

# INTRA-FIRM TRADE AND PRODUCT CONTRACTIBILITY\*

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## Abstract

This paper examines the determinants of intra-firm trade in U.S. imports using detailed country-product data. We create a new measure of product contractibility based on the degree of intermediation in international trade for the product. We find important roles for the interaction of country and product characteristics in determining intra-firm trade shares. Intra-firm trade is high for products with low levels of contractability sourced from countries with weak governance, for skill-intensive products from skill-scarce countries, and for capital-intensive products from capital-abundant countries.

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## 1. Introduction

Research on multinational firms has recently been extended to incorporate elements of contract theory. Motivated by substantial increases in firms' cross-border production networks and rapidly rising trade volumes, this emerging literature addresses firms' decisions to source components in-house versus at arm's length in conjunction with their choices over whether to locate production at home or abroad.<sup>1</sup> In general, it differs from earlier work on multinationals in its emphasis on the costs associated with writing contracts for specialized inputs and on the importance of traded intermediate goods.<sup>2</sup> At its heart, this literature seeks to understand the factors that govern intra-firm trade.

This paper provides an empirical examination of the determinants of intra-firm trade across both a large number of countries and detailed product categories. We focus on testable predictions from the existing theoretical literature, paying special attention to the interaction of product and country attributes, in particular the interaction of product contractibility with the quality of countries' contracting environments.

Our analysis of intra-firm trade takes advantage of a dataset that tracks U.S. international trade at the transaction level. These data are derived from the customs documents that accompany every shipment that crosses the U.S. border. For each import shipment, we are able to observe the Harmonized System product classification and date of shipment, the value shipped, the source country, and whether the transaction takes place at "arm's length" or between "related parties".

The main contribution of this paper is the characterization of the product and country attributes that determine firms' decisions to import from related parties rather than at arm's length. Theoretical models addressing this issue focus on the ability of the firm to write contracts for the production of specialized inputs. In practice, the ability of firms to write such contracts depends upon many factors, including product, firm and country characteristics. We introduce a new measure of products' revealed contractibility that is based on the types of firms importing each product. Under the assumption that products for which contracting is easier are more likely to be traded by intermediaries such as retailers or wholesalers, we define an index of intermediation as the weighted average of the retail and wholesale employment shares of each firm importing the product, using the firms' importance in a product market in value terms as weights.

A second contribution of the paper is the identification of an important selection problem in any analysis of intra-firm trade. The decision to establish a foreign affiliate

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<sup>1</sup>See the literature survey by Helpman (2006).

<sup>2</sup>See Markusen (2002) for a survey of the wider literature.

in a country differs from the choice of how much to source from the affiliate once it is established. The selection issues manifests itself most clearly in the role of country governance in influencing intra-firm trade. Our results point to an important non-linearity in the relationship between the quality of country governance and the share of intra-firm trade. Countries with weak governance are less likely to have foreign affiliates; increases in country governance raise the probability that affiliates are present. However, once affiliates are present further increases in governance quality are associated with substantially greater shares of arms-length trade; arms-length contracting is easier in countries with the best governance systems.

More importantly, the quality of country governance interacts with the contractibility of the product. Improvements in country governance allow the least contractible products to be sourced at arms-length. Products that are the least likely to be handled by intermediaries such as wholesale and retail firms are most likely to be outsourced when governance quality is higher. Intra-firm trade shares are relatively higher for products with low intermediation in countries with poor contracting environments. On the other hand, the intensity of related-party trade varies little in response to variation in country governance quality for high intermediation products.

Our results both complement and extend the existing empirical literature on intra-firm trade. As in Antràs (2003), we find a positive relationship between physical capital and intra-firm trade shares. However, our results suggest that the dominant effect comes from the interaction of the industry capital intensity and country capital abundance. Intra-firm trade shares are high for capital-intensive products coming from capital-abundant countries.

Unlike previous work, we find a much larger role for skill. Product skill intensity is generally positively related to intra-firm trade shares. Country skill abundance is negatively related to intra-firm trade shares but the effect depends heavily on skill intensity of the industry. Imports to the U.S. are most likely to be inside the firm for skill-intensive products from skill-scarce countries.

The paper is organized as follows: Section 2 discusses the motivating theoretical literature and reviews related empirical work on intra-firm trade. In Section 3 we introduce the trade data; the share of intra-firm trade is detailed by country and industry in Section 4. Section 5 discusses the new product measure of intermediation. Section 6 presents the empirical results on the determinants of intra-firm trade. In Section 7 we discuss the results in light of the theory and Section 8 concludes.

## 2. Motivating theory and prior empirical research

An early paper addressing the contracting costs of multinationals is Antràs (2003) who develops a Helpman-Krugman general equilibrium model of trade with an incomplete-contracting, property-rights view of the boundaries of the firm. In the model, transactions costs of using the market are increasing in the capital intensity of the input and as a result in general equilibrium the firm will outsource labor intensive activities and keep capital intensive activities inside the firm. The argument for the importance of capital intensity in intra-firm trade is driven by the assumption that it is easier for final-goods producers to share investment costs (and solve the supplier underinvestment problem) with suppliers for investments in physical capital than for investments in labor.

When combined with variation in countries' capital abundance, and thus comparative advantage, Antràs (2003) predicts that capital-intensive imports to the U.S. are more likely to be produced inside the firm and sourced from capital-abundant countries. Antràs (2003) is unusual in that he combines empirical work with the development of the theory. He reports results for 23 aggregate industries that demonstrate a positive correlation between industry capital intensity and their share of intra-firm imports. Similarly, regressions on 28 countries exhibit a positive correlation between capital abundance and country-level intra-firm import shares.

Antràs and Helpman (2004) develop a model that combines heterogenous firms and incomplete contracts in a North-South setting. In their model, higher firm productivity and greater intensity of headquarters services in final goods production increases the likelihood that a firm will import intermediates from subsidiaries in the South. While most of their results focus on the organizational choice of firms within sectors, they show that a larger share of final-good producers use imported intermediates in sectors with higher productivity dispersion. In sectors in which the equilibrium is characterized by both integration and outsourcing, higher productivity dispersion leads to more final goods producers importing intra-firm. Both results suggest that intra-firm trade should be increasing in industry productivity dispersion.

In Grossman and Helpman (2002), increased competition in an industry leads to more integration as specialized input producers need a greater per unit cost advantage. In less competitive markets, the decision to integrate or outsource depends on relative fixed costs. Grossman and Helpman (2003, 2005) consider the choice to outsource or produce inside the firm. In Grossman and Helpman (2003), an increase in industry size favors outsourcing over integration, similarly an improvement in the contracting environment leads to more outsourcing. In Grossman and Helpman (2005), improvements in the

contracting environment in the South may raise or lower the level of outsourcing in the South.<sup>3</sup>

These theoretical models suggest several empirical hypotheses that we can take to the data. From Antràs (2003), we test whether product capital intensity and country capital abundance are positively related to intra-firm trade shares. Antràs and Helpman (2004) suggest a positive relationship between industry productivity dispersion and intra-firm trade while Grossman and Helpman (2003, 2005) emphasize the role of the contract enforcement environment in the country.

### *2.1. Related empirical research*

While multinationals have been the focus of a large empirical literature, relatively few studies have addressed issues related to contracting, organizational structure and intra-firm trade. Antràs (2003) finds support for the importance of capital intensity and capital abundance in intra-firm trade. In our empirical analysis we exploit more finely detailed product-country data and show that these results are robust to the inclusion of a number of other economic determinants. Two additional results from Antràs (2003) are worth mentioning: first he finds no effect of country size (log population) on intra-firm trade shares, as predicted by his model, and second he finds no role for industry skill intensity or country skill abundance.

Yeaple (2006) uses data on trade between U.S. parent firms and their affiliates in 51 aggregate industries to examine the empirical implications of models of international trade and incomplete contracts. His results generally support those of Antràs with positive relationships between intra-firm trade shares and industry capital intensity and R&D intensity. He also includes a measure of industry productivity dispersion and finds a significant positive correlation with intra-firm imports. Yeaple runs separate specifications for each of three groups of source countries where the grouping depends on country income per capita. He finds the correlation with industry capital intensity is strongest for intra-firm trade from the lowest income group while the correlation with industry R&D intensity is largest for intra-firm from developed economies. Like Antràs, Yeaple finds no effect of human capital on intra-firm trade shares.

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<sup>3</sup>Other papers that discuss contracting issues, outsourcing and offshoring include McLaren (2000) on the link between market thickness and organizational form, Grossman and Helpman (2004) on the role of firm variation within an industry. Feenstra and Spencer (2005) consider the determinants of contractual versus generic outsourcing where the former requires a relationship-specific investment as opposed to the latter which occurs in the market. Antràs (2005) on links between changes in the organizational form of the firm and product life cycles.

A recent paper by Nunn and Treffer (2008) uses product-country data to examine the role of inputs provided by the headquarters firm (physical and human capital), of productivity dispersion, and the role of supplier contracting. They confirm the earlier work of Antras (2003) and Yeaple (2006) on the role of industry physical capital intensity while also reporting a positive relationship between industry human capital intensity and intra-firm trade shares. As in Yeaple (2006) they find a positive effect of productivity dispersion on intra-firm trade, particularly for headquarters intensive industries.

Most closely related to our work, Nunn and Treffer also examine the importance of contractibility in intra-firm trade shares. They employ a measure of industry relationship specificity developed by Nunn (2007) that considers the extent of exchange-traded inputs in production interacted with a country-level indicator of the rule of law from Kaufman, Kraay and Zoido-Lobaton (2006). They find that intra-firm trade is increasing in the interaction of contractibility and governance for more productive industries which is attributed to the role of the increasing relative importance of non-contractible inputs delivered by the US headquarters.

We build on this existing empirical work on intra-firm trade and contracting by considering the role of physical capital in intra-firm trade for a large number of countries and for more detailed product categories. In addition, we estimate a single specification with product-country intra-firm trade shares as our dependent variable and test for the importance of the interaction between product capital intensity and country capital abundance as well as product skill intensity and country skill abundance. We extend the examination of product contractibility by considering the interaction of country governance and a new product-level indicator of contractibility based on the importance of intermediaries in international trade. We also examine the robustness of all these factors when controlling for selection by firms in where to locate their subsidiaries.

While they do not consider contracting motives for intra-firm trade, Hanson, Mataloni and Slaughter (2005) examine factors affecting the share of imported intermediates by foreign affiliates of U.S. multinationals in total foreign affiliate sales, i.e. exports from U.S. parents to their affiliates for further processing. Looking across countries within firm-industry pairs, they find demand for imported inputs by foreign affiliates is higher in countries with lower trade costs, lower wages for less-skilled labor and lower corporate income tax rates.

Our work is also related to a larger literature on the importance of imported intermediates in overall trade. Feenstra and Hanson (1996), Campa and Goldberg (1997), Hummels, Ishii and Yi (2001), and Yeats (2001) all emphasize an increasing role for in-

intermediates, as opposed to final goods, in world trade in recent decades. Some or all of these papers have been cited as explicit motivation for the theoretical work on contracting and organizational form.

### 3. Data

We use the Linked/Longitudinal Firm Trade Transaction Database (LFTTD) assembled by Bernard et al. (2008) which links individual trade transactions to firms in the United States.<sup>4</sup> The dataset records all U.S. import and export transactions by the respective importing and exporting firms. This dataset has two components. The first, foreign trade data assembled by the U.S. Census Bureau and U.S. Customs, captures all U.S. international trade transactions between 1992 and 2005 inclusive. For each flow of goods across a U.S. border, this dataset records the product classification, the value and quantity shipped, the date of the shipment, the destination (or source) country, the transport mode, and whether the transaction takes place at “arm’s length” or between “related parties”. “Related-party”, or intra-firm, trade refers to shipments between U.S. companies and their foreign subsidiaries as well as trade between U.S. subsidiaries of foreign companies and their affiliates abroad. For imports, firms are “related” if either owns, controls or holds voting power equivalent to 6 percent of the outstanding voting stock or shares of the other organization (see Section 402(e) of the Tariff Act of 1930).<sup>5</sup>

The second component of the LFTTD is the Longitudinal Business Database (LBD) of the U.S. Census Bureau, which records annual employment, industry (4-digit 1987 Standard Industrial Classification SIC4), and survival information for most U.S. establishments.<sup>6</sup> Employment information for each establishment is collected in March of every year and we aggregate the establishment data up to the level of the firm. Matching the annual information in the LBD to the transaction-level trade data yields the LFTTD. Products in the LFTTD are tracked according to ten-digit Harmonized System (HS) categories. There are 8572 categories for exported products and 22305 categories for imported products.

For our empirical work we integrate several datasets into the LFTTD. First, from the Longitudinal Research Database, we generate industry-level (4-digit 1987 Standard Indus-

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<sup>4</sup>See Bernard et al. (2008) for a description of the LFTTD and its construction.

<sup>5</sup>The 6 percent threshold for imports is lower than that used by the Bureau of Economic Analysis and will result in somewhat higher measured amounts of intra-firm trade.

<sup>6</sup>This dataset excludes the U.S. Postal Service and firms in agriculture, forestry and fishing, railroads, education, public administration and several smaller sectors. See Jarmin and Miranda (2002) for an extensive discussion of the LBD and its construction.

trial Classification SIC4) measures of log capital per worker, share of skilled workers and a measure of the dispersion of productivity within the industry, the log standard deviation of labor productivity at single-product plants.<sup>7</sup> These industry-level measures are then matched to the 10-digit HS products based on the concordance in Feenstra, Romalis and Schott (2002). We add country characteristics from several sources: measures of openness to FDI and trade from the Heritage Foundation/WSJ (2006); measures of population, capital abundance, and human capital abundance from Hall and Jones (1999); and a single composite index of country governance created by factor analysis from six measures of governance tabulated by the World Bank (Kaufman, Kraay and Zoido-Lobaton 2006).<sup>8</sup>

#### 4. Intra-firm imports

This section documents the extent of U.S. intra-firm imports by trading partner and industry for 2000. To maximize our ability to report results across countries and industries, we use recently published, publicly available data on related-party trade from the Foreign Trade Division of the U.S. Census Bureau.<sup>9</sup> The public, industry data on related-party trade is reported according to the North American Industry Classification System (NAICS) and, as a result, differs from the more detailed Harmonized System codes available in the LFFTD and employed in the subsequent regression analysis.

##### 4.1. *By Country*

We begin by considering variation in related-party imports across countries in 2000. The data are summarized in Table 1 which reports the level of imports and the share of related-party imports by country. Over 46 percent of U.S. imports are intra-firm, however, as indicated in the table, there is a wide range of exposure to intra-firm trade across countries. For the average country, 23.8 percent of exports to the U.S. are intra-firm and more than a quarter of countries have intra-firm shares less than 5 percent. On the low end, imports from Bangladesh are almost entirely arms-length transactions, with just 2 percent of the total value of imports taking place inside the firm. In contrast, imports from Japan and Ireland are dominated by intra-firm transactions. In 2000, 76 percent of the value of imports from Ireland and 74 percent of the imports from Japan were conducted by multinationals trading with related foreign divisions. Anecdotal evidence would suggest

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<sup>7</sup>We use the dispersion at single product plants to minimize problems of productivity measurement when plants produce in more than one sector, see Bernard, Redding and Schott (2006).

<sup>8</sup>See the data Appendix for details on the construction of the governance factor.

<sup>9</sup>The data source for all the results in this section is <http://sasweb.ssd.census.gov/relatedparty>.



that the intra-firm imports of Ireland and Japan stem from different types of organizations. Japanese intra-firm shipments to the U.S. are likely trades between Japanese parents and U.S. subsidiaries, while Irish intra-firm shipments are more likely to be between Irish subsidiaries and U.S. parents, or U.S. affiliates of European multinationals.

In general, countries with low shares of intra-firm exports to the U.S. are less developed and have lower overall export volumes, while high-income countries in the OECD generally report above average intra-firm imports to the United States. Imports from China, the fourth largest exporter to the U.S. in 2000, are still largely conducted between unrelated parties with just 18 percent exchanged inside the firm.

#### 4.2. *By Industry*

Table 2 summarizes variation in related-party imports across industries in 2000, using relatively aggregate 3-digit NAICS industries.<sup>10</sup> As with the country-level data, industries vary widely in the extent to which their trade takes place within firms. Imports of leather, textiles and apparel are dominated by arms-length transactions while more than half of imports in transportation equipment, computers and electronics products and chemicals are conducted between related parties.

Table 3 reports the manufacturing industries with the 20 highest and 20 lowest shares of related-party trade in 2000 using 6-digit NAICS industries. Footwear industries are heavily represented in the low end of the distribution of intra-firm trade shares. In rubber and plastic footwear, for example, intra-firm imports account for just 1.8 percent of total imports. Imports of autos and related equipment, medical equipment and pharmaceuticals, and instruments, on the other hand, are dominated by intra-firm transactions. In each of these industries, more than 70 percent of all imports are between related parties.

These industry averages obscure important variation across countries within products. Figure 1 shows the distribution of imports of Photo Films, Plates and Chemicals (NAICS 325992) across countries. This industry has fifth highest share of intra-firm imports. The figure shows both the share of intra-firm imports from each country (line - left axis) and the level of overall imports (bar - log scale right axis). The countries are sorted by the share of intra-firm imports in total imports in 2000. While the industry as a whole has a high level of intra-firm trade, there is substantial variation across countries. Half the countries, including most of the major exporters by volume, have intra-firm shares greater than 70 percent. Most of the remaining countries, including a number of middle

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<sup>10</sup>In this section we use publicly available data from the foreign trade division of the Census Bureau. As a consequence these table use the NAICS industry classification system. In our regression results below we use the much more disaggregated 10-digit products of the Harmonized System.

income and developing countries, have little or no related-party exports to the U.S.. We allow for variation in both country and product characteristics and their interaction in our subsequent empirical work.

## 5. Measuring intermediation

The theoretical literature on international trade, contract theory, and the structure of the firm discussed above and summarized in Helpman (2006) focuses on the ability of the firm to write a contract for the production of specialized inputs. In practice, the ability of firms to write such contracts depends upon many factors related to the input, the firms involved, and the institutional setting in which contracting takes place. Existing empirical research has focused on several proxies for measuring products' contractibility. Antràs (2003), for example, relies on an interaction of goods' capital intensity and countries' capital abundance. Nunn (2006), by contrast, measures industry contract intensity as the share of inputs that are neither sold on an organized exchange nor have a reference price.

Here, we explore a new dimension of contractibility based on the types of firms that import the product. The underlying premise is that products for which contracting is easier are more likely to be imported by retailers or wholesalers. In constructing the measure, we take advantage of the fact that the LFFTD records the primary industry and employment of each establishment of a firm for all traded products. We use these data to compute the share of employment at each firm that is engaged in wholesaling or retailing. The intermediation of a product is defined to be a weighted average of the retail and wholesale employment shares of each firm importing the product, using the firms' importance in a product market in value terms as weights,

$$IMED_p = \sum_f \frac{RW_f}{EMP_f} \frac{M_{pf}}{M_p}. \quad (1)$$

The first term in the intermediation measure is the share of firm  $f$ 's total employment ( $EMP_f$ ) engaged retail and wholesale sectors ( $RW_f$ ). The second term is the import share of firm  $f$  in product market  $p$ , with  $M_{pf}$  and  $M_f$  representing firm  $f$ 's imports of product  $p$  and total U.S. imports of product  $p$ , respectively. Intermediation ranges between zero and unity: if no firms importing product  $p$  have any retail or wholesale establishments then  $IMED_p = 0$ . On the other hand, if product  $p$  is imported exclusively by pure retailing or wholesaling firms, then  $IMED_p = 1$ .

Table 4 reports the intermediation measure for 77 HS2 industries in 1997. The first column of the table sorts industries according to intermediation, from high to low, while

the second column sorts industries according to their two-digit HS classification. Across industries, intermediation averages 0.45, ranging from 0.16 in pharmaceuticals (HS 30) to 0.88 in straw (HS 46), with an interquartile range of 0.32 to 0.58. Agricultural goods and relatively labor intensive industries such as apparel and footwear generally have the highest measured intermediation, while more “sophisticated” products such as pharmaceuticals, chemicals and photographic goods have the lowest measures of intermediation.

Intermediation is inversely related to intra-firm trade shares across HS2 industries. This relationship can be seen visually in Figure 2, which reports a scatter of industries’ intermediation versus their share of intra-firm imports for 1997. Intermediation and intra-firm import shares are related but are not synonymous: industries with similar levels of intermediation display a wide range of intra-firm trade shares. Printed Books (HS 49) and Electrical Machinery (HS85) have comparable levels of intermediation, 0.29 and 0.28 respectively. However, more than two thirds of Electrical Machinery imports are conducted by related parties while the intra-firm trade share for Printed Books is less than 25 percent.<sup>11</sup>

## 6. Determinants of intra-firm trade

In this section we examine the theoretical implications of intra-firm trade models using the import data available in the LFTTD. As indicated above, these models predict that intra-firm imports are influenced by a number of product and country characteristics, as well as interactions of these characteristics. To test these predictions, we combine the data available in the LFTTD with additional datasets measuring these characteristics.

The empirical work focuses on testing the implications of the new models of contract theory and international trade. Antràs (2003) emphasizes the role of capital intensity and capital abundance in related-party trade. His model predicts industries that are more capital-intensive and countries that are more capital-abundant will have higher shares of intra-firm imports in U.S. imports. In addition he predicts no relationship between intra-firm import shares and country size (log population). For country capital abundance and population, we follow Antràs (2003) and use the measures from Hall and Jones (1999).

Product characteristics such as capital intensity are not available for ten-digit HS products, i.e., the most detail product classification for U.S. imports and exports. As a result, we concord HS product codes to more aggregate four-digit Standard Industry Classification (SIC4) industries and assign all products within a particular industry the

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<sup>11</sup>Intermediation indices are relatively stable over time. The correlation of the intermediation indices in 1993 and 2000 is 0.93, significant at the 1 percent level.

characteristic of that industry. We obtain SIC4 industry characteristics from the 1997 U.S. Census of Manufactures. To measure an SIC4 industry’s capital intensity, we use the average capital intensity of all plants in that industry.

Antràs and Helpman (2004) predict that industries with increased dispersion of productivity across firms will be more likely to undertake FDI. For our measure of product dispersion we use the log variance of labor productivity across single-product plants within SIC4 industries from the 1997 Census of Manufactures.

Grossman and Helpman (2003, 2005) emphasize the contracting environment in the country in the choice between outsourcing and integration. We use a single composite index of countries’ governance quality for 1996 created by factor analysis from six measures of governance tabulated by Kaufman, Kraay and Zoido-Lobaton (2004) for the World Bank.<sup>12</sup> Our comparable product-level variable is the intermediation index, which can be computed for every HS10 product.

Theoretical work on the determinants of FDI enjoys a long history and encompasses a wide range of potential explanatory variables. We focus on a subset of additional explanatory variables in our empirical analysis. For country skill abundance, we again follow Antràs (2003) and use the measures from Hall and Jones (1999). As with capital intensity, product-level measures of skill intensity are not readily available. Instead we use skill intensity as measured by the average share of non-production workers in total employment for SIC4 industries concorded to the HS10 products.

Finally, we consider measures of both country trade protection and FDI protection which are expected to be associated with increased levels of intra-firm trade and thus intra-firm imports to the U.S., see Hanson, Mataloni and Slaughter (2005).<sup>13</sup>

We estimate the relationship between intra-firm trade and product and country characteristics via the following set of cross-sectional OLS regressions, first across products, next across countries, and finally for product-country groups,

$$IF_p = c + \alpha X_p + \epsilon_p \quad (2)$$

$$IF_c = c + \beta Z_c + \epsilon_c \quad (3)$$

$$IF_{pc} = c + \alpha X_p + \beta Z_c + d_i + \epsilon_{pc} \quad (4)$$

$$IF_{pc} = c + \alpha X_p + \beta Z_c + \gamma X Z_{pc} + d_i + \epsilon_{pc}. \quad (5)$$

$IF_p$  is the share of intra-firm import value in total imports in product  $p$  in 1997,  $IF_c$  is the share of intra-firm import value in total imports from country  $c$ , and  $IF_{pc}$  is the

<sup>12</sup>See the data Appendix for details on the construction of the governance factor.

<sup>13</sup>The Heritage/WSJ FDI and trade measures are described as indicators of openness. We relabel them as measures of protection as higher values are associated with less openness to FDI or trade.

share of intra-firm import value in total imports from country  $c$  in product  $p$ .  $X_p$  is a vector of product characteristics,  $Z_c$  is a vector of country characteristics,  $XZ_{pc}$  is a set of interactions between country and product variables and  $d_i$  indicates a set of fixed effects (product or country). In every case, the regressions are run on all observations with positive import values.

### 6.1. Product

In the first four columns of Table 5, we report univariate product-level regressions for each of the product characteristics. The dependent variable in each case is the share of intra-firm import value in total imports for the HS10 product in 1997. After matching with the industry characteristics from the Census of Manufactures, there are a total of 15,373 products in the import data.

The results conform closely to the predictions of the theoretical frameworks for all four characteristics in the univariate specifications. Intermediation is strongly and significantly negatively correlated with intra-firm trade. More contractible products, i.e. those with high intermediation indices, are less likely to be imported from related parties. Conversely, both industry capital and skill intensity are positively and significantly correlated with intra-firm trade. Finally the univariate relationship between productivity dispersion and intra-firm trade is positive. Industries with greater productivity dispersion have higher amounts of intra-firm trade.

Column 5 of the table reports a multivariate specification with all four characteristics. The sign and significance of intermediation, capital intensity, and skill intensity are all unchanged, although the point estimates are reduced in each case. Dispersion is no longer significant and the point estimate is negative and close to zero. In spite of the detailed nature of the dependent variable the four characteristics are able to explain a substantial fraction of the variance of intra-firm trade shares.

### 6.2. Country

In Table 6, we consider the role of country characteristics. The dependent variable in each case is the share of intra-firm import value in total imports for each source country in 1997. After matching with the six country characteristics, we are left with 105 countries in the sample.

Columns 1-6 report univariate regressions for each country variable. Again the theoretical predictions are largely supported as both capital and skill abundance are positively correlated with countries' intra-firm export shares to the U.S.. Country size as measured

by log population is not correlated with intra-firm import shares. Both trade and FDI protection are strongly positively and significantly correlated with intra-firm import shares - higher numbers are associated with decreased openness for both of the Heritage/WSJ measures.

The indicator of good governance is also strongly positively and significantly correlated with intra-firm import shares. Of the characteristics, country governance is notable in that it has a large positive coefficient and it can explain more than one third of the cross-country variance in intra-firm import shares. While the theoretical models disagree about the predicted sign for country governance, the large positive coefficient is somewhat surprising. Generally arms-length relationships would be expected to increase as contract enforcement improves.

In column 7, we consider a multivariate specification with all the country variables. Only the governance factor continues to be positive and significant at the 10 percent level. The multivariate results suggest a substantial amount of colinearity in the country-level variables.

### *6.3. Product-country*

In Table 7 we exploit both product and country dimensions of the data. The dependent variable is the share of intra-firm import value in total imports for the product-country pair in 1997. The resulting data contains 205,042 product-country pairs including all observations with positive imports to the U.S.. Product-country pairs with no trade are not included in the regressions.<sup>14</sup>

Column 1 includes all the available product characteristics and country variables. Intermediation is negatively and significantly associated with intra-firm trade while physical capital intensity and skill intensity of the industry have positive and significant coefficients. As in the product-level specification, industry productivity dispersion is positive but not significant.

Turning to the coefficients on the country characteristics, we again find that physical capital abundance is positive and significant. In contrast to the country-level regressions, we find that human capital abundance is negative and significant and that log population enters with a positive and significant coefficient. The country governance indicator remains significant and with a positive sign. Greater FDI protection is positively correlated with intra-firm trade. However, trade protection is significantly, negatively correlated with intra-firm trade shares.

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<sup>14</sup>See Helpman, Melitz and Rubinstein (2007) on zeros in bilateral trade flows.

In columns 2 and 3 we add country and product fixed effects respectively. The inclusion of the fixed effects leaves the magnitude and significance of the variables largely unchanged. Lower intermediation, higher physical capital intensity and increased skill intensity are all positively related to the share of intra-firm trade in product-country imports. Across countries, greater physical capital abundance, larger population size, increased governance quality, and increased openness to FDI increase intra-firm import shares while greater skill abundance and trade openness are associated with lower intra-firm shares.

There are two major potential problems with the simple OLS regression on country-product pairs: censoring of the dependent variable on both ends, i.e. the intra-firm share cannot be less than zero or greater than one, and likely selection on the dependent variable, intra-firm share cannot be observed unless firms have affiliates in the country of interest. In results available upon request, estimation using Tobit and Poisson regression methods yield no substantive differences from the OLS regressions reducing concerns about censoring.

To gain an understanding of the selection issue, we run the specification just on observations with positive intra-firm imports to the U.S. in column 4 of Table 7. The number of observations falls by more than half, i.e. there are large numbers product-country pairs that have no intra-firm trade. In addition, the results differ in important ways from the full sample, suggesting a likely role for selection in shaping the pattern of intra-firm trade flows. The largest differences are for country governance and the two measures of protectionism, all of which switch signs and are significant. The coefficient on industry productivity dispersion is increases in magnitude and is significant.

Over all country-product pairs, better country governance is associated with higher shares of intra-firm trade. However, conditioning on positive intra-firm imports, country governance has the expected negative sign, better governance is associated with a greater share of arms-length transactions. Countries with weak governance are less likely to have foreign affiliates; increases in country governance raise the probability that affiliates are present. However, once affiliates are present further increases in governance quality are associated with substantially greater shares of arms-length trade, i.e. arms-length contracting is easier in countries with the best governance systems.

In Table 8, we add interaction terms for physical capital, skill and intermediation to the specifications with all observations and positive intra-firm imports. The capital interaction is the product of industry log capital intensity and country log capital abundance; the skill interaction is the product of industry skill intensity and country log skill

abundance; the intermediation interaction is the product of HS10 product intermediation and country governance.

Column 1 reports the results of the OLS regression with interaction terms on all the country-product pairs with positive imports. The addition of the capital interaction term changes both the sign and significance of the physical capital intensity variable (negative and significant) as well as the coefficient on country physical capital abundance which is negative and no longer significant. The interaction term on physical capital is positive and significant.

The inclusion of the interaction effects dramatically increases the positive coefficient on skill intensity, strongly significant, and reverses the sign (to positive) on country skill abundance. The interaction term skill itself is large, negative, and significant. Coefficients on intermediation, productivity dispersion, country governance and the two protection measures are largely unchanged. The intermediation interaction is negative but not significant.

Column 2 contains results of the OLS regression with interaction terms only for country-product pairs with positive intra-firm imports. As with the specification excluding interaction terms there are substantial differences between these results and those for the entire sample. The coefficient on log population is negative and significant. The intermediation index is negative and significant and the magnitude is almost doubled. Similarly, the country governance index has a negative, significant coefficient. The interaction between the two is positive, large and significant, in contrast to the results on the entire sample.

The capital intensity variable is negative and insignificant and the coefficient on country capital abundance is negative and not significant. The interaction term is positive and significant, although the magnitude is much smaller than for the entire sample. The inclusion of the interaction effects dramatically increases the positive coefficient on skill intensity, now strongly significant, and reverses the sign (to positive) on country skill abundance. The interaction term itself is large, negative, and significant. Trade protection enters with a positive sign while FDI protection is negatively related to intra-firm trade shares.

#### *6.4. Selection and Intra-firm Trade*

To address the problem of selection, in Table 9 we estimate a Heckman model. Appropriate instruments are variables that are correlated with the fixed cost of setting up an affiliate in the country but largely uncorrelated with the variable cost of sourcing from a



related party. We use two variables to proxy for the fixed costs of establishing an affiliate: the number of international airline departures from the country in 1990 and the 1996-97 average cost of a 3 minute phone call from the country to the U.S.. In addition, we obtain identification from the variation in coefficients on country governance, log population and the intermediation interaction.<sup>15</sup>

Column 1 of Table 9 reports the first stage of the Heckman model. The addition of the instruments reduces the number of available observations by 12 percent to 181,353. Both airline departures and phone costs are strongly correlated with the presence of intra-firm trade. The  $\chi^2$  test with two degrees of freedom is 323.71 with a p-value of 0.000.<sup>16</sup> More airline departures and lower phone call costs are associated, as expected, with a higher likelihood of positive intra-firm trade flows. The magnitude of the industry capital and skill intensity coefficients increases substantially as does the coefficient on country governance and log population.

Figure 3 shows the effects of intermediation and country governance quality in the first stage of the Heckman model. The intermediation index is distributed between zero and one inclusive across products, while the country governance factor is a  $N(0,1)$  and ranges from -2.5 to 2.5 in the sample of countries. The probability of positive intra-firm trade is high in countries with good governance and for products with low intermediation indices, i.e. low contractibility.

The results of the second stage equation are reported in column two of Table 9. Industry capital intensity and country capital abundance have negative but insignificant coefficients. The interaction term is positive and significant. Using the point estimates from the second stage regression and the range of value for industry capital intensity and country capital abundance, we can examine the net effects these variables and their interaction on intra-firm trade shares. Country log capital abundance ranges from 5.75 to 11.58; industry log capital intensity ranges from 1.73 to 6.87. As shown in Figure 5, intra-firm shares are generally increasing in both intensity and abundance. For the least capital intensive products, moving from the least capital-abundant country to the most raises the intra-firm trade share by 3.8 percentage points. The comparable increase for the most capital-intensive product is 30 percentage points. Imports are most likely to occur for capital-intensive products from capital-abundant countries. However, given the

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<sup>15</sup>The inclusion of additional instruments such as fax machines per capita, the aids rate, firing costs, and unpaid parking fines by country embassy staff in the UK reduces the number of observations but does not change the signs, magnitudes or significance of the results. Results are available upon request from the authors.

<sup>16</sup>The results on the smaller sample are consistent with those from the larger sample throughout.

large standard errors on the estimated coefficients, these point estimates should be viewed with some caution.

The coefficients on industry skill intensity and country human capital abundance are large, positive and significant. The interaction term, however, is large, negative, and significant. We use the coefficients from column 2, the range of skill intensity across products (0.06 - 0.83) and the range of log skill abundance across countries (0.05 - 1.2) to examine the nature of the relationship between skill and intra-firm trade (see Figure 6). For products with high skill intensity, intra-firm trade shares are sharply decreasing in country skill abundance. In contrast for products with low skill intensity, increases in country skill abundance are associated with small increases in intra-firm trade shares. Skill-intensive products from skill-scarce countries are more likely to be imported from related parties.

In contrast to the results from the first stage, we find that intra-firm shares are highest for products with low intermediation in countries with weak governance (see Figure 4). The role of country governance is most important for products with low intermediation. Moving from one standard deviation below the mean to one standard deviation above the mean in the governance indicator increases the intra-firm share by 13.6 percentage points for a product with a low intermediation measure of 0.2. Intra-firm shares are lowest when product intermediation is high and country governance is weak; however for these more contractible products the effect of increasing country governance quality is small. For a product with a intermediation of 0.7, a comparable rise in the governance measure decreases the intra-firm share by 1.2 percentage points.

Looking at other variables, we find that industry productivity dispersion has the predicted positive sign and country size is negative and significant. FDI protection is positive but not significant and greater trade protection is associated with smaller intra-firm trade shares.

## 7. Discussion

We test the implications of recent theory models of intra-firm international trade using detailed country-product data on U.S. imports. The results emphasize the importance both country and product characteristics and their interactions in intra-firm trade. Indeed, we find that running cross-sectional country or product regressions alone can yield misleading results. Similarly, controlling for selection bias is important in evaluating the role of most country characteristics including governance quality, physical and human capital, country size and trade and FDI protection.

Throughout the analysis, we find a strong role for the contractibility of the product as indicated by the intermediation index of the product and for the contracting environment of the country. Increases in intermediation are associated with substantial decreases in the share of intra-firm trade. Similarly, increases in country governance quality, i.e. the contracting environment, lead to more arm's-length shipments. Both these results follow naturally from the predictions of the theory models. Of perhaps greater interest is the importance of the interaction of product intermediation and country governance. Intra-firm trade shares are relatively higher for products with low contractibility in countries with poor contracting environments. Intra-firm trade shares vary little in response to variation in country governance quality for high intermediation products.

Our results largely confirm the positive relationship between industry physical capital intensity, country physical capital abundance and higher intra-firm trade shares predicted by Antràs (2003). Two points stand out: first, it is the interaction of product and country characteristics that is important for physical capital. Second, a degree of caution is needed as the significance of the coefficients in the selection model is marginal at best.

Considering other hypotheses from the theoretical literature, we confirm that industries with greater productivity dispersion have higher intra-firm trade shares, as predicted by Antràs and Helpman (2004). Country size as measured by log population, however, is significantly negatively associated with intra-firm trade shares in all the product-country specifications in contrast to the prediction in Antràs (2003).

Nowhere is the interaction of product and country characteristics more important in the effects of skill intensity and human capital abundance. Intra-firm trade shares are low for less-skill intensive products in skill-scarce countries as well as for skill-intensive products in skill-abundant countries. High levels of intra-firm shares are found for skill-intensive products from skill-scarce countries. These findings suggest a need for more work on the role of skills and incomplete contracts in trade.

## 8. Conclusions

Stimulated by the work of Antràs (2003), the literature on firms and international trade has focused attention on issues of contracting and the boundaries of the firm. This research speaks directly to the increasingly contentious policy issues surrounding the growth of outsourcing, offshoring and international production networks. We examine the implications of the new round of theory models using detailed product-country data on U.S. imports, introduce a new product-level measure of contractibility and document the importance of selection for empirical work on intra-firm trade.

The results point to an important role for contracting in production location decisions and the flow of trade within and outside the firm. Our work identifies an important selection problem facing any analysis of intra-firm trade. The decision to establish a foreign affiliate in a country differs from the choice of how much to source from the affiliate once it is established. For example, affiliates are more likely to be situated in countries that are larger and have better governance whereas the share of intra-firm trade, controlling for the existence of affiliates, is negatively related to both country size and country governance quality.

Our findings both complement and extend the existing empirical literature on intra-firm trade. As suggested in Antràs (2003), our results confirm the positive relationship between intra-firm trade shares and the interaction of the industry capital intensity and country capital abundance. Intra-firm trade shares are high for capital-intensive products coming from capital-abundant countries. Product skill intensity is also generally positively related to intra-firm trade shares. Country skill abundance is negatively related to intra-firm trade shares but the effect depends heavily on skill intensity of the industry. Imports to the U.S. are most likely to be inside the firm for skill-intensive products from skill-scarce countries. We find evidence supporting the Antras and Helpman (2004) prediction that greater productivity dispersion, i.e., an increased probability of high productivity firms, is associated with greater intra-firm trade shares.

A major new finding of this paper is in the role of country governance and product contractibility. The quality of country governance interacts with the contractibility of the product. Improvements in country governance allow the least contractible products to be sourced at arms-length. Products that are the least likely to be handled by intermediaries such as wholesale and retail firms, i.e., those that are least contractible, are most likely to be outsourced when governance quality is higher. Intra-firm trade shares are relatively higher for the least contractible products in countries with poor contracting environments. On the other hand, the intensity of related-party trade varies little in response to variation in country governance quality for products that are relatively easily contractible.

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## A Appendix

### *A1. The country governance factor*

We create a univariate measure of governance at the country level from six World Bank measures (see Kaufman, Kraay and Zoido-Lobaton 2006). The six measures are voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and corruption and are available every other year from 1996-2004. Factor analysis on the pooled data reveals that the six measures are largely driven by a single underlying factor with an eigenvalue of 4.96 (all other factors have eigenvalues below 0.1). Pairwise correlations of the factor with each of the six variables range from 0.83 to 0.97. We use the calculated factor in 1996 as our measure of country-level governance.<sup>17</sup>

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<sup>17</sup>Results from the factor analysis are available upon request.



Country/Territory	Total Imports (millions)	Related-Party Import Share	Country/Territory	Total Imports (millions)	Related-Party Import Share	Country/Territory	Total Imports (millions)	Related-Party Import Share
Brunei	387.40	0.000	United Arab Emirates	936.70	0.073	Bosnia-Herzegovina	17.81	0.296
Lesotho	140.10	0.000	India	10,680.00	0.077	Kuwait	2,499.00	0.307
Equatorial Guinea	154.70	0.000	Nicaragua	596.90	0.078	Italy	24,790.00	0.312
Palau	13.57	0.001	Qatar	490.70	0.078	Portugal	1,571.00	0.321
Turkmenistan	28.02	0.001	Bulgaria	231.10	0.081	Bolivia	184.20	0.327
Micronesia	13.73	0.002	Guyana	126.70	0.083	Czech Republic	1,069.00	0.334
Republic of Yemen	151.10	0.002	Belarus	104.20	0.086	Thailand	16,300.00	0.340
Mozambique	24.38	0.003	Cyprus	22.68	0.086	St Lucia	22.21	0.342
Botswana	40.51	0.003	Ecuador	2,267.00	0.089	Norway	5,540.00	0.353
Swaziland	52.58	0.005	Turkey	3,027.00	0.095	Nigeria	9,680.00	0.364
Oman	256.90	0.006	Kenya	109.40	0.097	Maldives	94.02	0.368
Uzbekistan	34.69	0.007	Panama	296.90	0.105	Iraq	4,393.00	0.372
Mauritius	286.00	0.008	Ghana	206.40	0.114	New Zealand	2,055.00	0.379
Algeria	2,690.00	0.008	Guatemala	2,603.00	0.122	Morocco	456.20	0.380
Cambodia	823.60	0.009	Lithuania	132.40	0.123	Gabon	2,038.00	0.403
Faroe Islands	31.35	0.011	Netherlands Antilles	721.00	0.126	France	29,430.00	0.410
Madagascar	157.70	0.011	Ivory Coast	367.00	0.136	Belgium	9,844.00	0.415
Namibia	42.19	0.015	Sri Lanka	2,002.00	0.137	Iceland	260.10	0.416
Bermuda	39.03	0.015	Hong Kong	11,350.00	0.140	Slovakia	241.50	0.421
Bangladesh	2,416.00	0.019	Tanzania	35.29	0.142	Bahamas	272.80	0.434
Ethiopia	28.66	0.023	Congo (Kinshasa)	212.20	0.145	Canada	229,100.00	0.440
Burma (Myanmar)	468.10	0.024	Barbados	38.45	0.145	Denmark	2,953.00	0.451
Macedonia (Skopje)	138.10	0.025	South Africa	4,204.00	0.151	El Salvador	1,925.00	0.456
Cameroon	145.80	0.027	Venezuela	17,430.00	0.151	Dominican Republic	4,378.00	0.459
Uganda	29.06	0.031	Greece	601.70	0.157	Jamaica	631.50	0.475
Peru	1,985.00	0.032	Georgia	23.96	0.160	United Kingdom	42,840.00	0.488
British Virgin Islands	30.94	0.032	Argentina	3,095.00	0.163	St Kitts and Nevis	36.81	0.493
Nepal	228.90	0.032	Bahrain	337.60	0.164	Philippines	13,940.00	0.496
Uruguay	309.20	0.033	Ukraine	872.00	0.166	Austria	3,118.00	0.506
Pakistan	2,164.00	0.035	Zambia	17.73	0.173	Honduras	3,091.00	0.519
Haiti	296.70	0.035	Chile	3,258.00	0.179	Suriname	135.30	0.523
Macao	1,265.00	0.036	China	99,580.00	0.181	Switzerland	10,090.00	0.536
Fiji	146.00	0.036	Malawi	68.13	0.189	Netherlands	9,679.00	0.536
Angola	3,343.00	0.036	Tunisia	90.97	0.200	Saudi Arabia	14,330.00	0.549
Estonia	542.40	0.038	Romania	470.90	0.215	Korea, South	39,830.00	0.554
Mongolia	116.50	0.039	Taiwan	40,380.00	0.216	Luxembourg	330.90	0.575
Iran	168.60	0.043	Croatia	140.80	0.218	Finland	3,238.00	0.617
Paraguay	42.06	0.045	Indonesia	10,320.00	0.228	Malaysia	25,450.00	0.645
Papua New Guinea	36.87	0.046	Colombia	6,681.00	0.228	Germany	58,350.00	0.647
Jordan	72.84	0.046	Aruba	1,222.00	0.229	Mexico	134,700.00	0.661
Azerbaijan	20.48	0.046	French Polynesia	43.93	0.231	Malta	461.80	0.675
Lebanon	75.99	0.050	Spain	5,674.00	0.241	Costa Rica	3,555.00	0.692
Vietnam	827.40	0.053	Slovenia	313.50	0.242	Hungary	2,711.00	0.694
Moldova	105.40	0.060	Israel	12,950.00	0.248	Sweden	9,570.00	0.700
Armenia	22.81	0.063	Kazakhstan	431.50	0.253	Singapore	19,110.00	0.727
Zimbabwe	113.00	0.065	Trinidad and Tobago	2,179.00	0.253	Japan	145,700.00	0.743
Greenland	15.76	0.066	Russia	7,761.00	0.266	Ireland	16,370.00	0.761
Grenada	27.07	0.066	Congo (Brazzaville)	507.90	0.272	Guinea	88.36	0.882
Syria	149.60	0.068	Poland	1,040.00	0.275	Liechtenstein	293.00	0.886
Latvia	295.30	0.068	Monaco	22.76	0.275	Liberia	45.41	0.888
Egypt	924.60	0.070	Australia	6,213.00	0.290	New Caledonia	31.39	0.972
Belize	91.07	0.073	Brazil	13,730.00	0.293			

Table 1: U.S. Imports and Related-Party Share By Country, 2000

NAICS	Industry	Total Imports (millions\$)	Related-Party Imports (millions\$)	Related-Party Import Share
114	FISH, FRESH/CHILLED/FROZEN & OTHER MARINE PRODUCTS	8113.04	718.99	0.089
112	LIVESTOCK & LIVESTOCK PRODUCTS	3084.77	309.20	0.100
316	LEATHER & ALLIED PRODUCTS	21462.91	2327.80	0.108
321	WOOD PRODUCTS	15387.92	1678.04	0.109
314	TEXTILE MILL PRODUCTS	7347.21	1008.91	0.137
315	APPAREL & ACCESSORIES	62927.61	9806.70	0.156
313	TEXTILES & FABRICS	7041.91	1117.61	0.159
211	OIL & GAS	76166.30	13240.54	0.174
337	FURNITURE & FIXTURES	15606.89	2930.03	0.188
323	PRINTED MATTER AND RELATED PRODUCTS, NESOI	4196.50	815.35	0.194
111	AGRICULTURAL PRODUCTS	11770.98	2337.95	0.199
339	MISCELLANEOUS MANUFACTURED COMMODITIES	56577.49	13238.30	0.234
312	BEVERAGES & TOBACCO PRODUCTS	8349.83	2139.17	0.256
311	FOOD & KINDRED PRODUCTS	18943.84	5032.38	0.266
327	NONMETALLIC MINERAL PRODUCTS	14739.57	4377.95	0.297
324	PETROLEUM & COAL PRODUCTS	40156.04	12655.38	0.315
212	MINERALS & ORES	3674.94	1206.33	0.328
332	FABRICATED METAL PRODUCTS, NESOI	27973.73	9887.24	0.353
331	PRIMARY METAL MFG	43833.20	15715.14	0.359
322	PAPER	19079.53	7075.65	0.371
113	FORESTRY PRODUCTS, NESOI	1409.09	607.40	0.431
326	PLASTICS & RUBBER PRODUCTS	17362.41	7604.15	0.438
335	ELECTRICAL EQUIPMENT, APPLIANCES & COMPONENTS	39567.08	19763.82	0.500
333	MACHINERY, EXCEPT ELECTRICAL	79366.23	39918.27	0.503
325	CHEMICALS	76605.67	45452.36	0.593
334	COMPUTER & ELECTRONIC PRODUCTS	250693.73	166279.15	0.663
336	TRANSPORTATION EQUIPMENT	213109.58	161150.04	0.756

Table 2: U.S. Related Party Trade by 3-Digit NAICS Industry, 2000

	Total Imports (millions\$)	Related- Party Imports (millions\$)	Related- Party Import Share
<b>20 Lowest Related-party Import Shares (NAICS 6-digit)</b>			
MOTOR HOMES	118.51	0.51	0.004
RUBBER & PLASTIC FOOTWEAR	583.66	10.28	0.018
PRIMARY SMELTING & REFINING OF COPPER	2395.74	65.82	0.027
MISSILE/SPACE VEH PARTS & AUXILIARY EQUIP, NESOI	224.47	7.42	0.033
CUT STONE & STONE PRODUCTS	1280.52	43.61	0.034
OTHER FOOTWEAR	4163.67	150.81	0.036
FOLDING PAPERBOARD BOXES	384.94	15.70	0.041
JEWELERS' MATERIAL & LAPIDARY WORK	13227.68	582.20	0.044
CANVAS & RELATED PRODUCTS	234.50	11.23	0.048
PREFABRICATED WOOD BUILDINGS	104.02	5.55	0.053
DRIED & DEHYDRATED FOODS	161.28	9.08	0.056
SPICES & EXTRACTS	501.43	29.10	0.058
WOMEN'S FOOTWEAR (EXC ATHLETIC)	6011.76	349.38	0.058
WOMEN S/GIRLS DRESSES	2103.96	125.64	0.060
FUR & LEATHER APPAREL	1973.30	120.53	0.061
MEN'S FOOTWEAR (EXC ATHLETIC)	3590.32	230.01	0.064
HATS & CAPS	922.92	62.68	0.068
WINES	2706.20	204.21	0.075
SOFTWOOD VENEER & PLYWOOD	270.58	20.78	0.077
MISCELLANEOUS WOOD PRODUCTS	1765.43	139.69	0.079
<b>20 Highest Related-party Import Shares (NAICS 6-digit)</b>			
ELECTROMEDICAL APPARATUS	3129.36	2261.53	0.723
AUTOMATIC ENVIRONMENTAL CONTROLS	619.21	450.24	0.727
MOTOR VEHICLE GASOLINE ENGINES & ENGINE PARTS	10262.29	7503.56	0.731
SANITARY PAPER PRODUCTS	736.16	538.35	0.731
TELEPHONE APPARATUS	13040.60	9552.21	0.732
MOTOR VEHICLE ELECTRICAL & ELECTRONIC EQUIP, NESOI	7337.15	5374.45	0.732
MEDICINAL & BOTANICAL DRUGS & VITAMINS	17399.88	12823.11	0.737
CARBON PAPER & INKED RIBBON	314.00	232.76	0.741
PHARMACEUTICAL PREPARATIONS	10130.55	7591.10	0.749
MOTOR VEHICLE AIR-CONDITIONING	1224.81	918.86	0.750
BOTTLED WATERS	200.16	151.10	0.755
TIRES & TIRE PARTS (EXCL RETREADINGS)	4719.71	3587.08	0.760
COMPUTER STORAGE DEVICES	16283.20	12682.52	0.779
PESTICIDES & OTHER AGRICULTURAL CHEMICALS	499.76	400.61	0.802
PHOTO FILMS, PAPERS, PLATES & CHEMICALS	2485.33	2026.36	0.815
IRRADIATION APPARATUS	1486.62	1263.22	0.850
HEAVY DUTY TRUCKS & CHASSIS	16998.54	15308.62	0.901
AUTOS & LIGHT DUTY MOTOR VEHICLES, INCL CHASSIS	112438.52	107137.86	0.953
GUIDED MISSILES & SPACE VEHICLES	101.79	100.78	0.990

Table 3: U.S. Related Party Trade by 6-Digit NAICS Industry, 2000

HS Chapter	Intermediation	HS Chapter	Intermediation		
46	Straw; basketware	0.88	3	Fish, crustaceans	0.56
8	Fruit and nuts	0.74	6	Trees and plants	0.65
57	Carpets, floor coverings	0.74	7	Vegetables	0.63
64	Footwear, gaiters	0.73	8	Fruit and nuts	0.74
20	Vegetables, fruit, nuts	0.72	9	Coffee, tea, spices	0.64
42	Leather; saddlery and harness	0.71	10	Cereals	0.33
16	Preparations of meat, fish	0.66	12	Oil seeds, grains, plants	0.42
6	Trees and plants	0.65	13	Gums, resins	0.37
9	Coffee, tea, spices	0.64	15	Animal, vegetable fats and oils	0.40
7	Vegetables	0.63	16	Preparations of meat, fish	0.66
65	Headgear and parts thereof	0.63	17	Sugars	0.50
18	Cocoa	0.62	18	Cocoa	0.62
22	Beverages, spirits	0.62	19	Cereals, flour, milk	0.56
61	Knitted or crocheted apparel	0.62	20	Vegetables, fruit, nuts	0.72
63	Other made up textile articles	0.62	21	Misc. edible preparations	0.55
62	Apparel, not knitted or crocheted	0.61	22	Beverages, spirits	0.62
94	Furniture; prefab buildings	0.61	23	Residues from food industries	0.31
95	Toys, games	0.61	24	Tobacco	0.20
52	Cotton	0.60	25	Salt; earths and stone	0.27
69	Ceramic products	0.58	27	Mineral fuels, oils, waxes	0.20
3	Fish, crustaceans	0.56	28	Inorganic chemicals+Z77	0.28
19	Cereals, flour, milk	0.56	29	Organic chemicals	0.27
53	Vegetable textile fibres	0.56	30	Pharmaceutical products	0.16
60	Knitted or crocheted fabrics	0.56	31	Fertilisers	0.43
92	Musical instruments	0.56	32	Tanning or dyeing extracts	0.29
21	Misc. edible preparations	0.55	33	Oils; perfumery	0.37
91	Clocks and watches	0.55	34	Soap, waxes, candles	0.29
82	Tools, implements, cutlery	0.54	35	Starches, glues, enzymes	0.39
93	Arms and ammunition	0.53	37	Photographic goods	0.17
55	Man-made staple fibres	0.52	38	Misc. chemical products	0.17
96	Misc. manufactured articles	0.52	39	Plastics and articles thereof	0.32
17	Sugars	0.50	40	Rubber and articles thereof	0.34
50	Silk	0.50	41	Raw hides, skins, leather	0.39
54	Man-made filaments	0.50	42	Leather; saddlery and harness	0.71
58	Woven fabrics; tapestries	0.50	44	Wood articles; wood charcoal	0.35
73	Articles of iron or steel	0.50	46	Straw; basketware	0.88
68	Stone, plaster, cement	0.48	47	Pulp of wood	0.23
72	Iron and steel	0.46	48	Paper; articles of paper pulp	0.41
74	Copper and articles thereof	0.45	49	Printed books, newspapers	0.31
31	Fertilisers	0.43	50	Silk	0.50
12	Oil seeds, grains, plants	0.42	51	Wool, woven fabric	0.41
83	Misc. articles of base metal	0.42	52	Cotton	0.60
48	Paper; articles of paper pulp	0.41	53	Vegetable textile fibres	0.56
51	Wool, woven fabric	0.41	54	Man-made filaments	0.50
15	Animal, vegetable fats and oils	0.40	55	Man-made staple fibres	0.52
56	Wadding, yarns, ropes, cables	0.40	56	Wadding, yarns, ropes, cables	0.40
35	Starches, glues, enzymes	0.39	57	Carpets, floor coverings	0.74
41	Raw hides, skins, leather	0.39	58	Woven fabrics; tapestries	0.50
70	Glass and glassware	0.39	59	Textile fabrics	0.32
13	Gums, resins	0.37	60	Knitted or crocheted fabrics	0.56
33	Oils; perfumery	0.37	61	Knitted or crocheted apparel	0.62
44	Wood articles; wood charcoal	0.35	62	Apparel, not knitted or crocheted	0.61
40	Rubber and articles thereof	0.34	63	Other made up textile articles	0.62
10	Cereals	0.33	64	Footwear, gaiters	0.73
84	Nuclear reactors, machinery	0.33	65	Headgear and parts thereof	0.63
90	Instruments	0.33	68	Stone, plaster, cement	0.48
39	Plastics and articles thereof	0.32	69	Ceramic products	0.58
59	Textile fabrics	0.32	70	Glass and glassware	0.39
76	Aluminum and articles thereof	0.32	71	Pearls, precious metals, coin	0.23
23	Residues from food industries	0.31	72	Iron and steel	0.46
49	Printed books, newspapers	0.31	73	Articles of iron or steel	0.50
32	Tanning or dyeing extracts	0.29	74	Copper and articles thereof	0.45
34	Soap, waxes, candles	0.29	75	Nickel and articles thereof	0.23
81	Other base metals	0.29	76	Aluminum and articles thereof	0.32
85	Electrical machinery	0.29	81	Other base metals	0.29
28	Inorganic chemicals+Z77	0.28	82	Tools, implements, cutlery	0.54
87	Non-Railway vehicles	0.28	83	Misc. articles of base metal	0.42
25	Salt; earths and stone	0.27	84	Nuclear reactors, machinery	0.33
29	Organic chemicals	0.27	85	Electrical machinery	0.29
47	Pulp of wood	0.23	87	Non-Railway vehicles	0.28
71	Pearls, precious metals, coin	0.23	90	Instruments	0.33
75	Nickel and articles thereof	0.23	91	Clocks and watches	0.55
24	Tobacco	0.20	92	Musical instruments	0.56
27	Mineral fuels, oils, waxes	0.20	93	Arms and ammunition	0.53
37	Photographic goods	0.17	94	Furniture; prefab buildings	0.61
38	Misc. chemical products	0.17	95	Toys, games	0.61
30	Pharmaceutical products	0.16	96	Misc. manufactured articles	0.52

Note: Table displays average intermediation of ten-digit Harmonized System products in 1997 by two-digit HS chapters. First column is sorted by intermediation Second column is sorted by HS chapter.

Table 4: Intermediation Index by HS2 Industry, 1997

	(1)	(2)	(3)	(4)	(5)
Intermediation	-0.234 *** 0.030				-0.141 *** 0.028
Capital Intensity		0.083 *** 0.006			0.057 *** 0.011
Skill Intensity			0.822 *** 0.080		0.577 *** 0.084
Dispersion				0.068 *** 0.010	-0.017 0.011
R-squared	0.052	0.091	0.106	0.039	0.158
Observations	15373	15373	15373	15373	15373

Note: Dependent variable is the intra-firm share of import value by HS10 product. Standard errors are robust to clustering at the SIC4 level. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent levels respectively.

Table 5: Determinants of Intra-firm Imports, HS10 Product 1997

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log capital abundance	0.075 *** 0.010						0.018 0.016
Log human capital abundance		0.437 *** 0.048					0.133 0.133
Log population			-0.003 0.013				0.003 0.011
Governance				0.128 *** 0.014			0.075 * 0.039
FDI protection					-0.090 *** 0.022		0.001 0.023
Trade protection						-0.072 *** 0.018	-0.005 0.023
R-squared	0.283	0.327	0.001	0.359	0.109	0.161	0.385
Observations	105	105	105	105	105	105	105

Note: Dependent variable is the intra-firm share of import value by country. All specifications report robust standard errors. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent levels respectively.

Table 6: Determinants of Intra-firm Imports, Country 1997

	(1) OLS	(2) OLS	(3) OLS	(4) OLS
Intermediation	-0.111 *** (0.017)	-0.104 *** 0.016		-0.092 *** (0.021)
Capital Intensity	0.017 ** (0.007)	0.017 ** 0.007		0.043 *** (0.008)
Skill Intensity	0.219 *** (0.051)	0.210 *** 0.049		0.090 * (0.047)
Dispersion	0.013 (0.008)	0.010 0.007		0.024 *** (0.008)
Log capital abundance	0.054 *** (0.004)		0.056 *** (0.004)	0.067 *** (0.006)
Log human capital abundance	-0.097 *** (0.015)		-0.101 *** (0.014)	-0.085 *** (0.023)
Log population	0.011 *** (0.002)		0.012 *** (0.002)	0.033 *** (0.002)
Governance	0.036 *** (0.004)		0.032 *** (0.004)	-0.030 *** (0.008)
FDI protection	0.017 *** (0.027)		0.016 *** (0.003)	-0.014 *** (0.005)
Trade protection	-0.006 ** (0.002)		-0.006 *** (0.002)	0.015 *** (0.004)
Fixed Effects	none	country	product	none
R-squared	0.073	0.120	0.165	0.071
Observations	205042	205042	205042	96191

Note: Dependent variable is the intra-firm share of import value by HS10-country. Columns 1-3 include all country-product pairs with positive imports. Column 4 only includes country-product pairs with positive intra-firm imports. Standard errors are robust to clustering at the SIC4 level. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent levels respectively.

Table 7: Determinants of Intra-firm Imports, HS10-Country 1997

	(1) OLS	(2) OLS
Intermediation	-0.100 *** (0.015)	-0.208 *** (0.025)
Capital Intensity	-0.169 *** (0.041)	-0.039 (0.038)
Skill Intensity	0.505 *** (0.093)	0.768 *** (0.132)
Dispersion	0.009 (0.007)	0.025 *** (0.009)
Log capital abundance	-0.014 (0.016)	0.034 ** (0.015)
Log human capital abundance	-0.003 (0.025)	0.144 *** (0.047)
Log population	0.012 *** (0.002)	-0.033 *** (0.002)
Governance	0.039 *** (0.005)	-0.072 *** (0.009)
FDI protection	0.015 *** (0.003)	-0.015 *** (0.005)
Trade protection	-0.005 ** (0.002)	0.015 *** (0.004)
Capital interaction	0.018 *** (0.004)	0.007 ** (0.004)
Skill interaction	-0.330 *** (0.090)	-0.779 *** (0.130)
Intermediation interaction	-0.009 (0.008)	0.100 *** (0.014)
Fixed Effects	none	none
R-squared	0.076	0.077
Observations	205042	96,191

Note: Dependent variable is the intra-firm share of import value by HS10-country. The capital interaction is the product of industry log capital intensity and country log capital abundance; the skill interaction is the product of industry skill intensity and country log skill abundance; the intermediation interaction is the product of HS10 intermediation and country governance. Column 1 includes all country-product pairs with positive imports. Column 2 only includes country-product pairs with positive intra-firm imports. Standard errors are robust to clustering at the SIC4 level. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent levels respectively.

Table 8: Determinants of Intra-firm Imports including Interactions, HS10-Country 1997,



	Heckman Selection Model	
	First Stage	Second Stage
Intermediation	-0.266 *** 0.064	-0.254 *** 0.032
Capital Intensity	-0.621 *** 0.143	-0.063 0.044
Skill Intensity	1.612 *** 0.365	0.894 *** 0.146
Dispersion	-0.035 0.030	0.022 ** 0.010
Log capital abundance	-0.046 0.049	-0.009 0.019
Log human capital abundance	0.200 ** 0.095	0.228 *** 0.053
Log population	0.123 *** 0.011	-0.040 *** 0.004
Governance	0.136 *** 0.022	-0.093 *** 0.010
FDI protection	0.105 *** 0.014	0.006 0.007
Trade protection	-0.071 *** 0.013	-0.040 *** 0.004
Capital interaction	0.059 *** 0.014	0.009 ** 0.004
Skill interaction	-0.580 * 0.316	-0.869 *** 0.141
Intermediation interaction	-0.127 *** 0.028	0.124 *** 0.014
Airline Departures (1990) '000s	0.417 *** 0.055	
US Phone Call Cost	-0.020 *** 0.008	
Fixed Effects	none	none
Observations	181,353	181,353

Note: Dependent variable is dummy variable for whether there is intra-firm trade in the HS10-country pair. The capital interaction is the product of industry log capital intensity and country log capital abundance; the skill interaction is the product of industry skill intensity and country log skill abundance; the intermediation interaction is the product of HS10 product intermediation and country governance. Airline departures is the number of international airline flights departing from the country in 1990 in '000s. US phone call cost is the average cost of a 3 minute call to the US in 1996-97. Standard errors are robust to clustering at the SIC4 level. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent levels respectively.

Table 9: Selection and the Determinants of Intra-firm Imports, HS10-Country 1997

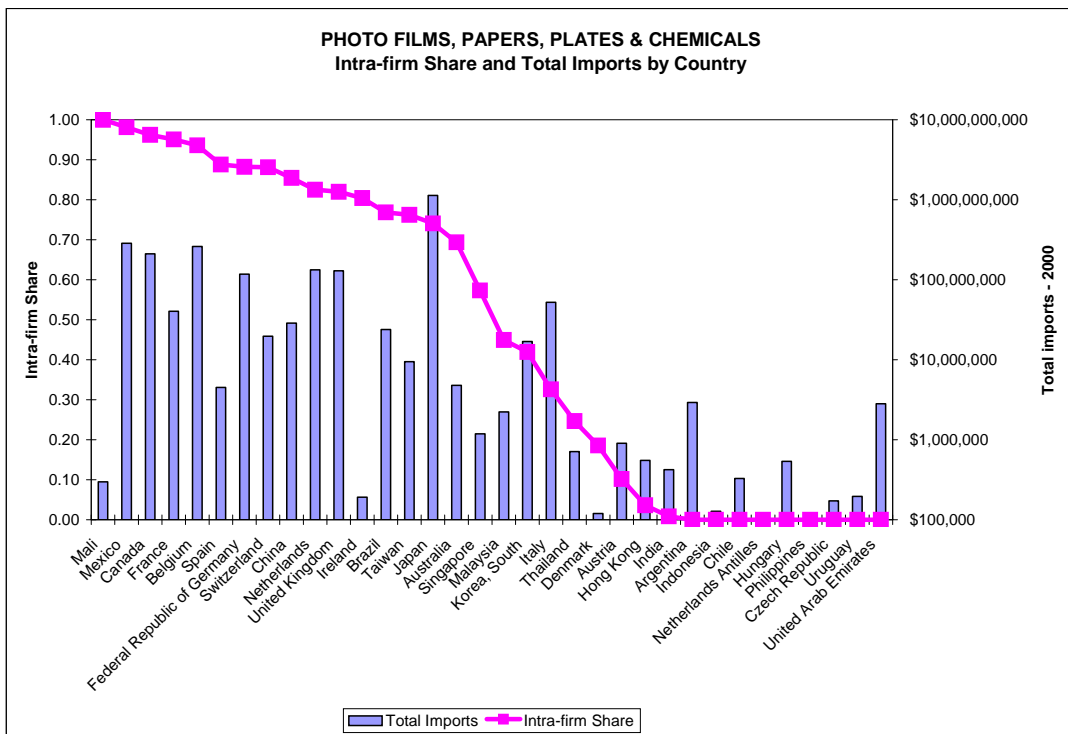


Figure 1: Intra-firm Import Share and Total Imports in 2000, NAICS Industry 325992

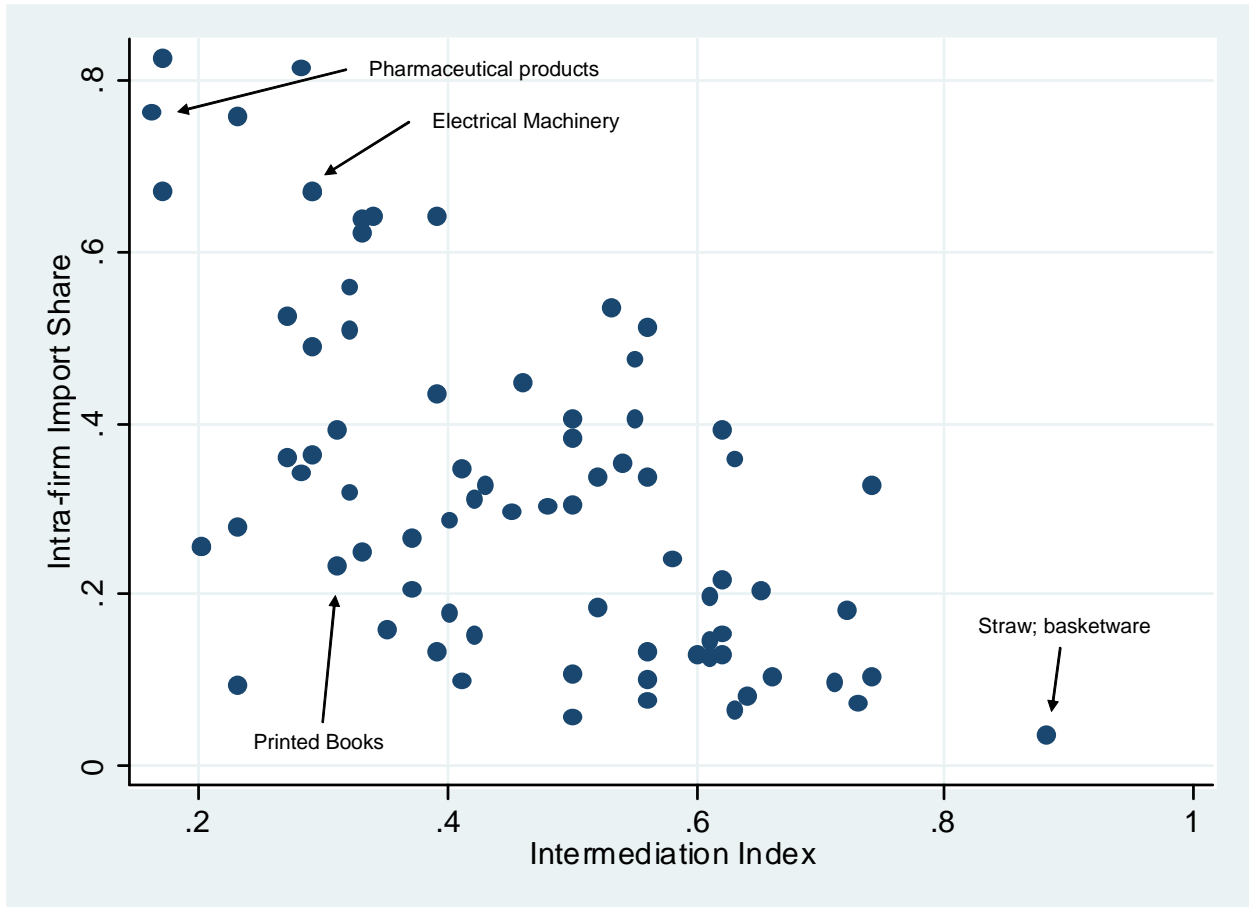


Figure 2: Intermediation and Intra-firm Trade Shares for HS2 Industries, 1997

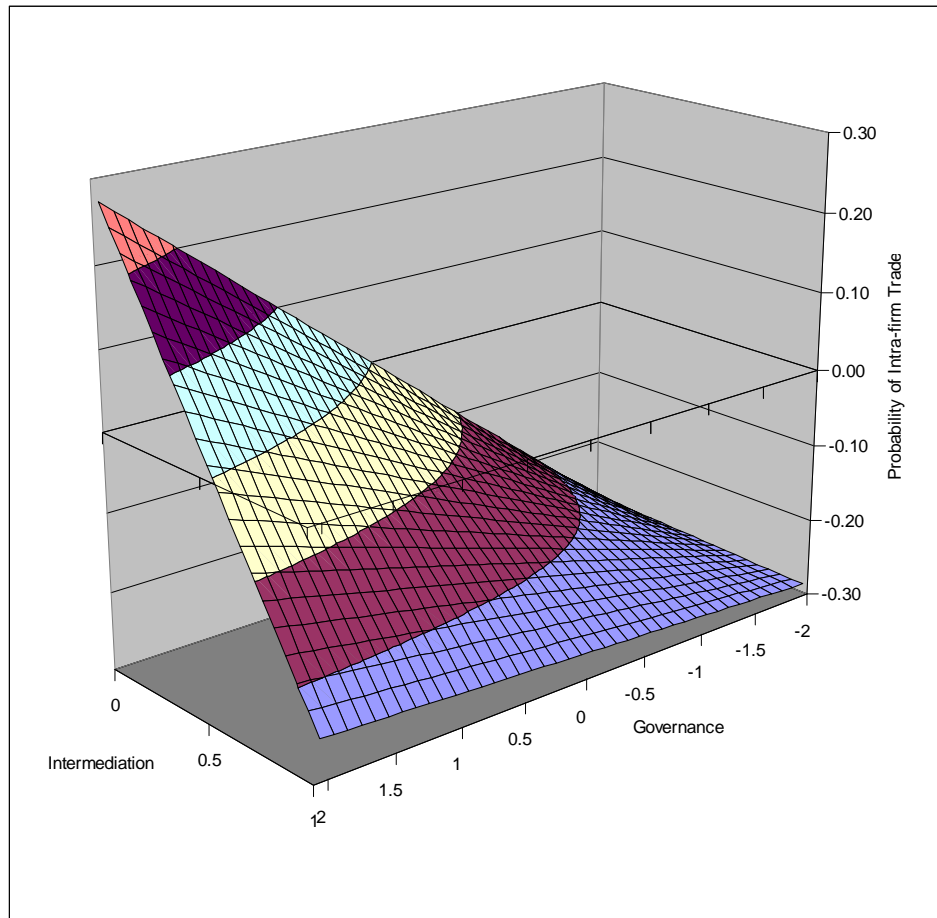


Figure 3: Selection equation - effects of intermediation and country governance

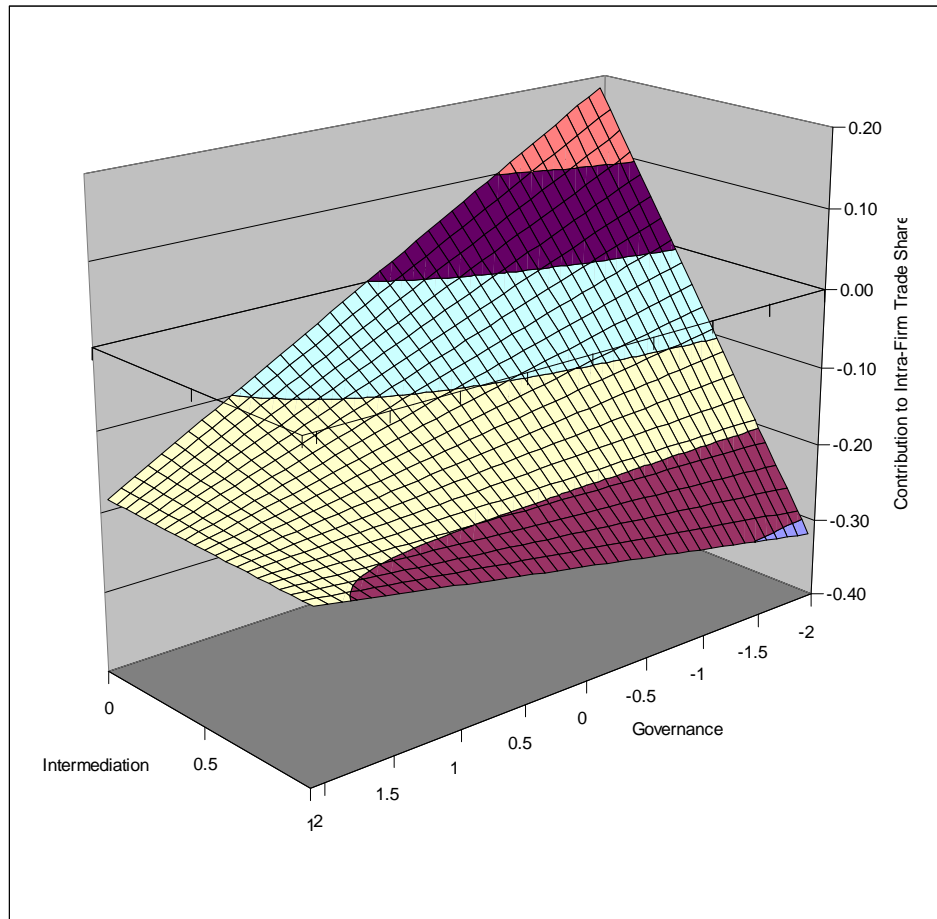


Figure 4: Intra-firm trade share - interaction effects of intermediation and country governance

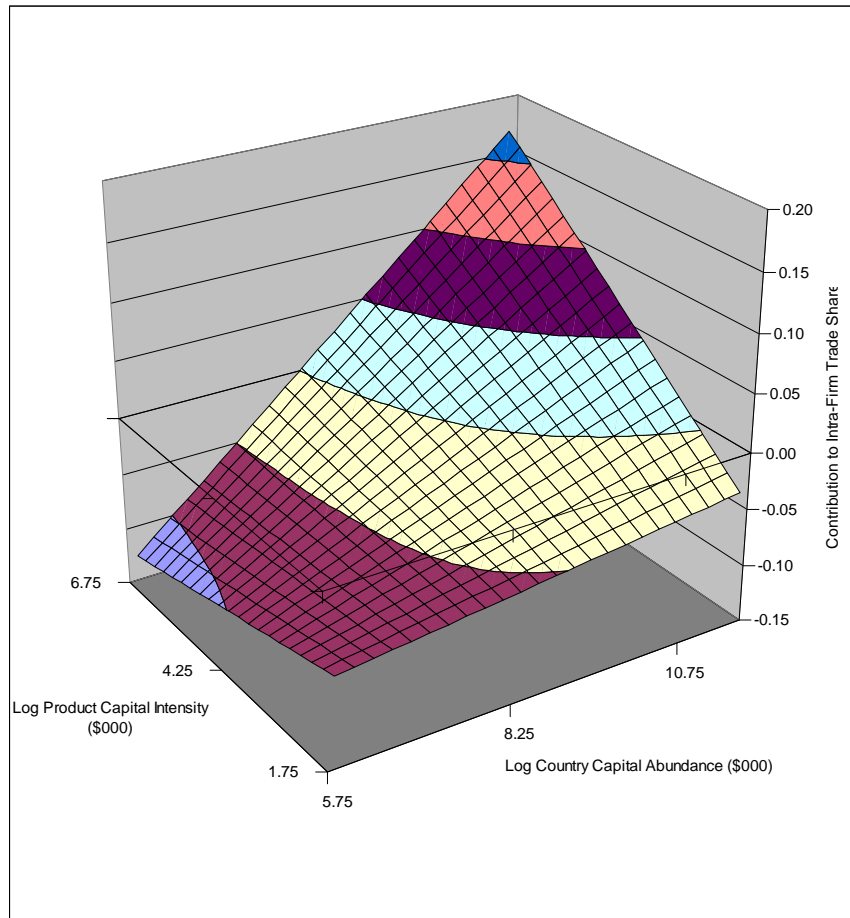


Figure 5: Interaction effects of log physical capital intensity and log capital abundance

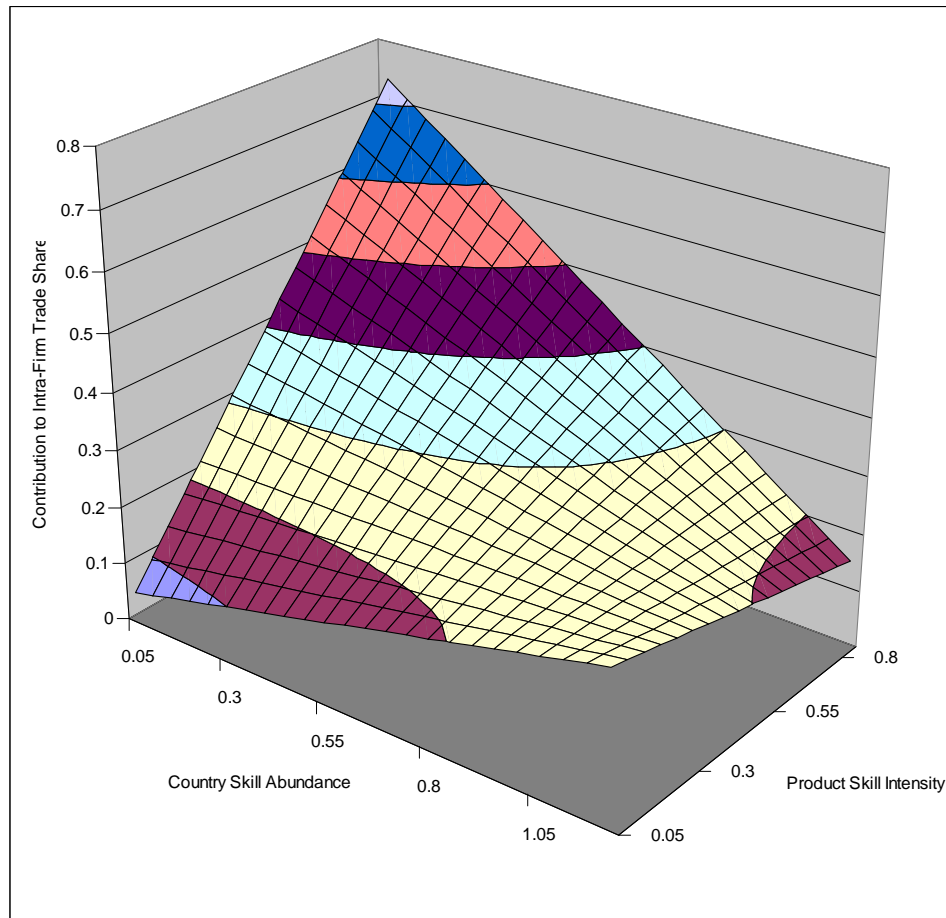


Figure 6: Interaction effects of skill intensity and log human capital abundance