with US as top ten Export Partner	**131**
Countries with US as top ten Import Partner	**145**
Countries with US as top ten Export & Import Partner	**109**
Total Countries in the WITS database	**186**

Below is the list of top ten countries that are export partners of each country in the World bank WITS trade database in 2020:

EXPORTER COUNTRY					Top 10 trade partners					
Afghanistan	India	Pakistan	China	Turkey	United Arab Emirates	Iran	Iraq	Germany	Saudi Arabia	Tajikistan
Albania	Italy	Serbia	Spain	Germany	Greece	North Macedonia	China	Montenegro	United States	Romania
Algeria	Italy	France	Spain	United States	Brazil	Netherlands	Turkey	United Kingdom	Portugal	Belgium
Andorra	Spain	France	Norway	Austria	Hong Kong	Netherlands	Italy	United Arab Emirates	Germany	Kuwait
Anguila	Guyana	Netherlands Antilles	United States	United Kingdom	France	Israel	Canada	Switzerland	British Virgin Islands	Netherlands
Antigua and Barbuda	United Arab Emirates	United States	Netherlands	Saint Maartin	St. Lucia	Hong Kong	St. Kitts and Nevis	France	Dominica	British Virgin Islands
Argentina	Brazil	China	United States	Chile	Vietnam	India	Netherlands	Switzerland	Indonesia	Peru
Armenia	Russia	Switzerland	Bulgaria	China	Iraq	Netherlands	Iran	Germany	Georgia	Canada
Australia	China	Japan	Korea	United Kingdom	United States	India	Singapore	New Zealand	Malaysia	Hong Kong
Austria	Germany	United States	Italy	Switzerland	France	Hungary	Czech Republic	Poland	China	United Kingdom
Azerbaijan	Italy	Turkey	Israel	India	Germany	China	Russia	Spain	Czech Republic	Georgia
The Bahamas	United States	Ireland	Panama	Turks and Caicos	France	United Kingdom	Germany	Agrentina	Japan	Brazil
Bahrain	Saudi Arabia	United Arab Emirates	United States	Oman	Egypt	China	India	Kuwait	Turkey	Korea
Bangladesh	Spain	France	Italy	Canada	Japan	Belgium	Netherlands	China	Australia	Turkey
Barbados	United States	Jamacia	Guyana	Trinidad and Tobago	St. Lucia	Canada	St. Vincent and the Grenadines	Antigua and Barbuda	Grenada	Hong Kong
Belarus	Russia	Ukraine	United Kingdom	Germany	Poland	Lithuania	Netherlands	Kazakhstan	China	Brazil
Belgium	Germany	France	Netherlands	United Kingdom	United States	Italy	Spain	Poland	China	Luxembourg
Belize	United Kingdom	United States	Ireland	Jamacia	Trinidad and Tobago	Barbados	Guatemala	Honduras	Netherlands	Bahamas
Benin	Bangladesh	India	Vietnam	China	Nigeria	Denmark	Egypt	Niger	Malaysia	Burkina Faso
Bhutan	India	Bangladesh	Italy	Japan	Nepal	Hong Kong	Netherlands	Germany	Singapore	Bulgaria
Bolivia	Brazil	Argentina	United Arab Emirates	India	Japan	United States	Columbia	China	Peru	Korea
Bosnia and Herzegovina	Germany	Croatia	Serbia	Italy	Austria	Slovenia	Montenegro	Turkey	Hungary	France
Botswana	India	Belgium	United Arab Emirates	South Africa	Israel	Hong Kong	Singapore	Switzerland	Namibia	United States
Brazil	China	United States	Netherlands	Argentina	Japan	Chile	Mexico	Germany	Spain	Korea
Brunei	Japan	Singapore	Australia	Malaysia	India	Thailand	China	Korea	Vietnam	Philippines
Bulgaria	Germany	Romania	Italy	Turkey	Greece	France	Belgium	China	Spain	Netherlands
Burkina Faso	Switzerland	India	Singapore	Ivory Coast	France	Chana	Denmark	Togo	Vietnam	Mali
Burundi	United Arab Emirates	Dem Rep Congo	Pakistan	Switzerland	Germany	Singapore	Belgium	Uganda	Egypt	China
Cape Verde	Spain	Portugal	Italy	United States	Germany	Romania	Guinea-Bissau	Netherlands	Algeria	Gambia
Cambodia	United States	Japan	Germany	China	United Kingdom	Canada	Belgium	Spain	Thailand	Netherlands
Cameroon	Italy	China	France	Netherlands	Spain	India	Belgium	Portugal	Vietnam	Bangladesh
Canada	United States	China	United Kingdom	Japan	Germany	Korea	Netherlands	India	Hong Kong	France
Central African Republic	France	United Arab Emirates	Cameroon	China	Nigeria	Vietnam	Morocco	Germany	Belgium	Switzerland
Chad	South Africa	United States	Ukraine	Tunisia	Thailand	Togo	Sweden	Singapore	Senegal	Sudan
Chile	China	United States	Japan	Korea	Brazil	Peru	Netherlands	Mexico	Spain	India
China	United States	Hong Kong	Japan	Korea	Vietnam	Germany	India	Netherlands	United Kingdom	Singapore
Colombia	United States	China	Panama	Ecuador	Brazil	Mexico	Netherlands	Turkey	Peru	Chile
Comoros	France	India	Germany	Madagascar	United Arab Emirates	Tanzania	United States	Netherlands	Canada	Greece
Congo, Democratic Republic of the	China	India	Netherlands	United States	Spain	Australia	Italy	United Kingdom	Angola	Gabon
Cooks Islands	Japan	China	United States	New Zealand	Vietnam	Italy	Australia	Netherlands	Samoa	Hong Kong
Costa Rica	United States	Netherlands	Belgium	Guatemala	Panama	Nicaragua	Honduras	El Salvador	Japan	Dominican Republic
Côte d'Ivoire	Netherlands	United States	France	Malaysia	Vietnam	Mali	Spain	Switzerland	Germany	Burkina Faso
Croatia	Italy	Germany	Slovenia	Bosnia and Herzegovina	Austria	Serbia	Hungary	France	United States	Spain
Cuba	Venezuela	Spain	Rissua	Bolivia	France	Mexico	Dominican Republic	Netherlands	Cyprus	Brazil
Cyprus	Netherlands	Bunkers	Libya	Greece	United Kingdom	Hong Kong	Marshall Islands	United States	Norway	Germany
Czech Republic	Germany	Slovak Republic	Poland	France	United Kingdom	Austria	Italy	Netherlands	Hungary	Spain
Denmark	Germany	Sweden	Norway	United Kingdom	Netherlands	United States	China	Poland	France	Italy
Djibouti	Ethiopia	France	Somalia	Brazil	Qatar	Pakistan	Yemen	Kenya	United Arab Emirates	Saudi Arabia

EXPORTER COUNTRY					Top 10 trade partners					
Dominica	Trinidad and Tobago	Jamacia	St. Kitts and Nevis	Guyana	France	Barbados	Antigus and Barbuda	United States	St. Lucia	Suriname
Dominican Republic	United States	Haiti	India	Canada	Netherlands	China	Switzerland	Spain	United Kingdom	Germany
East Timor (Timor-Leste)	Indonesia	United States	Germany	China	Australia	Portugal	Japan	Singapore	Hong Kong	Korea
Ecuador	United States	China	Panama	Chile	Peri	Russia	Columbia	Spain	Netherlands	Italy
Egypt	United States	United Arab Emirates	Turkey	Saudi Arabia	Italy	United Kingdom	India	Spain	Malta	Jordan
El Salvador	United States	Guatemala	Honduras	Nicaragua	Costa Rica	Mexico	Dominican Republic	Canada	China	Spain
Eritrea	Sudan	Singapore	Italy	Netherlands	India	Greece	Russia	Hong Kong	United Kingdom	France
Estonia	Finland	Sweden	Latvia	Russia	United States	Germany	Lithuania	Denmark	Norway	Netherlands
Eswatini	South Africa	Kenya	Nigeria	Mozambique	Tanzania	Spain	Botswana	Portugal	Uganda	Nambia
Ethiopia	China	Saudi Arabia	United States	United Arab Emirates	Israel	Djibouti	Somalia	Vietnam	Germany	Japan
Faroe Islands	United Kingdom	Denmark	France	Germany	Norway	United States	Spain	Nigeria	Russia	Italy
Fiji	United States	Australia	Bunkers	New Zealand	Tonga	China	Japan	Vanuatu	Samoa	Cook Islands
Finland	Germany	Sweden	United States	Netherlands	Russia	China	United Kingdom	Italy	Belgium	France
France	Germany	United States	Italy	Spain	United Kingdom	Belgium	China	Switzerland	Netherlands	Poland
French Polynesia	Japan	Hong Kong	United States	France	Denmark	New Zealand	New Caledonia	China	Vietnam	Germany
Gabon	United States	China	Spain	France	Malaysia	Netherlands	United Kingdom	Korea	Congo	South Africa
The Gambia	Mali	Giunea-Bissau	China	India	Korea	Senegal	Chile	Vietnam	Turkey	Guinea
Georgia	Azerbaijan	Russia	Armenia	Bulgaria	Ukraine	China	Turkey	Romania	United States	Uzbekistan
Germany	United States	France	China	Netherlands	United Kingdom	Italy	Poland	Austria	Switzerland	Belgium
Ghana	China	Switzerland	India	South Africa	Netherlands	United Arab Emirates	United States	United Kingdom	France	Italy
Greece	Italy	Germany	Turkey	Cyprus	Bulgaria	United States	United Kingdom	France	Lebanon	Spain
Grenada	Zimbabewe	Zambia	South Afirca	Vietnam	British Virgin Islands	Venezuela	St. Vincent and the Grenadines	United States	Uruguay	Ukraine
Guatemala	United States	El Salvador	Honduras	Mexico	Nicaragua	Costa Rica	Netherlands	Panama	Canada	Saudi Arabia
Guinea	United Arab Emirates	Ghana	India	Switzerland	France	Spain	Ireland	China	Germany	Ukraine
Guinea-Bissau	India	Singapore	Portugal	Netherlands	Panama	Korea	Gambia	United States	Senegal	Cape Verde
Guyana	Trinidad and Tobago	Canada	Portugal	Ghana	Norway	United States	Germany	United Arab Emirates	Panama	Columbia
Honduras	United States	Germany	El Salvador	Nicaragua	Guatemala	Belgium	Netherlands	Costa Rica	Mexico	Italy
Hong Kong	China	United States	India	Japan	Singapore	Thailand	Vietnam	Germany	Netherlands	United Kingdom
Hungary	Germany	Slovak Republic	Italy	Romania	Austria	France	Czech Republic	Poland	Netherlands	United Kingdom
Iceland	Netherlands	United Kingdom	Spain	United States	France	Germany	Canada	Norway	China	Denmark
India	United States	United Arab Emirates	China	Hong Kong	Singapore	Netherlands	United Kingdom	Germany	Bangladesh	Nepal
Indonesia	China	United States	Japan	Singapore	India	Malaysia	Korea	Philippines	Thailand	Vietnam
Iran	China	Iraq	United Arab Emirates	Afganistan	Korea	Turkey	India	Pakistan	Indonesia	Oman
Ireland	United States	United Kingdom	Belgium	Germany	Netherlands	China	Switzerland	France	Italy	Japan
Israel	United States	United Kingdom	China	Bunkers	Hong Kong	Netherlands	India	Turkey	Germany	Belgium
Italy	Germany	France	United States	Switzerland	United Kingdom	Spain	Belgium	Poland	China	Netherlands
Jamaica	United States	Netherlands	Canada	Iceland	Russia	Norway	United Kingdom	China	Georgia	Trinidad and Tobago
Japan	United States	China	Korea	Hong Kong	Thailand	Germany	Singapore	Vietnam	Australia	Indonesia
Jordan	United States	Saudi Arabia	India	Iraq	United Arab Emirates	Kuwait	China	Lebanon	Egypt	Indonesia
Kazakhstan	Italy	China	Russia	Netherlands	France	Korea	Switzerland	Turkey	Spain	Uzbekistan
Kenya	Uganda	United States	Netherlands	Pakistan	United Kingdom	United Arab Emirates	Tanzania	Rwanda	Egypt	China
Kiribati	Malaysia	Fiji	East Timor	Japan	Australia	Vietnam	United States	New Zealand	Hong Kong	Tuvalu
Korea, Rep.	China	United States	Vietnam	Hong Kong	Japan	India	Singapore	Mexico	Malaysia	Germany
Kuwait	Iraq	China	India	Saudi Arabia	United Arab Emirates	Qatar	Oman	Pakistan	Jordan	Turkey
Kyrgyz Republic	United Kingdom	Kazakhstan	Russia	Uzbekistan	Turkey	China	Tajikistan	Lithuania	Iran	Ukraine
Latvia	Lithuania	Estonia	Russia	Germany	Sweden	United Kingdom	Denmark	Poland	Netherlands	Finland
Lebanon	United Arab Emirates	Saudi Arabia	Syrian Arab Republic	South Africa	Iraq	Qatar	Switzerland	Turkey	Jordan	Kuwait
Lesotho	South Africa	United States	Eswatini	Germany	Canada	Botswana	Mauritius	Zimbabwe	New Zealand	Australia

EXPORTER COUNTRY					Top 10 trade partners					
Libya	Italy	China	Spain	France	United Arab Emirates	United States	Greece	United Kingdom	Netherlands	Malaysia
Lithuania	Russia	Latvia	Poland	Germany	Estonia	Sweden	Belarus	United Kingdom	United States	Netherlands
Luxembourg	Germany	France	Belgium	Netherlands	Italy	United Kingdom	United States	Poland	Spain	Austria
Macao	Hong Long	China	United States	Cambodia	Singapore	Germany	United Kingdom	Vietnam	Japan	Philippines
Madagascar	France	United States	China	Japan	Germany	Korea	Netherlands	United Arab Emirates	South Africa	Canada
Malawi	Belgium	Kenya	Eqypt	South Africa	United States	Netherlands	China	Russia	Tanzania	Zambia
Malaysia	China	Singapore	United States	Hong Kong	Japan	Thailand	India	Vietnam	Korea	Indonesia
Maldives	Thailand	Germany	United Kingdom	United States	France	Italy	Sri Lanka	Switzerland	Vietnam	Spain
Mali	South Africa	Switzerland	Burkina Faso	Bangladesh	Ivory Coast	Senegal	India	United Arab Emirates	Turkey	China
Malta	Bunkers	Germany	Italy	France	Japan	United States	Singapore	Libya	Hong Kong	Spain
Martinique	France	Guadeloupe	Belgium-Luxembourg	United Kingdom	French Guiana	United States	St. Lucia	British Virgin Islands	Cameroon	St. Vincent and the Grenadines
Mauritania	China	Spain	Japan	Russia	Italy	Ivory Coast	Germany	France	Nigeria	Australia
Mauritius	France	United Kingdom	United States	South Africa	Madagascar	Italy	Spain	Vietnam	Netherlands	Kenya
Mayotte	France	Comoros	Madagascar	Indonesia	Mauritius	India	Benin	China	Japan	Singapore
Mexico	United States	Canada	Germany	China	Brazil	Japan	Columbia	United Kingdom	Korea	Netherlands
Moldova	Romania	Italy	Russia	Germany	Turkey	Poland	Switzerland	Belarus	Ukraine	Czech Republic
Mongolia	China	United Kingdom	Singapore	Switzerland	Russia	Italy	Australia	Korea	United States	Iran
Montenegro	Serbia	Hungary	Bosnia and Herzegovina	Slovenia	Poland	Czech Republic	China	Italy	Germany	Albania
Montserrat	United States	France	St. Kitts and Nevis	Trinidad and Tobago	Antiguila	Antigua and Barbuda	Mashall Islands	Togo	Aruba	British Virgin Islands
Morocco	Spain	France	Italy	United States	Germany	Brazil	India	Netherlands	United Kingdom	Turkey
Mozambique	India	Netherlands	South Afirca	China	Hong Kong	Singapore	Poland	United States	United Kingdom	United Arab Emirates
Myanmar	China	Thailand	Japan	United States	Germany	India	Spain	United Kingdom	Korea	Netherlands
Namibia	China	South Africa	Botswana	Belgium	Spain	Zambia	United Arab Emirates	Congo	Netherlands	France
Nepal	India	United States	Turkey	Germany	United Kingdom	China	Italy	France	Bangladesh	Japan
Netherlands	Germany	Belgium	France	United Kingdom	United States	Italy	Spain	Poland	China	Sweden
Netherlands Antilles	Netherlands	United States	Aruba	Germany	Venezuela	Namibia	Antigus and Barbuda	Canada	France	Belgium
New Zealand	China	Australia	United States	Japan	Korea	United Kingdom	Hong Kong	Singapore	Malaysia	Indonesia
Nicaragua	United States	El Salvador	Mexico	Honduras	Costa Rica	Guatemala	Spain	Germany	United Kingdom	Belgium
Niger	Thailand	France	Switzerland	Malaysia	Nigeria	Brazil	China	Indonesia	Mali	Turkey
Nigeria	India	Spain	Netherlands	Ghana	France	South Africa	United States	Italy	China	Indonesia
North Macedonia	Germany	Serbia	Bulgaria	Belgium	Italy	Greece	Hungary	Romania	China	United Kingdom
Norway	United Kingdom	Germany	Netherlands	Sweden	France	Denmark	United States	Belgium	China	Poland
Oman	United Arab Emirates	Qatar	Saudi Arabia	India	China	United States	Yemen	Iran	Kuwait	Pakistan
Pakistan	United States	China	United Kingdom	Germany	Afganistan	United Arab Emirates	Netherlands	Spain	Italy	Bangladesh
Palau	Japan	Panama	Micronesia	United States	Guam	Cambodia	Fiji	China	Hong Kong	Kenya
Panama	United States	Columbia	Costa Rica	Dominican Republic	Venezuela	Guatemala	Honduras	Equador	El Salvador	Cuba
Papua New Guinea	Australia	Japan	Germany	China	Singapore	Netherlands	India	Philippines	United Kingdom	Korea
Paraguay	Brazil	Argentina	Chile	Russia	India	United States	Isreal	Peru	Netherlands	Uruguay
Peru	China	United States	Canada	Korea	Switzerland	Japan	India	Brazil	Netherlands	Chile
Philippines	United States	Japan	China	Hong Kong	Singapore	Korea	Thailand	Germany	Netherlands	Malaysia
Poland	Germany	Czech Republic	United Kingdom	France	Italy	Netherlands	Russia	United States	Hungary	Sweden
Portugal	Spain	France	Germany	United Kingdom	United States	Italy	Netherlands	Belgium	Bunkers	Angola
Qatar	Japan	Korea	China	India	Singapore	Thailand	Pakistan	United Kingdom	Italy	Bangladesh
Romania	Germany	Italy	France	Hungary	United Kingdom	Poland	Bulgaria	Turkey	Czech Republic	Netherlands
Russia	China	Netherlands	Germany	Belarus	Turkey	Korea	Utaly	Kazakhstan	United Kingdom	United States
Rwanda	Congo	United Arab Emirates	Uganda	Switzerland	Pakistan	United Kingdom	Burundi	Singapore	South Sudan	Belgium
Samoa	American Samoa	New Zealand	United States	Tokelau	Australia	Japan	Fiji	Thailand	Singapore	Vanuatu
Sao Tome and Principe	Poland	Netherlands	Slovenia	Belgium	United States	Angola	Canada	France	Brazil	Gabon

EXPORTER COUNTRY					Top 10 trade partners					
Saudi Arabia	China	United Arab Emirates	India	Singapore	Turkey	Belgium	Egypt	Kuwait	Malaysia	Jordan
Senegal	Mali	Switzerland	India	Chain	Bunkers	Ivory Coast	Spain	Guinea	United States	Italy
Seychelles	United Arab Emirates	United Kingdom	British Virgin Islands	France	Italy	Malaysia	Mauritius	Thailand	Denmark	Spain
Sierra Leone	China	Korea	Netherlands	Somalia	Ghana	Romania	Germany	Guinea	Senegal	Ivory Coast
Singapore	China	Hong Kong	Malaysia	United States	Indonesia	Japan	Thailand	Korea	Vietnam	India
Slovakia	Germany	Czech Republic	Poland	France	Hungary	Austria	United Kingdom	Italy	United States	Spain
Slovenia	Germany	Italy	Croatia	Switzerland	Austria	France	Serbia	Poland	Hungary	Russia
Solomon Islands	China	Italy	India	Switzerland	Thailand	Netherlands	Philippines	Malaysia	Hong Kong	United Kingdom
South Africa	China	Germany	United States	United Kingdom	Japan	India	Botswana	Mozambique	Namibia	Netherlands
Spain	France	Germany	Italy	Portugal	United Kingdom	United States	Netherlands	Morocoo	Belgium	China
Sri Lanka	United States	United Kingdom	India	Germany	Italy	China	Belgium	United Arab Emirates	Turkey	Singapore
Saint Kitts and Nevis	United States	St. Lucia	Trinidad and Tobago	Antigua and Barbuda	Dominica	Grenada	Belize	British Virgin Islands	St. Vincent and the Grenadines	Barbados
Saint Lucia	United States	Barbados	Trinidad and Tobago	United Kingdom	Dominica	France	Guyana	Antigua and Barbuda	St. Vincent and the Grenadines	Grenada
Saint Vincent and the Grenadines	Barbados	Dominica	St. Lucia	Antigua and Barbuda	United States	Trinidad and Tobago	St. Kitts and Nevis	Grenada	British Virgin Islands	Canada
Sudan	United Arab Emirates	China	Saudi Arabia	Egypt	India	Ethiopia	Pakistan	France	Qatar	Indonesia
Suriname	United Arab Emirates	Belgium	Brazil	Switzerland	China	Jamacia	United States	Netherlands	Singapore	Vietnam
Sweden	Norway	Germany	United States	Finland	Denmark	United Kingdom	Netherlands	China	France	Belgium
Switzerland	Germany	United States	United Kingdom	China	France	India	Italy	Hong Kong	Japan	Spain
Syria	Iraq	Italy	Germany	Turkey	Saudi Arabia	France	Lebanon	Jordan	United States	Netherlands
Tanzania	Rwanda	Kenya	Congo	Zambia	Uganda	United States	China	Indonesia	Malawi	Belgium
Thailand	United States	China	Japan	Vietnam	Hong Kong	Malaysia	Australia	Indonesia	Singapore	India
Togo	Burkina Faso	Benin	India	Niger	Ghana	Mali	Ivory Coast	France	Nigeria	Malaysia
Tonga	New Zealand	Hong Kong	United States	Japan	Australia	Samoa	Philippines	Korea	Fiji	Vanuatu
Trinidad and Tobago	United States	Argentina	Colombia	Peru	Chile	Spain	Jamacia	Brazil	France	Guyana
Tunisia	France	Italy	Germany	Spain	Libya	Algeria	United Kingdom	Netherlands	United States	Belgium
Turkey	Germany	United Kingdom	Iraq	Italy	United States	Spain	France	Netherlands	Israel	Russia
Turkmenistan	Russia	Italy	Iran	Turkey	Ukraine	Switzerland	United Kingdom	Cyprus	Afganistan	Azerbaijan
Turks and Caicos	United States	Haiti	Dominican Republic	Ukraine	Curacao	Thailand	Sweden	Saudi Arabia	Panama	New Zealand
Tuvalu	Samoa	Vanuatu	Vietnam	United States	Thailand	Singapore	Philippines	New Zealand	Malaysia	Korea
Uganda	Kenya	United Arab Emirates	South Sudan	Rwanda	Congo	Italy	Netherlands	Germany	Belgium	Tanzania
Ukraine	Russia	Poland	Italy	Turkey	Germany	China	India	Hungary	Netherlands	Egypt
United Arab Emirates	Saudi Arabia	India	Iraq	Switzerland	Oman	China	Kuwait	Iran	United States	Hong Kong
United Kingdom	United States	Germany	France	Netherlands	China	Ireland	Belgium	Switzerland	Spain	Italy
United States	Canada	Mexico	China	Japan	United Kingdom	Germany	Korea	Netherlands	Brazil	France
Uruguay	China	Brazil	United States	Argentina	Netherlands	Algeria	Russia	Mexico	Turkey	Germany
Vanuatu	Malaysia	Philippines	New Zealand	Australia	Fiji	New Caledonia	Japan	Papua New Guinea	United States	Solomon Island
Venezuela	United States	China	Colombia	Netherlands	Brazil	Belgium	Trinidad and Tobago	Chile	Korea	Mexico
Vietnam	United States	China	Japan	Korea	Hong Kong	Netherlands	India	Germany	United Kingdom	Thailand
Wallis and Futura Islands	South Africa	Vanuatu	United States	Uruguay	Ukraine	Turkey	Tunisia	Tonga	East Timor	Thailand
Yemen	Egypt	Turkey	Oman	Sudan	Eritrea	Indonesia	China	Argentina	Japan	Korea
Zambia	Switzerland	China	Congo	Singapore	South Africa	Malawi	Zimbabwe	Hong Kong	Tanzania	Luxembourg
Zimbabwe	South Africa	United Arab Emirates	Mozambique	Belgium	Zambia	Botswana	Kenya	Eswatini	Namibia	Hong Kong

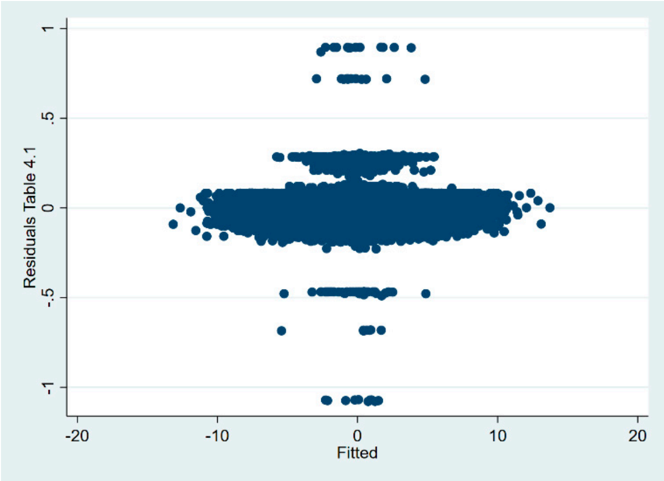
Appendix D

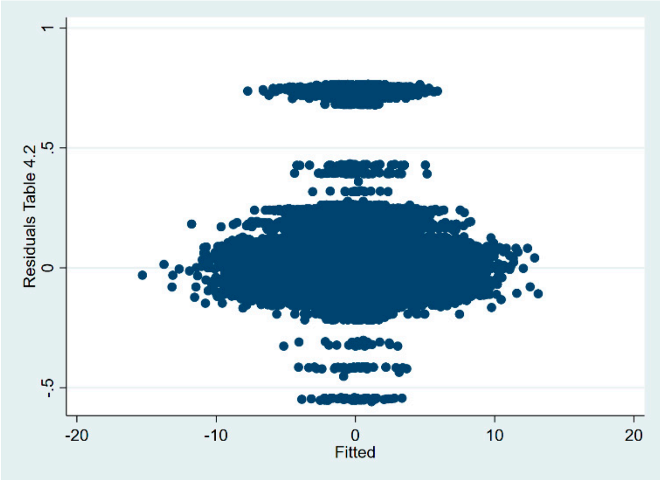
The *t*-stat of the difference is calculated using the formula

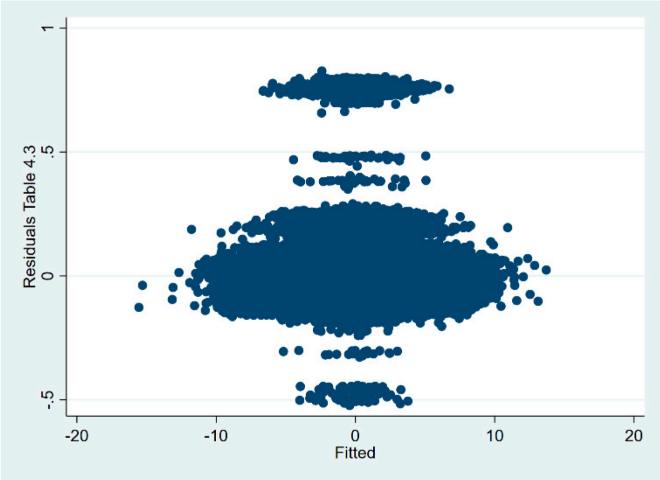
$$\frac{\overline{x}-\overline{y}}{\sqrt{\frac{s_x^2}{n_1}-\frac{s_y^2}{n_2}}} = \textbf{test statistic} \quad \text{(A1)}$$

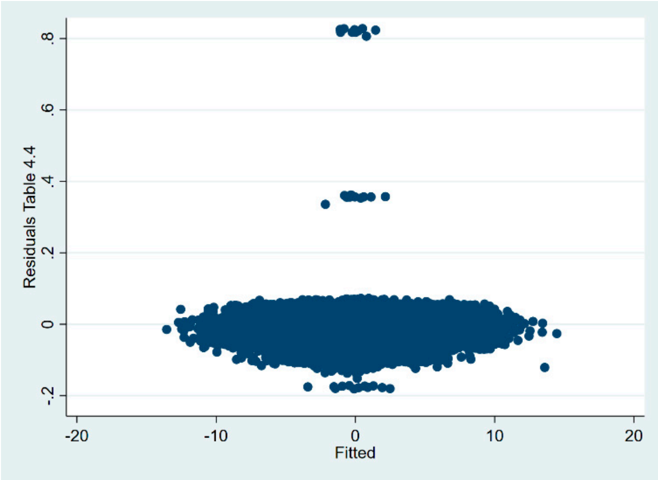
where the null hypothesis is $H_0\!:\mu_x - \mu_y = 0$, x and y are the values of the bars, i.e., the percentage of countries with a positive coefficient, $\overline{x}$, $\overline{y}$, s_x, and s_y are the sample means and standard deviations constructed by setting the value of the country observation where there is a significant positive coefficient to 1 and 0 if it is not positively significant, n_1 and n_2 are the two sample sizes.

Appendix E


Residuals Table 4.1
1
.5
0
-.5
-1
-20
-10
0
10
20
Fitted


Residuals Table 4.2
1
.5
0
-.5
-20
-10
0
10
20
Fitted


Residuals Table 4.3
1
.5
0
-.5
-20
-10
0
10
20
Fitted



Appendix F

Table 4's first Stage Regression:	Dependent variable: **Δ** Log skill level		
Log skill level first lag	0.22 (82.3) ***	Services exporter dummy	−0.01 (−74.02) ***
Log skill level second lag	−0.24 (−89.65) ***	Fuel exporter dummy	0.02 (9.01) ***
Low income dummy	−0.003 (−13.89) ***	Constant	0.06 (60.09) ***
High income dummy	0.007 (49.27) ***	R-squared	0.22
Manufacturing exporter dummy	−0.001 (−19.72) ***	Observations	527,441
Table 5's first Stage Regression:	Dependent variable: **Δ** Log Capital Per worker		
Log capital per worker first lag	0.68 (470.88)	Services exporter dummy	0.002 (30.59)
Log capital per worker second lag	−0.68 (−461.78)	Fuel exporter dummy	−0.01 (−16.08)
Low income dummy	−0.002 (−12.52)	Constant	0.02 (16.27)
High income dummy	−0.002 (−16.67)	R-squared	0.63
Manufacturing exporter dummy	0.01 (145.6)		
Table 6's first Stage Regression:	Dependent variable: **Δ** Log PGDP		
Log PGDP first lag	0.34 (217.72) ***	Services exporter dummy	0.0001 (0.73)
Log PGDP second lag	−0.35 (−223.44) ***	Fuel exporter dummy	−0.02 (−24.83) ***
Low income dummy	−0.02 (−68.14) ***	Constant	0.07 (21.47) ***
High income dummy	0.01 (54.13) ***	R-squared	0.34
Manufacturing exporter dummy	0.01 (189.82) ***		
Table 7's first Stage Regression:	Dependent variable: **Δ** Log skill level		
Log skill level first lag	0.06 (42.23)	Services exporter dummy	0.03 (55.53)
Log skill level second lag	−0.101 (−77.45)	Fuel exporter dummy	−0.02 (−36.89)
Low income dummy	0.001 (2.78)	Constant	0.19 (152.57)
High income dummy	0.01 (44.73)	R-squared	0.17
Manufacturing exporter dummy	−0.01 (−79.23)		

Table 8's first Stage Regression:	Dependent variable: **Δ** Log PGDP		
Log PGDP first lag	−0.32 (−156.99) ***	Services exporter dummy	0.01 (95.99) ***
Log PGDP second lag	0.30 (148.77) ***	Fuel exporter dummy	−0.03 (−49.67) ***
Low income dummy	0.01 (25.62) ***	Constant	0.17 (173.60) ***
High income dummy	0.02 (96.90) ***	R-squared	0.57
Manufacturing exporter dummy	0.02 (179.13) ***		

* significant at 10%; ** significant at 5%; *** significant at 1%.

Notes

1. I seek to address within-product changes in unit values and not changes in the product mix. Therefore, the focus is the changing unit value of the same product. Schott (2004) found evidence of within-product specialization among countries in cross-sectional analysis. According to Schott (2004), high- and low-income countries export higher and lower unit value versions, respectively, of the same products. My analysis seeks to address this issue over time to investigate if individual countries move up the value ladder in their *existing* exports. Thus WPI is used as the deflator for this exercise.
2. The low R-squared was investigated by residual plots for each of the regressions in Tables 4–8. These are presented in Appendix E. The residuals are randomly distributed around 0 when plotted against the fitted value of the equation. The low R-squared appears to come from the noisiness of the data, and the trends we find are still significant and practically meaningful.
3. Each table's cell gives the proportion of countries with a significant regression coefficient on the factor accumulation variable. For example, in the first cell, six out of 23—approximately 25%—of high-income countries, in 1989–2001, have a significant positive coefficient on skill accumulation.
4. Further details are presented in Appendix D.

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