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**Intrafirm trade and product contractibility**

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## Intrafirm Trade and Product Contractibility

By ANDREW B. BERNARD, J. BRADFORD JENSEN, STEPHEN J. REDDING,  
AND PETER K. SCHOTT\*

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

These figures highlight the importance of product and country characteristics—and especially their interaction—in explaining intrafirm 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.<sup>2</sup> 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 intrafirm trade.<sup>3</sup> 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 intrafirm trade in interesting and intuitive ways, and that factors associated with engaging in related-party trade differ from those associated with the intensity of intrafirm 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 intrafirm trade in low contractibility products.

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<sup>1</sup> A longer version of this paper, Bernard, Jensen, Redding, and Schott (forthcoming), contains additional results and is available on the AER Web site (<http://www.aeaweb.org/articles.php?doi=10.1257/aer.99.2.487>) and from the authors.

<sup>2</sup> See, for example, Pol Antràs (2003), Antràs and Elhanan Helpman (2004), and Gene M. Grossman and Helpman (2005).

<sup>3</sup> Our findings complement existing empirical examinations of intrafirm trade by Gregory Corcos, Delphine Irac, Giordano Mion, and Thierry Verdier (2008), Fabrice Defever and Farid Toubal (2007), Nathan Nunn and Daniel Treffer (2008) and Stephen R. Yeaple (2006).

## I. Data

We use the US Linked/Longitudinal Firm Trade Transaction Database (LFTTD), which links individual US trade transactions to US firms.<sup>4</sup> Import transactions take place between related parties if either party owns, directly or indirectly, six percent or more of the other party. To align Standard Industrial Classification (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 foreign direct investment (FDI) protection from Heritage Foundation/WSJ (2006).<sup>5</sup> We measure products' capital and skill intensity using data from the 1997 US Census of Manufactures. We assign all ten-digit HS products within a particular four-digit SIC industry the average capital or skill (nonproduction 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.<sup>6</sup>

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,

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

<sup>4</sup> See Bernard, Jensen, and Schott (2009) for more details.

<sup>5</sup> 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.

<sup>6</sup> For further discussion of the data definitions and sources, see Bernard et al. (2010).

The first term in the intermediation measure is the share of wholesale employment ( $W_f$ ) in firm  $f$ 's total employment ( $EMP_f$ ).<sup>7</sup> 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 US 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 intrafirm 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 intrafirm 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 intrafirm trade share for Footwear is less than ten percent.

## II. Determinants of Intrafirm Trade

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

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

We consider two measures of intrafirm trade: the share of intrafirm imports in US imports, which we refer to as the "intensive" margin, and a dummy variable which is equal to one if there are positive intrafirm imports for a product and country, which we call the "extensive"

<sup>7</sup> We observe employment and major industry at the establishment level. We assign all employees in an establishment to the major industry of that establishment. Firms with a single establishment necessarily have 100 percent employment in a single industry. Wholesale is NAICS sector 42.

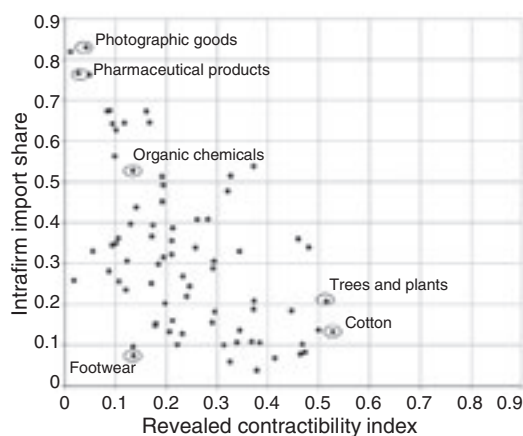


FIGURE 1. INTRA FIRM IMPORT INTENSITY AND “REVEALED CONTRACTIBILITY” BY TWO-DIGIT HS CATEGORY, 1997

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 contractibility 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 contractibility 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 intrafirm trade. Columns 2 and 4 focus on the intensive margin, and the sample is all observations with positive intrafirm trade. Columns 3 and 4 control for the nonrandom selection of observations with positive intrafirm 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 United States, which arguably affects the fixed costs of establishing an affiliate but not the relative variable costs of intrafirm versus arm’s length trade.<sup>8</sup>

Consistent with the recent theoretical literature on contractual frictions in international trade, we find in columns 1 and 2 that higher revealed product contractibility is associated with less intrafirm 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 intrafirm trade conditional on positive intrafirm trade occurring (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 nonlinearities are present for population and FDI protection.

Results in Table 1 also indicate the relevance of interactions of product and country characteristics in determining intrafirm 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 intrafirm trade as governance quality declines. Likewise, improved governance is

<sup>8</sup> The likelihood ratio test of  $\rho = 0$  yields a chi-squared statistic of 26.21, rejecting the null of independent equations.

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

	Intra-firm trade dummy (1)	Share of intra- firm trade (2)	Intra-firm trade dummy (3)	Share of intra- firm trade (4)
Intermediation	−0.715*** (0.050)	−0.165*** (0.019)	−0.719*** (0.050)	−0.235*** (0.025)
Governance	0.154*** (0.014)	−0.031*** (0.007)	0.103*** (0.019)	−0.031*** (0.009)
× Intermediation	−0.058 (0.039)	0.084*** (0.015)	−0.056 (0.039)	0.090 *** (0.017)
Capital intensity	−0.005 (0.021)	0.059*** (0.007)	−0.005 (0.020)	0.056 *** (0.008)
Log capital abundance	0.213*** (0.016)	0.067*** (0.006)	0.173*** (0.017)	0.068*** (0.007)
× Capital intensity	0.068*** (0.016)	0.005 (0.004)	0.072*** (0.015)	0.010** (0.005)
Skill intensity	1.336*** (0.192)	0.196*** (0.051)	1.348*** (0.192)	0.324*** (0.067)
Log human capital abundance	−0.105** (0.044)	−0.066*** (0.022)	−0.044 (0.046)	−0.059** (0.023)
× Skill intensity	−0.415 (0.407)	−1.063*** (0.152)	−0.460 (0.411)	−1.142*** (0.174)
HQ intensity	−0.103 (0.196)	0.043 (0.065)	−0.099 (0.196)	0.016 (0.071)
Log population	0.152*** (0.008)	−0.034*** (0.002)	0.145*** (0.009)	−0.033*** (0.003)
FDI protection	0.13*** (0.015)	−0.017*** (0.005)	0.154*** (0.014)	0.039*** (0.007)
Trade protection	−0.098*** (0.011)	0.017*** (0.004)	−0.092*** (0.011)	−0.023*** (0.005)
US phone call cost	—	—	−0.050*** (0.003)	
Inverse Mills ratio	—	—		0.150*** (0.029)
Sample	Full	Positive intra- firm trade	Full	Positive intra- firm trade
Estimation	Probit	OLS	Heckman first-stage	Heckman second-stage
$R^2$		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. Columns 2 and 4 include country-product pairs with positive intrafirm trade. Robust standard errors adjusted for clustering at the four-digit SIC level are reported below coefficient estimates.

\*\*\*Significant at the 1 percent level.

\*\*Significant at the 5 percent level.

\*Significant at the 10 percent level.



associated with less intrafirm trade, especially for goods with lower intermediation.<sup>9</sup>

As in Antràs (2003), industry capital intensity and country capital abundance play a role in determining the share of intrafirm trade. The positive coefficient on the interaction between industry capital intensity and country capital abundance implies that intrafirm 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 intrafirm 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 intrafirm trade and leads to larger increases in more skill scarce countries. In contrast, greater country skill abundance reduces the share of intrafirm trade, and leads to larger reductions in more skill intensive products.

### III. 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 intrafirm 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 intrafirm trade is negatively related to both country size and country governance quality. Our results also highlight interactions between country and product characteristics—e.g., improvements in country governance matter most for products for which contracting is relatively difficult.

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<sup>9</sup> Bernard et al. (forthcoming) reports a wide range of robustness tests.

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