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THE VARIETY AND QUALITY OF A NATION'S TRADE

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ABSTRACT

Not surprisingly, big countries trade more than small countries. In this paper we use data on shipments by 110 exporters to 59 importers in 5,000 product categories to ask: *how*? Do big countries trade larger quantities of a common set of goods (the intensive margin), a larger set of goods (the extensive margin), or higher quality goods? We find that the extensive margin accounts for two-thirds of the greater exports of larger economies, and one-third of the greater imports of larger economies. Richer countries export more units at higher prices. These calculations are useful for distinguishing features of trade models that correspond more or less well to the data. Models with Armington national product differentiation do not feature the extensive margin, and wrongly predict that greater output will be accompanied by worse terms of trade. "Krugman" style models with firm level product differentation fare better, but must be modified to include quality differentiation and fixed costs of trading to match all of the facts. Estimates based on these modifications imply that differences in goods' quality could be the proximate cause of about 25% of country differences in real income per worker.

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1. Introduction

Virtually every theory of international trade predicts that, ceteris paribus, larger economies trade more than smaller economies. Trade theories differ, however, in their predictions for *how* larger economies trade more. Models that assume Armington (1969) national differentiation emphasize the "intensive" margin: a country with double the resources will trade twice as much but will not trade a greater number of goods. Monopolistic competition models in the vein of Krugman (1981) stress the "extensive" margin for exports: economies twice the size will produce and export twice as many goods. Romer's (1994) model displays an extensive *import* margin because of fixed costs of importing each variety.[1] In his model larger economies import a wider diversity of products from a wider array of foreign suppliers. Vertical differentiation models such as Flam and Helpman (1987) feature a quality margin, with richer countries producing and exporting higher quality goods.

These different predictions matter because they carry with them very different consequences for welfare. Expanding exports of distinct national varieties on a purely intensive margin can drive down the prices of those varieties on the world market, worsening a country's terms of trade. In large-scale CGE models with distinct national varieties, the simulated welfare changes associated with trade liberalization are dominated by such terms of trade effects (see Brown, 1987). In Acemoglu and Ventura (2001), these terms of trade effects prevent real per capita incomes from diverging across countries with high versus low investment rates. These authors argue that such terms of trade effects exist in the data and are the critical force maintaining a stationary world income distribution.

To the extent larger economies export more on extensive margins or export higher quality goods, adverse terms of trade effects are no longer a necessary consequence. Rather than sliding down world demand curves for their varieties, bigger economies may export more varieties to more countries. Or they may export higher quality goods at higher rather than lower prices. If variety and quality margins dominate, then growth and development economists must rely on other forces to

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[1] A related model is Melitz (1999), which features fixed costs of production *and* fixed costs of exporting.

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tether the incomes of high and low investment economies together.[2] And the welfare effects of trade liberalization could be very different than is typically found in many CGE models.

The welfare stakes are just as high on the import side. Romer (1994) shows that the welfare costs of tariffs can be an order of magnitude larger when available import variety is endogenous. In the same spirit, geographic isolation could be much costlier if it lowers available import variety. This would help explain two intriguing results in the literature: Gallup, Sachs and Mellinger (1998) find that a country's access to navigable waterways is strongly related to its trade and development;. Frankel and Romer (1999) find that distance from other economies is very negatively related to its trade and per capita income.[3]

Large economies, just like those with low trade barriers or ones near other markets, may have access to more varieties of imported goods. Evidence on whether larger economies import more varieties (vs. more per variety) can help quantify one causal channel from trade to income and welfare. Rich economies tend to be large economies, so differential access to specialized intermediate and capital goods could amplify differences in income across countries. And because utility gains from consumption variety are not captured in conventional PPP accounting, differences in access could mean that the differences we observe actually understate the true differences.

In this paper we use highly detailed U.N. data on exports in 1995 by 110 countries to 59 importers in over 5,000 6-digit product categories. To check robustness we also examine U.S. imports in 1995 from 119 countries in over 13,000 10-digit product categories. We decompose the greater trade of larger economies into contributions from intensive vs. extensive margins. We measure extensive margins using the number of category-partners, appropriately weighting each category-partner by the amount of trade involved. We carry out decompositions for both exports and imports and relate them to country size as measured by PPP GDP (as well as its GDP per worker and worker components). By comparing the prices and quantities of exports by different countries to a given market-categories, we also estimate quality differences across exporters.

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[2] For example, technology diffusion and/or diminishing returns to capital.
[3] Rodrik (2001) and others, however, are skeptical that these correlations reflect causal effects of isolation.

Our investigation builds on the empirical work of many predecessors. Feenstra (1994) mapped out a method for measuring variety growth. He applied his method to U.S. import price indices for six manufactured goods, and found evidence of substantial import variety growth. Klenow and Rodríguez-Clare (1997) estimated very modest variety gains to Costa Rica from its 1986-1992 trade liberalization. Feenstra, Madani, Yang and Liang (1999) related variety growth in South Korean and Taiwanese exports to TFP growth in 16 sectors over 1975-1991. Feenstra and Rose (2000) documented a classic product cycle among exporters to the U.S.: countries with faster growth rates began exporting the products exported by higher income countries. Funke and Ruhwedel (2001) found that direct measures of product variety are positively correlated with per capita income across 19 OECD countries.

Head and Ries (2001) try to empirically distinguish between increasing returns and national product differentiation models by looking for home market effects in U.S. and Canadian trade. They examine whether manufacturing industries produce proportionately more of what is locally demanded (as in increasing returns models) or proportionately less (as with national differentiation models). They find evidence mostly consistent with national product differentiation. By comparison, we examine model implications for extensive (increasing returns) versus intensive (national product differentiation) margins, along with the terms of trade effects that each implies.

Schott (2001) finds that richer countries export to the U.S. at higher unit prices within narrow categories. He finds that these unit value premia increased over 1972-1994. Over the same period he documents a marked decline in the tendency of individual types of products to come exclusively from poor or rich countries. Navaretti and Soloaga (2001) show that European transition economies import equipment at lower prices than the U.S. does, suggesting these countries import lower-quality equipment than the U.S. does. Like these studies we exploit data on export prices in narrow categories by countries of differing income levels. Unlike these studies, we use quantity data along with price data to extract information about quality differences.

The rest of the paper proceeds as follows. In section 2 we describe how we decompose exports and imports into respective extensive and intensive margins (and the latter into price and

quantity components). In section 3 we describe the datasets we use. We present the decomposition results in section 4, and compare them to the predictions of various trade theories in section 5. In section 6 we offer conclusions and possible directions for future work.

2. Decomposition Methodology

2a. Decomposing Exports

We decompose each country's exports into the product of extensive and intensive margins. This enables us to ask: do countries that export more ship larger values of a common set of goods (intensive margin), or do they ship a larger set of goods to more markets (extensive margin). We also decompose the intensive margin into price and quantity components in order to evaluate whether higher export values correspond to more units, or higher priced units.

We construct measures so that for each country and each year,

Share of World Exports = Intensive Export Margin • Extensive Export Margin

Intensive Export Margin = Export Price Index • Export Quantity Index.

After taking logs, we will regress each of the terms on country log GDP (as well as, jointly, log income per worker and log number of workers). The regression samples will be cross-sections of exporting countries in a given year. Because OLS is a linear operator, the coefficients from right-hand-side component regressions sum to the coefficients from left-hand-side regressions. In effect, the regressions additively decompose the margins along which larger economies tend to export more. For exporting country j in a given year, we define the variables as follows:

(2.1) $$\text{Share of World Exports } = \ x_j/x_W$$

where x_j = nominal exports of country j, and x_W = nominal world exports (from all countries to

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all countries).

$$(2.2) \qquad \text{Intensive Export Margin} \; = \; \frac{x_j}{\displaystyle\sum_{i \neq j} \sum_{s \in X_{jis}} x_{Wis}}$$

where x_{Wis} = world exports to country i in product category s, and X_{jis} = {the set of market-category (i, s) pairs for which $x_{jis} > 0$}, where x_{jis} = nominal exports of country j to country i in product category s. The intensive export margin measures a country's share of world exports *in those market-categories in which it exports*.

$$(2.3) \qquad \text{Extensive Export Margin} \; = \; \frac{\displaystyle\sum_{i \neq j} \sum_{s \in X_{jis}} x_{Wis}}{x_W} \; .$$

The extensive margin for country j measures the fraction of *world* exports that occur in those market-categories in which country j exports. This extensive margin is a cross-country and export analogue of Feenstra's (1994) measure of import variety growth across time for a given country. Other things equal, if a country concentrates all of its exports in a small number of market-categories, it will have a higher intensive export margin and a lower extensive margin. If that country spreads its exports thinly over many market-categories, it will have a lower intensive export margin and a higher extensive margin.

      An alternative decomposition would define the extensive margin simply as the number of market categories in which the country exports, with the intensive margin described by an average of exports per market-category. Such a simple count of market-categories treats small and large market-categories equally in calculating the extensive margin. That is, selling wind-up toys to Lichtenstein gets equal weight with selling cars to Germany. Our measure of the extensive margin (2.3) can be understood as a weighted count, with each market-category receiving a weight equal to its share in world exports.[4]

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[4] Because (2.3) weights market-categories by their importance in world exports rather than a country's own exports, it might overstate the extensive margin if the distribution of exports across market-categories is more left-skewed in

The intensive margin in (2.2) is calculated using nominal export shares in each market-category. For each market-category, we break the intensive margin down into price and quantity components. We then aggregate these components across market-categories to calculate an export price index and an export quantity index for each country. The export price index for exporter j is

$$
(2.4) \quad \text{Export Price Index} = \left[\frac{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{jis} q_{jis}}{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{Wis} q_{jis}} \right]^{\frac{1}{2}} \left[\frac{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{jis} q_{Wis}}{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{Wis} q_{Wis}} \right]^{\frac{1}{2}}
$$

where q_{jis} = the quantity of exports from country j to country i in category s, $p_{jis} = x_{jis}/q_{jis}$, q_{Wis} = the quantity of world exports to country i in category s, and $p_{Wis} = x_{Wis}/q_{Wis}$. The index is a geometric-weighted average of two price indices, one using the country's own export quantities to weight market-categories and the other using world export quantities to weight market-categories. This is a Fisher Ideal Index, which is widely used for constructing price and quantity indices (e.g., U.S. Bureau of Economic Analysis, 2001). The export price index in (2.3) summarizes the extent to which an exporter's prices are high or low relative to other prices in the same market-category. Price variation within market-categories may be due, in part, to quality variation, but the two are distinct objects. We elaborate on this point in Section 5.

We define the quantity price index for exporter j compatibly:

$$
(2.5) \quad \text{Export Quantity Index} = \left[\frac{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{jis} q_{jis}}{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{jis} q_{Wis}} \right]^{\frac{1}{2}} \left[\frac{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{Wis} q_{jis}}{\sum_{i \neq j} \sum_{s \in X_{jis}} p_{Wis} q_{Wis}} \right]^{\frac{1}{2}} .
$$

This is likewise a Fisher Ideal Index. The product of (2.4) and (2.5) equals (2.2). That is, differences across exporters in prices and quantities combine to yield differences in nominal export values on the intensive margin.

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larger economies. We find no correlation between a country's size and the skewness of its export shares across market-categories.

In our empirical implementation we will also calculate intensive and extensive margins based on export categories rather than export market-categories. Comparing the two measures of the extensive margin will allow us to gauge the importance of categories compared to that of destination countries within categories. Decompositions based on categories replace the set X_{jis} with the set X_{js} = {categories s in which $x_{jis} > 0$ for *some* importer i}.

2b. Decomposing Imports

For importing country i in a given year, we define the import variables analogously:

$$(2.6) \qquad \text{Share of World Imports} \ = \ m_i/m_W$$

where m_i = nominal imports of country i, and m_W = world imports (by all countries from all countries).

$$(2.7) \qquad \text{Intensive Import Margin} \ = \ \frac{m_i}{\displaystyle\sum_{j \neq i} \sum_{s \in M_{ijs}} m_{Wjs}}$$

where m_{Wjs} = world nominal imports from country j in category s, and M_{ijs} = {source-categories (j, s) for which $m_{ijs} > 0$} where m_{ijs} = nominal imports by country i from country j in category s. The intensive import margin measures a country's share of world imports *in those source-categories in which it imports*.

$$(2.8) \qquad \text{Extensive Import Margin} \ = \ \frac{\displaystyle\sum_{j \neq i} \sum_{s \in M_{ijs}} m_{Wjs}}{m_W} \ .$$

The extensive import margin for country i measures the fraction of world imports that occur in the source-categories in which country i imports.

Unfortunately, we cannot decompose the intensive margin for imports into price and quantity components, as we did for exports. The reason is that quantity units may differ across importers in a particular category.[5] This means we cannot determine, for example, the extent to which richer countries import higher priced products within categories. This is not a problem on the export side because all calculations are defined relative to world shipments to a particular importer in a particular category.

3. Data Description

The trade data we use are drawn from two sources. Worldwide trade data are taken from UNCTAD's Trade Analysis and Information System (TRAINS) CD-ROM for 1995. The TRAINS project combines bilateral imports data collected by the national statistical agencies of 76 importing countries, covering all exporting countries (227 in 1995). The data are reported in the Harmonized System classification code at the 6 digit level, or 5,017 goods, and include shipment values and quantities. For a subset of these countries (110 of the 227 exporters and 59 of the 76 importers), we have matching employment and GDP data (discussed below). The 59 importers represent the vast majority of world imports, so total shipments for each exporter reported in TRAINS closely approximates worldwide shipments for that exporter.

U.S. trade data with more product detail are taken from the "U.S. Imports of Merchandise" CD-ROM for 1995, published by the U.S. Bureau of the Census. These data are drawn from electronically submitted Customs forms that report the country of origin, value, quantity, freight paid, duties paid, and Harmonized System (HS) classification code for each shipment entering the United States. The 10-digit HS scheme includes 13,386 highly detailed goods categories. There are, for example, 13 separate lines covering motorcycles, and 140 lines covering various auto

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[5] Email correspondence from Hiroaki Kuwahara, Chief of the Trade Information Section of the Trade Analysis Branch of DITC/UNCTAD: "The quantity of imports can only be compared among different exporters in a given market for a given product in a given year. While in most cases, quantity is given in KG or Metric Tons, other units, such as litres, square meters etc, are also used, and are NOT consistent among different markets (and sometimes not even in a same market in different years) for a given product."

parts. The data include all countries shipping to the United States, a total of 222 in 1995. We have employment and output data in 1995 for 119 of these exporters.[6]

In both datasets, we measure prices as unit values (value/quantity). Quantity (and therefore price) data are missing for approximately 16 percent of U.S. observations and 18 percent of worldwide observations for 1995.[7] When the U.S. data include multiple shipments from an exporter to an importer in a 10-digit category, we aggregate values and quantities. The resulting prices are quantity-weighted averages of prices found within shipments from that exporter in that category.

Data on national employment and GDP at 1996 international prices (PPP) come from Summers and Heston (2001). We use PPP GDP, as opposed to GDP at current market exchange rates, to avoid any "mechanical" association between an exporter's price and GDP through the value of its market exchange rate. For some calculations in Section 5, however, we need import shares in GDP at market exchange rates. We obtain GDP at market exchange rates in 1995 from the World Bank's World Development Indicators.

4. Decomposition Results

4a. Results for Exports

Table 1 presents extensive vs. intensive margins estimated using 1995 U.N. data on exports by 110 countries to 59 importers in 5,017 categories. Each exporting country is an observation (so 110 observations total). All of the coefficients in this and subsequent Tables are significantly different from zero (p-values below 1%) unless otherwise noted. Table 1 includes results from regressions on GDP per worker and number of workers jointly, but for brevity we focus on the third column, regressions on total GDP. The first row shows that countries with twice the PPP GDP (in 1996 dollars) export roughly twice as much. The second and third rows indicate that one-third of the additional exporting done by larger economies occurs on the

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[6] The remaining 103, primarily very small or former Soviet-bloc countries, comprise only 6% of U.S. trade in 1995.
[7] The likelihood that quantity data are missing is unrelated to any of the variables employed in this study, and so our analyses should not be biased by dropping these observations.

intensive margin (within each market-category) and two-thirds on the extensive margin (exporting in more categories and to more countries within categories).

Table 2 sheds light on the extensive margin by calculating it in several different ways. The first row repeats the last row of Table 1. The second row measures the extensive margin using a simple count of category-markets in which the exporter ships. Unlike the first row, this gives an equal weight to all categories and markets, regardless of their size. The second row shows that larger economies export in a higher *number* of markets and categories, and that the simple count of market-categories rises faster with GDP than does the count weighting market-categories by their share of world export volume (compare rows 1 and 2). This indicates that larger economies are more likely to export in "small" market-categories.

The third row calculates the extensive margin using categories rather than market-categories. That is, if two countries export the same set of goods, but one exports to more markets, it will have a larger extensive margin in row one, but the same extensive margin in row three. The extensive margin defined in terms of categories accounts for 44% of the greater volume of exports of larger economies. Comparing the first and third rows, around two-thirds of the extensive margin comes from exporting in more categories, while one-third comes from shipments to additional destinations within categories. The fourth and final row of Table 2 again defines the extensive margin in terms of categories, but uses a simple count that gives equal weight to all categories regardless of their importance in trade. It shows that a country with twice the GDP typically exports in 62% more categories. Because counts rise faster with GDP than do weighted counts, larger economies must be more likely to export in "small" categories.

Table 3 breaks the intensive margin into its price and quantity components. Countries with twice the GDP per worker (but the same employment) export 21% more quantity at 19% higher prices within market-categories. Also within market-categories, countries with twice the employment export 27% more quantity at 4% higher prices.

4b. Results for Imports

Table 4 presents extensive and intensive margins for the imports of 59 countries (from 110 exporters in 5,017 categories in 1995). Twice the GDP per worker is associated with almost twice the imports (94% more according to the first row). In contrast to exports, we find a larger intensive margin (72%) than extensive margin (28%), i.e. for imports we find that greater imports mostly take the form of more imports per source-category rather than more source-categories.

Table 5 provides alternative estimates of the extensive margin for imports (see the Table 3 discussion for details). Comparing the first two rows of Table 5 reveals that simple counts of source-categories rise more quickly with importer size than do the counts of these source-categories weighted by their share in world imports. This tells us that larger economies are more likely to import in "smaller" source-categories. Looking at the final two rows of Table 5, we can see that economies twice the size import in 17% more categories, but that the greater range of categories accounts for only 9% of their additional imports. Larger economies have a greater propensity to import in categories accounting for a small share of world imports.

4c. Robustness to Using U.S. Import Data

Our results with the U.N. data might understate the extensive margin if there are multiple varieties within 6-digit U.N. product categories to a given market from a given source country. For example, Japan exported 56 distinct car models to the U.S. in 1995.[8] For this reason (and to check overall robustness), we examine U.S. imports, which are available in 10-digit category detail (13,386 categories compared to the 5,017 in the 6-digit U.N. data).

Table 6 decomposes exports for a sample of 119 countries exporting to the U.S. in 1995. The extensive margin in Table 3 accounts for 54% of additional exports to the U.S. by larger economies. The extensive margin here is categories (rather than market-categories) because the U.S. is the only destination market. The results are therefore not directly comparable to the results with the 6-digit U.N. data. We can, however, compare extensive margins at different levels of

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[8] Source: Ward's Motor Vehicle Facts & Figures, which distinguishes domestic production from imports by model.

aggregation for a single dataset. Table 7 does this for the U.N. dataset and the U.S. dataset. For the U.N. dataset the measure of the extensive margin is categories. The two datasets display similar rates of decline of the extensive margin when moving from the 6-digit level to the 4-digit level and 2-digit level.[9] In the U.S. dataset, Table 7 shows that the extensive margin is notably higher at the 10-digit level (54%) than at the 6-digit level (46%). Bigger economies export to the U.S. in more 10-digit categories within 6-digit categories.

Table 8 decomposes each country's exports to the U.S. into their price and quantity components, and regresses on exporter size. Richer economies export higher quantities to the U.S. at higher prices, and countries with more workers export higher quantities at no lower prices. Exports by 119 countries to the U.S. in 1995 tell a remarkably similar story to that told by exports by 110 countries to 59 countries in 1995 in the U.N. data.

4d. Other Robustness Checks

We carried out a number of other robustness checks on our results. First and foremost, we explored whether the results change when we include measures of trade barriers. For the U.S. dataset, we used (total duties + total freight)/(nominal exports). We calculated this for each exporter j in each 10-digit category s, then weighted by the share of category s in U.S. imports from all countries to obtain a barrier τ_j for country j's exports. When we add this variable as a control to all of the Table 6 and Table 8 regressions, none of the coefficients on exporter size is altered by even one standard error, and the barrier measure is always insignificant. The same statements apply when the barrier measure is constructed from a country's barrier in category s relative to the average barrier across all exporters in that category.

For the U.N. countries and categories, data on tariffs and freight costs are not readily available. In their stead we deploy crude proxies for barriers. One proxy, in the spirit of Frankel and Romer (1999), is a country's distance to markets. For exporter j, the distance to market i is weighted by country i's share of world output in 1995 at market exchange rates. The weights are

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[9] The extensive margin is zero, of course, at the economy (0-digit) level.

normalized to sum to one for each exporter j and produce a j-specific measure of distance to markets. The other two barrier proxies we construct are averages of (j, i) indicator variables denoting a common language and a common border, both also summed across i's (again weighting by i's share of world output). When we included these three proxies as controls in the Table 1 and 3 regressions, it had no material effect on any of the exporter size coefficients.

As another robustness check, we examined decompositions for consumption goods and intermediate plus capital goods separately.[10] Smaller countries may have a narrower range of industries (because of fixed costs of production) and hence no demand for imports of certain intermediates and capital goods. For example, a country without a steel industry would have no demand for imported steel-making equipment. On the grounds that people are generalists in consumption (vs. specialists in production), this argument has much less force for consumer goods. The results, both for exports and imports, were very similar to those reported in Tables 1 through 5. We view this as crucial evidence that the (moderate) extensive margin we estimated for imports in Table 4 is not due to the absence of industrial demand.

We performed a variety of other robustness checks. We split the sample into the top and bottom halves of GDP. Again, the results were qualitatively similar to those with the entire sample. We redid Table 1 using only the 59 exporters for which we also had import data. The results changed very little. This means that the difference in the size of the extensive margin on the export size (around two-thirds) versus the import size (less than one-third) is not due to different samples of countries. For Table 2 in particular, we replaced the GDP per worker regressors with GDP per worker *relative to the category mean*. The idea was that an exporter's relative price should depend on whether the exporter was rich relative to other exporters in the category. The coefficients changed very little. Finally, we redid the U.S. import regressions using 1990 data. The results were very similar to those reported in Tables 6 and 7 with 1995 data.

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[10] We use the UN's Broad Economic Classification system which provides a split of trade categories into capital, intermediate, and consumption goods.

5. How Various Models Stack Up Against the Decompositions Results

In this section we compare the predictions of five trade models to the facts we documented in the previous section. We do not consider these to be "tests" in the formal sense, and the models we choose are deliberately stark in their predictions. Our goal is twofold: first, to use the structure of these models to interpret our facts and highlight potential welfare implications; second, to identify features of these models that fit our facts more or less well, with the hope that this can point future work in a useful direction.

The models we consider are as follows: a simple Armington model of nationally differentiated goods, Acemoglu and Ventura's (2001) model of the world income distribution, a simple Krugman model of increasing returns in production, a simple model of endogenous quality differentiation, and Romer's (1994) model of fixed costs of importing each variety. In Table 9 we summarize the data and each model's implication for the size of intensive vs. extensive margins for exports and imports. In Table 10 we summarize the data and model predictions for the price and quantity components of the intensive margin for exports. We now lay out one model at a time to explain the corresponding entries in the Tables.

5a. A Simple Armington Model

In this subsection we describe a simple model embodying the Armington (1969) assumption that goods are differentiated by national origin. There are J countries, with country j producing a unique variety. Consumer preferences are identical across countries. All workers within a country have the same income and preferences. A representative worker/consumer in each country i chooses q_{ij} for $j = 1, ..., J$ to maximize

$$(5.1) \qquad U_i = \sum_{j=1}^{J} q_{ij}^{1-1/\sigma}$$

subject to

$$(5.2) \qquad \sum_{j=1}^{J} p_j q_{ij} \leq w_i L_i = p_i q_i = Y_i.$$

Here q_{ij} is the number of units of country j's variety purchased by country i, and $\sigma > 1$ is the elasticity of substitution between varieties. In (5.2) p_j is the world price of country j's variety, q_i is the number of units that country i produces of its variety, and Y_i is GDP in country i. There are no tariffs, transportation costs, or other trade barriers.

Since all consumers in the world face the same prices and have the same preferences, *world* demand reflects individual consumer demand. From (5.1) and (5.2) we get that relative demands are decreasing in relative prices:

$$(5.3) \qquad\qquad \frac{q_j}{q_i} = \left(\frac{p_j}{p_i} \right)^{-\sigma}.$$

A representative firm produces a country's variety with the production technology

$$(5.4) \qquad\qquad q_j = A_j L_j ,$$

where A_j and L_j are labor productivity and the number of workers in country j. The model has no physical capital. (In each country, the representative firm is a stand-in for a continuum of competitive firms operating with this linear technology.) The firm hires labor (taking the country wage rate a given) to maximize profits

$$p_j q_j - w_j L_j ,$$

where w_j is the wage in country j. A competitive market for each variety ensures that price equals marginal cost:

$$(5.5) \qquad\qquad p_j = \frac{w_j}{A_j} .$$

Substituting (5.5) for countries i and j into (5.3) yields

(5.6)
$$\frac{q_j}{q_i} = \left(\frac{A_j/w_j}{A_i/w_i} \right)^{\sigma}.$$

This expression incorporates both preferences and technology. It says that, conditional on wages, country j produces more units (relative to country i) the higher the country's process productivity.

Combining (5.4) and (5.6) pins down the market-clearing wage as

(5.7)
$$\frac{w_j}{w_i} = \left(\frac{L_j}{L_i} \right)^{-1/\sigma} \left(\frac{A_j}{A_i} \right)^{1-1/\sigma}.$$

Using (5.7) in (5.5) and (5.6) gives

$$\frac{p_j}{p_i} = \left(\frac{A_j L_j}{A_i L_i} \right)^{-1/\sigma}$$

and

$$\frac{q_j}{q_i} = \frac{A_j L_j}{A_i L_i}$$

In turn, relative GDP's are

(5.8)
$$\frac{Y_j}{Y_i} = \left(\frac{A_j L_j}{A_i L_i} \right)^{1-1/\sigma}.$$

and therefore

(5.9)
$$\frac{q_j}{q_i} = \left(\frac{Y_j}{Y_i} \right)^{\frac{\sigma}{\sigma-1}}$$

and

(5.10)
$$\frac{p_j}{p_i} = \left(\frac{Y_j}{Y_i} \right)^{\frac{-1}{\sigma-1}}$$

Having a large economy drives up the quantities produced of each variety (5.9), thereby driving

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down their unit prices (5.10). This important property of the Armington model arises because each country is assumed to produce a unique variety. Producing more drives consumers down a single demand curve for the national variety, adversely affecting the country's terms of trade. (This terms of trade effect dominates welfare calculations of trade liberalizations conducted in CGE models with Armington preferences, see Brown (1987)). The price effect only partially offsets the quantity effect, however, because demand is elastic ($\sigma > 1$). Thus a bigger workforce lowers GDP per worker but increases GDP (5.8). Higher GDP per worker occurs as a result of higher process productivity A.

This simple Armington model predicts that larger economies trade more entirely on the intensive margin. Without an extensive margin the model misses two-thirds of how larger economies export more, and one-third of how they import more. (See the first and second rows of Table 9.) The model also predicts that countries with higher GDP will export higher quantities at lower prices. In the data, countries with higher GDP do export higher quantities, though not nearly to the extent predicted by the model (elasticities around a quarter in the data vs. greater than one in the model). The price facts are similarly at odds with the predictions of this Armington model. Richer countries export at higher prices, and countries with more workers export at no lower prices than countries with fewer workers. (Compare the first and second rows of Table 10.)

5b. Acemoglu and Ventura's Model of the World Income Distribution

Acemoglu and Ventura (2001) add endogenous capital accumulation and an endogenous number of varieties to the Armington model of the previous section. They posit constant returns to capital in the production of each variety, and a fixed labor requirement for producing each variety. In equilibrium the number of varieties a country produces is proportional to its employment, and countries with higher income per worker have lower export prices. The terms of trade are a crucial mechanism in their model. Absent counterbalancing terms of trade effects, incomes of high investment rate countries would diverge from low investment rate countries. This is an important point as their story challenges the traditional view that diminishing returns to

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capital prevent income divergence. With a strong enough terms of trade mechanism their model does not require any externalities, such as technology diffusion across countries, to maintain a stationary world income distribution.

Acemoglu and Ventura's model contains an extensive export margin with respect to the size of the labor force but not an extensive import margin: countries with more workers will produce and export more varieties, but all countries import all varieties. Their model contains no extensive margin with respect to GDP per worker, and this is critical to their explanation for why the world income distribution remains stationary. In the model, richer countries export higher quantities of each variety, driving down their prices on the world market. In contrast, the data reveal an important extensive margin with respect to GDP per worker. Exporting in more market-categories accounts for over two-thirds of the greater exports of richer countries.

Acemoglu and Ventura report that their model comes close to generating the observed variation in income across countries if 1% higher GDP per worker goes along with 0.7% lower export prices. This requires an elasticity of substitution of around 2.3 between the varieties of different countries. If the elasticity is higher than 2.3 then the terms of trade effects will be weaker. If richer countries produce more varieties, this too will weaken the terms of trade effects. Whatever the cause, if the evidence does not support a terms of trade elasticity in the neighborhood of -0.7%, then their model generates more variation in income per worker across countries than we observe in the data.

The third row of Table 10 summarizes these predictions for export prices and quantities. Comparing the first and third rows, it is clear that the Acemoglu and Ventura model matches only the fact that countries with more workers have no lower export prices. Just like the simpler Armington model of the previous subsection, they predict that richer countries export much higher quantities of each variety and at sharply lower prices. In the data, richer economies export modestly higher quantities of each variety at modestly higher prices. This suggests that diminishing returns and technology diffusion may be needed to ensure a stationary world income distribution because terms of trade effects alone are insufficient (and indeed, go the wrong way).

5c. A Krugman Model

Krugman (1980, 1981) modeled countries as producing an endogenous number of varieties.[11] In these models, love of variety in utility and/or production plus free entry by firms leads to a proliferation of varieties. This is tempered by fixed costs of production, so the number of varieties produced in a country is increasing with country size. We sketch a simple model with these properties.

Country j produces N_j varieties, each selling for the same price and having the same quality. The representative worker/consumer in country i maximizes

$$(5.11) \qquad U_i = \sum_{j=1}^{J} N_j (q_{ij}/N_j)^{1-1/\sigma}$$

subject to

$$(5.12) \qquad \sum_{j=1}^{J} p_j q_{ij} \leq w_i L_i = p_i q_i = Y_i.$$

Here q_{ij} represents the total units purchased by country i of all country j varieties. Units bought per variety are q_{ij}/N_j, the same for each of the N_j varieties by the symmetry we impose.

From (5.11) and (5.12) relative demands satisfy

$$(5.13) \qquad \frac{q_j}{q_i} = \left(\frac{p_j}{p_i}\right)^{-\sigma} \frac{N_j}{N_i}.$$

Conditional on prices, relative demand is proportional to the relative number of varieties.

A single firm produces a single variety with the production technology

$$(5.14) \qquad q_j/N_j = A_j \left(\frac{L_j}{N_j} - \frac{\phi}{A_j}\right).$$

Each firm is a monopolistic competitor in the world market of N $(= N_1 + ... + N_J)$ firms, and is a

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[11] See also Ethier (1979, 1982).

price taker in the local labor market. In (5.14) we are using the symmetry of firms within country j: they choose the same number of workers and the same level of production, taking N_j as given. In (5.13) there is a fixed cost of production equal to ϕ/A_j units of labor. Each firm chooses L_j/N_j workers to maximize profits, where profits are given by

(5.15)
$$p_j q_j/N_j - w_j L_j/N_j.$$

Substituting (5.13) and (5.14) into (5.15), one can show that profit-maximization implies

(5.16)
$$\frac{L_j/N_j}{L_i/N_i} = \left(\frac{w_j}{w_i}\right)^{-\sigma} \left(\frac{A_j}{A_i}\right)^{\sigma-1}.$$

Combining (5.13), (5.14) and (5.16), the price is a constant markup over marginal cost:

(5.17)
$$p_j = \frac{\sigma}{\sigma-1}\frac{w_j}{A_j}$$

and therefore

(5.18)
$$\frac{p_j}{p_i} = \frac{w_j/A_j}{w_i/A_i}.$$

Substituting (5.18) into (5.13) gives

(5.19)
$$\frac{q_j/N_j}{q_i/N_i} = \left(\frac{A_j/w_j}{A_i/w_i}\right)^{\sigma}.$$

Setting (5.15) to zero (the zero profit condition) and using (5.14) and (5.18) we get

(5.20)
$$L_j/N_j = \frac{\phi\sigma}{A_j}$$

and therefore

(5.21)
$$\frac{L_j/N_j}{L_i/N_i} = \frac{A_i}{A_j}.$$

Expression (5.20) is familiar in the literature: the size of the fixed cost (ϕ/A_j), combined with the elasticity of substitution, pins down employment per firm. Using (5.20), the number of varieties a country produces is proportional to the product of its labor force and process productivity:

$$(5.22) \qquad\qquad N_j = \frac{A_j L_j}{\phi \sigma}.$$

Equating (5.21) to (5.16), relative wages are

$$(5.23) \qquad\qquad \frac{w_j}{w_i} = \frac{A_j}{A_i}.$$

Substituting (5.23) into (5.18) and (5.19) we obtain

$$\frac{p_j}{p_i} = 1 \quad \text{and} \quad \frac{q_j}{q_i} = \frac{A_j L_j}{A_i L_i}.$$

In turn relative GDP's are

$$\frac{Y_j}{Y_i} = \frac{A_j L_j}{A_i L_i}.$$

Here a larger workforce or higher process productivity do not drive down the relative price of a country's varieties. Higher GDP increases the number of varieties produced (5.22) rather than the quantity produced per variety.

This simple Krugman model is consistent with larger economies exporting more mostly on the extensive margin and importing more mostly on the intensive margin. The model goes too far in these directions, however, relative to the data. On the export side, it predicts only an extensive margin, and only in the form of exporting in more *categories,* as opposed to more categories and

more markets.[12] In the data, larger economies export to and import from more countries per category (sees Table 2 and 5). A fixed cost of importing each variety, as in Romer (1994), might help fit these patterns.

Table 10 shows the Krugman model's predictions for export prices and quantities. They are closer to the data than were those of the two preceding models. Yet several discrepancies exist between the model and the data. Richer economies reap higher export prices and export higher quantities in each market-category. Countries with more workers export higher quantities at no lower prices. Of these, the hardest for the Krugman framework to explain may be the higher price of rich country exports. Quality differentiation, as in Flam and Helpman (1987) or Grossman and Helpman (1991), would seem to be necessary. The higher quantities exported to each market-category, however, could be reconciled with this Krugman model. Just as larger economies export to the U.S. in more 10-digit categories within each 6-digit category (see Table 7), larger economies may export more varieties per 6-digit category to a given market.

5d. A Simple Quality Differentiation Model

Here we provide a simple Armington model modified to include endogenous choice of quality. This allows us to make predictions about the equilibrium interactions between quantity, quality, and price, as well as the relation of each to the size of the work force and GDP per worker.

Consumers maximize utility

(5.24) $$U_i = \sum_{j=1}^{J} Q_j q_{ij}^{1-1/\sigma}$$

subject to

(5.25) $$\sum_{j=1}^{J} p_j q_{ij} \leq p_i q_i = Y_i.$$

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[12] In Krugman's original (1979) model, σ is a function of income so that, in equilibrium, larger economies export more on both margins (extensive and intensive). Dinopoulos and Xu (2000) obtain the same result in a model with non-homothetic preferences.

where Q_j is the quality of country j's variety.[13] Based on this we obtain

$$(5.26) \qquad \frac{q_j}{q_i} = \left(\frac{p_j/Q_j}{p_i/Q_i} \right)^{-\sigma}$$

so that relative demand is decreasing in *quality-adjusted* relative prices.

A single firm produces a country's variety. The firm's production technology is

$$(5.27) \qquad q_j = A_j \exp(\tfrac{-Q_j}{Z_j}) L_j \ .$$

Conditional on A_j and Z_j, producing at higher levels of quality Q_j lowers the number of units produced per worker, q_j/L_j. Higher A_j scales up productivity uniformly for all quality levels, whereas higher Z_j raises productivity more at higher quality levels.

The firm is a monopolistic competitor in the world market of J firms, and is a price taker in the local country labor market. The firm hires workers L_j and chooses quality Q_j to maximize

$$(5.28) \qquad p_j q_j - w_j L_j \ ,$$

where w_j is the wage in country j. Using (5.26), (5.27) and (5.28), one can show that the profit-maximizing levels of L_j and Q_j satisfy

$$(5.29) \qquad Q_j = \tfrac{\sigma}{\sigma\text{-}1} Z_j$$

and

$$(5.30) \qquad \frac{L_j}{L_i} = \left(\frac{Z_j/w_j}{Z_i/w_i} \right)^{\sigma} \left(\frac{A_j}{A_i} \right)^{\sigma\text{-}1} .$$

According to (5.29), higher Z induces a higher Q. Expression (5.30) shows that a firm's profit-

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[13] GDP will exceed the wage bill here because we do not impose a zero profit condition in what follows. We assume that each consumer/worker receives an equal share of economywide pure profits.

maximizing level of labor input is increasing in both productivity indices (Z_j and A_j) and decreasing in the wage (w_j).

Combining (5.26), (5.27), (5.29) and (5.30) yields the profit-maximizing price conditional on the choice of quality:

(5.31)
$$p_j = \tfrac{\sigma}{\sigma\text{-}1}w_j/[A_j\exp(\tfrac{-Q_j}{Z_j})] \ .$$

Because Q_j is proportional to Z_j in (5.29), for a given w_j/A_j the price does not vary with quality. Combining (5.29) and (5.31) yields

(5.32)
$$\frac{p_j}{p_i} = \frac{w_j/A_j}{w_i/A_i}.$$

Substituting (5.32) into (5.26) yields

(5.33)
$$\frac{q_j}{q_i} = \left(\frac{Q_jA_j/w_j}{Q_iA_i/w_i}\right)^{\sigma}.$$

Equation (5.33) incorporates both preferences and technology. It says that, conditional on wages, country j produces more units the higher are country quality and process productivity.

Using (5.30) we can pin down the market-clearing wage as

(5.34)
$$\frac{w_j}{w_i} = \left(\frac{L_j}{L_i}\right)^{-1/\sigma}\frac{Q_j}{Q_i}\left(\frac{A_j}{A_i}\right)^{1-1/\sigma}.$$

Substituting (5.34) into (5.32) and (5.33) gives

(5.35)
$$\frac{p_j}{p_i} = \left(\frac{A_jL_j}{A_iL_i}\right)^{-1/\sigma}\frac{Q_j}{Q_i}$$

(5.36)
$$\frac{q_j}{q_i} = \frac{A_j L_j}{A_i L_i}.$$

In turn, relative GDP's are

(5.37)
$$\frac{Y_j}{Y_i} = \left(\frac{A_j L_j}{A_i L_i}\right)^{1-1/\sigma} \frac{Q_j}{Q_i}.$$

Countries with higher "quality productivity" Z_j produce higher quality products (5.29) and charge higher prices (5.35) rather than sell more units of each variety (5.36). This leads to higher GDP per worker in proportion to their higher quality (5.37).

Like the simple Armington model, this quality differentiation model has no extensive margin so it is at odds with the facts in Table 9. But it has a shot at explaining some of the export price and quantity facts in Table 10. Absent quality differentiation, an output expansion must drive consumers down the demand curve for the national variety, lowering prices. With an endogenous quality choice, larger economies need not experience a terms of trade deterioration. It is possible to export higher quantities at the same or higher prices if resources are also invested in improving product quality. We can use (5.26) to infer the cross-country differences in quality necessary to reconcile our Table 3 facts on price and quantity with this model.

To illustrate, consider U.S. imports of new assembled passenger cars by country of origin.[14] In 1995, Japan's exported models sold 19 times as many units in the U.S. as Sweden's exported models to the U.S. did (2172k vs. 114k). Sweden's models were 37% more expensive on average ($25,194 vs. $18,371). Japan exported 56 models vs. 5 for Sweden (so 11.2 of the factor of 19 was more models).[15] Japan sold 1.7 times as many units per exported model (38,800 units per Japanese model vs. 22,800 per Swedish model). Reconciling these facts with (5.26) requires that Swedish models were 20% higher quality if the elasticity of substitution between models $\sigma = 5$. Note, however, that Japanese cars have lower quality-adjusted prices (Swedish cars are 37%

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[14] The data is from Ward's Motor Vehicle Facts & Figures, which distinguishes domestic production from imports by model. We include domestic production of models exported to the U.S. in "sales of models exported to the U.S."
[15] There are only 7 6-digit categories covering passenger motor vehicles in the U.N. data, so Japan exported at least 8 car models to the U.S. per 6-digit car category. This underscores the possibility that larger economies export more varieties to a given market within 6-digit categories.

higher price but only 20% higher quality) — this explains why sales per model were higher for Japanese models despite their lower quality.[16]

Using (5.26) in this way, Table 11 shows how much quality would need to differ with country size in order for this model to explain export prices and quantities. The calculations require a value for σ, the elasticity of substitution between different country varieties within categories. Based on estimates by Hummels (1999) we consider $\sigma = 5$ and $\sigma = 10$, which correspond to markups of 25% and 10%, respectively. Table 3 suggests that countries with twice the GDP per worker export 19% higher quantity at 21% higher prices within market-categories. Table 11 indicates that, with $\sigma = 5$, these facts can be reconciled with the model if countries with twice the GDP per worker export products of 25% higher quality. With $\sigma = 10$, twice the GDP per worker would need to be associated with 23% higher quality. If a country's exports are representative of their production, as in this model, the implication would be that quality differences explain about a quarter of the differences in GDP per worker across countries.[17]

A country with twice as many workers (but the same GDP per worker) exports 27% more quantity at 4% higher prices to a given market-category. Table 11 reports that doing so would require products of 7% to 10% higher quality. Although this is possible, the model sketched above provides no reason why it should be so. The model also provides no reason why *quality-adjusted* prices should be slightly lower in larger economies, as Table 11 also reports. The inference that quality-adjusted prices must be lower follows from the higher quantities exported within market-categories. An alternative interpretation is that quality-adjusted prices are no lower for larger economies, but larger economies export more varieties within 6-digit U.N. market-categories. If so, then a hybrid of this quality differentiation model and the Krugman model in the previous subsection would fit all of the Table 10 facts.[18]

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[16] For Japanese vs. South Korean models in 1995: Japanese firms sold 11.8 times as many units, 7 times as many models (56 vs. 8), and 1.7 times as many units per model at about 2.4 times the average unit price ($18,371 vs. $7,768). The implication from (5.26) is that Japanese models were 2.7 times as good as South Korean models if σ=5. If so, Japanese models sold for a lower quality-adjusted price than South Korean models (2.7 times the quality for 2.4 times the price), thereby explaining the higher units sold per Japanese model.

[17] To the extent that prices of same-quality products are compared, producing higher quality should be reflected in higher measured PPP GDP in a country.

[18] An appendix with such a model is available upon request.

5e. Romer's Fixed Costs of Exporting Model

Romer (1994) modeled a small open economy facing fixed costs of importing intermediate good varieties. A model with this flavor could explain why larger economies import in more categories and from more countries within categories. Calibrating his model, Romer found the welfare and productivity losses from applying a tariff to be an order of magnitude larger with endogenous import variety than without it: a loss of 10% of GDP, compared to 1% of GDP in a more standard model, in response to a 10% tariff on all imports.

In Romer's model, lowering import tariffs increases demand for foreign varieties, allowing more of them to enter the local market and sell enough units to cover local fixed costs. A larger domestic economy should do the same thing. We therefore ask how big the variety gains to importer size appear from our estimates in Tables 5 and 6. To translate these extensive margins for imports into welfare gains, we adapt Feenstra's (1994) methodology for estimating welfare gains from import variety growth. Feenstra showed that, if imports are inside a CES aggregator separable from domestic goods, then the GDP-equivalent of the welfare gains from greater import variety can be expressed as

$$(5.38) \qquad \text{(share of imports in GDP)} \cdot \text{(the extensive import margin)}^{1/(\sigma-1)}$$

where σ is the elasticity of substitution between import varieties in utility and "the extensive import margin" is represented by expression (2.8) in section 2 above. Romer's model yields this same expression (5.38) for intermediate import variety gains with respect to importer size. In his model imported varieties are symmetric (the same price and quantity) so the extensive import margin equals the number of varieties imported. But (2.8), based on Feenstra's methodology, is the appropriate generalization for asymmetric prices and quantities.

Earlier we estimated a modest tendency for larger economies to import in more categories (see Table 5). When we distinguished imports by country of origin as well as category, we found a larger extensive margin (see Table 4). Treating each import source-category as a different

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variety, we use (5.38) to calculate import variety gains with respect to importer size. We translate them into equivalent percentage point increases in GDP. We calculate gains separately for consumer imports and capital plus intermediates imports, based on estimates of their extensive margins and import shares. We do this because one might worry that the extensive margin for capital goods and intermediates reflects Krugman increasing returns in production (more domestic industries translate into more demand for specialized inputs) rather than Romerian increasing returns due to fixed costs of importing. The average level of imports relative to GDP at market exchange rates across the 59 importers in the U.N. data is 6% for capital and intermediate goods and 21% for consumer goods.

The top panel of Table 12 provides variety welfare gains based on (5.38). We estimate that an economy double the size enjoys variety gains between 1.5% and 3% of GDP. Most of these gains come from consumption imports, largely because they account for most imports but also because the extensive margin is larger for consumption imports. The bottom panel of Table 12 details why our estimates fall so far short of the 50% of GDP welfare gain in Romer's calibrated model. First, Romer used a smaller elasticity of substitution between varieties ($\sigma = 2$, implying a markup of 100%) than we prefer ($\sigma = 5$ and a markup of 25%). Even using $\sigma = 2$, however, our variety gains are between one-fourth and one-eighth of Romer's. Most of the remaining difference stems from our using an import share equal to 27% of GDP (the average across our 59 countries). Romer assumed an import share of 100% of GDP. Using $\sigma = 2$ and Romer's import share, we get similarly large gains from having twice the GDP per worker, but gains only half as big as his with respect to employment. These remaining discrepancies come from the elasticity of variety with respect to importer size, which is 0.5 in Romer's calibration versus 0.45 for GDP per worker and 0.22 for employment in our Table 4. An important caveat is that our estimates understate the true variety elasticity if larger economies import more varieties from a given source-category.

6. Conclusion

Larger countries trade more than smaller countries do. In this paper we decompose a country's share of world trade into margins that account for these differences. We ask: do larger economies trade higher volumes of each good they export and import (intensive margins)? Do they trade a larger set of goods with more partners (extensive margins)? Do they trade higher price/higher quality goods?

Using 1995 trade data for many countries in many product categories, we find that the extensive margin accounts for two-thirds of the greater exports of larger economies, and one-third of the greater imports of larger economies. For both imports and exports, larger economies trade in more categories, and trade with more partners. Price and quantity decompositions indicate that richer countries export more units at higher prices (controlling for category and partner), consistent with producing higher quality. Our estimates imply that quality differences could be the proximate cause of about 25% of country differences in real income per worker.

These calculations, apart from providing a new decomposition of cross-sectional differences in trade patterns, are useful for distinguishing features of trade models that correspond more or less well to the data. Such distinctions can be extremely important in determining the welfare consequences of access to trade.

Armington models of national product differentiation include no extensive margins for export expansion, and so fail to explain the largest margin by which the trade of large/small economies differ. Because they lack this margin, these models also imply that output and trade expansions will be accompanied by adverse terms of trade effects. In the Acemoglu and Ventura model (2000), these terms of trade effects result in a stationary world income distribution despite divergent investment rates. We find that countries with more workers export higher quantities to each market-category at no lower prices. This is consistent with a model in which larger countries avoid terms of trade deterioration by enlarging the set and/or increasing the quality of the goods they produce .

"Krugman" style models with increasing returns to scale and products differentiated by firms come closer to fitting the facts on intensive/extensive export margins. However, matching facts on the relationship between goods' prices (and quantities) and exporter income per worker requires modifying these models to include quality differentiation. Similarly, matching facts on intensive/extensive import margins requires modifications such as fixed costs of importing each variety a la Romer (1994). We find that economies twice the size may enjoy greater import variety worth the equivalent of several percent more GDP per person.

Table 1

Exports from 110 countries to 59 countries

Independent Variable → Dependent Variable ↓	Y_j/L_j	L_j	Adjusted R^2	Y_j	Adjusted R^2
Overall Exports	1.43 (0.08)	0.85 (0.05)	0.83	1.03 (0.05)	0.77
Intensive Margin	0.40 (0.04) **28%**	0.31 (0.03) **37%**	0.62	0.34 (0.03) **33%**	0.61
Extensive Margin	1.04 (0.07) **72%**	0.54 (0.05) **63%**	0.76	0.69 (0.05) **67%**	0.68

Notes: All variables are in natural logs. Number of exporting countries = Number of observations = 110. Standard errors are in parentheses. For definitions of each margin see equations (2.1) through (2.3) in the text. Percentages describe the contribution of each margin to the overall export elasticity. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: UNCTAD for 1995 exports to 59 countries by 110 exporters in 5,017 6-digit categories. Summers and Heston (2001) for employment and GDP.

Table 2

Alternative Extensive Margins for Exports

Independent Variable → Dep. Var. Based On ↓	Y_j/L_j	L_j	Adjusted R^2	Y_j	Adjusted R^2
Weighted Market-Categories	1.04 (0.07) **72%**	0.54 (0.05) **63%**	0.76	0.69 (0.05) **67%**	0.68
Number of Market-Categories	1.47 (0.08) **103%**	0.69 (0.05) **81%**	0.82	0.89 (0.05) **87%**	0.70
Weighted Categories	0.79 (0.07) **55%**	0.30 (0.04) **36%**	0.61	0.43 (0.04) **44%**	0.47
Number of Categories	1.04 (0.06) **73%**	0.48 (0.04) **58%**	0.78	0.62 (0.04) **62%**	0.65

Notes: All variables are in logs. Number of exporting countries = Number of observations = 110. Standard errors are in parentheses. For the extensive margin based on "weighted market-categories" see (2.3) in the text and the results in Table 1. The "number of market-categories" equals the number of elements in X_{jis} = {market-categories for which $x_{jis} > 0$}. The extensive margin based on "weighted categories" is defined over X_{js} = {categories in which $x_{jis} > 0$ for *some* importer i}. The "number of categories" equals the number of elements in X_{js}. Percentages describe the contribution of each margin to the overall export elasticity. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: UNCTAD for 1995 exports to 59 countries by 110 exporters in 5,017 6-digit categories. Summers and Heston (2001) for employment and GDP.

Table 3

Price and Quantity Components for Exports

Independent Variable → Dependent Variable ↓	Y_j/L_j	L_j	Adjusted R^2	Y_j	Adjusted R^2
Price Component of the Intensive Margin	**0.21** (0.04)	**0.04** (0.02)	0.25	**0.09** (0.02)	0.14
Quantity Component of the Intensive Margin	**0.19** (0.05)	**0.27** (0.04)	0.39	**0.25** (0.03)	0.38

Notes: All variables are in natural logs. Number of exporting countries = Number of observations = 110. Standard errors are in parentheses. For definitions of the price and quantity components see equations (2.4) and (2.5) in the text. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: UNCTAD for 1995 exports to 59 countries by 110 exporters in 5,017 6-digit categories. Summers and Heston (2001) for employment and GDP.

Table 4

Imports by 59 countries from 110 countries

Independent Variable → Dependent Variable ↓	Y_i/L_i	L_i	Adjusted R^2	Y_i	Adjusted R^2
Overall Imports	1.44 (0.08)	0.82 (0.04)	0.91	0.94 (0.06)	0.83
Intensive Margin	0.99 (0.07) **69%**	0.60 (0.04) **73%**	0.88	0.68 (0.04) **72%**	0.82
Extensive Margin	0.45 (0.06) **31%**	0.22 (0.03) **27%**	0.63	0.26 (0.03) **28%**	0.55

Notes: In the regressions all variables are in logs. Number of countries = Number of observations = 59. Standard errors are in parentheses. For definitions of each margin see equations (2.6) through (2.8) in the text. Percentages describe the contribution of each margin to the overall import elasticity. L_i = Employment in importing country i. Y_i = 1996 PPP GDP in importing country i.

Data Sources: UNCTAD for 1995 imports to 59 countries by 110 exporters in 5,017 6-digit categories. Summers and Heston (2001) for employment and GDP.

Table 5

Alternative Extensive Margins for Imports

Independent Variable → Dep. Var. Based On ↓	Y_j/L_j	L_j	Adjusted R^2	Y_j	Adjusted R^2
Weighted Source-Categories	0.45 (0.06) **31%**	0.22 (0.03) **27%**	0.63	0.26 (0.03) **28%**	0.55
Number of Source-Categories	0.60 (0.07) **42%**	0.38 (0.03) **46%**	0.75	0.42 (0.03) **45%**	0.72
Weighted Categories	0.09 (0.04) **6%**	0.08 (0.02) **11%**	0.18	0.08 (0.02) **9%**	0.20
Number of Categories	0.15 (0.06) **10%**	0.16 (0.03) **20%**	0.32	0.16 (0.03) **17%**	0.33

Notes: All variables are in logs. Number of importing countries = Number of observations = 59.   Standard errors are in parentheses. For the extensive margin based on "weighted source-categories" see (2.8) in the text and the results in Table 4. The number of source-categories equals the number of elements in M_{ijs} = {source-categories for which $m_{ijs} > 0$}. The extensive margin based on "weighted categories" is defined instead over M_{is} = {categories in which $m_{ijs} > 0$ for *some* exporter j}. The number of categories equals the number of elements in M_{is}. Percentages describe the contribution of each margin to the overall import elasticity. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: UNCTAD for 1995 imports by 59 countries from 110 exporters in 5,017 6-digit categories. Summers and Heston (2001) for employment and GDP.

Table 6

Exports from 119 Countries *to the U.S.*

Independent Variable → Dependent Variable ↓	Y_j/L_j	L_j	Adjusted R^2	Y_j	Adjusted R^2
Overall Exports	1.77 (0.16)	1.10 (0.10)	0.67	1.26 (0.09)	0.63
Intensive Margin	0.64 (0.12) **36%**	0.57 (0.07) **52%**	0.41	0.59 (0.06) **46%**	0.41
Extensive Margin	1.13 (0.08) **64%**	0.53 (0.05) **48%**	0.69	0.68 (0.05) **54%**	0.58

Notes: All variables are in logs. Number of exporting countries = Number of observations = 119. Standard errors are in parentheses. Each margin is defined as in equations (2.1) through (2.3) in the text, only over sets X_{js} = {categories in which $x_{jis} > 0$ for importer i = U.S.}. Percentages describe the contribution of each margin to the overall export elasticity. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: U.S. Census Data on 1995 exports to the U.S. by 119 countries in 13,386 10-digit categories. Summers and Heston (2001) for employment and GDP.

Table 7

Extensive Margin for Exports at Various Product Levels

Regressor →	U.N. DATA			U.S. DATA		
	Y_j/L_j	L_j	Y_j	Y_j/L_j	L_j	Y_j
10 digit				**64%**	**48%**	**54%**
8 digit				59%	42%	48%
6 digit	55%	36%	44%	**57%**	**40%**	**46%**
4 digit	43%	26%	32%	48%	32%	38%
2 digit	14%	5%	9%	31%	16%	21%

U.N. Data: Number of exporting countries = Number of observations = 110.   Entries are percentages of the overall export elasticity. Based on UNCTAD data on 1995 exports to 59 countries by 110 exporters in 5,017 6-digit categories.

U.S. Data: Number of exporting countries = Number of observations = 119.   Entries are percentages of the overall export elasticity. Based on U.S. Census Data on 1995 exports to the U.S. by 119 countries in 13,386 10-digit categories.

L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j. Source: Summers and Heston (2001).

Table 8

Price and Quantity Components of Exports *to the U.S.*

Independent Variable → Dependent Variable ↓	Y_j/L_j	L_j	Adjusted R^2	Y_j	Adjusted R^2
Price Component of the Intensive Margin	**0.32** (0.05)	**-0.01** (0.03)	0.23	**0.07** (0.03)	0.03
Quantity Component of the Intensive Margin	**0.32** (0.13)	**0.58** (0.08)	0.33	**0.52** (0.07)	0.31

Notes: All variables are in logs. Number of exporting countries = Number of observations = 119. Standard errors are in parentheses. Each margin is defined as in equations (2.4) and (2.5), only over sets X_{js} = {categories in which x_{jis} > 0 for importer i = U.S.}. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: U.S. Census Data on 1995 exports to the U.S. by 119 countries in 13,386 10-digit categories. Summers and Heston (2001) for employment and GDP.

Table 9

Extensive and Intensive Margins: Data vs. Models

	Exports		Imports	
	Intensive	Extensive	Intensive	Extensive
Data	**1/3**	**2/3**	**2/3**	**1/3**
Armington	1	0	1	0
Acemoglu & Ventura	1,0	0,1	1	0
Krugman	0	1	1	0
Quality Differentiation	1	0	1	0
Romer	1	0	0	1

Notes: The Data row distills results from Table 1 (for exports) and Table 4 (for imports). For the predictions of each model, see section 5 in the text.

Table 10

Export Prices and Quantities: Data vs. Models

	Prices		Quantities	
	Y/L	*L*	*Y/L*	*L*
Data	**0.21** **(0.04)**	**0.04** **(0.02)**	**0.19** **(0.05)**	**0.27** **(0.04)**
Armington	$-1/(\sigma-1)$		$\sigma/(\sigma-1)$	
Acemoglu & Ventura	-0.7	0	1.7	0
Krugman	0		0	
Quality Differentiation	1	$-1/(\sigma-1)$	0	1
Romer	0		1	

Notes: The Data row contains results from Table 3. For the predictions of each model, see section 5 in the text.

Table 11

Quality Implied by Export Prices and Quantities

		Y_j/L_j	L_j	Y_j
$\sigma = 5$	Quality	0.25	0.10	0.14
	Quality-Adjusted Prices	-0.04	-0.06	-0.05
$\sigma = 10$	Quality	0.23	0.07	0.12
	Quality-Adjusted Prices	-0.02	-0.03	-0.03

Notes: All variables are in logs. Number of exporting countries = Number of observations = 110. The results are based on estimates in Table 3. For the required variation in quality, see equation (5.26) in the text. σ = the elasticity of substitution in utility or production between different varieties (imports from different source-categories). Quality adjusted prices are simply the price elasticities from Table 3 minus the quality elasticities. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

Data Sources: UNCTAD for 1995 exports to 59 countries by 110 exporters in 5,017 6-digit categories. Summers and Heston (2001) for employment and GDP.

Table 12

Variety Welfare Gains from Doubling Importer Size

Gains as a % of GDP	Y_j/L_j	L_j	Y_j
Consumption Imports $\sigma = 5$	2.5%	1.4%	1.6%
Capital and Intermediates Imports $\sigma = 5$	0.6%	0.2%	0.3%
All Imports $\sigma = 5$	**3.1%**	**1.6%**	**1.9%**
Using $\sigma = 2$ (Romer's value)	12.5%	6.3%	7.5%
Also using Imports/GDP = 1 (Romer's value)	46%	23%	27%
Also using a Variety Elasticity = 0.5 (Romer's value)	50%	50%	50%

Notes: Welfare gains from import variety (expressed in terms of % of GDP) = (import share of GDP)*(imports extensive margin)$^{1/(\sigma-1)}$. See the discussion surrounding equation (5.38) in the text. The top panel is based on estimates of the form of Table 4, only using separate regressions for consumption imports vs. imports of capital and intermediates. The variety elasticity equals the estimated elasticity of the extensive margin with respect to the size variable. L_j = Employment in exporting country j. Y_j = 1996 PPP GDP in exporting country j.

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