Intra-Firm Trade and Product Contractability

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Forty-six percent of U.S. imports occur between related parties. This aggregate statistic, however, obscures considerable variation in intra-firm intensity across import partners as well as products. Indeed, while 74 percent of U.S. imports from Japan are intra-firm, the figure for Bangladesh is just 2 percent. Likewise, trade between related parties accounted for 2 percent of U.S. imports of rubber and plastic footwear, but more than 70 percent of U.S. imports of autos, medical equipment and instruments. There is also significant variation in intra-firm intensity *across* countries *within* products. Photo Films, Plates and Chemicals (NAICS 325992), for example, ranks fifth overall in terms of the share of intra-firm trade, but half of the countries from which it is sourced (by volume) exported it to the United States almost completely at arm's length.[1]

[1] A longer version of this paper, Andrew B. Bernard, J. Bradford Jensen, Stephen J. Redding and Peter K. Schott (2009), contains additional results and is available on the AER website and from the authors.

These figures highlight the importance of product and country characteristics – and especially their interaction – in explaining intra-firm trade. Such factors are emphasized in recent theoretical models of multinational firms that stress the role of contracting in firms' decisions both to source components in-house versus at arm's length and to locate production at home versus abroad.[2] These models differ from earlier theories of multinationals in their emphasis on the costs associated with writing contracts for specialized inputs and the attention they pay to traded intermediate goods.

Guided by these models, we examine the product and country determinants of intra-firm trade.[3] In particular, we introduce a new measure of products' "revealed contractibility" based on the idea that contracting likely is easier for products passing through intermediaries such as wholesalers. We find that both this measure and countries' governance quality are associated with variation in intra-firm trade in interesting and intuitive ways, and that factors associated with engaging in related-party trade differ from those associated with the intensity of intra-firm trade once a link is established. Higher-quality country governance, for example, is associated with a higher probability of related-party trade taking place. Further increases in quality, however, coincide with *lower* shares of related-party trade, presumably due to the greater ease with which arm's-length contracts can be written. With respect to interactions of product and country attributes, improvements in country governance lead to the largest reductions in intra-firm trade in low contractability products.

[2] See, for example, Pol Antràs (2003), Pol Antràs and Elhanan Helpman (2004), and Gene M. Grossman and Elhanan Helpman (2005).

[3] Our findings complement existing empirical examinations of intra-firm trade by Gregory Corcos, Delphine Irac, Giordano Mion and Thierry Verdier (2008), Fabrice Defever and Farid Toubal (2007), Nathan Nunn and Daniel Trefler (2008) and Stephen R. Yeaple (2006). They also relate to recent research on institutions and trade by Andrei Levchenko (2007) and Nathan Nunn (2007).

I. Data

We use the U.S. Linked/Longitudinal Firm Trade Transaction Database (LFTTD), which links individual U.S. trade transactions to U.S. firms.[4] For each import transaction, we observe the U.S. firm engaging in the transaction, the ten-digit Harmonized System (HS) classification of the product shipped, the (nominal) value shipped, the shipment date, the source country, and whether the transaction takes place at "arm's length" (AL) or between "related parties" (RP). Import partners are "related" if either party owns, directly or indirectly, 6 percent or more of the other party.[5] To concord SIC production and HS trade data, and to expand the sample of countries on which data on country characteristics are available, we focus on the year 1997.

To explore the role of various country characteristics discussed below, we combine these trade data with measures of physical capital abundance, human capital abundance, and population from Robert E. Hall and Charles I. Jones (1999), a composite index of countries' governance quality from the World Bank, and measures of trade and FDI protection from Heritage Foundation/WSJ (2006).[6] We measure products' capital and skill intensity using data from the 1997 U.S. Census of Manufactures. We assign all ten-digit HS products within a particular four-digit SIC industry the average capital or skill (non-production workers as a share of employment) intensity of all plants whose output is concentrated in that industry. Industry headquarters intensity is measured by the average share of firm employment at headquarters and auxiliary establishments.[7]

We assume that products passing through intermediaries are the easiest over which to contract. As a result, we measure products' "revealed" contractibility as the weighted average wholesale employment share of firms importing the product, using firms' import

value as weights,

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

The first term in the intermediation measure is the share of wholesale employment (W_f) in firm f's total employment (EMP_f).[8] The second term is the import share of firm f in ten-digit HS product market p, with M_{pf} and M_p 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 wholesale establishments, $IMED_p = 0$. On the other hand, if product p is imported exclusively by firms with 100 percent employment in wholesaling, $IMED_p = 1$.

Intermediation and intra-firm import shares are inversely related across two-digit HS categories, as shown in Figure 1. There is however substantial independent variation in the two variables, as industries with similar levels of intermediation span a wide range of intra-firm intensity. Footwear (HS 64) and Organic Chemicals (HS 29), for example, have comparable levels of intermediation, 0.135 and 0.136 respectively. However, more than half of Organic Chemicals imports are conducted by related parties while the intra-firm trade share for Footwear is less than 10 percent.

II. Determinants of intra-firm trade

Our empirical analysis uses cross-sectional data on intra-firm and total U.S. imports of product p from county c in 1997. Our empirical specification regresses measures of intra-firm trade (IF_{pc}) on product characteristics (X_p), country characteristics (Z_c) and interactions between product and country characteristics ($X_p \times Z_c$):

$$(2) \quad IF_{pc} = \theta + \alpha X_p + \beta Z_c + \gamma \left(X_p Z_c \right) + \epsilon_{pc},$$

We consider two measures of intra-firm trade: the share of intra-firm imports in U.S. imports, which we refer to as the "intensive" margin, and a dummy variable which is equal to one if there is positive intra-firm imports for a product and country, which we call

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[4]See Andrew B. Bernard, J. Bradford Jensen and Peter K. Schott (2009) for more details.

[5]This dataset excludes the U.S. Postal Service and firms in agriculture, forestry and fishing, railroads, education, public administration and several smaller sectors.

[6]We use factor analysis to create a univariate measure of country governance for 1996 from the six World Bank measures reported by Daniel Kaufman, Aart Kraay and Massimo Mastruzzi (2006). The first factor upon which we focus accounts for around 90 percent of the variance of the six measures.

[7]For further discussion of the data definitions and sources, see Bernard et al. (2009).

[8]We observe employment at the establishment level and therefore assign all employees in an establishment to the major industry of the establishment. Firms with a single establishment necessarily have 100 percent employment in a single industry. Wholesale is NAICS sector 42.

the "extensive" margin. In constructing the interaction terms, we subtract the sample mean from each variable entering the interaction term. This normalization ensures that the main effects of each variable can be interpreted as the effect at the sample mean.

Our choice of product and country characteristics is motivated by the recent theoretical literature on contractual frictions and international trade. This literature emphasizes the relative importance of relationship-specific investments by headquarters and supplier firms and the degree of verifiability of these investments. In Antràs (2003), capital intensity captures the relative importance of headquarters' investments, and hence we include industry capital intensity and country capital abundance. To allow for the possibility that other factor intensities matter, we also include industry skill intensity and country skill abundance. In Antràs and Helpman (2004), headquarters investments are interpreted more broadly, and hence we include our direct measure of headquarters intensity discussed above. In Grossman and Helpman (2005), the degree of verifiability of relationship-specific investments can vary with for example product and country characteristics, and hence we include revealed product contractibility and country governance as further independent variables. Finally, we explore the impact of policy-based barriers by including measures of trade and FDI protection as country characteristics.

Table 1 reports the results of estimating specification (2). Columns (1) and (3) use the extensive margin as the dependent variable, so the sample comprises all product-country cells with positive imports, including those with zero intra-firm trade. Columns (2) and (4) focus on the intensive margin, and the sample is all observations with positive intra-firm trade. Columns (3) and (4) control for the non-random selection of observations with positive intra-firm imports using the Heckman two-stage estimation procedure. The two stages are separately identified by functional form and the excluded variable from the second-stage regression. For the excluded variable, we choose the cost of phone calls to the US, which arguably affects the fixed costs of establishing an affiliate but not the relative variable costs of intra-firm versus arms-length trade.[9]

Consistent with the recent theoretical literature on contractual frictions in international trade, we find in columns (1) and (2) that higher revealed product contractability is associated with less intra-firm trade on both the extensive and intensive margins. We also find that the sign on the quality of country governance changes between columns (1) and (2). Increases in governance quality raise the probability that foreign affiliates are present (column 1), but are associated with lower shares of intra-firm trade (column 2). This result suggests good governance promotes the establishment of related-party trade but not its intensity once established, which is consistent with the idea that arm's-length contracting is easier in countries with good governance. Similar non-linearities are present for population, FDI protection and HQ intensity.

Results in Table 1 also indicate the significance of interactions of product and country characteristics in determining intra-firm trade. While the main effects for intermediation and country governance are both negative in column (4), the interaction term has a positive coefficient. That is, higher product intermediation (revealed contractibility) is associated with greater reductions in intra-firm trade as governance quality declines. Likewise, improved governance is associated with less intra-firm trade, especially for goods with lower intermediation.[10]

As in Antràs (2003), industry capital intensity and country capital abundance play a role in determining the share of intra-firm trade. The positive coefficient on the interaction between industry capital intensity and country capital abundance implies that intra-firm trade shares are high for capital-intensive products coming from capital-abundant countries. In contrast to previous work, we also find a role for industry skill intensity and country skill abundance. The main effects of industry skill intensity on intra-firm trade are positive for both the intensive and extensive margins; the main effects of country human capital abundance are negative; and the estimated coefficients on the skill interaction terms are negative. Therefore, greater industry skill intensity increases the share of intra-firm trade, and leads to larger increases in more skill-scarce countries. In contrast, greater country skill abundance reduces the share of intra-firm trade, and leads to larger reductions in more skill-intensive

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[9]The likelihood ratio test of rho=0 yields a chi-squared statistic of 150.07, rejecting the null of independent equations.

[10]As a robustness check, we re-estimated the specifications in Table 1 replacing the main effects of the country and product characteristics with country and product fixed effects, which yields a similar pattern of coefficients on the interaction terms.

products.

Finally, consistent with the theoretical literature discussed above, we find that intra-firm trade is increasing in headquarters intensity. Additionally, both FDI and trade protection influence intra-firm trade.

IV. Conclusions

The literature on firms and international trade has focused attention on issues of contracting and the boundaries of the firm. This research speaks to policy issues surrounding the growth of outsourcing, offshoring and international production networks.

Our results provide evidence on the role of country governance and product contractibility in determining intra-firm trade. We find evidence of selection: 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. While affiliates are more likely to be situated in countries that are larger and have better governance, once affiliates exist, the share of intra-firm trade 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. Our results confirm the positive relationship between intra-firm trade shares and the interaction between industry capital intensity and country capital abundance. Our results also point to other interactions between country and product characteristics – improvements in country governance matter most for products for which contracting is relatively difficult.

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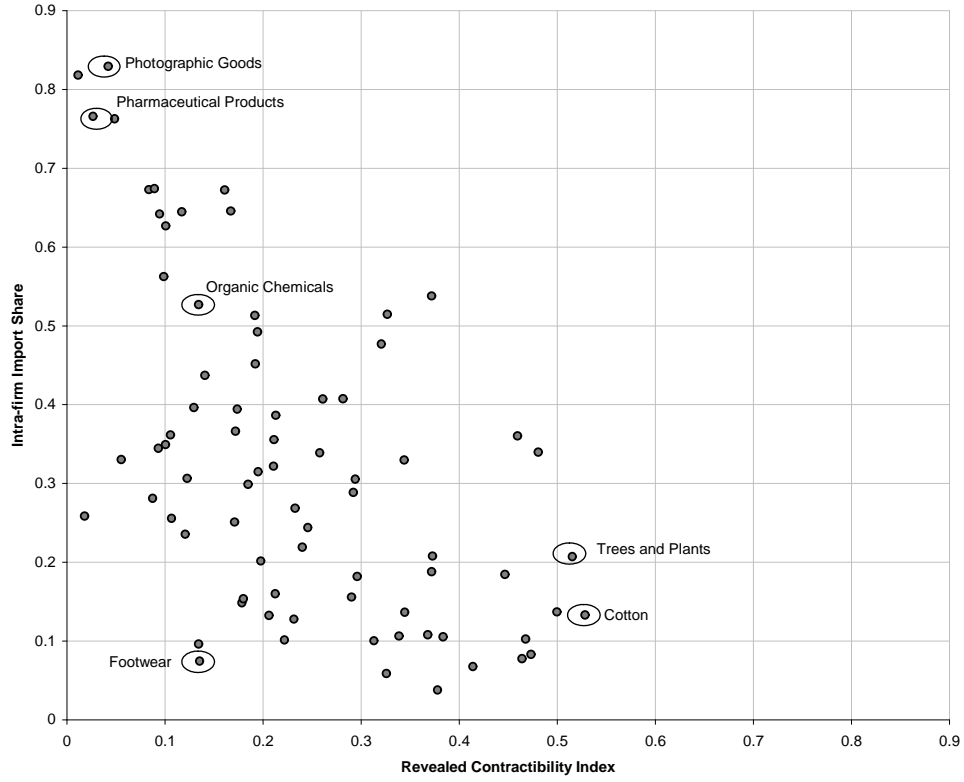
Intra-firm Import Intensity and "Revealed Contractability" by Two-Digit HS Category

TABLE 1—DETERMINANTS OF INTRA-FIRM IMPORTS, HS10-COUNTRY 1997

	(1) Intra-Firm Trade Dummy	(2) Share of Intra-Firm Trade	(3) Intra-Firm Trade Dummy	(4) Share of Intra-Firm Trade
Intermedation	-0.715 *** 0.015	-0.165 *** (0.007)	-0.719 *** 0.015	-0.235 *** 0.009
Governance	0.154 *** 0.007	-0.031 *** (0.003)	0.103 *** 0.008	-0.031 *** 0.004
x Intermediation	-0.058 *** 0.018	0.084 *** (0.008)	-0.056 *** 0.018	0.090 *** 0.009
Capital Intensity	-0.005 0.003	0.059 *** (0.001)	-0.005 0.003	0.056 *** 0.002
Log capital abundance	0.213 *** 0.005	0.067 *** (0.002)	0.173 *** 0.006	0.068 *** 0.003
x Capital intensity	0.068 *** 0.003	0.005 *** (0.001)	0.072 *** 0.003	0.010 *** 0.002
Skill Intensity	1.336 *** 0.031	0.196 *** (0.012)	1.348 *** 0.031	0.324 ** 0.015
Log human capital abundance	-0.105 *** 0.024	-0.066 *** (0.011)	-0.044 ** 0.025	-0.059 ** 0.011
x Skill intensity	-0.415 *** 0.145	-1.063 *** (0.058)	-0.460 *** 0.145	-1.142 *** 0.062
HQ Intensity	-0.103 *** 0.038	0.043 *** (0.015)	-0.099 *** 0.038	0.016 ** 0.016
Log population	0.152 *** 0.003	-0.034 *** (0.001)	0.145 *** 0.003	-0.033 *** 0.001
FDI protection	0.13 *** 0.007	-0.017 *** (0.003)	0.154 *** 0.007	0.039 *** 0.003
Trade protection	-0.098 *** 0.004	0.017 *** (0.002)	-0.092 *** 0.004	-0.023 *** 0.002
US Phone Call Cost	-	-	-0.050 *** 0.003	-
Lambda	-	-	-	0.150 *** 0.010
Sample	Full	Positive Intra-firm Trade	Full	Positive Intra-firm Trade
Estimation	Probit	OLS	Heckman First-Stage	Heckman Second-Stage
R-squared		0.079		
Observations	180,774	92,656	180,774	92,656

Note: In constructing the interaction terms, we subtract the sample mean from each variable entering the interaction term, so that the main effects of each variable can be interpreted as the effect at the sample mean. Columns 1 and 3 include all country-product pairs with positive imports. Robust standard errors adjusted for clustering at the four-digit SIC level are reported below coefficient estimates. ***, **, and * indicate significance at the 1, 5, and 10 percent levels respectively.