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THE DETERMINANTS OF INTRAFIRM TRADE: EVIDENCE FROM FRENCH FIRMS

Gregory Corcos, Delphine M. Irac, Giordano Mion, and Thierry Verdier*

Abstract—How well does the theory of the firm explain the choice between intrafirm and arm’s-length trade? This paper uses firm-level import data from France to look into this question. We find support for three key predictions of property rights theories of the multinational firm. Intrafirm imports are more likely in capital- and skill-intensive firms, in highly productive firms, and from countries with well-functioning judicial institutions. We bridge previous aggregate findings with our investigation by decomposing intrafirm imports into an extensive and intensive margin and uncover interesting patterns in the data that require further theoretical investigation.

I. Introduction

MULTINATIONAL companies (MNCs) are central to international trade. Intrafirm imports alone account for over 40% of U.S. total imports (Zeile, 2003; Bernard et al., 2010). MNCs have therefore become central to public debate too, not least in OECD countries, where concerns about the relocation of production facilities to low-wage emerging economies are widespread. The pattern of cross-border production networks and FDI flows has also attracted much attention from scholars in both economics and international business. An important seminal contribution is the so-called eclectic theory of FDI, emphasizing the importance of three dimensions: ownership, location, and internalization—the Dunning’s (1981) celebrated OLI paradigm.

Understanding the very existence of MNCs requires a theory of why foreign operations are kept internal rather than licensed to local firms (the “internalization” question in Dunning, 1981). A well-established literature emphasizes intangible assets such as knowledge and reputation.¹ In these theories MNCs exploit the public good nature of intangible assets in multiplant operations, which, gives them an edge over single-plant local rivals. Internalization is driven by the risk of third parties’ dissipating the value of these assets, given the legal environment.

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¹ Prime examples are Ethier (1986), Horstmann and Markusen (1987), and Ethier and Markusen (1996). Good surveys of this literature are available in Markusen (1995) and Barba Navaretti and Venables (2004).

More recent contributions have taken on an explicit contract-theoretical approach of multinationals.² These theories provide foundations for the existence of cross-border contractual frictions, which in turn drive organizational choice. Some of them also explain how these frictions combine with other country characteristics, such as factor abundance, to affect comparative advantage and trade patterns.

This rapidly expanding theoretical literature has triggered a series of empirical investigations on U.S. intrafirm trade (Antràs, 2003b; Yeaple, 2006; Nunn & Trefler 2008; Bernard et al., 2010; Costinot, Oldenski, & Rauch, 2011). Most of these studies find support for the property rights approach taken by Antràs (2003b) and Antràs and Helpman (2004, 2008). However, while these analyses are useful and important first steps, they are confined to the industry- or imported product-level.

This paper exploits firm-level data on imports of manufactured goods by French firms in 1999 to offer a deeper look at international sourcing modes. Breaking down imports by firm, origin country, and product category, we look into the predictions of property rights models of multinationals’ organizational choices. Our data allow us to go beyond aggregate intrafirm trade shares and distinguish between the likelihood of a firm-country-product triple to belong to one of the two sourcing modes (extensive margin) and the average value of imports in that mode (intensive margin).

Two new lessons can be drawn from our analysis. First, key results of property rights theory find empirical support at the firm level. In particular, we find that the choice of intrafirm sourcing is more likely in capital- and skill-intensive firms. More productive firms are also more likely to engage in intrafirm trade, typically importing higher amounts. These results match the predictions of Antràs (2003b) and Antràs and Helpman (2004, 2008). In addition, we find that imports from countries with well-functioning judicial institutions are more likely to be intrafirm, a result that can be explained by property rights models. Transaction costs models would predict the opposite, as stronger contract enforcement mostly reduces the costs of outsourcing.

Second, our analysis shows two important limits of an industry- or product-level approach. On the one hand, we find a firm’s factor intensity to be an important determinant of sourcing decisions, but one that varies substantially within narrowly defined sectors. This suggests that the property

² See, among others, McLaren (2000), Antràs (2003b), Grossman and Helpman (2002, 2003, 2004, 2005), Antràs and Helpman (2004, 2008), Marin and Verdier (2003, 2008), and Costinot, Oldenski, and Rauch (2011). Good surveys of the literature are found in Helpman (2006), Spencer (2005), and Antràs and Rossi-Hansberg (2008). Some of the most illustrative recent work along this line of research is published in Helpman, Marin, and Verdier (2008).

rights model can be profitably extended to allow firm-specific technologies. On the other hand, we find that some previous results on aggregate intrafirm import shares are driven by import values (intensive margin) rather than individual sourcing choices. For instance, country intrafirm import shares increase with capital abundance, as in previous studies, but the likelihood of engaging in intrafirm trade decreases with capital abundance. The former result is driven by the intensive margin: import volumes under outsourcing tend to decrease with capital abundance. Overall, our results suggest that future theoretical research should look more deeply into determinants of both the extensive and intensive margins of intrafirm trade.

In addition to the work already cited, our framework is related to the large empirical literature on firm boundaries within countries.³ One can think of two useful ways in which the research program on the boundaries of multinationals complements its domestic counterpart. It exploits more systematically collected data on the nature of transactions and does not overwhelmingly focus on the transaction cost approach (although a recent exception is Acemoglu et al., 2010).

Our paper is also related to studies of internalization in multinationals that focus on narrower samples or narrower aspects of sourcing choices. Using a subset of our French data, Defever and Toubal (2007) find a positive relationship between firm total factor productivity (TFP) and the outsourcing choice among MNCs that report higher fixed costs of outsourcing, and the opposite among MNCs that report higher costs of internalization. Their finding complements the self-selection based on TFP result we point to in our paper. Using the same data, Carluccio and Fally (2009) find that complex inputs are more likely to be imported intrafirm from countries with a low level of financial development. We complement that result by providing evidence that complex goods and inputs are more likely to be produced within firm boundaries. Finally, Kohler and Smolka (2009), using cross-sectional Spanish data, find that more productive firms are more likely to engage in intrafirm rather than arm's length and foreign rather than domestic sourcing. However, they do not explore other determinants of the sourcing choice or investigate the difference between the extensive and intensive margin.

The rest of the paper is organized as follows. In section II, we state four testable predictions of property rights models and explain their intuition. In section III, we describe the construction of our estimation sample and give a general overview of the key variables in our analysis, which are described in more detail in the online appendix. In section IV, we present and discuss our econometric tests of the four predictions. In section V, we replicate existing product- and industry-level evidence and show the importance of examining both the intensive and the extensive margins of

international sourcing. Section VI concludes and suggests avenues for future research.

II. Theoretical Background

Our empirical analysis is motivated by the theoretical predictions of three models: Antràs (2003b) and Antràs and Helpman (2004, 2008). These three models jointly predict which firms are more likely to resort to intrafirm trade and which countries are more likely to be involved. In particular, we are interested in the following predictions:

1. Capital- and skill-intensive firms are more likely to engage in intrafirm trade.
2. More productive firms are more likely to engage in intrafirm trade.
3. Intrafirm imports are more likely to originate from capital-abundant countries.
4. More productive firms are more likely to import intrafirm from countries with good contract enforcement, although it may not be the case for the average importing firm

In what follows we describe the intuition for these predictions.

Antràs (2003b) and Antràs and Helpman (2004, 2008) build on a common partial equilibrium framework inspired by the property rights approach to the firm (Grossman & Hart, 1986; Hart & Moore, 1990). Consider a supplier and a buyer (final producer) whose assets and investments are relationship specific. Due to the incompleteness of contracts, each party risks being held up by the other after production, leading to a new division of surplus. No matter what transfers were agreed ex ante, each party's marginal benefit of investment will be restricted by the share of surplus secured in the ex post renegotiation. Anticipating this, both parties underinvest ex ante.

One way to secure greater bargaining power ex post is to own the productive assets. Property rights act as residual rights of control by giving their owner the right to exclude the other party from production. That possibility raises the owner's outside option when bargaining over surplus ex post. Expecting a greater share of ex post surplus, the owner has greater incentives to invest ex ante, which alleviates the underinvestment problem. Therefore, giving ownership rights to the party responsible for the main investment (the final producer in the case of intrafirm and the supplier in the case of outsourcing) maximizes joint surplus. That will effectively be the organizational form chosen by both parties if ex post bargaining is efficient and utility is costlessly transferable ex ante.

This property rights result can be applied to the analysis of intrafirm trade thanks to two additional assumptions. First, capital investments and skill-intensive headquarter services (general management and coordination tasks) are provided by

³ See, for instance, the survey by Lafontaine and Slade (2007).

the final producer due to legal or technical reasons.⁴ Therefore in capital- and skill-intensive production processes, the headquarter firm needs to be incentivized, and vertical integration is optimal (prediction 1). Second, intrafirm imports entail higher initial fixed costs than arm's-length imports. For example, affiliate setup costs are plausibly higher than supplier search costs. Therefore, Antràs and Helpman (2004) predict that all else equal, a more productive firm is more likely to engage in intrafirm trade (prediction 2). In labor-intensive sectors, where by prediction 1 variable costs are already such that outsourcing is preferred, TFP heterogeneity has no bearing on organizational choice. By contrast, in other sectors, the most productive firms self-select into intrafirm trade: only firms sufficiently productive to leverage differences in variable costs on large sales and cover the higher fixed costs of intrafirm will choose this sourcing mode.

Antràs (2003b) embeds a simpler version of that setup in a general equilibrium model of international trade with imperfect competition, as in Helpman and Krugman (1985). There are two factors, labor and capital, and two sectors with identical firms. By prediction 1, integration is pervasive in the capital-intensive sector, while outsourcing is pervasive in the labor-intensive sector. Intrafirm imports are the same thing as capital-intensive imports, whose pattern is governed by comparative advantage. Assuming free entry, identical and homothetic preferences, and that immobile endowments are in the factor price equalization set, Antràs (2003b) shows that the share of intrafirm imports increases in the origin country's capital-labor ratio (prediction 3). This is a pure composition effect: more varieties of capital-intensive inputs than labor-intensive inputs are imported from capital-abundant countries. Importantly, factor abundance should have no effect on the likelihood of intrafirm trade within a given industry.⁵

Antràs and Helpman (2008) extend their 2004 model to allow for partially contractible production tasks. Both headquarter services and component production require contractible and noncontractible tasks, to an extent that depends on the local contracting environment. Suppose more component production tasks become contractible, that is, "input contractibility" increases. This does not change anything in labor-intensive partnerships, which by prediction 1 were fully outsourcing their input production. But in other sectors, a *ceteris paribus* improvement in input contractibility has two effects: the most productive domestic producers switch to offshore outsourcing, and the most productive firms resorting to

offshore outsourcing start insourcing from foreign affiliates (prediction 4).⁶ The second effect derives from a lower need to incentivize component producers after the input contractibility improvement. In sum, improved contract enforcement in the origin country favors international sourcing but does not clearly favor one sourcing mode. Which effect dominates is an empirical question that requires data on the contractibility of tasks performed by each party.

III. Data

The population of interest consists of importing firms, since the theoretical predictions apply to them and not to firms sourcing only domestically. We use data on the two sourcing modes—either arm's length or intrafirm—of French imports in 1999. The observation unit is a firm-country-product triple: firm i sourcing product p from country c either at arm's length or intrafirm. In what follows we describe the construction of the sample and the variables used in the analysis.

A. Primary Data Sources

We rely on three primary data sources. First, the EIIG (Échanges internationaux intra-groupe) database documents the sourcing mode in a firm's yearly imports by origin country and by CPA96 or HS4 four-digit product codes in 1999. Intrafirm trade is defined as trade with an affiliate controlled by a single French entity with at least 50% of its equity capital. The data cover 4,305 firms and come from a survey conducted in 1999 by the French Ministry of Industry's SESSI (Service des études statistiques industrielles). The survey was addressed to all firms incorporated in France and trading more than 1 million euros, owned by manufacturing groups that control at least 50% of the equity capital of an affiliate based outside France. We refer to this group of firms (8,236 units) as the EIIG target population.⁷ The response rate was 52.27%, but the 4,305 respondent firms represent more than 80% of total exports and imports of French multinationals. Nonrespondent firms are excluded from our analysis because information on the sourcing mode is not available. We discuss and address sample selection issues in the online appendix. These data have been previously used by Defever and Toubal (2007) and Carluccio and Fally (2009), who do not deal with sample selection.

Although some firms in the EIIG data set source some of their imports at arm's length, by construction they all have an affiliate so that limiting ourselves to these firms would bias our results toward intrafirm trade. For instance, SESSI estimates that around 36% of the total value of manufacturing imports is intrafirm (Guannel & Plateau, 2003), while in the EIIG data, the corresponding value is much higher

⁴ Antràs (2003b) mentions evidence of higher cost sharing in capital investments than in labor investments among U.S. multinationals, even in their affiliates. This may come from credit market imperfections or from the fact that labor investment decisions require local knowledge, but is in any case beyond the scope of the model. That the supplier does not provide any capital investment or headquarter services can be thought of as a limit case.

⁵ More precisely, this statement applies to the baseline version of the Antràs (2003b) model. In a working paper version, Antràs (2003a) suggests an extension to a constant elasticity of substitution (CES) production function where that prediction is altered. We discuss that possibility in section IVC.

⁶ Nunn and Trefler (2008) term these two effects the standard and surprise effect, respectively.

⁷ We thank Boris Guannel from SESSI for providing us with the complete list of firms belonging to the target population.

(55.4%). We must thus complement the EIIG with import data on nonmultinational firms.

To this end, we use a second database, from the French Customs Office, documenting the universe of import and export flows in 1999 at the firm, origin country, and product level. These data were used (among others) by Eaton, Kortum, and Kramarz (2004). The data are collected from custom declarations.⁸ The total value of imports in the database represents about 99% of French aggregate imports in 1999 as reported by EUROSTAT, with the 1% difference being due to the imputed trade of firms not obliged to report information to the French Customs Office. Regrettably, this data set does not provide information on whether imports come from a related party (unlike U.S. customs data, for example).

Finally, the EAE (Enquête annuelle entreprise) database provides balance sheet data on manufacturing firms. The data come from a census of all French firms with at least twenty employees whose primary activity is in the manufacturing sector (NACE rev1 D category), conducted by the French Ministry of Industry's SESSI and the Ministry of Agriculture's SCEES (Service central des enquêtes et des études statistiques). Firms in the EAE database represent 9.8% of the total number of French manufacturing firms but 87.2% of production in 1999, as reported by EUROSTAT.

By merging information from customs data with the EIIG data on respondent firms, we get our baseline estimation sample. In our analysis, we refer to this sample as the large sample. It has 281,419 firm-country-product triples spanning over 14,711 firms, 219 countries, and 272 CPA96 four-digit products. Matching the large sample with the EAE data generates what we refer to as the small sample: 98,168 triples spanning over 5,175 firms, 185 countries, and 270 products. (More details on the construction of the two samples are provided in the online appendix.)

B. Variables Used in the Empirical Analysis

In most of the analysis, our dependent variable is $y_{i,p,c}$, a binary variable that takes a value of 1 if a French firm i imports product p from country c (mostly) from a foreign affiliate in 1999 and 0 otherwise.

We use a binary variable for several reasons. First, only a few product-country-firm triples involve both intrafirm and arm's-length imports, so that intrafirm trade shares cluster around 0 and 1. Furthermore, we keep a record of most of this mixed-transactions information by recording as intrafirm or outsourcing a firm-country-product triple for which at least 80% of the total value occurs in one of the two sourcing modes.⁹ Second, we are mainly interested in the determinants of the sourcing mode, and in the theories, we consider

that a given firm-product-country triple should correspond to a unique choice. Finally, intrafirm trade values may be distorted in systematic ways for reasons unrelated to these models (such as taxation or accounting purposes). That said, in section V, we look simultaneously at the extensive (sourcing mode) and the intensive (import value for a given sourcing mode) margins.

Our key covariates can be divided into three groups: (a) importing firm total factor productivity (TFP_i), capital intensity (k_i), and skill intensity (h_i); (b) sourcing country capital abundance (k_c), skill abundance (h_c), and quality of the judiciary and the enforcement of contracts (Q_c); and (c) imported product contractibility (μ_p), embodied capital intensity (k_p), embodied skill intensity (h_p), and (main) final product contractibility (μ_f). Our set of controls includes corporate tax rates, a measure of financial development, distance, OECD membership, past colonial ties, common language, and common legal origin. (Additional information about data sources and the construction of variables is provided in the online appendix.)

IV. Firm-, Country-, and Product-Level Determinants of the Intrafirm versus Outsourcing Decision

We start by stating two important facts about the data in section IVA. We then conduct two sets of estimations: one focusing on firm-level determinants and the other on country- and product-level determinants of the intrafirm versus outsourcing decision. The methodology and results of each set of estimations are presented in sections IVB and IVC, respectively.

In most of the analysis, we estimate a two-stage probit model. In the first stage, which is estimated on the group of firms belonging to the EIIG target population, we use a probit specification to model the selection into response to the EIIG survey from which information on intrafirm trade is coming. In the second stage, we combine EIIG and customs data and model the probability that imports at the firm-country-product level are intrafirm depending on firm-, country-, and product-level characteristics. We use, again, a probit specification with the binary dependent variable $y_{i,p,c}$ taking value 1 if firm i imports product p from country c intrafirm and 0 otherwise. In the second stage, we take into account selection into response to the EIIG survey by means of the inverse Mills ratio coming from the first stage ($IM1$). Raw correlations of $y_{i,p,c}$ with the key variables used in our analysis are reported in table 1.

In section IVB, we use the small sample to estimate the probability that imports at the firm-country-product level are intrafirm depending on firm-level characteristics, while using product and country dummies to control for unobserved heterogeneity. This approach reduces the risk of omitted variable bias without imposing further assumptions on the correlation between the dummies and the firm-level regressors. In addition, as we systematically cluster standard errors by firm, our estimations allow for correlations in the error structure across

⁸For trade outside the EU15, there is no minimal amount for data to be recorded. Within the EU, only trade whose total annual amount exceeds 250,000 euros should be registered. Even then, many trade flows below this threshold are still registered.

⁹That way, we exclude only 1.72% of all observations in the final sample. See the online appendix for details.

TABLE 1.—RAW CORRELATIONS BETWEEN OUR MAIN DEPENDENT VARIABLE (INTRAFIRM TRADE DUMMY $y_{i,p,c}$) AND KEY REGRESSORS

Firm-Level Variables			
Productivity (TFP_i)	Capital intensity (k_i)	Skill intensity (h_i)	
0.1230	0.1070	0.1680	
Country-Level Variables			
Capital abundance (k_c)	Skill abundance (h_c)	Contract enforcement (Q_c)	
-0.0094	0.0525	0.0389	
Product-Level Variables			
Imported product contractibility (μ_p)	Final product contractibility (μ_f)	Embodied capital intensity (k_p)	Embodied skill intensity (h_p)
-0.0548	-0.0763	0.0068	0.0793

Correlations with firm variables refer to the small sample, while in all other cases but μ_f , correlations are computed in the large sample. In the case of μ_f , correlation is computed on the subset of the large sample referring to firms with main activity in (essentially) manufacturing.

countries and products involved in a given firm sourcing strategy. In section IVC, we analyze the probability that imports at the firm-country-product level are intrafirm based on country and product characteristics. This second set of estimations makes use of both the large and small sample, allowing us to control for firm-specific heterogeneity in several ways.

A. Descriptive Analysis

Descriptive statistics provide two interesting insights. First, intrafirm import flows are fewer but larger. Second, some previously analyzed industry-level determinants of internalization show considerable within-industry heterogeneity.

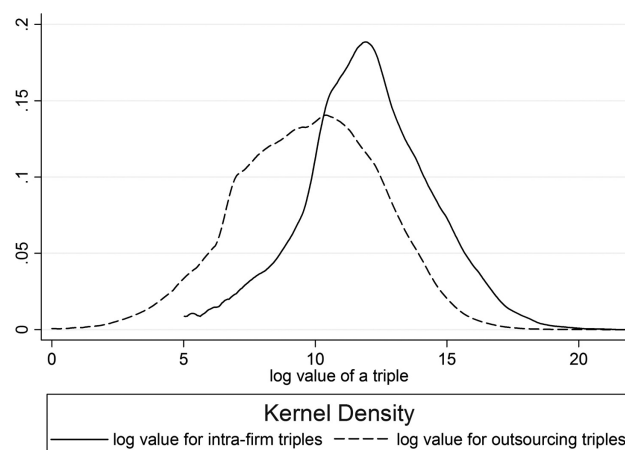
Intrafirm flows are larger. In our baseline sample (large sample), only 8.49% of firm-country-product triples correspond to intrafirm imports, but they account for 38.86% of total imports' value. In the small sample (for which we have balance sheet information), triples corresponding to intrafirm imports account for 13.65% of all triples but represent 42.67% of the value of imports.¹⁰ Figure 1 shows the kernel-smoothed distribution of log imports' value (in euros) by firm-country-product for both intrafirm and outsourcing. As the figure shows, the distribution of intrafirm imports values lies to the right of that of outsourcing. The two distributions have somewhat similar shapes and very close upper bounds of the supports (21.39 for intrafirm and 21.82 for outsourcing) but very different lower bounds. Summarizing, intrafirm imports are rare but typically involve larger values (fact 1).

While there are many possible interpretations of fact 1, it is definitely consistent with prediction 2. If intrafirm sourcing requires higher fixed costs, the most productive firms will self-select into that mode. As they operate on a higher scale, intrafirm import values will be higher.

Within-industry heterogeneity. Descriptive analysis also suggests high within-sector heterogeneity in some previously

¹⁰ Among respondents to the EIIG survey, intrafirm flows represent 31.3% of all triples but 55.4% of the value of imports. Along with other reasons, this suggests some bias in nonresponse to the EIIG and further motivates our systematic treatment of sample selection bias. See the online appendix for more details.

FIGURE 1.—KERNEL SMOOTHED DISTRIBUTION OF LOG IMPORTS' VALUE BY FIRM-COUNTRY-PRODUCT



analyzed industry-level determinants of the organizational choice. Firm-level data can thus provide a deeper look into the issue and potentially lead to results different from those of studies based on aggregate data. In our analysis, we will indeed encounter examples of such discrepancies.

First, in the large sample, intrafirm trade and outsourcing coexist in virtually all NACE rev1 three-digit manufacturing industries (roughly 100 units). Second, some key determinants of internalization show considerable heterogeneity within NACE rev1 3-digit industries. Table 2 reports summary statistics, as well as correlations, of our key covariates. In particular, the table provides standard deviations and decomposes them into a between- and a within-sector component. Statistics are reported for both all EAE firms (top panel) and the small sample, used in firm-level estimations (bottom panel) and provide the same message. More specifically, in the small sample, most of the standard deviation of capital intensity (80.51%) comes from within-industry differences across firms. The same applies to skill intensity (88.58%). This holds despite the fact that we trimmed observations to exclude outliers in value added and capital per worker. Within-industry heterogeneity in factor intensity is in fact even more pronounced than its TFP counterpart, which is well documented in the trade literature. This echoes Bernard et al. (2003), who observe that “industry . . . is a poor indicator of factor intensity” in data on U.S. manufacturing firms. Summarizing, firm characteristics such as capital and

TABLE 2.—SUMMARY STATISTICS ON FIRM-LEVEL VARIABLES

Variable	Observations	Mean	% Intra-NACE3				Correlation with		
			SD	SD	Minimum	Maximum	TFP_i	k_i	h_i
Full EAE firm data									
TFP_i	22,673	3.8076	1.4065	0.3116	-79.0078	11.7314	1.0000		
k_i	22,673	3.3040	1.0257	0.8261	-8.2213	8.3878	0.0452	1.0000	
h_i	22,673	3.0357	0.3093	0.8804	-6.6951	6.2796	0.1808	0.2114	1.0000
EAE firm sample used in estimations									
TFP_i	5,134	3.9955	1.9309	0.2363	-55.8379	11.1462	1.0000		
k_i	5,134	3.7547	0.9764	0.8051	-6.7092	7.4743	0.0357	1.0000	
h_i	5,134	3.1075	0.3484	0.8858	-6.6951	5.3584	0.1474	0.1751	1.0000

Summary statistics on firm productivity TFP_i , capital intensity k_i , and skill intensity h_i refer to either the full EAE firm data (top panel) or the subsample of EAE firms used in estimations (bottom panel). % Intra-NACE3 SD refers, for each variable considered, to the ratio between the standard deviation within NACE three-digit industries and the overall standard deviation.

skill intensity display much more variance within than across industries (fact 2).

One would think it natural to test predictions of theories of the firm with firm-level data, which is what we do. What fact 2 suggests is that there is a substantial loss of information by focusing on the industry dimension with the potential of reaching different conclusions.¹¹ Having said that, we certainly acknowledge that some of the heterogeneity we observe may be due to measurement error in factor intensity variables.

B. Firm-Specific Determinants

To study the impact of firm determinants, we estimate the following two-stage probit model:

$$Response_i = \mathbf{1}_{[Response_i^* > 0]}$$

$$Response_i^* = a + b_1 \ln(Imports_i) + b_2 \ln(NbProducts_i) + b_3 \ln(NbCountries_i) + \mathbf{D}_s + \xi_i, \quad (1)$$

$$y_{i,p,c} = \mathbf{1}_{[y_{i,p,c}^* > 0]}$$

$$y_{i,p,c}^* = \alpha + \mathbf{X}_i \beta_1 + \mathbf{D}_p + \mathbf{D}_c + \varepsilon_{i,p,c}. \quad (2)$$

In the first-stage equation, which is estimated on the group of firms belonging to the EIIG target population, $Response_i$ takes value 1 if firm i has responded to the EIIG survey; $Imports_i$ equals the total value of firm i 's imports; and $NbProducts_i$ and $NbCountries_i$ measure the number of product categories and origin countries involved in firm i 's imports, respectively. \mathbf{D}_s refers to NACE three-digit sector dummies. These variables reflect our presumption that a higher data collection effort was allocated to large importers or certain sectors. Unreported results, available on request, indeed show that all variables are highly significant and have the expected sign, ending up with a pseudo- R^2 of 0.2788.

In the second-stage equation, $y_{i,p,c}$ takes value 1 if imports of firm i of product p from country c are intrafirm and 0

¹¹Note that fact 2 does not necessarily imply that firms use different technologies. Firms using the same non-CES technology but operating at different scales will exhibit differences in factor intensities. While we cannot rule this out, we would then expect that TFP and factor intensities are correlated, since TFP determines scale. However, table 2 reveals weak correlations between TFP and factor intensities. Unreported results, available on request, show that a weak correlation pattern emerges when considering deviations from the industry average.

otherwise. \mathbf{D}_p and \mathbf{D}_c stand for product and country dummies. The vector of key firm determinants, \mathbf{X}_i , is composed of productivity (TFP_i), capital intensity (k_i), and skill intensity (h_i).¹² Information needed to construct $y_{i,p,c}$ comes from both the EIIG and customs data. For firms i for which information comes from the EIIG data, we use the inverse Mills ratio obtained from the first stage ($IM1$) to control for selection into response. For firms i for which information comes from the customs data, there is no issue of selection ($IM1 = 0$), as they are a random sample of the population of nonmultinational French large importers matching the response rate of the EIIG survey.¹³

First-stage variables are excluded from second-stage estimations, which are carried out on the small sample. The number of observations in the estimations is a bit smaller than the small sample size because some country or product dummies perfectly predict the outcome, and the corresponding observations are thus dropped.

Table 3 reports second-stage estimations using variants of equation (2). Columns 1 to 4 report marginal effects of the three firm-level regressors independently and jointly. All explanatory variables have positive and significant coefficients. Columns 1 to 3 reveal that all three regressors, taken separately, have significant coefficients (at the 1% level) with a sign consistent with prediction 1. Column 4 further shows that they keep their sign and significance when considered jointly. In sum:

Result 1: Firms with higher capital and skill intensity are more likely to engage in intrafirm trade.

Result 2: Intrafirm trade is more likely, the higher is firm total factor productivity.¹⁴

Result 1 supports prediction 1 and the residual property rights literature. It also confirms prior industry- and

¹²Reverse causality would be a concern if the two types of international sourcing (intrafirm versus outsourcing) had a strong differential impact on firms' characteristics, such as productivity or skill intensity. This is a priori unlikely. Nonetheless, we have estimated variants of the model with lagged firm variables and found the same qualitative pattern. Results are omitted to save space but available on request.

¹³See the online appendix for further details.

¹⁴In unreported regressions, we use both a more conservative measure of productivity (value added per worker) and an Olley and Pakes (1996) measure of TFP obtaining the same qualitative results.

TABLE 3.—FIRM-SPECIFIC DETERMINANTS OF INTRAFIRM TRADE

Dependent Variable: Intrafirm Dummy $y_{i,p,c}$	(1)	(2)	(3)	(4)
	Firm-Level Covariates			
Productivity (TFP_i)	0.0599*** (0.0109)			0.0405*** (0.0109)
Capital Intensity (k_i)		0.0235*** (0.0068)		0.0156*** (0.0058)
Skill Intensity (h_i)			0.1030*** (0.0324)	0.0713** (0.0287)
	Controls			
IM1, country, and product dummies	Yes	Yes	Yes	Yes
Number of observations	95,493	95,493	95,493	95,493
Pseudo- R^2	0.1467	0.1405	0.1502	0.1565
Log likelihood	-32,767	-33,005	-32,634	-32,391

The dependent variable $y_{i,p,c}$ equals 1 if imports by firm i of product p from country c are intrafirm and 0 otherwise. The key covariates are firm i total factor productivity TFP_i , capital intensity k_i , and skill intensity h_i . IM1 is the inverse Mills ratio, coming from the estimation of selection into response to the EIIG survey, which is set to 0 for firms outside the EIIG target population. A probit model is estimated for all specifications. Marginal effects are presented. Firm-clustered standard errors in brackets. Significantly different from 0 at ***1%, **5%, and *10%.

product-level U.S. studies while suggesting that residual property rights models could be extended to allow for heterogeneity in capital and skill intensity.

Result 2 is in line with prediction 2 and complements empirical findings by Tomiura (2007) and Defever and Toubal (2007). In unconditional comparisons, Tomiura (2007) shows that Japanese firms outsourcing abroad are less productive than Japanese multinationals, even when the two categories are mutually exclusive. However, in his data, intrafirm imports of multinationals are presumed, not observed. Defever and Toubal (2007) run a regression similar to the second stage of equation (2) on the sample of firms responding to the EIIG only. They find that the sign of the TFP coefficient switches with the firm's relative magnitude of (fixed) outsourcing and integration costs (as reported by the firm), suggesting self-selection, as in Antràs and Helpman (2004). However the Antràs and Helpman (2004) self-selection finding applies to affiliate setup costs, which are already sunk in a population of existing multinationals (EIIG firms). They are therefore likely to pick up the effect of recurrent fixed costs associated with each mode. An additional concern with that study is that it does not account for sample selection.¹⁵

While results 1 and 2 strongly support property rights theories, our data do not allow us to assess predictions of intangible asset theories of multinational firms. For instance, in Ethier and Markusen (1996), multinationality is more likely in firms with high knowledge capital relative to physical capital. Data on R&D and advertising expenditure, which are unavailable to us, would nicely complement our analysis.

C. Country and Product Determinants

In this section we explore country and product determinants of intrafirm trade. As discussed in section II, the Antràs

(2003b) model predicts that intrafirm imports are positively correlated with origin country human capital abundance h_c and capital abundance k_c (prediction 3). But this is a pure composition effect: factor abundance should have no impact on sourcing when controlling for industry factor intensity. Therefore, we expect k_c and h_c to have significantly positive coefficients in the absence of firm, industry, or product measures of factor intensity, and insignificant coefficients otherwise. In what follows, we run both types of regressions: with and without factor intensity measures at the product level (k_p and h_p) and at the firm level (k_i and h_i).

Section II also discusses the influence of the quality of judicial institutions Q_c , as well as intermediate and final product contractibility (μ_p and μ_f). A priori, these variables have an indeterminate average effect on sourcing choices, but with systematic differences along the firm productivity dimension. Improved contract enforcement causes the most productive firms to insource and the least productive firms to outsource (prediction 4).

In addition to these key covariates, we control for other variables that may affect the optimal sourcing mode. We first include an OECD dummy ($OECD_c$) and the country's corporate tax rate (Tax_c). Prediction 3 relies on factor price equalization, which is more likely to hold among OECD countries due to similar factor endowments. Corporate tax rates proxy for the benefits of profit shifting, which may affect sourcing choices. We also control for variables commonly used in gravity equations, such as the log of distance of country c to France ($Distw_c$), past colonial ties ($Colony_c$), common language ($Language_c$), and common legal origin ($Same - leg - orig_c$) indicators.¹⁶ Finally, since FDI (leading to intrafirm trade) can partly substitute for weak financial

¹⁵ First, all firms in the EIIG survey have foreign affiliates by construction. Since each firm has a unique TFP measure, identification of the TFP coefficient comes not from comparing firms that do with firms that do not engage in intrafirm, but rather from the share of intrafirm imports within a firm. Also they do not deal with nonresponse in that survey.

¹⁶ We do not include GDP per capita for two reasons. First, it is highly correlated with the capital-labor ratio, the human capital-labor ratio as well as with the quality of institutions. Second, although wages can affect the sourcing choice (in Antràs & Helpman, 2004), GDP per capita is at best a poor proxy for labor costs. Wages and productivity vary across countries, and what we would really need is a productivity-deflated measure of wages in country c (we leave this exercise for future work).

markets, we also control for the origin country's level of financial development ($Fin - Dev_c$). This is measured by the ratio of private credit to GDP, which we borrow from Beck (2002).

Again, we use a two-stage procedure to address selection into response to the EIIG survey. As earlier, we estimate the probability of response to the EIIG survey according to equation (3) and use the inverse Mills ratio $IM1$ as an additional covariate in the second stage. We then consider four alternative specifications of the second-stage equation (4).

$$Response_i = \mathbf{1}_{[Response_i^* > 0]},$$

$$Response_i^* = a + b_1 \ln(Imports_i) + b_2 \ln(NbProducts_i) + b_3 \ln(NbCountries_i) + \mathbf{D}_s + \xi_i \quad (3)$$

$$y_{i,p,c} = \mathbf{1}_{[y_{i,p,c}^* > 0]}$$

$$y_{i,p,c}^* = \alpha + \mathbf{X}_c \beta_1 + \mathbf{X}_p \beta_2 + \mathbf{CC}_c \beta_3 + \mathbf{FC}_i \beta_4 + \varepsilon_{i,p,c}, \quad (4)$$

where the vectors \mathbf{X}_c and \mathbf{X}_p denote our key country and product covariates, \mathbf{CC}_c stands for our country controls, and \mathbf{FC}_i indicates firm controls.

The estimation of the different specifications of equation (4) reflects some trade-offs in using the data. In specification 1, we estimate a simple probit and exploit all firm-country-product observations available by using the large sample. In doing so, we do not use firm controls ($\mathbf{FC}_i = 0$) and do not consider final product contractibility μ_f , which is available only for (essentially) manufacturing firms.¹⁷ In order to shed light on the Antràs (2003b) composition effect linking factor abundance and intrafirm trade, we estimate specification 1 both with and without product covariates \mathbf{X}_p .

Specifications 2 and 3 account for unobserved firm heterogeneity by, respectively, random and fixed firm effects. We choose to estimate specification 2 on the group of manufacturing firms only, rather than the full large sample, in order to be able to estimate the coefficient of μ_f . Specification 3 allows for firm fixed effects by means of a conditional fixed effects logit model. In this case, identification of the coefficients of \mathbf{X}_c and \mathbf{X}_p relies on firms that import different products from several countries under different sourcing modes. This reduces drastically the number of observations actually used by the conditional fixed effects logit procedure. Another drawback is that we cannot identify the impact of the contractibility of the final good μ_f , which is firm specific. Finally, specification 4 is estimated by a probit model on the small sample for which firm-level information from the EAE database is available. The vector of firm controls \mathbf{FC}_i corresponds in this case to the firm characteristics used in the previous section. In all specifications, a few observations are lost during estimations because of the lack of data for some countries or products.

¹⁷ Our contractibility measure builds on the Rauch (1999) classification, which is mostly limited to manufacturing, agriculture and mining goods. We thank Sébastien Roux for providing us with data on the NACE code of the whole population of French firms.

The five columns of table 4 report the results of the estimation of the different models.¹⁸ In columns 1 and 2, we estimate the probit specification 1, respectively, without and with product-level regressors. In column 3, we estimate the random effects probit model (specification 2), while in column 4, we report results of the conditional fixed effects logit model (specification 3). Finally in column 5, we estimate specification 4, the probit model with firm controls.

Looking across columns, table 4 reveals a pattern in the sign and significance of some coefficients. We can state two results:

Result 3: Intrafirm trade is more likely with capital scarce countries. Result 3 holds in different samples of firms using different estimation techniques and is robust to considering or not firm or product measures of capital intensity, as well as controlling for the origin country's skill abundance (h_c), financial development ($Fin - Dev_c$), or an OECD dummy.¹⁹

At first glance result 3 seems to contradict prediction 3. According to that prediction, k_c should have a positive coefficient when we do not control for product or firm capital intensity (as in column 1) and an insignificant one when we do (columns 2 to 5). Instead, the finding that intrafirm imports are more likely when the origin country is capital rich is remarkably robust.

Does result 3 invalidate the Antràs (2003b) model? Not necessarily. Antràs (2003b) mentions that his prediction relies on a specific production function and factor price equalization. With a general CES production function and an elasticity of substitution between factors below 1 (as often found empirically), he argues that firms should outsource more whenever the wage-rental ratio is high. That is, if factor prices are not equalized, we should observe more outsourcing from capital-rich countries.²⁰ In an unreported robustness check, we have interacted capital abundance with OECD membership (a proxy for a common diversification cone in the absence of factor price data). We find a nonsignificant coefficient for the interaction term, suggesting that prediction 3 does not hold even in the favorable setting of OECD countries. This does certainly not discard the extended Antràs (2003b) model but suggests that the prediction deserves further investigation.

Result 3 is also difficult to reconcile with intangible asset theories such as Ethier (1986) or Ethier and Markusen (1996), which emphasize factor endowment differences between countries. In these theories, endowment similarities make MNCs more profitable than licensing arrangements or than production in the nonmanufacturing sector. France is among the top 10% capital-intensive and top 25% skill-intensive

¹⁸ To save space, we do not report estimates of country controls \mathbf{CC}_c and firm controls \mathbf{FC}_i .

¹⁹ Since $Fin - Dev_c$ is not available for China in 1999, we have excluded China from the analysis. In an unreported robustness check, we find that removing that control and including China among origin countries does not affect result 3.

²⁰ This is explained in note 22 in the Antràs (2003a).

TABLE 4.—COUNTRY AND PRODUCT-SPECIFIC DETERMINANTS OF INTRAFIRM TRADE

Depended variable: Intrafirm Dummy $y_{i,p,c}$	(1)	(2)	(3)	(4)	(5)
	Key Covariates				
Country-level covariates					
Capital Abundance (k_c)	-0.0044* (0.0023)	-0.0083*** (0.0024)	-0.1575*** (0.0290)	-0.0227*** (0.0080)	-0.0186*** (0.0055)
Skill Abundance (h_c)	0.0336*** (0.0079)	0.0317*** (0.0080)	0.0665 (0.0932)	-0.0104 (0.0190)	0.0610*** (0.0190)
Contract Enforcement (Q_c)	0.0981*** (0.0159)	0.1020*** (0.0165)	0.6891*** (0.1661)	0.1611* (0.0849)	0.1454*** (0.0379)
Product-level covariates					
Imported Product Contractibility (μ_p)		-0.0379*** (0.0040)	-0.2290*** (0.0284)	-0.0369** (0.0178)	-0.0447*** (0.0068)
Final Product Contractibility (μ_f)			-0.2730*** (0.0907)		-0.0779*** (0.0147)
Embodied Capital Intensity (k_p)		0.0085*** (0.0024)	-0.0600*** (0.0186)	-0.0183** (0.0088)	0.0022 (0.0051)
Embodied Skill Intensity (h_p)		0.0750*** (0.0067)	0.1061* (0.0555)	0.0231 (0.0171)	0.0597*** (0.0178)
Controls	IM1 and country controls	IM1 and country controls	IM1 and country controls	Country controls and firm FE	IM1, country controls and firm controls
			Estimation Method		
			Random Effects	Conditional Firm Fixed Effects Logit	Probit
Number of observations	Probit 251,022	Probit 234,786	Probit 101,771	35,802	82,923
Pseudo- R^2	0.1949	0.2002	—	—	0.1110
Log likelihood	-61,224	-58,470	-18,749	-13,948	-30,549

The dependent variable $y_{i,p,c}$ equals 1 if imports by firm i of product p from country c are intrafirm and 0 otherwise. The key covariates are country c , capital intensity k_c , skill intensity h_c , and quality of judicial institutions Q_c , as well as imported product p contractibility μ_p , embodied capital intensity k_p , and embodied skill intensity h_p . In some specifications, the contractibility of the importing firm main final product μ_f is also considered. Our measures of contractibility are available only for merchandised goods. Therefore, estimating μ_f requires us to focus on firms with primary activity in (essentially) manufacturing reducing, as can be seen by comparing columns 1 and 2 with column 3, the number of observations considerably. With the conditional firm fixed-effects logit, column 4, the identifying variation is provided by those observations (35,802) referring to firms engaging in, depending on the country or product, both intrafirm and outsourcing. In this case, μ_f , which is firm specific, cannot be estimated. Finally, column 5 corresponds to observations for which firm-level controls are available from the EAE database. IM1 is the inverse Mills ratio, coming from the estimation of selection into response to the EIIG survey, which is set to 0 for firms outside the EIIG target population. Marginal effects are presented in all cases. In the fixed-effects logit case, marginal effects are obtained by setting fixed effects to 0. Firm-clustered standard errors (except for the random effects probit and fixed effects logit) in brackets. Significantly different from 0 at ***1%, **5%, and *10%.

countries, in our sample. One would therefore expect more intrafirm imports from capital- and skill-rich countries or possibly a nonsignificant coefficient. Intangible asset theories may be consistent with our finding on skill abundance, whose coefficient is positive whenever significant, but not with the regularity found for capital abundance.

Finally, result 3 is at variance with previous evidence on U.S. imports (Antràs, 2003b; Bernard et al., 2010). However, as these empirical studies apply to the industry or product level, findings are not directly comparable. In section V, we bridge the gap between our and the above-mentioned results by considering both the extensive and intensive margins of import sourcing.

Our second result relates to contract enforcement:

Result 4: Intrafirm trade is more likely with countries having good judicial institutions.

Result 4 states that the better a country's judicial system (high Q_c), the less likely firms are to engage in arm's-length relationships. The result is robust to controlling for imported and final good contractibility. As an additional check (results available on request), we break firms into quartiles of TFP and find a higher coefficient of Q_c for more productive firms.

These results are consistent with prediction 4. In Antràs and Helpman (2008), improved product contractibility in

the origin country has two opposite effects. First, more domestic firms turn to arm's-length imports (the standard effect). Second, the most productive importers switch to intrafirm trade due to a weaker need to provide the supplier with high-powered incentives (the surprise effect). Our results suggest that the surprise effect dominates the standard effect. We therefore confirm the findings by Nunn and Trefler (2008) on product-level U.S. data at the firm level.

Interestingly, result 4 challenges the transaction cost approach of, among others, McLaren (2000) and Grossman and Helpman (2002). In these models, stronger legal protection should reduce costs of agents' interactions outside the firm and favor arm's-length relationships instead.

Moving to product characteristics, we report a consistent pattern across different estimations on the role of intermediate and final product contractibility:

Result 5: The production of complex intermediate and final goods (low μ_p and μ_f) is more likely to occur within firm boundaries.

This result does not correspond to a theoretical prediction of the property rights approach. In Antràs and Helpman (2008), comparative statistics rely on contractibility by input-country pair. It is generally unclear how a joint improvement

in the contractibility of inputs in both the North and the South affects the make-or-buy decision in the South.

However, result 5 can be related directly to the transaction cost approach. Products that are neither sold on an organized exchange nor reference priced, according to Rauch (1999), are likely to have three important attributes. First, as Nunn (2007) suggested, these products involve more relationship-specific investments, which creates appropriate quasi-rents. Transaction cost theory, starting from Williamson (1971), predicts that ownership prevents costly haggling over appropriate quasi-rents. Second, these products are more complex, which increases the risk of costly ex post renegotiation (see, for instance, Costinot et al., 2011). Third, these products typically embody costly R&D efforts, which are better protected against imitation within firm boundaries, as emphasized by the intangible asset theories.

Finally, neither product-embodied capital (k_p) nor skill intensity (h_p) has a clear effect. Coefficients take either sign or are not significant in some cases.

V. The Extensive and Intensive Margins of International Sourcing

Some of our findings, and in particular result 3, are at odds with the evidence provided by studies using U.S. industry- or product-level data. Why are our findings different? We start by replicating the same industry- and product-level estimations carried in those studies to rule out differences in the patterns of French and US intrafirm trade or data collection.²¹ After successfully confirming U.S. aggregate-level findings with French data, we go one step further in our analysis and show that there are interesting patterns operating, sometimes in opposite directions, at the extensive (choice of sourcing mode) and intensive margins (value of imports in a given mode) of international sourcing. The responsiveness of the firm-level intensive margin to factor abundance, product contractibility, and so on is not predicted by theory. In Antràs (2003b), for instance, that margin is governed by some simplifying assumptions that are justified by the general equilibrium focus. Future theoretical work can take further advantage of the fresh evidence provided by our firm-level data on such margin.

A. France Is Not Different from the United States

We start by replicating U.S. findings with our French data. Table 5 reproduces some of the cross-industry (column 1) and cross-country (column 2) regressions of Antràs (2003b) for France. The dependent variables $Share_s$ and $Share_c$ represent the share of intrafirm imports value at the industry and country

²¹ For instance, the definition of affiliate trade differs in the two countries. Our French data record imports from affiliates where the parent holds more than 50% of the stock. In the United States, the equivalent thresholds are 6% in Customs data and 10% in the Bureau of Economic Analysis survey of multinationals. Besides, the EIIG covers only about 80% of French multinationals' imports due to nonresponse, while U.S. Customs data are in principle exhaustive.

TABLE 5.—REPRODUCING PREVIOUS AGGREGATE FINDINGS: THE SHARE OF INTRAFIRM TRADE IN IMPORTS' VALUE AT THE INDUSTRY AND COUNTRY LEVELS

Dependent variable	(1) $Share_s$	(2) $Share_c$
Industry-level covariates		
Industry Capital Intensity (k_s)	0.0543* (0.0304)	
Industry Skill Intensity (h_s)	0.2361*** (0.0905)	
Final Product Contractibility (μ_f)	-0.1283*** (0.0420)	
Country-level covariates		
Capital Abundance (k_c)		0.0426** (0.0191)
Skill Abundance (h_c)		0.0855 (0.1014)
Log Population ($Population_c$)		0.0178 (0.0111)
Number of observations	215	112
R^2	0.0976	0.1938

The dependent variables $Share_s$ and $Share_c$ represent the ratio of intrafirm imports value over total imports value in industry (NACE rev1 three-digit) s and country c , respectively. Estimation is carried out by OLS. Robust standard errors in brackets. Significantly different from ***1%, **5%, and *10%.

levels, respectively. Industry-level covariates are NACE rev1 three-digit sector averages of capital and skill intensity (k_s and h_s) and the final good contractibility measure μ_f .²² Country covariates are capital and skill abundance (k_c and h_c), as well as the log of country c population in 1999 ($Population_c$), taken from the IMF World Economic Outlook database.

Our estimations confirm findings on U.S. data by Antràs (2003b) and other authors. In particular, the intrafirm share increases with industry capital intensity as well as with the capital abundance of the origin country. Interestingly, the second finding contrasts, at first sight, with result 3 in the firm-level analysis of the previous section.

We also replicate product-country-level estimations on U.S. data by Bernard et al. (2010). These authors estimate a model of intrafirm shares at the country-product level ($Share_{pc}$). Since at this level of disaggregation, $Share_{pc}$ has many zeros, they use a Heckman two-stage procedure to control for selection bias. In particular, their model has a first-step probit model on the variable $\widetilde{Share}_{pc} = 1$ if $Share_{pc} > 0$ and 0 otherwise, and a second-step equation similar to our equation (4) but (obviously) without firm controls.

Table 6 reports estimation results with $IM2$ being the inverse Mills ratio coming from the first step. Our excluded variables are $Colony_c$, $Same - leg - orig_c$, and $Population_c$. Our findings echo those of Bernard et al. (2010). In particular, we find again a positive coefficient of k_c at the product-country level. In addition, we find that the quality of institutions (Q_c) has a positive effect in the first-stage equation and a negative effect (though not significant in our analysis) in the second-stage equation.

²² There is a direct correspondence between CPA products f and NACE rev1 three-digit industries s . Data on advertising and R&D intensity, used in Antràs (2003b), are not available to us.

TABLE 6.—REPRODUCING PREVIOUS AGGREGATE FINDINGS: THE SHARE OF INTRAFIRM TRADE IN IMPORTS' VALUE AT THE IMPORTED PRODUCT-COUNTRY LEVEL WITH A HECKMAN SELECTION MODEL

Dependent Variable	Heckman First Stage	Heckman Second Stage
	(1) \widehat{Share}_{pc}	(2) $Share_{pc}$
Product-level covariates		
Embodied Capital Intensity (k_p)	-0.0166 (0.0290)	0.0580*** (0.0106)
Embodied Skill Intensity (h_p)	0.4246*** (0.0861)	0.2705*** (0.0304)
Imported Product Contractibility (μ_p)	-0.2231*** (0.0458)	-0.1524*** (0.0165)
Country-level covariates		
Capital Abundance (k_c)	0.1359*** (0.0332)	0.0633*** (0.0129)
Skill Abundance (h_c)	0.3758*** (0.1175)	0.0059 (0.0402)
Contract Enforcement (Q_c)	1.9991*** (0.1705)	-0.1060 (0.0674)
Log Distance ($Distw_c$)	-0.3364*** (0.0190)	-0.0288*** (0.0080)
Common Language Dummy ($Language_c$)	-0.1846*** (0.0571)	-0.0519*** (0.0181)
Ex Colony Dummy ($Colony_c$)	-0.0637 (0.0632)	Excluded -
Common Legal Origin Dummy ($Same - leg - orig_c$)	0.3321*** (0.0447)	Excluded -
Log Population ($Population_c$)	0.2935*** (0.0137)	Excluded -
Selection		
Inverse Mills ratio (IM2)	-	0.2687*** (0.0253)
Number of observations	7,500	3,202
R^2	0.2135	0.0944
Log likelihood	-4,026	-

The dependent variable \widehat{Share}_{pc} in the first stage of the Heckman procedure, column 1 equals 1 if the share of intrafirm trade of product p with country c is positive and 0 otherwise. The excluded variables in the second stage are ex French colony, same (French) legal origin, and log population. The dependent variable $Share_{pc}$ in the second stage of the Heckman procedure, column 2, corresponds to the positive values of the share of intrafirm trade of product p with country c with covariates, including the inverse Mills ratio coming from the first stage (IM2). Robust standard errors in brackets. Significantly different from 0 at ***1%, **5%, and *10%. Marginal effects and pseudo- R^2 are reported for the first stage.

B. Determinants of the Type and Value of Firms' International Sourcing

We now investigate both the firm binary choice between intrafirm and arm's-length imports (extensive margin) and the value of firm imports in a given sourcing mode (intensive margin).

We proceed by estimating a two-stage Heckman model. The first-stage equation is based on specification 4 of equation (4) using the small sample and firm controls. To obtain an exclusion restriction, we add the firm's multinational status in 1994 as an additional regressor in the first stage.²³ We then

²³ This information comes from the LIFI (Liaisons financières) database collected by the French Statistical Office (INSEE), which describes ownership ties between firms that have a legal entity in France. These data exhibit strong persistence of multinational status, which suggests the presence of substantial sunk costs of creating a foreign affiliate. For this reason, we argue that, conditional on other firm variables, past multinational status conveys information on a firm's incentives to engage in intrafirm imports without directly affecting their value. The logic echoes analyses of the persistence of export status in Roberts and Tybout (1997) or Bernard and Jensen (2004). In our data set the correlation multinational status in 1994 and 1999 is 0.38. The correlation between multinational status in 1994 and y_{ipc} is 0.25.

run two separate second-stage regressions—one for intrafirm (log) import values and one for outsourcing (log) import values with IM3 being the inverse Mills ratio coming from the first stage. To save space, only estimates on our key firm, country, and product covariates are reported in table 7.

Columns 2 and 3 of table 7 provide covariates estimates for the two intensive margins. Firm total factor productivity and capital intensity are associated with larger import values under both modes. Firm skill intensity, however, does not have a significant impact on either case. The TFP_i finding is rather intuitive, basically requiring more productive firms to operate at a larger scale. However, estimates and standard errors indicate that the positive relationship between firm productivity and import values is stronger in the case of outsourcing. On capital intensity (k_i), the difference between coefficients' values points to a stronger effect for arm's-length sourcing. That result complements existing evidence on importing firms, which is relatively scarce. For instance, Tomiura (2007) finds that Japanese firms outsourcing abroad are less capital intensive than Japanese multinationals. Bernard et al. (2007) find that U.S. importers are more capital intensive than U.S. domestic firms.

Turning to country-level covariates, k_c displays a negative and significant coefficient at the outsourcing intensive margin, while the coefficient at the intrafirm intensive margin is not significant. The same applies to country skill abundance h_c . With respect to k_c , our decomposition of international sourcing into the extensive and intensive margins thus reveals a complex picture. Firms are more likely to import from capital-abundant countries at arm's length (result 3), but in relative terms, average values of intrafirm imports increase with capital abundance. Given the positive coefficient of k_c in tables 5 and 6, we conclude that the intensive margin effect dominates.

How can we interpret this result? Existing theories do not explain why the value of intrafirm and outsourcing imports at the firm level varies across countries. An extension where the assumption of identical factor intensities in fixed and variable costs is relaxed does not seem promising. Fixed costs would need to be less capital intensive under integration than under outsourcing to explain the negative coefficient, which seems rather implausible. We can, however, risk a conjecture. Relax the assumption of perfect transferability between the two parties and suppose that independent suppliers must pay capital costs on entry. Entry of independent suppliers is easier in capital-rich countries where the costs of capital are lower. These countries are therefore more likely to benefit from thick-market externalities, for example, through the alleviation of ex post hold-up problems, as in McLaren (2000), or search frictions, as in Grossman and Helpman (2005). That makes outsourcing relatively more profitable in capital-abundant countries. That conjecture would also imply lower variable costs and greater imports under outsourcing in capital-rich countries. Regrettably, we do not have data on the number of available suppliers to test this conjecture.

TABLE 7.—THE EXTENSIVE AND INTENSIVE MARGIN OF FIRMS' INTERNATIONAL SOURCING: HECKMAN SELECTION MODEL

Dependent Variable	Heckman First Stage	Heckman Second Stage	
	Intrafirm dummy $y_{i,p,c}$ (1)	Intrafirm Import Value (2)	Outsourcing Import Value (3)
Firm-level covariates			
Productivity (TFP_i)	0.0328** (0.0128)	0.1523* (0.0910)	0.5774*** (0.0745)
Capital Intensity (k_i)	0.0145** (0.0064)	0.0979** (0.0434)	0.3983*** (0.0307)
Skill Intensity (h_i)	0.0821*** (0.0318)	-0.1765 (0.1428)	-0.0169 (0.1070)
Country-level covariates			
Capital Abundance (k_c)	-0.0190*** (0.0053)	-0.1149 (0.0842)	-0.1812*** (0.0386)
Skill Abundance (h_c)	0.0554*** (0.0186)	-0.0988 (0.2484)	-0.3651*** (0.1269)
Contract Enforcement (Q_c)	0.1265*** (0.0387)	-1.8175*** (0.4024)	-1.0554*** (0.2372)
Product-level covariates			
Imported Product Contractibility (μ_p)	-0.0405*** (0.0067)	-0.1076 (0.0939)	0.7286*** (0.0496)
Final Product Contractibility (μ_f)	-0.0644*** (0.0137)	0.0484 (0.1066)	0.0370 (0.0796)
Embodied Capital Intensity (k_p)	0.0028 (0.0050)	0.2713*** (0.0610)	0.1989*** (0.0298)
Embodied Skill Intensity (h_p)	0.0572*** (0.0171)	0.7282*** (0.1693)	-0.0816 (0.0979)
		Controls	
	IM1, Past MNE Status, Country and Firm Controls	IM1, IM3, Country, and Firm Controls	IM1, IM3, Country, and Firm Controls
Number of observations	82,923	11,973	70,739
R^2	0.1338	0.1150	0.1596
Log likelihood	-29,765	-	-

The first stage of the Heckman procedure, column 1, is a probit where the variable $y_{i,p,c}$ equals 1 if imports by firm i of product p from country c are intrafirm and 0 otherwise. Estimations are carried out on the small sample for which firm-level data are available from the EAE database. The excluded variable in the second stage is firm multinational status in 1994. The second stage of the Heckman procedure, columns 2 and 3, is an OLS regression on the values of (log) imports for a given mode (either intrafirm or outsourcing) and contains the inverse Mills ratio coming from the first stage (IM3) as well as the inverse Mills ratio coming from the selection into response for EIIG firms (IM1). The latter is set to 0 for firms outside the EIIG target population. Firm-clustered standard errors in brackets. Significantly different from 0 at ***1%, **5%, and *10%. Marginal effects and pseudo- R^2 are reported for the first stage.

We also find that the coefficient of Q_c is positive at the extensive margin but negative at the intensive margin for both modes, with a greater magnitude for intrafirm imports. This echoes results on product-country intrafirm shares in Bernard et al. (2010), which we replicate in table 6. One plausible explanation is that judicial systems matter more for the fixed costs of integration and the variable costs of outsourcing. More theoretical research on this topic would certainly be desirable.

Concerning product features, the contractibility of the imported product μ_p has a negative but not significant effect on the intensive margin of intrafirm trade, while displaying a positive and significant effect on outsourcing import values. Together with the negative extensive margin coefficient, our findings are consistent with the intrafirm share analysis of Bernard et al. (2010) and our replication of their results, although our contractibility measure is less disaggregated than theirs. Finally, while both final product contractibility and embodied capital intensity do not display a differential impact on the intensive margin of the two modes, embodied skill intensity does, with intrafirm imports growing with h_p .

Again, more theoretical work is needed in order to rationalize these findings.

VI. Conclusion

We have conducted a detailed examination of firm-, country- and product-level determinants of intrafirm trade on a sample of 234,786 French firm-country-product import triples in 1999.

Our analysis is motivated by the property rights models of the multinational firm of Antràs (2003b), Antràs and Helpman (2004), and Antràs and Helpman (2008). Three of our four key empirical results accord with these theories, thereby confirming prior industry- and product-level U.S. evidence. Holding origin country and product attributes constant, we find that more productive capital- and skill-intensive firms are more likely to engage in intrafirm imports (results 1 and 2). Controlling for observed and unobserved firm heterogeneity, we find that intrafirm imports are more likely to originate from countries with good judicial institutions. The effect is strongest for highly productive firms (result 4). This

contrasts with transaction cost models where improved contract enforcement makes outsourcing more likely. Overall, our results broadly support the property rights approach to the multinational firm. They further indicate that some of the underlying industry-level assumptions of the theory can be profitably extended to the firm level, from which most of the variation in key covariates, such as capital and skill intensity, comes from.

We also uncover some empirical patterns of intrafirm trade that have escaped previous industry- and product-level analyses. In order to bridge previous aggregate findings with our investigation, we decompose intrafirm and arm's-length imports into an extensive and intensive margin. For example, we find a hitherto unexplained role for the intensive margin of imports to explain cross-country patterns in intrafirm trade. Although country and product-country intrafirm shares increase with capital abundance, firms are less likely to engage in intrafirm imports from capital-abundant countries (result 3). That second result is very robust and holds even when controlling for observable and unobservable firm characteristics. A two-stage regression analysis further shows that capital abundance has a positive impact on the value of intrafirm imports relative to outsourcing imports. These features suggest that in our French firms' data, the patterns of industry- and product-level intrafirm trade shares are actually driven by the intensive margin. Replication of our result on disaggregated data for other countries and further theoretical research to explain these patterns would certainly be welcome.

Finally, we find some robust empirical evidence that complex goods and inputs are more likely to be produced within firm boundaries. This is consistent with the recent property rights model by Carluccio and Fally (2009), where the desirability of transferring ownership to suppliers of complex products is limited by the latter's financial constraints. Our finding, however, is also consistent with the transaction cost approach via a dissipation of intangible assets argument. Complex inputs embody costly R&D efforts or the use of other intangible assets, which are likely to be more effectively protected against imitation within firm boundaries. While beyond the reach of this paper, disentangling these competing explanations certainly deserves further investigation.

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ONLINE APPENDIX

THE DETERMINANTS OF INTRAFIRM TRADE: EVIDENCE FROM FRENCH FIRMS

The EIIG database

Intrafirm trade is defined in the primary EIIG data as trade with an affiliate controlled by a single French entity with at least fifty percent of its equity capital. The SESSI defines two types of trade with independent suppliers: 1) formal contractual relationships that refer to alliances, franchising, joint-ventures, and licensing agreements; 2) ‘informal’ relationships that involve less stringent contractual links. We consider both types of trade with independent suppliers as outsourcing.

In the primary EIIG data 20,952 out of the 81,217 import flows are ‘pure’ intrafirm (in the sense that 100% of imports of product p from country c come from a foreign affiliate), 50,021 are ‘pure’ outsourcing, and 10,244 are ‘mixed triples’. Out of the 10,244 mixed triples, 5,391 have 80% or more of the import value under a single sourcing mode (intrafirm or outsourcing). We choose to record these mixed triples according to the prevalent sourcing mode. Therefore, we end up with 76,364 triples from the EIIG database. As will be explained below, our final sample has 281,419 observations. Mixed triples represent 3.64% of the final sample, while the 4,853 mixed triples excluded from the analysis represent only 1.72% of all observations in the final sample. Further details on the EIIG database can be found in Guannel and Plateau (2003).

Construction of the estimation sample

In order to construct our estimation sample, we start by refining the population of interest. The EIIG survey was addressed to large traders, i.e. firms trading more than 1 million euros. There are 30,028 such firms in 1999 French Customs data, accounting for the bulk of imports (95.46%) in 1999. Out of these 30,028 large traders, 8,236 belong to the EIIG target population. We match the Customs and EIIG datasets under the assumption that *import flows recorded in Customs data by firms other than the EIIG target population, occur with a third party*. Put differently, we assume that SESSI successfully identified multinational firms among large traders.

Had all the 8,236 firms who received the EIIG questionnaire replied to the survey, a simple match of the EIIG data with imports by the remaining 21,792 non-multinational firms would provide us with full information on the population of large traders. However, about half of them (3,931) did not reply to the survey with these firms accounting for less than 20% of total exports and imports of the EIIG target population. Non-response to the EIIG survey thus seems to be

non-random with responding firms likely to be larger and possibly more productive than non-respondents.

To address potential biases, we construct a representative sample of the population of both multinational and non-multinational large importing French firms. To deal with sample selection due to non-response in the EIIG survey we use a two-stage Heckman procedure. In the first stage we estimate the probability that one of the importing firms in the EIIG target population responds to the survey, using firm total imports value, number of product categories imported, number origin countries involved, and NACE rev1 3-digit industry dummies. These variables reflect our presumption that a higher data collection effort was allocated by SESSI to large importers and/or certain sectors. This generates an inverse Mills ratio ($IM1$) at the firm-level for all firms responding to the EIIG survey. We subsequently use $IM1$, but none of the above first-stage variables, as an additional regressor throughout our firm-country-product analysis.

Finally, we construct a random sample of the population of non-multinational French large importers, i.e. importers that trade 1 million euros or more but do not belong to the EIIG target population. We do so by drawing a fraction of non-multinational importers that matches the response rate of the EIIG survey. By merging such a random sample with the EIIG data on respondent firms we get our final sample. In our analysis we will refer to this final sample as the ‘large sample’. It includes 281,419 observations spanning over 14,711 firms, 219 countries and 272 CPA96 4-digit products. Matching that sample with the EAE survey that documents manufacturing firm characteristics generates a ‘small’ sample of 98,168 observations spanning over 5,175 firms, 185 countries and 270 products.

Firm Variables

Productivity. We estimate TFP as the residual (plus the constant) of a log-linearized three-factor Cobb-Douglas production function with labor, capital and material inputs. We use the value-added based Levinsohn and Petrin (2003) estimator (LP).

We estimate TFP based on the unbalanced EAE panel of 28,587 firms over 3 years (1998 to 2000) for a total of 74,120 observations. Observations with negative or missing values of value added, production, capital stock, material inputs and wages are eliminated. Outliers, identified as observations falling outside the 1st and 99th percentile of the distributions of value added per worker and capital stock per worker, are also not considered. This leaves us with TFP information on 22,673 firms for the core year 1999. TFP estimation has been carried out separately for each of the NACE 3-digit industries in the manufacturing sector.

Factor intensities. Our measure of capital intensity k_i is the log of the ratio between the capital stock and employment of firm i . h_i is the log of the ratio between total wage expenses and employment of firm i . This variable is meant to capture the average skills of workers of firm i with the underlying hypothesis being that more skilled workers are paid higher salaries.

Imported Product Variables

Contractibility. Our contractibility measure is based on the same idea as Nunn (2007): inputs sold on an organized exchange or reference priced are likely to be less relationship-specific, and therefore that sales contracts of these inputs are less incomplete. We also use the Rauch (1999) ‘Liberal’ product classification.

However we apply the relationship-specificity index to imported products *directly*. In Section 2 we contended that a proper test of Antràs and Helpman (2008) predictions would need to distinguish between contractibility of the inputs provided by the foreign supplier and those provided by the final producer. A second advantage of having product-level measures is that a final producer typically imports several products, with potentially different organizational decisions.

Our approach contrasts with Nunn (2007) and Nunn and Trefler (2008) who compute a weighted average of that index *by final industry*, using input-output matrix coefficients as weights. In their approach an emphasis on institutional comparative advantage makes it logical to measure how much *exporting* industries rely on complex inputs. Our approach focuses on organizational decisions by *importers*, so that a measure at the imported product level is more appropriate.

Denoting by $R_j^{neither}$ a dummy variable that takes value 1 if the HS6 product j is neither sold on an organized exchange nor reference priced, and by $\theta_{p,j}$ the share of the HS6 product j in the French imports of CPA96 4digit product p in 1999 we have:

$$\mu_p = 1 - \left(\sum_j \theta_{p,j} R_j^{neither} \right)$$

The basic data needed to construct contractibility measures comes from Rauch (1999) and are organized on the basis of the SITC rev2 4 digit. Our import data are at the CPA96 4digit classification. To aggregate the Rauch data at the imported goods level, we proceed in two steps. First we establish (using data from the RAMON project) a correspondence between HS6 and SITC rev2 4 digit and a correspondence between HS6 and CPA96 4digit. Then we use import trade data in 1999 for France at the HS6 level (provided by EUROSTAT) as weights to aggregate the original SITC rev2 4 digit information to the CPA96 4digit.

Embodied capital and skill intensity. Embodied capital k_p and skill intensity h_p of the imported product p are constructed using French technology. We introduce these variables because in Antràs (2003) factor intensities of the imported product play a key role. In the absence of cross-country product-level data on technology these variables should be seen as reasonable proxies.

To build k_p and h_p , we start by using a correspondence table between the industry classification NACE rev1 4digit (available in our EAE firm dataset) and the product classification CPA96 4digit. We then compute the average capital intensity (log of capital/labor ratio) and skill intensity (log of total wage expenses/number of full time equivalent workers) of French firms associated to a given CPA96 4digit product.

Final Product Variables

Contractibility. Contractibility of a final good f is measured in the same way as that of an imported product. Defining $R_j^{neither}$ as dummy variable that takes value 1 if the PRODCOM2002 8 digit product j is neither sold on an organized exchange nor reference priced, and by $\theta_{f,j}$ the share of the PRODCOM2002 8 digit product j in the French production of CPA96 4digit product f in 1999 we have:

$$\mu_f = 1 - \left(\sum_j \theta_{f,j} R_j^{neither} \right)$$

Origin Country Variables

Key covariates. k_c and h_c stand (respectively) for the capital and skill abundance of country c . They are respectively measured by the log of the capital/labor and human capital/labor ratios provided by Hall and Jones (1999). Q_c is a measure of the quality of institutions based on the “Rule of Law” index from Kaufmann, Kraay, and Mastruzzi (2003). This is a weighted average of a number of variables that measure individuals’ perceptions of the effectiveness and predictability of the judiciary and the enforcement of contracts in each country between 1997 and 1998.

Controls. Tax_c is the top corporate tax rate prevailing in a given country in 1999 taken from the World Tax Database (University of Michigan). $Fin - Dev_c$ is a proxy for the degree of development of financial markets which we borrow from Beck (2002). $OECD_c$ is a dummy indicating membership to the OECD in 1999. $Same - leg - orig_c$ is a dummy indicating whether country c has a French civil law system (Djankov et al., 2003). $Distw_c$ is the log of distance of country c to France. $Colony_c$ is dummy indicating whether country c is a former French colony and $Language_c$

is a dummy indicating whether French is spoken in country c . Data on $Distw_c$, $Colony_c$, and $Language_c$ come from CEPII (Centre d'Etude Prospectives et d'Informations Internationales).