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## Why countries trade Insights from firm-level data

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Two theories dominate economic thinking on the causes of international exchange. Comparative advantage explains trade by inherent differences between countries. Increasing returns explains trade by the productivity and variety advantages from specialization and exchange even among like economies. But one-hundred-eighty years after the publication of Ricardo's "Principles," and two decades into the "new trade theory" revolution, we know little about their relative importance in giving rise to observed trade patterns.<sup>1</sup>

An assessment of their relative importance would require identifying features which distinguish the theories, and employing appropriate data to quantify the relative contributions. While the theories are quite distinct at the microeconomic level, it has proven very difficult to identify features of aggregate trade patterns which would help to distinguish the theories. In particular, two features of trade patterns which have in the past been advanced as distinguishing the theories—*intra-industry* and *North–North* trade—do not help to separate the theories (Chipman (1988), Davis (1995, 1997), Harrigan (1994)).

Since the available data has most frequently concerned trade flows at a reasonably aggregated level, it was inherently difficult to formulate a test of the theories. Davis and Weinstein (1996, 1999, 2003), do place comparative advantage and increasing returns in direct contest, and quantifies their relative importance in contributing to production structure within the OECD, and across regions of Japan. Similar efforts have been made by Head and Ries (2001) and Trionfetti (2001). Two qualifications should be noted. First, that work provided an appropriate test of the two theories, but they quantified the contribution

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<sup>1</sup> Krugman (1994, p. 23) asks: "How much of world trade is explained by increasing returns as opposed to comparative advantage? That may not be a question with a precise answer. What is quite clear is that if a precise answer is possible, we do not know it."

of each to production, not trade. Second, the version of increasing returns that they tested against comparative advantage was that Krugman has dubbed “economic geography.” While this is a variant of increasing returns of great analytic interest, it is arguably as yet less influential than the simpler monopolistic competition framework derived from Krugman (1979).

In recent years, the availability of large new data sets has allowed trade economists to employ firm-level microeconomic data to investigate an impressive array of hypotheses (see, for example, the excellent and comprehensive survey by Tybout (2003)). Important contributions have come from Aitken et al. (1997), Levinsohn (1999), Clerides et al. (1998), and Roberts and Tybout (1997). Notable among these have been the papers by Bernard and Jensen (1999), and Bernard et al. (2002). These papers have been very important; however, they have not simultaneously estimated the influence of all three determinants of export behavior.

The present paper, accordingly, aims to measure the contribution of our theories in giving rise to trade. In doing so, we hope to make two contributions. The first is to develop a simple analytic structure that integrates the principal theories, so provide a sound and sensible structure for our empirical investigation. We do this cognizant of the conundrums that makes matching of theory and data trying. The second is to show how a rich new data set on Japanese firms can be employed to give answers to these central questions.

We hasten to acknowledge that the answers we provide are far from final and complete. The match between the theoretical structure we work from and the empirical exercise we carry out is less exact than we would desire. Our sample concerns the characteristics of firms of but a single country. Numerous strong identifying assumptions are required to structure the data analysis. Accordingly, the results should be considered provisional until they can be confirmed, as appropriate new data sets become available.

Nevertheless, we believe that the paper breaks important new ground. It shows that assessing the relative contributions of our theories in giving rise to observed trade patterns need be judged neither an empty nor a hopeless enterprise. It provides a framework and a methodology for making the assessments. Moreover, employing a rich new data set, we provide a first serious attempt to provide an empirical answer of the relative contribution of the theories to actual trade patterns. If we cannot provide a complete answer to why countries trade, we can at least derive some important insights on this question.

## **1. A theoretical framework for empirics**

### *1.1. Introduction*

This section develops a theoretical framework for the empirical exercise to follow. In doing so, we integrate a variety of forces that may determine production and trade patterns. These include endowment differences, as in the Heckscher–Ohlin (HO) model; cross-country technical differences, as in the Ricardian model; and scale economies, as in the models of the “new” trade theory. The broad analytic framework that we will work in is that of the “integrated equilibrium,” due to Dixit and Norman (1980). The HO framework that we use is that with more industries than factors, as discussed in Dornbusch, Fischer, and

Samuelson. A simple solution to certain problems with indeterminacy in production and trade patterns is based on Xu (1993). The monopolistic competition framework considered is that of Krugman (1979), based on Dixit and Stiglitz. Helpman (1981) showed how to integrate the HO and scale economies models, and Davis (1995) extended this to include the Ricardian model. It is convenient to build our model in stages, beginning with Heckscher–Ohlin, then Ricardo, and finally scale economies.

## 1.2. The Dornbusch, Fischer, and Samuelson's Heckscher–Ohlin continuum model

### 1.2.1. A frictionless world

Our analysis will build on the Dornbusch et al. (1980) (DFS) continuum-of-goods Heckscher–Ohlin model. While our analysis ultimately will be of a trading world, it is simplest to begin by considering a closed economy, which may be thought of as an “integrated equilibrium” of a trading world in the sense of Dixit and Norman (1980).

We next need to consider the conditions under which trade in goods alone, absent factor mobility, will allow a trading world to replicate the equilibrium of this integrated economy. We consider this for a two country world. The conditions are a simple transformation of the conventional restrictions for a finite good economy (see Helpman and Krugman (1985)). Essentially, they require that we be able to assign to the countries non-negative shares of the integrated equilibrium output of all goods  $i$ , that these shares sum to unity, and that all countries be able to fully employ their factors while producing these goods with the integrated equilibrium techniques. Graphically, in this infinite-good world, this will give rise to a Deardorff (1994) “lens” that defines the factor price equalization (FPE) set (see Fig. 1). Any time the division of the endowments between the two countries falls within this lens, the trading economy will replicate the integrated equilibrium.

The first observation we would like to make is that the Heckscher–Ohlin–Vanek (HOV) theorem holds in this setting—the net factor content of a country's trade will simply be the difference between its endowment and its spending-share of the world implicit consumption of factor services. This net factor content is indicated in Fig. 1 by the segment VC (see Helpman and Krugman (1985)). It is not surprising that this holds in the infinite-good, two-factor case, since Vanek's (1968) original paper was precisely concerned with robustness for cases where the number of goods exceeded the number of factors. However, the observation will, nonetheless, play an important role in what is to follow.

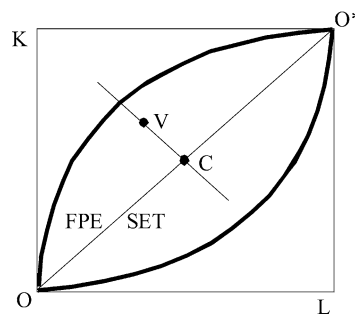


Fig. 1.

In this world, a country's absorption is fully determinate. But with zero transport costs and more goods than factors, its production—hence trade—will not generally be determinate. In their paper, DFS (1980, p. 205) observe that this indeterminacy is more apparent than real, since “when transport costs are positive, the invisible hand of competitive arbitrage will solve the problem that minimizes deadweight loss from cross-haulage or non-optimal specialization.”

### 1.2.2. The case of “small” trade costs

Xu (1993) follows up on this suggestion of DFS, and develops a highly plausible solution.<sup>2</sup> In the remainder of this section, we develop our own heuristic for thinking about the solution that Xu proposes to make production and trade determinate. In doing so, we want to preserve the simplicity of the integrated equilibrium framework. Accordingly, we address the problem in two steps. First, we use the integrated equilibrium framework to establish the output and absorption levels of all goods for the world, as well as the *required* HOV net factor content of trade. Then we ask how this output should be distributed across countries consistent with the requirements of the integrated equilibrium and attaining the required net factor content of trade. The latter, in particular, is sensible, since the net factor content reflects the fundamental endowment-difference pressures for which trade in goods is simply a mode of relief. We pursue this approach under the assumption that *all goods* face iceberg transport costs at rate  $\vartheta > 1$ , so that  $\vartheta$  units of a good must be shipped for one unit to arrive.<sup>3</sup> In order to be (approximately) consistent with the integrated equilibrium framework, we can think of these transport costs as strictly positive, but vanishingly small.

Consider the case of two countries. Home is assumed to be the capital abundant country, and Foreign (indicated by an \*) is the labor abundant country, so  $k > k^W > k^*$ . Since all goods have the same iceberg transport factor, our task is equivalent to minimizing the volume of trade subject to attaining the required net factor content. A dollar's worth of exports accomplish greater export of capital services (and less of labor services) the more capital intensive the good, and vice versa for exports of very labor intensive goods. This makes it clear that minimizing transport costs requires that the capital abundant country concentrate its exports to the greatest extent possible among the most capital intensive goods. Correspondingly, the labor abundant country will concentrate its exports to the greatest extent possible among the most labor intensive goods.

The consequence of this for production structure and trade is as follows. Divide the goods space into three intervals:  $[0, i_Y]$ ,  $[i_Y, i_X]$ , and  $[i_X, 1]$ . We will refer to goods in the three intervals as *Y*, *N*, and *X*, respectively. Production structure and trade will be as follows. Home will be the world's only producer of *X* goods, which it will export to foreign

<sup>2</sup> The essential similarity of our approach and that of Xu is that the goods space is divided into three segments, with each country exporting the class of goods that uses its abundant factor most intensively, and intermediate factor intensities being nontraded. Xu proposes the interesting interpretation of this as historically determined by progressive liberalization of trade taxes. Our heuristic, which focuses on minimizing trade costs subject to the HOV requirements, is entirely consistent with this interpretation.

<sup>3</sup> In effect, this assumes that other potential determinants of the transportability of particular goods are orthogonal to factor intensity. Naturally, this need not be true in reality. However, this greatly simplifies our project, and the influences on production and trade patterns identified here will continue to matter even if there are other influences.



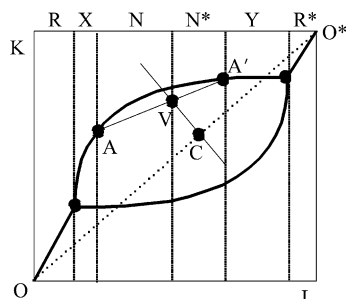


Fig. 3.

important identifying assumption is that the Ricardian advantages are available only in one country or the other (we will assume that the other country has this coefficient equal to unity). Let  $R$  and  $R^*$  represent the class of goods with a Ricardian advantage for the home and foreign countries, respectively.

The conditions for (approximately) replicating the integrated equilibrium for this world are straightforward, combining elements of Davis (1995) and Xu (1993), and are depicted in Fig. 3. Each country must produce the entire world supply of all goods in which it has a technical advantage. The division of world endowments then needs to lie within the FPE lens as discussed above. The division of goods between the countries, and between traded and nontraded is as in the discussion above. The capital abundant country specializes in the most capital intensive HO goods, the labor abundant country the most labor intensive goods, and goods of intermediate factor intensity are nontraded.<sup>4</sup> The boundary depends on achieving the HOV-required net factor content, as well as balanced trade.

#### 1.4. Introducing scale economies and monopolistic competition

Here we introduce industries with scale economies and monopolistic competition to our framework. Our integration of HO and Ricardo was straightforward. Likewise, our use of trade costs to resolve the indeterminacies inherent in the continuum HO model was simple. However, consideration of scale economies in the presence of trade costs involves a variety of subtleties.

The basic framework of trade under Dixit–Stiglitz monopolistic competition is due to Krugman (1979). Its essential framework is too familiar to require exposition. Consideration of this type of model with costs of trade began with Krugman (1980), and with Krugman (1991) has developed into a branch of the literature denoted “economic geography.” The model of Krugman (1980) featured a one-factor, two-country world, with trade costs only in the monopolistically competitive differentiated goods, not in the competitive homogeneous goods.

The present framework adds a new wrinkle to this problem, namely the fact that differences in factor proportions across countries may give rise to comparative advantage

<sup>4</sup> It is possible that the usage of factors to produce the Ricardian goods could reverse the factor intensity rankings in the factors employed in producing HO goods, as discussed in Davis (1995). We ignore this possibility.

reasons for trading the homogeneous goods, even if all goods have the same trade costs. A consideration of the various possible cases, and a complete solution to the associated theoretical problems is beyond the scope of this paper. Here we content ourselves with summarizing the insights drawn from the previous literature, and highlighting the elements that seem relevant to the empirical project we pursue.

There are three principle insights we wish to emphasize. The first is that absent prohibitive trade costs, each variety of a good within a monopolistically competitive industry is produced in a single country, which then becomes the sole exporter of that variety. The second, in line with the insights drawn from Xu (1993), is that *ceteris paribus* the capital abundant country will have reason to focus on those monopolistically competitive industries that are relatively capital intensive (and vice versa for the labor abundant country). Finally, the capital to labor ratio that serves as the dividing line between those monopolistically competitive goods produced in the two countries will depend on the interplay of the forces identified above:

- (a) the Krugman (1980) pressures for a “home market” effect,
- (b) the Davis (1997) pressures to minimize trade in homogeneous goods, and
- (c) the requirement to meet the HOV net factor requirements due to incipient factor price differences.

A heuristic interpretation of this appears Fig. 4. Let  $M$  and  $M^*$  represent the class of monopolistic competition industries that in equilibrium locate in the home and foreign markets respectively. Then the division of the goods production across the countries will appear as indicated in Fig. 4. Much of the empirical work that will follow will concern how characteristics of firms will move goods among this group of production activities. For now, consider the case of a capital abundant home country. Then there are three characteristics that indicate export propensity—technological proficiency (Ricardo); the presence of scale economies in production (increasing returns); and capital abundance (Heckscher–Ohlin). When considered in a panel, any of these influences can move a firm from the non-traded sector to become an exporter.

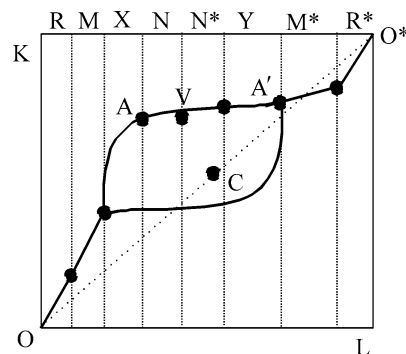


Fig. 4.

## 2. Data overview

Japanese firm-level export data are available from the NEEDS database. We obtained data on exports for the years 1965 to 1990. All other firm-level data was taken from the Japan Development Bank database. Great care was taken to ensure that the NEEDS data was comparable with the JDB numbers. This was accomplished by checking that sales numbers, reported in both databases, were identical. A major difficulty in this matching was the idiosyncratic way in which both databases deal with firms that changed the start dates of their accounting years over the course of the sample. This often resulted, in the JDB data, in two short fiscal years within one calendar year or one fiscal year of more than 12 months. NEEDS' method of dealing with these accounting irregularities sometimes caused firm fiscal years to deviate from calendar years by one year. We dealt with this problem by annualizing the JDB data wherever possible and adjusting the firm fiscal years so that at least six months of each fiscal year fell within the corresponding calendar year.

Capital stocks were calculated according to the perpetual inventory method. Since the JDB data lists five different investment goods—buildings, structures, machinery, tools, and transportation equipment—we decided to incorporate these independently in our capital measures applying the depreciation rates estimated by Hulten and Wykoff (1979, 1981) of 4.7%, 5.64%, 9.49%, 14.7%, and 8.38%, respectively. In the first year that a firm appeared in our sample, we set the capital stock equal to the book value of the particular asset, and then adjusted this number based on the asset-specific investment numbers.

The cost of capital for each asset was calculated on the basis of the Jorgenson user cost of capital. Price series for capital goods was taken from the Nikkei Telecom database and the interest rate used was the average annual short-term call rate. Each firm's cost of capital was then calculated by averaging the cost of capital for each asset using the asset amounts as weights.

For intermediate input prices we used the sectoral price series from the Japanese input output matrix. This source listed thirteen different input price series. Firm-level wages were calculated by dividing total labor expenses by the number of employees. Firm total costs equal the sum of materials costs, labor costs, and capital costs where the latter was calculated above. All nominal data was deflated by the wholesale price index for that sector. The Bank of Japan provides these series for the 59 sectors used in this study.

Japanese exports appear to be dominated by a relatively small number of firms. One can obtain a sense for how concentrated exporting is by comparing distribution of firm level exports to that of sales. One quarter of all Japanese exports by listed firms were made by four firms and half by 12 firms. By contrast, the four largest sellers in Japan only accounted for 13 percent of sales and the largest 12 accounted for 30 percent. The largest 80 exporters account for 78% of our sample of exports whereas the top eighty firms in terms of sales only account for 55 percent of aggregate sales. These numbers appear to have increased over time. In 1970, the four largest exporters only accounted for 16 percent of exports and the 50 largest for 73 percent of Japanese exports.

Figure 5 shows the break down of firm export shares by industry for 1980. There are several features of the data that are worth noting. First is that there is typically a wide dispersion in the export behavior of firms. For example, if we look at Paper and Pulp



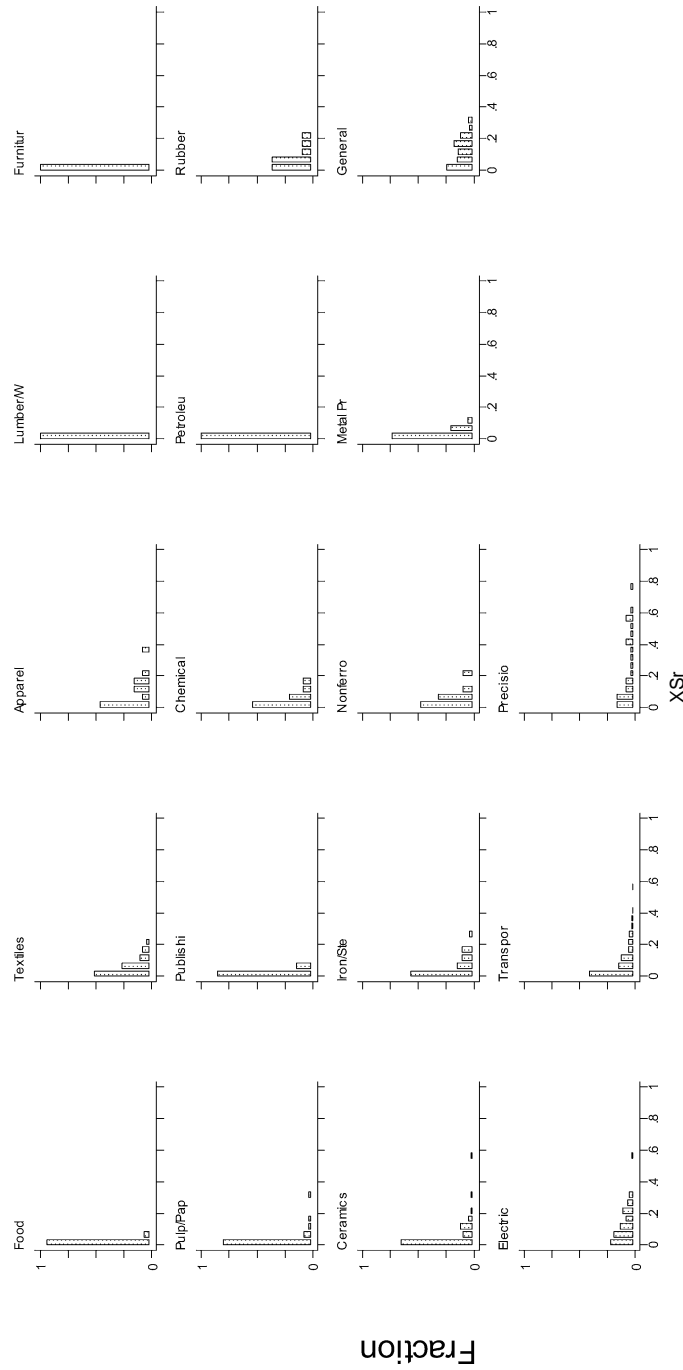


Fig. 5. Exports as a share of sales, 1990.

Products, one finds that practically all firms export nothing or extremely small shares of their output while Tomoegawa Paper exports 24% of its output. What accounts for these sorts of differences? While we will be exploring the theories that explain these differences, it is worth recognizing that there is enormous heterogeneity in the output of firms that is unlikely to be explainable by off-the-shelf models. For example in the case of Tomoegawa Paper, after reading company reports seems clear that the firm is producing a variety of high technology products like information media paper in addition to the kraft pulp and paper that most firms in the industry produce. This sort of heterogeneity makes it very difficult to explain cross-sectional variation in these data. One would like to solve this sort of problem by disaggregating further, but one often discovers upon careful reading of the report that there really isn't any other firm in Japan that produces exactly the same good.

### 3. Estimation strategy

We need to accomplish three things before we can examine the determinants of exports. The first is to measure TFP, the second to measure increasing returns, and the last to obtain an estimate of the importance of factor proportions on exports. We begin with the estimation of TFP on the firm level. Most studies have measured TFP on the by estimating production functions. This has a number of problems. First, as Hall (1988) has shown, estimates of TFP levels formed this way are polluted by mark-ups. One alternative is to estimate changes in output as in Levinsohn (1993). While appropriate for that study, this approach is also unsatisfactory for our work because of the possibility that both margins and productivity may vary over the course of time.

We therefore opted to obtain productivity estimates by estimating the non-homothetic translog cost function presented below. For firm  $i$  in industry  $m$  at time  $t$ , we postulate that its cost function for firm  $f$  is of the form

$$\begin{aligned} \ln C_{ft} = & \alpha_f + \sum_{i=1}^n \alpha_i^I \ln w_{ift} + \alpha_Y^I \ln Y_{ft} + \frac{1}{2} \gamma_{YY}^I (\ln Y_{ft})^2 + \sum_{i=1}^n \gamma_{iY}^I \ln w_{ift} \ln Y_{ft} \\ & + \sum_{i=1}^n \beta_{iT}^I \ln(w_{ift})t + \alpha_T^I t + \frac{1}{2} \gamma_{TT}^I (t^2) + \alpha_{YT}^I t \ln Y_{ft} + \varepsilon_{ft}, \end{aligned} \quad (1)$$

where  $Y_{it}$  is the output of the firm,  $t$  is a time trend,  $w_{ift}$  denote factor prices, and the Greek letters are parameters of the cost function that will be estimated. Homogeneity of degree 1 in factor prices,  $w_{ift}$ , implies that

$$\sum_{i=1}^n \alpha_i^I = 1, \quad \sum_{i=1}^n \gamma_{iY}^I = \sum_{i=1}^n \beta_{iT}^I = 0. \quad (2)$$

Our three factors of production are capital, labor, and materials.

Readers familiar with the estimation of cost functions will recognize that we have modified the standard translog cost function slightly. In our proposed specification, we save some degrees of freedom by suppressing the cross factor price terms. Our specification, however, does allow us to let technology matter more generally by permitting factor biased

technical change, total factor productivity (TFP) and, changes in minimum efficient scale. Following standard procedure, we can improve efficiency of our estimates by also imposing the first order conditions on our estimates. This yields

$$\frac{\partial \ln C_{ft}}{\partial \ln w_{ift}} = \frac{w_{ift}}{C_{ft}} \frac{\partial C_{ft}}{\partial w_{ift}} = \frac{w_{ift} X_{ift}}{C_{ft}} \equiv S_{ift} \quad (3)$$

where  $X_{ift}$  is the amount of factor  $i$  used in production. Combining this with Eq. (1) produces

$$S_{ift} = \alpha_i^I + \gamma_{iY}^I \ln Y_{ft} + \beta_{iT}^I t + \xi_{ft} \quad (4)$$

where  $\xi_{ft}$  is an error term. The share equations in addition to the cost function yields four simultaneous equations. It can be shown, that the restrictions in Eq. (1) in combination with the fact that the shares must sum to one enables us to arbitrarily drop one of the share equations and obtain parameter estimates from the remaining equations. This lets us estimate three simultaneous equations, the cost function denoted in Eq. (1) (with the restrictions given in equations and (3) imposed) and two share equations.

Based on this estimation procedure, we can obtain estimates of TFP and economies of scale. For example, in this specification the TFP of a firm is simply

$$TFP_{ft} = \left( \alpha_f + \ln \alpha_0^I + \alpha_T^I t + \frac{1}{2} \gamma_{TT}^I (t^2) + \sum_{i=1}^n \beta_{iT}^I \ln(w_{ift}) + \varepsilon_{ft} \right)^{-1} \quad (5)$$

Similarly, a firm's cost elasticity of scale is simply the derivative of Eq. (1) with respect to output or

$$DRS_{ft} \equiv \alpha_Y^I + \gamma_{YY}^I \ln Y_{ft} + \sum_{i=1}^n \gamma_{iY}^I \ln w_{ift} + \alpha_{YT}^I t. \quad (6)$$

By this measure, firms with an DRS number larger than one exhibit decreasing returns (a larger elasticity of cost with respect to size), firms with a cost elasticity equal to one exhibit constant returns, and firms with an elasticity of less than one produce using economies of scale. Note that our choice of the translog specification allows us to be extremely general in the type of scale economies present within an industry. Firms can have upward sloping, downward sloping or U-shaped cost curves. Indeed, this specification also allows us to consider cases where only some firms in an industry have exhausted their economies of scale.

One of the problems with this methodology is that there is a potential simultaneity problem between costs and output. Firms suffering from an adverse shock to their cost function in one period are likely to have lower output. This will bias us in favor of finding economies of scale. Furthermore, since output is deflated by a sector specific price index, firms that can charge above marginal cost, will appear to have higher output than identical firms employing the same numbers of factors without market power. This will tend to cause firms with market power to appear to have higher productivity. We therefore decided to instrument for output using lagged inputs which eliminates both of the simultaneity problems.

Once we have obtained the TFP and IRS measures, we can then turn directly to the estimation. The first problem that we face is that the theory predicts a hierarchy of effects. First, Ricardian technical differences will determine which firms are exporters; then increasing returns, and finally factor endowments. While the theory is written in cross-sectional terms in practice it is implausible that it is testable in that form for a number of reasons. First, as noted earlier, while we would like it to be the case that all firms produce identical products, in reality this is not the case. Small differences in the types of products produced are likely to pollute the TFP level estimates, and render it impossible to gauge relative levels of TFP. Second, even if we could accurately measure firm levels of TFP, we would face the problem that there is no clear mapping from TFP into exports in a Ricardian model with more than two countries. This makes it impossible to look at a country's TFP levels and infer which sectors will be exporters.

Rather than look at the cross-sectional approach, we therefore decided to examine the within variation in two specifications. The first is a random effects probit specification of the form

$$Export_{ft} = \alpha_f + \alpha_t + \beta_R RTFP_{ft} + \beta_D DRS_{ft} + \beta_K KVA_{ft} + \beta_W WVA_{ft} + \omega_{ft} \quad (7)$$

where  $Export_{ft}$  is a dummy that equals one if a firm exports in a given year,  $KVA_{ft}$  is the capital to value added ratio,  $WVA_{ft}$  is the labor cost to value added ratio,  $DRS_{ft}$  is our inverse measure of increasing returns, and  $\omega_{ft}$  is an i.i.d. error term. A few words are in order about this specification. By allowing a firm specific intercept term, we are can remain agnostic about how all of the variables interact in the world economy to determine which firms are exporters and which firms are not. Identification in this approach is realized by examining innovations on the firm level. For example, given a firm's level of exports, if one learned that the firm became more productive, it would make them more prone to export. Similarly, if its production technology shifted from being CRS to IRS (a decline in  $DRS_{ft}$ ) then one again would expect the firm to become an exporter. Finally, Heckscher–Ohlin theory suggests that as long as Japan was relatively capital intensive compared to the world as a whole over the period 1965 to 1990, a reasonably safe assumption, then one should expect that firms that became more capital intensive over the time period, due to, say, capital biased technical change or non-homotheticities in production, should also cause firms to export. In other words, one should expect that  $\beta_R$  is positive,  $\beta_D$  is negative,  $\beta_K$  is positive, and  $\beta_W$  is negative.

There are several caveats about this estimation strategy that also bear contemplation. First is the error term. The error term contains many factors left out of our specification. For example, we must assume that all foreign technological innovations, and factor accumulations by firms are orthogonal to the innovations in Japan. Most probably, foreign technological innovations and factor accumulations are positively correlated with Japanese innovation and accumulation. This is likely to attenuate our estimates of the impact of factor shares and bias our estimate of productivity's contribution to exporting downward. Because of this, we should be clear that our estimates in the following sections probably understate the impact of classical causes of trade. Note that the same argument does not apply to our increasing returns term. Models of increasing returns predict higher levels of exports regardless of whether all increasing returns firms are located in the home country or not.

Table 1  
Regressions without time dummies

	Dependent variable is 1 if firm exports (random effects probit)		Dependent variable is exports/sales (random effects tobit regression)	
Relative TFP	7.88 (0.634)	8.37 (0.662)	0.528 (0.0523)	0.533 (0.0556)
Decreasing returns	0.945 (0.0922)		0.0207 (0.00419)	
Decreasing returns (binary variable)		1.51 (0.0932)		0.01950 (0.00391)
Capital/value added	0.0161 (0.00211)	0.0141 (0.00178)	0.00107 (0.000173)	0.00106 (0.000172)
Wage bill/value added	−1.48 (0.0920)	−1.27 (0.0777)	−0.0926 (0.00507)	−0.0921 (0.00328)
Log likelihood	−4463	−4554	7231	7234
Observations	21214	21214	21214	21214
Number of groups	942	942	942	942

Note. Standard errors in parentheses.

We begin our estimation by considering a probit specification. Table 1 presents the results from this exercise. The first variable is our measure of the deviation in TFP from the firm mean. Interestingly, this variable comes out significantly positive, indicating that firms whose TFP rises are more likely to export than firms whose TFP falls. This supports a basic Ricardian view of firm level exports.<sup>5</sup>

The coefficient on decreasing returns, however, actually has a positive, indicating that firms without increasing returns are actually more likely to export than IRS firms. This is the opposite of what is predicted by theory, but seems to fit nicely with a long line of industry studies that actually found that interindustry trade is typically negatively correlated with measures of increasing returns. One possible interpretation of this result is that short-run cost curves are upward sloping but long-run ones are not. Hence it is possible that our measure of increasing returns does not capture the long run advantages of higher output levels and thus the coefficient in the export regression is biased downwards.

Our two factor endowment terms have the expected signs. Firms that become more capital intensive over time are more likely to export than firms without this tendency, and the reverse is true for labor intensity. This lends support to the basic view of which firms exports generated by the continuum of goods, Heckscher–Ohlin framework.

The failure of increasing returns to predict export patterns is troubling. In the following specifications we examine the robustness of this finding. One possible explanation for this result is that we are using a continuous, rather than a discrete variable to measure increasing returns. Theory predicts that increasing returns yields higher export levels, but there is no

<sup>5</sup> These results complement a number of similar results in the literature. Clerides et al. (1998), Bernard and Jensen (1999), and Bernard et al. (2002) all link exporting to various measures of productivity and costs. A distinguishing feature of our study is our ability to test for a separate effect for productivity as opposed to other factors that might affect firm costs such as increasing returns or labor costs.

theoretical justification for linking the degree of increasing returns to the propensity to export. This suggests that we should modify our specification to allow increasing returns to matter in a binary fashion, i.e. firms that have are more likely to export than firms that do not. In order to do this we recoded  $DRS_{ft}$  such that it equaled 0 if the firm had increasing returns and 1 otherwise. The second column of Table 1 runs the same specification with this dummy DRS variable. The variable comes in significant and positive, indicating again that firm level IRS does not seem to cause higher levels of exports.

Estimating the export equation in a binary format makes sense from a theoretical standpoint, but may not be the best overall specification because it throws out a large amount of information. Firm export levels may contain a large amount of information as well. For example, if a firm shifts from exporting 1% of its output to 20%, that represents a substantial shift in its export behavior, but it would not be picked up in a logistic specification. In columns 3 and 4 we repeat our experiments using exports as a share of sales as the dependent variable. The reason for doing this is that our right-hand side variables may not only affect the export decisions but also the share of exports in a firm's exports. In order to deal with the censoring problem, we estimated this model as a random-effects tobit model. The results are qualitatively similar to the earlier ones. Higher relative productivity and capital to labor ratios are associated with higher shares of exports in sales, but increasing returns consistently comes in with the wrong sign.

In Table 2 we repeat our experiments by including time dummies in the specification. The main impact of these time dummies seems to be on the relative importance of factor proportions. Neither capital nor labor seems to matter for firm level exports when we add time dummies. One interpretation of these results is that factor proportions may drive exports on a national level but not on a firm level. Increasing capital intensity at the national level may be reflected in industrial specialization and greater exporting in general, but may not matter so much for any firm's decision to export.

Table 2  
Regressions with time dummies

	Dependent variable is 1 if firm exports (random effects probit)		Dependent variable is exports/sales (random effects tobit regression)	
Relative TFP	4.34 (0.707)	4.38 (0.630)	0.200 (0.0560)	0.207 (0.0558)
Decreasing returns	0.347 (0.0779)		0.0207 (0.00447)	
Decreasing returns (binary variable)		0.111 (0.0676)		0.0206 (0.00436)
Capital/value added	-0.000417 (0.00245)	-0.00125 (0.00274)	-0.0000273 (0.000316)	-0.000357 (0.000296)
Wage bill/value added	-0.0508 (0.117)	-0.00292 (0.120)	-0.0114 (0.00701)	-0.00982 (0.00701)
Log likelihood	-4224	-4229	7607	7610
Observations	21214	21214	21214	21214
Number of groups	942	942	942	942

Note. Standard errors in parentheses.

#### 4. Conclusion

Returning to the question posed in the title, we find that standard models of comparative advantage seem to be quite relevant for understanding specialization and export behavior. Endowments seem to matter in that firms with the highest growth in capital intensity also saw the highest growth in export shares and the propensity to export. However, these results seem to only be present on a national level. After controlling for national factor accumulation, firm level export decisions seem to have little correlation with the capital intensity of their production process. Interestingly, we find very little support for the monopolistic competition model, which suggests that further work should be done in this area.

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