Organizational Forms of Importing Firms in U.S. Manufacturing

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Abstract

Importing firms in U.S. manufacturing choose different organizational forms. This paper uses a unique firm-country dataset to examine how an importer's choice between outsourcing and vertical integration is related to three factors: share of inputs provided by the headquarters firm, the firm's productivity, and trade costs. Higher headquarters input share, higher productivity, and lower trade costs are associated with a higher importer's fraction of inputs that are intra-firm. These results are consistent with the theoretical models based on the property-rights approach as opposed to those that emphasize the role of managerial incentives.

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1 Introduction

In recent years as the role of multinational corporations has become more pronounced, the process of vertical specialization, in which goods are produced in different stages in multiple countries, has become increasingly important for understanding the growth of trade and economies in general.[1]

Importing firms choose between two major organizational forms: outsourcing (when a firm purchases from an independent, arm's-length supplier) and vertical integration (when a related-party supplier is involved).

This paper takes advantage of uniquely detailed transaction-level trade data for the U.S. to test existing theoretical results and finds that a firm's share of headquarters inputs and productivity are positively associated with both the decision to integrate and the share of related-party imports. At the same time trade costs have a negative effect on the decision to purchase a foreign supplier and on the share of imports coming through the affiliate.

Although empirical research related to organizational forms of importers has received relatively little attention due to the lack of firm-level data, the theory of the importing firm has been a very active research area. There are two major approaches in theoretical literature that address importing firms' organizational decisions.

The first approach explains the choice of organizational forms based on the residual income property rights. Antras and Helpman (2004) present one of the most influential recent models of this approach. This model develops earlier work of Grossman and Hart (1986) as well as that of Hart and Moore (1990) and combines the within-sectoral heterogeneity of Melitz (2003) with insights on the organizational structure of firms from Antras (2003). The firms which operate in an incomplete-contracts environment, are characterized by two features. First, incomplete contracts matter both for outsourcing and for vertical integration. Second, two inputs are needed for production: one is provided by the final-goods producer, and the other is brought in by another supplier.

The second strand of literature explains the choice of organizational forms analyzing the role of managerial incentives. Grossman and Helpman (2004) use this approach to produce the alternative set of predictions using principal-agent framework, which was developed earlier in Holmstrom and Milgrom (1991).

The models based on two approaches produced alternative predictions related to the several factors that determine organizational choices of importers.

Antras and Helpman (2004) predict that higher headquarters intensity will make more firms prefer vertical integration, while in Grossman and Helpman (2004) the share of headquarters inputs has no effect on the organizational decision. For the empirical analysis here, importing firm's skilled

[1] See Feenstra and Hanson (1996), Hummels, Ishii, and Yi (2001), and Yeats (2001).

labor intensity and capital intensity were chosen as proxy variables for the U.S. headquarters input share. Both variables are found to have a positive effect on the decision to integrate as well as on the share of integrated imports for the firms that already have an affiliate in a given country.

The two theoretical models produce conflicting predictions about the role of importer's productivity. In Antras and Helpman (2004) there is a threshold value of productivity above which firms vertically integrate and below which they prefer outsourcing. In contrast, Grossman and Helpman (2004) predict that the most productive and least productive firms will outsource while intermediate-level productivity firms will choose vertical integration. The empirical results based on the unique firm-level dataset support the predictions of Antras and Helpman (2004) and, therefore, the property-rights approach in general. Higher productivity of importing firms in U.S. manufacturing is shown to affect positively both the decision to purchase a foreign supplier and the share of related-party imports when the firm already has a foreign affiliate.

The theoretical predictions related to the role of trade costs are more ambiguous in both models. While in Antras and Helpman (2004) lower variable costs lead to more firms involved in importing in general, the effect on the relative presence of vertical integration is not certain and depends on distribution of productivity across firms. In Grossman and Helpman (2004) the effect of trade liberalization depends on productivity-sorting of importers. If outsourcing firms are mostly high-productivity ones, then the effect of the change is positive for vertical integration. If the opposite is true, the predicted relative effect is negative. The empirical results based on transaction-level transportation costs show that higher trade costs make outsourcing relatively more attractive for importing firms. This effect is found both for the decision to integrate vertically and for the share of integrated imports.

These theoretical results are tested using a new dataset. The unique dataset consists of hundreds of thousands of observations produced by linking transaction-level imports from U.S Customs with the firm-level production data from the Annual Survey of Manufactures and Census of Manufactures for the years between 1992 and 2006. In particular, for 1992, 1997, and 2002 the information about practically all U. S. manufacturing firms is used for the analysis. To my knowledge, this paper is the first one that addresses the theoretical results about firms' organizational decisions with the firm-level data.

Previous literature addressing organizational decisions of importers includes Bernard et al. (2008), Lin and Thomas (2008), Nunn and Trefler (2008), Yeaple (2006), and Antras (2003). In the work of Bernard, Jensen, Redding and Schott (2008), the analysis is based on the same imports dataset but it is focused on the product and country attributes that determine importing firms' choice of organizational forms. Lin and Thomas (2008) use the data for a specific industry (hotels) to test the theoretical predictions related to productivity, and they find some evidence consistent with both managerial incentives and the property-rights approach. Nunn and Trefler

(2008), Yeaple (2006), and Antras (2003) employ industry-level data to address an importing firm's decision to vertically integrate and, to a different degree, they find support for some predictions of the property-rights theory.

Overall the empirical analysis which is based on firm-level data is the most promising way to test the theoretical results related to the influence of firm characteristics on an importer's organizational forms. Organizational decisions are made by the firms, and within-industry heterogeneity in firms' headquarters intensity is important. Since productivity comparisons are undefined across countries, only a firm-level within-industry analysis can address hypotheses related to productivity sorting. Finally, trade costs that vary across firms in the same industry also play an important role in the process of choosing the organizational form by importers.

2 Theoretical Models

There are two major strands in theoretical literature that explains importing firms' choice of organizational forms. The first emphasizes the role of managerial incentives and the importance of observability and control of the efforts. One of the most recent and most influential works in this vein is Grossman and Helpman (2004), which is related to previous work by Holmstrom and Milgrom (1991). The second strand is based on residual income property rights that depend on the organizational form. Antras and Helpman (2004) produce theoretical results based on the property-rights approach, drawing on the earlier work in Antras (2003).

The models representing the two strands produce potentially conflicting theoretical results related to the influence of different factors on the choice of organizational forms.

According to Grossman and Helpman (2004), the least and most productive importing firms prefer outsourcing, while importers with intermediate productivity levels choose vertical integration. Based on this productivity sorting pattern, the model predicts that the effect of trade costs on organizational forms depend on whether outsourcing is conducted mostly by high-productivity or low-productivity firms. In a given industry falling trade costs support vertical integration if high-productivity firms dominate outsourcing, and have a negative effect on related-party imports if the opposite is true.

This model, which uses a principal-agent framework, is based on imperfect observability of a manager's action.

Firms in an industry are distinguished by their productivity level. A firm's revenue is a non-decreasing function of productivity. The principal knows the production technology but needs the cooperation of a skilled partner.

The quality of the input produced by a skilled partner depends on his effort applied to multiple tasks. The effort for each task ranges from zero to some fixed maximum level, which is the same for all tasks.

The organizational form is chosen by the profit-maximizing principal. That principal can choose vertical integration and hire an agent to work as a manager. In this case the principal can observe a manager's effort on a fraction of tasks but pays the cost of inputs. The principal writes a contract that pays a non-negative wage, if the effort on observed tasks is acceptable, and a bonus, if the project is successful.

If the principal chooses outsourcing and turns to an arm's-length supplier then no effort is observed, but the costs are initially paid by the agent. In this case the principal writes a contract which specifies some fixed non-negative amount (which does not depend on the outcome of the project) and a bonus (which is paid only in case of success).

The model produces the sorting pattern, which predicts the profit-maximizing organizational form depending on the firm's productivity (revenue). As productivity increases, the effort level on all tasks that the principal finds optimal also goes up for both organizational forms. The tradeoff between input costs and effort observability determines the profit-maximizing organizational form.

The least and the most productive firms choose outsourcing, while the firms with intermediate levels of productivity prefer vertical integration.

In a case of low productivity and, therefore, low optimal effort level, the principal chooses outsourcing. This organizational form moves the input costs to the agent, making the agent's "stake" higher. If the principal chooses vertical integration, pays the costs, and gains little from observability, the agent does not compensate the principal for this, as negative wages are not allowed.

If a firm's productivity is very high and it is optimal to have the maximum level of effort on all tasks for both forms, then outsourcing is chosen. The agent's compensation is high enough to make the agent insensitive to paying the input costs. Therefore, the participation is assured in both organizational forms. For the principal the objective functions are identical except for the negative input cost component which appears in a case of vertical integration. Therefore, outsourcing is chosen because it provides higher profits.

However, for some firms with intermediate productivity levels, vertical integration may be optimal, if the observable fraction of tasks is relatively high. Vertical integration provides guaranteed effort level for a fraction of the tasks without bonus payment. At the same time, under outsourcing any positive effort level requires compensation. In this case the benefits from the observed fraction of the tasks may outweigh the fact that input costs are paid by the principal.

If the principal also chooses where to locate parts production (at home or abroad), the orga-

nizational choice of importers follows the pattern described above, i.e. least- and most-productive importing firms outsource, and intermediate-productivity importers choose vertical integration.

The effect of trade liberalization depends on the characteristics of the sorting pattern described above. If outsourcing is conducted mostly by high-productivity firms, then a fall in trade costs is predicted to favor vertical integration, but, if it is dominated by low-productivity firms than the change increases arm's-length trade.

In the model based on another approach, Antras and Helpman (2004) produce a series of predictions about the influence of different factors on the choice of organizational form. As in Antras (2003), the share of headquarters input in total costs plays a very important role. If it is below some cutoff value then firms always choose outsourcing. Another key variable is a firm's productivity. The model predicts that all importing firms with headquarters input intensity above the cutoff are divided into two groups: low-productivity importers outsource and high-productivity ones prefer vertical integration. This sorting pattern is different from the one in Grossman and Helpman (2004). Falling trade costs make importing profitable for more firms, but the relative effect on organizational forms is not clearly predicted, as in general it depends on firms' productivity distribution function.

In this model a firm produces a variety of goods in a particular sector, and faces the demand function generated by the constant elasticity of substitution (CES) preferences. Production requires two inputs; one of them, h, is made by the firm itself, and the second, m, is provided by a supplier. The production function is of the Cobb-Douglas type and employs two crucial parameters, productivity, θ, and headquarter input intensity, η.

$$q = \theta(\frac{h}{\eta})^{\eta}(\frac{m}{1-\eta})^{1-\eta}, 0 < \eta < 1 \tag{1}$$

The inputs are customized, and the intermediate input is required to be of high quality for the output of the final product to be positive. However, the quality of the intermediate input is not observable and is revealed only *ex post facto*. The process takes place in an incomplete-contracts environment, i.e., final-good producers and suppliers cannot sign enforceable contracts.

Headquarters chooses the organizational form, outsourcing or vertical integration. After both sides have made their investments, renegotiation determines how quasi-rents from the production are divided between the sides. In generalized Nash bargaining the headquarters side gets a fixed fraction of quasi-rents. At the same time the outside values depend on the chosen organizational form. In the case of outsourcing, outside values of both sides are defined as equal to zero. However, if vertical integration is chosen, then the headquarters can still force the production of intermediate input, and get some final good, but less then the full amount. The supplier still gets zero if bargaining breaks down under vertical integration. Therefore, in the end every side receives its

outside value plus its share of quasi-rents.

It follows that the shares and the size of revenue are determined by the choice of the organizational form. The headquarters faces the trade-off between the higher share and lower revenue in the case of vertical integration and a lower share and higher revenue if it chooses outsourcing.

The final fraction of revenue determines the degree of underinvestment by both sides. However, the overall importance of this effect for the production of a final good and therefore for the size of total revenue depends on headquarters intensity. If headquarters intensity is small, then a larger share is needed to motivate the supplier. If the opposite is true and the services provided by headquarters play a crucial role in production, then to reduce the underinvestment the firm must be given a larger share. This process may be seen as a particular case of the property-rights theory of the firm, where control rights are allocated to the producer of the final good.[2]

To incorporate heterogeneous productivity of the firms Antras and Helpman used the framework developed for exporting firms in Melitz (2003). The authors assumed that fixed costs for vertical integration are higher than for outsourcing, that is that managerial overload is more important than economies of scale. It follows that vertical integration becomes viable only if headquarters intensity is high enough and only for the most productive firms.

As trade costs fall more firms import, and more importers choose vertical integration, but the relative effect on the prevalence of organizational forms is ambiguous and depends on the productivity distribution function.

Overall, the models based on two alternative approaches produce the testable and, in some cases conflicting, predictions related to the influence of headquarters intensity, firms' productivity, and trade costs.

3 Data Sources

The new dataset used in this paper links production data for U.S.-based manufacturing firms with import transactions.

The production data for 1992-2006 comes from the Census of Manufactures (CM) and the Annual Survey of Manufactures (ASM) from the Longitudinal Research Database (LRD). The CM data form the sample in 1992, 1997, and 2002. For these years all domestic establishments in U.S. manufacturing are included, contributing 350,000-360,000 plant-level observations. The ASM data are used for all the other years between 1991 and 2006. In each of these years the sample consists of 50,000-60,000 plants.[3]

[2] See Grossman and Hart (1986).

[3] Some 10,000 plants are selected with certainty (including all plants with total employment above 250 workers),

The unified dataset contains annual plant information that includes total value of shipments, change in inventories, total employment, numbers of production and nonproduction workers, cost of materials, industry (4-digit SIC code and/or 6-digit NAICS code), etc. Due to missing data on capital stocks in the ASM, the capital series was constructed using data for capital from the CM, industry depreciation rates from the Bureau of Economic Analysis (BEA), and investment series available for all years.[4]

The data related to imports and organizational forms are taken from the U.S. Customs (1992-2006). These data include all shipments that entered the country during the given period. They contain information about value, product, quantity, relationship (intra-firm or arm's-length),[5]country of origin, the date, and transportation costs for every shipment. Transaction-level import data are aggregated for each firm according to relationship, country, and year.

Two data sets are linked at the level of the firm. The links between the data sets are made using the Employer Identification Number (EIN) where possible and using the business name information from the Census Bureau Business Register, also called Standard Statistical Establishment List (SSEL), when the EIN is not available (in particular, for imports from Canada).

4 Industries and Characteristics of Firms: Importing Status and Organizational Forms

This section provides information about the presence of imports and organizational forms of importers across industries in U. S. Manufacturing. Tables 1, 2, and 3 are based on the U.S. Census of Manufactures, 2002, which includes data for all manufacturing firms in the country.

The analysis of industries and importing firms shows that both outsourcing and vertical integration forms of imports are found in all industries. The data about distribution of all firms, importing firms and related-party importing firms between the 3-digit NAICS industries are summarized in Table 1. Column 1 shows the percent of all manufacturing firms in 3-digit NAICS industries. The numbers vary from 0.38 for Petroleum and Coal Products (324) to 18.62 for Fabricated Metal Products (332). These data demonstrate that U.S. manufacturing is not dominated by firms in one or several industries. Column 2 describes the distribution of importing firms across the same industries. Importing firms are present in all manufacturing industries. In general, the share of importing firms is close to the share of all manufacturing firms in a given industry. However, importing is

and more than 40,000 plants are selected with probability proportional to a composite measure of establishment size. See http://www.census.gov/ for details.

[4]See Appendix A.1 for details.

[5]According to Section 402(e) of the Tariff Act of 1930 the firms are defined as "related parties" if one of them owns, controls, or holds voting power equivalent to 6 percent of the outstanding voting stock or shares of the other organization.

less common in some industries. Wood Product Manufacturing (321) for example comprises 4.99 percent of all firms but only 1.76 percent of importing firms. At the same time, some industries are clearly "overrepresented" among importing firms. For example, Computer and Electronic Products (334) includes 4.77 percent of all firms and 11.89 percent of importers. An industry's share of firms that import using related parties in at least one country is shown in column 3. As was the case with importing, in most of the industries the percent of related-party importers is similar to the percent of all manufacturing firms. However, four industries stand out as relatively the most active in related-party importing: Machinery Manufacturing (333) with 8.37 percent of all firms and 16.08 percent of related-party importers; Computer and Electronic Products (334) with 4.77 percent and 14.48 percent respectively; Electrical Equipment, Appliance (335) with 1.87 percent and 5.24 percent; and Transportation Equipment (336) with 3.75 percent and 9.14 percent in the same groups. Overall, these industries have only 18.76 percent of manufacturing firms, but 44.94 percent of firms involved in related-party importing.

The relative number of importing firms is small and differs significantly across industries. The firms involved in related-party imports constitute a minority even among importers. Table 2 describes the relative intra-industry weight of importers and related-party importers. The percentage values in column 1 demonstrate that importing is a relatively scarce activity, as on average only about 12 percent of all manufacturing firms were involved in purchasing goods abroad in 2002. At the same time the level of importing activity by the firms varies dramatically between 2.4 percent for Printing and Related Support (323) to 33.15 percent for Leather and Allied Products (316). Among other industries strongly associated with imports are Computer and Electronic Products (334) with 29.8 percent of importers, as well as Electrical Equipment, Appliance (335) with 28.37 percent of involved firms. Column 2 shows the percent of firms which had positive related-party imports in every industry and in manufacturing in general. Overall, only 3.4 percent of all manufacturing firms were involved in intra-firm imports. In two industries, Wood Product Manufacturing (321) and Printing and Related Support (323), this share is below 1 percent. At the same time in Computer and Electronics (334) and Electrical Equipment, Appliance (335) approximately every tenth firm was importing using vertical integration. These numbers, showing that the share of vertically-integrated importers in one industry can be more than 20 times that in another one, demonstrate that industrial differences play a very important role in the choice of organizational form by importing firms. The share of related-party importers in the total number of an industry's importing firms is demonstrated in column 3. It shows that the firms that import using related parties are rare among importers in all industries, with the share for aggregate manufacturing equal to only 28.48 percent. However, even in the industry with the lowest presence of related-party importers the percent of such firms is 17.13, which underscores the importance of understanding the organizational forms of importing firms.

Manufacturing firms that import from an affiliate most of the time also purchase inputs from arm's-length suppliers in the same country. The positive share of related-party imports for a firm-country pair may vary between 0 and 1. Table 3 shows the results of a more focused look at organizational forms. All information about imports is aggregated at the level of firm-country pairs. Only firm-country pairs with positive related-party imports are left for the analysis, meaning that in every pair related-party importing was observed at least once in a given year. However, arm's-length importing was observed in most of the cases as well. Based on transaction-level data, the total value of imports for any firm-country pair for both organizational forms may be calculated and compared. Although in most of the theoretical models the importing firm that has a foreign affiliate is assumed to purchase all its imports through the related party, in reality importing firms demonstrate a more flexible approach. Column 1 demonstrates the percent of firm-country pairs with positive related-party imports in which value of related-party imports exceeds 25 percent of total value of the imports. This share for aggregate manufacturing is only 72 percent, which means that, in the remaining 28 percent of firm-country pairs the value of related-party imports is relatively minor. Column 2 exhibits the percent of pairs in which the value of related-party imports exceed that for arm's-length imports. In some industries, such as Textile Products Mills (314), Apparel Manufacturing (315), and Leather and Allied Products (316), this share is less than half, which means that in most of the firm-county pairs with related-party imports the value of imports comes mostly from unrelated suppliers. Finally, column 3 shows the percent of related-party firm-country pairs with only one organizational form, i.e. pure related-party pairs. In aggregate manufacturing this number is only 29 percent, meaning that in 71 percent of the pairs some kind of mixture of organizational forms is observed. Therefore, for firms involved in related-party importing, the analysis of the share of related imports in total imports from a given country becomes an important indicator of the prevalence of the organizational forms. One of the objectives of this paper is to analyze the effect of different factors on the share of related-party imports in mixed-form firm-country pairs.

Overall, importing firms that use different organizational forms are present in all industries of manufacturing. The share of importing firms is relatively small in each industry, and firms involved in related-party importing are rare even among other importers. In most of the cases manufacturing firms that import through a related party also purchase inputs in the same country using arm's-length suppliers.

5 Characteristics of Importing Firms and Choice of Organizational Forms

5.1 Headquarter Input Intensity

One of the key results initially produced in Antras (2003) and later developed in Antras and Helpman (2004) is related to the critical role of the headquarters input intensity parameter η for the choice of organizational form. Assuming that some other parameters are kept constant for all firms, the model predicts that there is a unique cutoff value $\widehat{\eta}$, such that the U.S. firm will outsource if its η is below this value and integrate only if it is above $\widehat{\eta}$. This theoretical result can be summarized the following way:

Hypothesis 1. *There exists a unique threshold $\widehat{\eta}$, such that all firms with $\eta<\widehat{\eta}$ choose to outsource, while integration takes place only if $\eta>\widehat{\eta}$.*

Previously, this relationship was estimated only with industry-level data. Antras (2003) employed data for 28 industries at 2-digit SIC level, and Nunn and Trefler (2008) used data for 370 industries at 4-digit SIC level.

In this study, the firm-level dataset for U.S manufacturing firms from 21 industries is linked with the transactions data on imports from 213 countries aggregated on an annual level. Only importing firms are included in the sample. Every observation represents a firm-country pair.

Import data provided by U.S. Customs contain the variable showing whether or not the transaction took place between related parties. Based on this variable it is possible to observe the presence of related-party imports in aggregated imports of firm-country pairs.

In general, Antras and Helpman (2004) allow for both a skill intensity and a capital intensity interpretation of headquarters input intensity. Variable IR_{ijc} is a dummy for related-party imports. It is equal to 1, if the firm i in industry j has related-party imports from a given country, c, during a particular year, t, and 0 otherwise. The following regression is estimated using conditional logit with country-industry-year groups:

$$IR_{ijct} = \gamma_{jct} + \gamma_{S/L} \ln S_i/L_i + \epsilon_{ijct} \tag{2}$$

where $\ln S_i/L_i$ is a log of skilled labor intensity, measured as the ratio of nonproduction hours of the firm to its total hours spent during the year. In a situation with many groups and few observations per group, estimating a non-linear probability model with fixed effects will produce inconsistent parameter estimates. At the same time, the conditional logit model estimates remain consistent if

the conditional likelihood function satisfies regularity conditions.[6]

The relationship is analyzed in detail for the three years for which information about all manufacturing firms is available (1992,1997, and 2002). The regression is estimated separately for these years as well as for the whole sample.

Estimates of equation (2) are presented in Table 4, Panel A. Columns 1-3 show the coefficients for separate years, while column 4 is based on all available data for 1992-2006. The results are consistent with industry-level estimates in Nunn and Trefler (2008). While Antras (2003) and Yeaple (2006) do not consider skill intensity, Nunn and Trefler (2008) include it. Using share of related imports in 4-digit SIC industries as a dependant variable, they find a positive and significant effect in all cases. Skilled labor intensity coefficients are significant at the 1% level for all separate years and for the whole sample. The effect is relatively stable across years.

The headquarters input intensity parameter in Antras and Helpman (2004) plays a role similar to that of capital intensity in Antras (2003). The following regression is estimated to capture this interaction:

$$IR_{ijct} = \gamma_{jct} + \gamma_{K/L} \ln K_i/L_i + \epsilon_{ijct} \tag{3}$$

where $\ln K_i/L_i$ is capital intensity measured as a log of the ratio of a firm's capital stock to its total hours.

The estimation results of equation (3) appear in Table 4, Panel B. As before, the method of estimation is conditional logit with country-industry-year groups. The effect of capital intensity is positive. All estimated coefficients for capital intensity are significant at the 1% level.

Finally, it is possible to interpret headquarters input intensity as an integrated parameter influenced by both capital intensity and skilled-labor intensity. The following equation is designed to study the simultaneous effect of these variables on the decision to integrate vertically.

$$IR_{ijct} = \gamma_{jct} + \gamma_{K/L} \ln K_i/L_i + \gamma_{S/L} \ln S_i/L_i + \epsilon_{ijct} \tag{4}$$

where all variables are defined as in equations (2) and (3).

Estimation results are presented in Table 4, Panel C. The method of estimation is conditional logit with country-industry-year groups. Coefficients for both variables are positive and significant at the 1% level in all cases. The magnitude of coefficients in the combined regression is smaller than in equations (2) and (3). This may be interpreted as the evidence of a higher amount of capital per unit of labor associated with a higher proportion of nonproduction labor.

[6] See Chamberlain (1980).

The same kind of analysis is repeated for a different dependent variable. SR_{ijc} is a share of related-party imports for firm i in industry j importing from a country c during a particular year t. Notice that IR_{ijc} and SR_{ijc} are identical if the firm purchases all imports from a given country through the related party every time it deals with the foreign affiliates. However, as Table 3 shows, this kind of behavior is observed in only 29 percent of the cases for aggregate manufacturing. The following equations are estimated using the ordinary least squares (OLS) method:

$$SR_{ijct} = \gamma_{S/L} \ln S_i/L_i + d_{jct} + \epsilon_{ijct} \tag{5}$$

$$SR_{ijct} = \gamma_{K/L} \ln K_i/L_i + d_{jct} + \epsilon_{ijct} \tag{6}$$

$$SR_{ijct} = \gamma_{S/L} \ln S_i/L_i + \gamma_{K/L} \ln K_i/L_i + d_{jct} + \epsilon_{ijct} \tag{7}$$

where d_{jct} is a set of industry-country-year dummy variables.

The results of equations (5), (6), and (7) are found in Table 5, Panels A, B, and C respectively. All coefficients are positive and significant, although smaller in magnitude compared with the similar results in equations (2), (3), and (4). One possible explanation for this difference is that skilled-labor intensity and capital intensity are less important for the relative trading volumes of firms which already import through related parties, and they are more influential for the decision to integrate at least one supplier in a given country. It may be also noted that the coefficients in equation (7) are almost identical to those in equations (5) and (6), demonstrating that the influence of any of the two explanatory variables is not strongly affected by the presence of another one.

However, the possibility of locating mostly those stages of production with lower capital intensity and skilled labor intensity abroad may lead to an endogeneity problem. Firms that choose this strategy will have higher capital and skilled labor intensity in the U.S. plants as a result. This possibility may produce biased coefficients in the estimated equations that employ capital and skilled labor intensity to explain the organizational decision.

It is possible that importing firms that are able to integrate will have higher measured productivity than non-integrating firms. This problem is likely to lead to a potential bias in the regressions that use productivity as a dependent variable. Although in the theoretical models the chosen organizational form does not have an effect on firm's productivity, more detailed empirical analysis is needed to address this potential problem.

Overall, the estimation results suggest that both skilled-labor intensity and capital intensity play a significant and positive role for the decision of an importing firm to choose vertical integration over

outsourcing as well as for the share of related-party imports. This is consistent with some industry-level findings in Antras (2003) and Yeaple (2006), as well as those in Nunn and Trefler (2008). Therefore, the tested hypothesis is strongly supported by the firm-level data for U.S manufacturing.

5.2 A Firm's Productivity

Another parameter which plays a crucial role in the theory of the choice of organizational form is a firm's productivity θ . According to the model of Antras and Helpman (2004) based on a property-rights approach, if headquarters input intensity is high enough, importing firms are divided into two groups. The firms whose productivity exceeds some cutoff value choose vertical integration, and the less productive ones outsource. Therefore, the sorting pattern predicted by the model may be described as following:

Hypothesis 2. *Given that* $\eta > \widehat{\eta}$ *, there is a unique productivity threshold* $\widehat{\theta}$ *such that importing firms outsource if* $\theta < \widehat{\theta}$ *and vertically integrate if* $\theta > \widehat{\theta}$ *.*

At the same time a different prediction about productivity and organizational forms is produced in Grossman and Helpman (2004). In this model, based on the role of managerial incentives, least-productive and most-productive importing firms outsource abroad while importers with intermediate-level productivity prefer vertical integration.

The theoretical result may be summarized as follows:

Hypothesis 2A. *Among importers, if vertical integration and outsourcing are present, least- and most-productive firms outsource, and moderately-productive firms integrate vertically.*

These hypotheses are tested using the unique dataset that contains linked production and import data for all manufacturing firms. Firms' productivity is estimated using the Olley-Pakes method (see Appendix, A2). Estimation is done on a plant level for all industries separately. The plant measures are aggregated on the firm level using shares in total value of shipments as weights.

In order to clarify the nature of the relationship between firms' productivity and their participation in related-party importing some preliminary analysis of the data is required.

Figure 1 shows the share of related-party pairs in the total number of importing firm-country pairs in groups of importers with different productivity levels.. All importing firms in the whole sample are ranked according to within-industry productivity (a firm's productivity minus an industry's mean productivity) and divided into ten equal groups. For every group the number of firm-country pairs with positive related-party imports is calculated. The resulting numbers are shown on the histogram. Given that the groups are of equal size, a higher share of observations with related-party imports indicate a higher level of participation in this form of importing. Overall,

a positive trend on the histogram is consistent with the idea that firms with higher productivity are more involved in related-party importing.

Preliminary analysis of the relationship between firms' productivity on one hand and the decision to integrate vertically and increase the share of related-party imports on the other is completed using nonparametric regression for the whole sample. The estimation is done by the LOESS method. Figure 2, Panel A demonstrates the estimated relationship between productivity and IR_{ijc}, the indicator variable for related-party imports. The effect of productivity on SR_{ijct} is shown on Figure 2, Panel B. In both cases the resulting curve has a positive slope for all productivity levels. Therefore, nonparametric analysis suggests that the most productive importers are more active in establishing the affiliates abroad and have a higher share of related-party imports compared with the importing firms that have a lower productivity.

In order to discriminate between the alternative theoretical predictions and analyze the role of an importer's productivity in general, the following equation is estimated:

$$IR_{ijct} = \gamma_{jct} + \gamma_P PROD_i + \epsilon_{ijct} \tag{8}$$

where $PROD_i$ is a firm's productivity measure.

The estimates are presented in Table 6, Panel A. The method of estimation is conditional logit with industry-country-year groups. The productivity of an importing firm is found to have a positive effect on the decision to integrate the foreign supplier. The productivity coefficients are significant at the 1% level for all time periods.

In order to separate the effect of productivity from that of other firms' characteristics several firm-level variables are added to the equation:

$$IR_{ijct} = \gamma_{jct} + \gamma_P PROD_i + \gamma_{K/L} \ln K/L_i + \gamma_{S/L} \ln S/L_i + \gamma_{TE} \ln TE_i + \epsilon_{ijct} \tag{9}$$

where $\ln TE_i$ is a measure of size (log of total employment).

The same method is used for the estimation of (8), and the results are demonstrated in Table 6, Panel B.

Productivity coefficients in (9) are still positive, significant at the 1% level, although somewhat smaller than in (8). Coefficients for skilled-labor intensity and capital intensity are also positive, significant at the 1% level.

Similar equations are estimated for the dependent variable that reflects relative involvement in related-party importing, SR_{ijc}. The method of estimation is OLS; industry-country-year dummy variables are added in both cases:

$$SR_{ijct} = \gamma_P PROD_i + d_{jct} + \epsilon_{ijct} \tag{10}$$

$$SR_{ijct} = \gamma_P PROD_i + \gamma_{K/L} \ln K/L_i + \gamma_{S/L} \ln S/L_i + \gamma_{TE} \ln TE_i + d_{jct} + \epsilon_{ijct} \tag{11}$$

The estimation results for (10) and (11) are demonstrated in Table 7, Panels A and B respectively. Productivity coefficients decrease in magnitude when additional variables are included but remain positive and significant at the 1% level. As before, all coefficients are smaller when the share of related-party imports is taken as a dependent variable.

In order to analyze to what degree the productivity estimation method is important for the analysis described above, firms' productivity is estimated on the same dataset using two alternative approaches, the Levinsohn-Petrin and the OLS methods. The estimation of equations (9) and (11) is done for both additional measures. The results for three productivity measures are demonstrated in Table 8, Panels A and B. The magnitude of coefficients and the significance levels for the additional measures are similar to that for the Olley-Pakes results. Productivity of an importing firm is found to be positively related to the decision to integrate vertically and the share of related-party imports. Both magnitude and significance of all estimated coefficients suggest that the choice of productivity estimation method does not play a crucial role for the analysis of the organizational forms of importers.

The model in Antras and Helpman (2004) predicts that the effect of firms' productivity on the choice of organizational form depends on the industry's headquarters intensity, which the firm takes as an exogenous parameter. In order to analyze the interaction between firm's productivity and industry's headquarters intensity, the following equations were estimated:

$$IR_{ijct} = \gamma_{ct} + \gamma_P PROD_i + \gamma_{PSL} PROD\_SL + \gamma_{SL} S_j/L_j + \epsilon_{ijct} \tag{12}$$

$$IR_{ijct} = \gamma_{ct} + \gamma_P PROD_i + \gamma_{PKL} PROD\_KL + \gamma_{KL} K_j/L_j + \epsilon_{ijct} \tag{13}$$

The method of estimation is conditional logit with country-year groups. The estimated coefficients, γ_{PSL} and γ_{PKL}, are shown in Table 9, Panels A and B respectively. All estimates are positive and significant at the 1% level.

Similar analysis is done for the share of related-party imports. The following equations are estimated using the OLS method:

$$SR_{ijct} = \gamma_P PROD_i + \gamma_{PSL} PROD\_SL + \gamma_{SL} S_j/L_j + d_{ct} + \epsilon_{ijct} \tag{14}$$

$$SR_{ijct} = \gamma_P PROD_i + \gamma_{PKL} PROD\_KL + \gamma_{KL} K_j/L_j + d_{ct} + \epsilon_{ijct} \quad (15)$$

where d_{ct} is a set of country-year dummy variables. Estimation results for γ_{PSL} and γ_{PKL} are reported in Table 10, Panels A and B respectively. The coefficients are positive and significant at the 1% level, but much smaller in magnitude than their analogs in equations (12) and (13).

The productivity sorting pattern of importing firms in Antras and Helpman (2004) is different from that produced in Grossman and Helpman (2004). For importers as a separate group, Grossman and Helpman (2004) predict that the most productive firms choose outsourcing, while the same firms prefer vertical integration according to the Antras and Helpman (2004) model. To differentiate between alternative predictions the more detailed analysis is required.

The productivity-ranked groups similar to those described above (see Figures 1 and 2) are used for more accurate estimation. Firms are ranked according to productivity and divided into ten equal groups. Deciles are indexed by k, k=1,...,10, where k=10 denotes the most productive group. The indicator variable I_{ik} is equal to 1 if firm i belongs to group k; otherwise I_{ik}=0. In order to estimate the effect of productivity on the decision to purchase a foreign supplier for different groups the following equation is estimated using conditional logit with country-industry-year groups:

$$IR_{ijct} = \gamma_{jct} + \sum_{k=1}^{10} \gamma_k I_{ik} + \sum_{n=1}^{10} \gamma_{pk} PROD_i I_{ik} + \epsilon_{ijct} \quad (16)$$

The results are presented in Table 11. The estimated coefficients γ_{pk} are positive and steadily increase with the group rank. The highest coefficients are found for the deciles with the most productive firms. Although the coefficient for I_2 is not significant at the 10% level, all other coefficients are significant at the 1% level. These results support the prediction that most productive firms are more likely to invest in a foreign country and get involved in related-party importing.

The effect of firms' productivity on the share of related-party imports is estimated using similar approach:

$$SR_{ijct} = \gamma_{jct} + \sum_{k=1}^{10} \gamma_k I_{ik} + \sum_{n=1}^{10} \gamma_{pk} PROD_i I_{ik} + d_{jct} + \epsilon_{ijct} \quad (17)$$

The OLS method is applied to equation (17). The results for γ_{pk} are demonstrated in Table 12. As was the case with equation (16), the coefficients increase with the group rank. The coefficients for the least-productive groups indicators, namely I_2 and I_3, are small and not significant at the 10% level. However, all other coefficients are significant at the 1% level.

One of the issues related to estimating the effect of productivity on the choice of organiza-

tional forms is a potential endogeneity problem. It is possible that importing firms that are able to integrate will have higher measured productivity than non-integrating firms. This problem is likely to lead to a potential bias in the regressions that use productivity as a dependent variable. Although in the theoretical models the chosen organizational form does not have an effect on firm's productivity, more detailed empirical analysis is needed to address this potential problem.

Overall, the estimation results support the sorting pattern predicted in Antras and Helpman (2004) as opposed to that produced in Grossman and Helpman (2004). The most productive importing firms are more likely to purchase a foreign supplier and have a higher share of related-party imports compared with other related-party importers.

Overall, the estimation results support the predictions of Antras and Helpman (2004) related to the effect of productivity level of importing firms on the relative prevalence of vertical integration. Productivity is found to be a significant variable that has a strong positive influence on importers' choice of vertical integration over outsourcing and their share of related-party imports. The positive effect of the interaction of firms' productivity and industry measures of headquarter intensity is also consistent with property-rights approach. The sorting pattern of firms based on productivity was shown to be similar to the result in Antras and Helpman (2004), representing the property rights approach, as opposed to that in Grossman and Helpman (2004), which is based on the role of managerial incentives.

5.3 Trade Costs

Empirical results show that trade costs affect the choice of an importer's organizational form and have a negative effect on both the decision to integrate the supplier and the share of related-party imports for firms in U.S. manufacturing.

According to both Antras and Helpman (2004) and Grossman and Helpman (2004) a decrease in variable costs may lead to the relative growth of vertical integration or outsourcing, depending on other parameters.

In Antras and Helpman (2004) the effect of the change in variable costs depends on the productivity distribution of the firms. In this model all variable costs associated with imports are described by the wage parameter, and the change in trade costs is seen by the authors as similar to the change in wages. If variable costs decrease more firms get involved in importing inputs as the cutoff productivity value that separates non-trading firms from importers goes down. At the same time more firms find it optimal to integrate, as the cutoff value that divides importers into two groups decreases.[7] However, the effect on the relative share of integrated firms among im-

[7] Feenstra and Hanson (1996) show that a decrease in transportation costs leads to an increase in foreign assembly both for related-party firms and for those at arm's length.

porters depends on the productivity distribution. In particular, Antras and Helpman (2004) show that if productivity is described by a Pareto distribution, lowering the wage rate abroad leads to a disproportional change in foreign outsourcing relative to FDI. Therefore, under this condition the decrease in variable costs is predicted to drive down the share of integrated firms among importers.

In Grossman and Helpman (2004) the effect of trade costs depends on the relative productivity of outsourcing importers in the industry. In industries where outsourcing is conducted mostly by high-productivity firms trade liberalization favors related-party importing. However, if outsourcing is dominated by low-productivity firms, then lower trade costs lead to relative growth of arm's-length importing.

Estimation results based on the production-imports dataset suggest that trade costs have a negative effect on an importing firm's decision to purchase a foreign supplier. For empirical analysis trade costs are proxied by transportation costs for all firm-country pairs. In the U.S. Customs dataset the value of transportation costs is reported for every transaction. Aggregation provides total transportation costs for each firm-country observation. The following equation is used to evaluate the effect of trade costs for separate years and for the whole sample:

$$IR_{ijct} = \gamma_{jct} + \gamma_{TR} \ln TR_i + \epsilon_{ijct} \tag{18}$$

where $\ln TR_i$ is a measure of transportation costs (log of transportation costs/total value of imports). The method of estimation is conditional logit with industry-country-year groups. The esimation results are shown in Table 13, Panel A. The coefficients are negative and significant at the 1% level.

The same equation is estimated with various combinations of control variables:

$$IR_{ijct} = \gamma_{jct} + \gamma_{TR} \ln TR_i + Z_i + \epsilon_{ijct} \tag{19}$$

where Z_i is a set of firm-related control variables. The method of estimation is the same as for equation (18). The results are displayed in Table 13, Panel B. In all cases the estimate of γ_{TR} remains negative and significant at the 1% level. Therefore, the results for all specifications demonstrate the negative and relatively stable effect of trade costs on an importer's integration decision.

The share of related-party imports of the importing firms that have an affiliate in a given country is negatively affected by trade costs. The equations similar to (15) and (16) are estimated for this dependent variable:

$$SR_{ijct} = \gamma_{TR} \ln TR_i + d_{jct} + \epsilon_{ijct} \tag{20}$$

$$SR_{ijct} = \gamma_{TR} \ln TR_i + Z_i + d_{jct} + \epsilon_{ijct} \tag{21}$$

The results are shown in Table 14, Panels A and B respectively. The coefficients are negative and significant at the 1% level but smaller in terms of economic magnitude. The results change only slightly as firm-related control variables are added to the original equation.

Overall, negative effect of trade costs is stable both for the decision to invest abroad and for the share of related-party imports for the sample that includes all firms in U.S. manufacturing. This finding is consistent with some predictions of Antras and Helpman (2004) as opposed to the results in Grossman and Helpman (2004).

6 Conclusion

The decision of importers to choose vertical integration or outsourcing as an organizational form depends on many factors. Previous empirical work addressing the organizational forms of importing firms was based on product, industry, or exporting country data.

In this paper the unique firm-level dataset is used to test the theoretical results produced by the models based on the role of property rights and managerial incentives. The focus of the analysis is an importing firm's characteristics and contracting environment, determined by industry and country.

In general, the estimation results are consistent with the predictions of the models based on the property-rights approach. The demonstrated significance of capital intensity and skilled-labor intensity for the decision to vertically integrate can be seen as empirical evidence of the importance of headquarters intensity for determining the boundaries of the firm as described in Antras (2003). The estimated relationship between the importing firm's productivity and its choice of organizational form support the conclusions of Antras and Helpman (2004) as opposed to that of Grossman and Helpman (2004). Moreover, the growth of trade costs is found to have a negative association with the integration decision of importers, leading to the conclusion about the positive effect of trade liberalization on the FDI. Overall, the empirical results, based on the firm-level data for importers in U.S. manufacturing, support the property-rights approach to the choice of organizational form and provide the ground for further analysis of the boundaries of multinational firms.

The possible venues for further analysis of importing firms' organizational forms may include a study that addresses at the same time the characteristics of products, importing firms, and industries on one hand and the exporting country or, possibly, the exporting firm on the other hand. The empirical work which is based on the firm-level data both for the importing and the

exporting sides is expected to produce new results that improve the understanding of organizational forms of trading firms.

Data Appendix

A1.Plant Capital Stocks

The plant capital stock for the years covered by the ASM is recovered using the method proposed in Bernard and Jensen (1999).

Time period: 1991

$$K_{i,1991} = \frac{1}{1-\delta}(K_{i1992} - INV_{i,1991})$$

Time period: 1993-1996

$$\overrightarrow{K}_{i,1992+m} = (1-\delta)^m K_{i1992} + \sum_{s=1}^{m}(1-\delta)^{s-1} INV_{i,1992+s}$$

$$\overleftarrow{K}_{i,1997-j} = (\frac{1}{1-\delta})^j K_{i1997} - \sum_{s=1}^{j}(\frac{1}{1-\delta})^{j-s+1} INV_{i,1997-s}$$

Time period:1998-2001

$$\overrightarrow{K}_{i,1997+m} = (1-\delta)^m K_{i1997} + \sum_{s=1}^{m}(1-\delta)^{s-1} INV_{i,1997+s}$$

$$\overleftarrow{K}_{i,2002-j} = (\frac{1}{1-\delta})^j K_{i2002} - \sum_{s=1}^{j}(\frac{1}{1-\delta})^{j-s+1} INV_{i,2002-s}$$

Time period: 2003-2006

$$K_{i,2002+m} = (1-\delta)^m K_{i2002} + \sum_{s=1}^{m}(1-\delta)^{s-1} INV_{i,2002+s}$$

For periods 1993-1996 and 1998-2001 If both $\overleftarrow{K}_{i,t}$ and $\overrightarrow{K}_{i,t}$ exist, then $\overleftrightarrow{K}_{i,t} = \frac{1}{2}(\overleftarrow{K}_{i,t} + \overrightarrow{K}_{i,t})$, otherwise $\overleftrightarrow{K}_{i,t} = \max(\overleftarrow{K}_{i,t}, \overrightarrow{K}_{i,t})$.

A2. Productivity Estimation

Olley-Pakes method.

Based on Ericson and Pakes (1995) and Olley and Pakes (1996), we can construct the measure of plant productivity using a semi-parametric series estimator.

It is assumed that an industry produces a homogeneous product with Cobb-Douglas technology, using capital, labor and materials. The production function is

$$y_{it} = \beta_0 + \beta_a a_{it} + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + p_{it} + \eta_{it}$$

where y_{it} is a log of the value of real production, l_{it} is a log of labor inputs, k_{it} is a log of capital stock, a_{it} is the age of the firm, m_{it} is a log of material inputs, p_{it} is its productivity and η_{it} is a measurement error.

Productivity is a sum of two components, $p_{it}+ \eta_{it}$, where p_{it} is assumed to be known to the firm at date t and is first-order Markov, and η_{it} is assumed to be unknown.

Capital accumulates according to

$$k_{t+1} = (1 - \delta)k_t + i_t$$

where δ is a depreciation rate and i_t is investment.

The investment decision can be written as

$$i_t = i(p_t, a_t, k_t)$$

Pakes (1994) shows that under some conditions productivity can be described as a function of investment, age, and capital,

$$p_t = h_t(i_t, a_t, k_t)$$

Substituting (7) into (4) provides the estimates of the coefficients, $\widehat{\beta}_l$ and $\widehat{\beta}_m$, on the variable parameters with the semi-parametric estimator,

$$y_{it} = \beta_l l_{it} + \beta_m m_{it} + \varphi_t(i_{it}, a_{it}, k_{it}) + \eta_{it}$$

where

$$\varphi_t(i_{it}, a_{it}, k_{it}) = \beta_0 + \beta_a a_{it} + \beta_k k_{it} + h_t(i_{it}, a_{it}, k_{it})$$

is a fourth order polynomial series estimator in investment, capital, and age.

We can estimate the probability of shutdown, Pr_{it}, for each plant and year in a probit,

$$Pr_{it} = \xi_{it}(i_{it}, a_{it}, k_{it})$$

A nonlinear, semi-parametric series estimator is then used to generate consistent coefficient on capital,

$$y_{it+1} - \widehat{\beta}_l l_{it+1} - \widehat{\beta}_m m_{it+1} = \widehat{\beta}_0 + \widehat{\beta}_a a_{it+1} + \widehat{\beta}_k k_{it+1} + g(Pr_{it}, \varphi_t(i_{it}, a_{it}, k_{it}) - \widehat{\beta}_a a_{it} - \widehat{\beta}_k k_{it}) + p_{it+1} + \eta_{it+1}$$

Finally, we can construct the measure of plant productivity:

$$p_{it} = y_{it} - \widehat{\beta}_l l_{it} - \widehat{\beta}_m m_{it} - \widehat{\beta}_a a_{it} - \widehat{\beta}_k k_{it}$$

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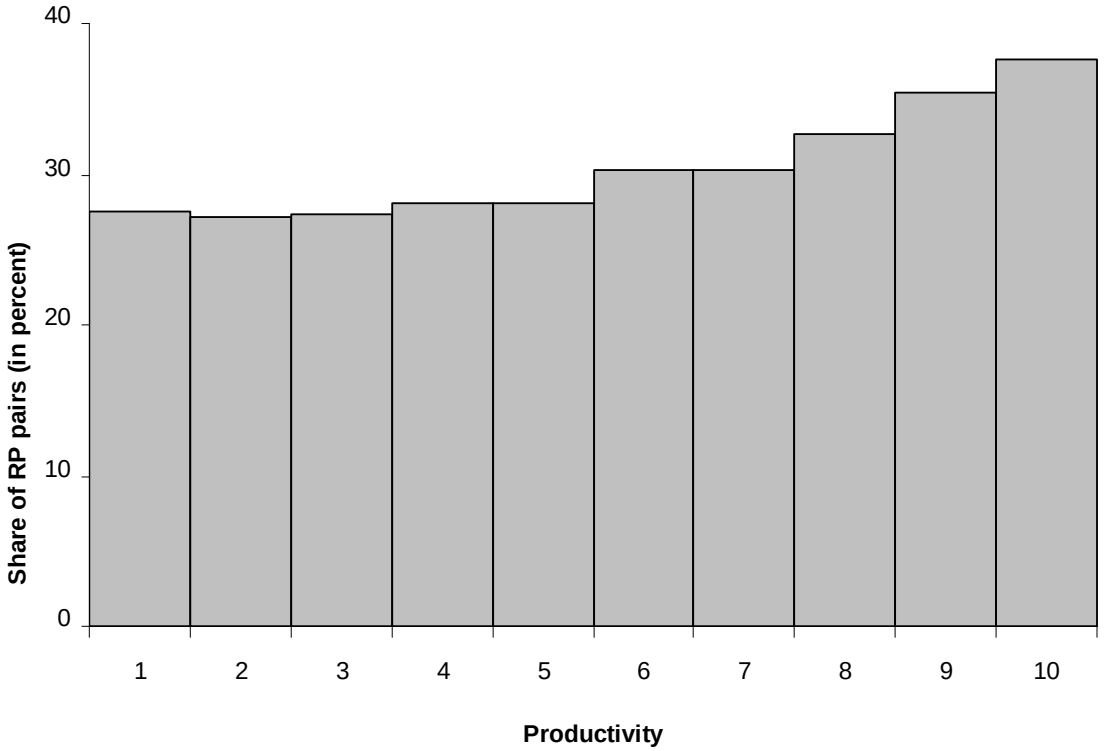
Figure 1

Share of firm-country pairs with related-party imports in productivity-ranked groups of firms, 1992-2006



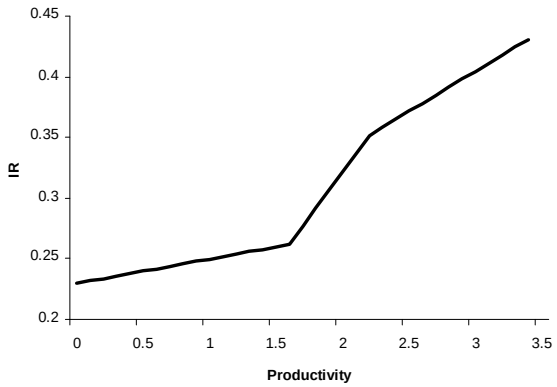
Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: Firms are ranked according to within-industry demeaned productivity and divided into ten equal groups. The share is calculated as a ratio of the number of firm-country pairs with related-party imports to the total number of firm-country importing pairs in each group.

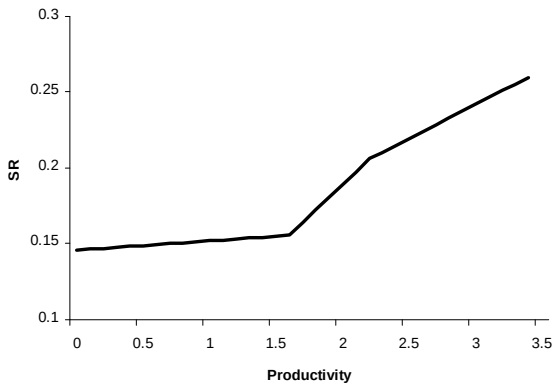
Figure 2

Organizational forms and share of related-party imports: nonparametric regressions on productivity, 1992-2006

Panel A



Panel B



Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs

Notes: The dependent variable for Panel A is IR_{ijc}, indicator variable for related-party imports. The dependent variable for Panel B is SR_{ijc}, share of related-party imports. Firm-country pair is the unit of observation. The nonparametric regressions are estimated using the LOESS method.

Table 1

Organizational Forms of Importing Firms in U.S. Manufacturing, 2002

NAICS industry	Percent of all firms	Percent of importers	Percent of RP importers
311 Food Manufacturing	7.60	5.11	3.42
312 Beverage and Tobacco Products	0.87	0.75	0.65
313 Textile Mills	1.04	2.02	1.70
314 Textile Product Mills	2.04	1.84	1.34
315 Apparel Manufacturing	3.06	4.37	2.82
316 Leather and Allied Products	0.39	1.07	0.64
321 Wood Product Manufacturing	4.99	1.76	1.21
322 Paper Manufacturing	1.22	1.59	1.48
323 Printing and Related Support	11.45	2.30	1.45
324 Petroleum and Coal Products	0.38	0.37	0.54
325 Chemical Manufacturing	3.38	6.64	8.59
326 Plastics and Rubber Products	4.17	6.61	6.89
327 Nonmetallic Mineral Products	3.94	3.14	2.24
331 Primary Metal Manufacturing	1.38	2.02	2.26
332 Fabricated Metal Products	18.62	10.38	8.72
333 Machinery Manufacturing	8.37	13.31	16.08
334 Computer and Electronic Products	4.77	11.89	14.48
335 Electrical Equipment, Appliance	1.87	4.43	5.24
336 Transportation Equipment	3.75	6.47	9.14
337 Furniture and Related Products	6.82	3.47	2.19
339 Miscellaneous Manufacturing	9.89	10.50	8.95
Aggregate Manufacturing	100	100	100

Sources: U.S. Census of Manufactures and U.S Customs.

Notes: Column 1 demonstrates the distribution of manufacturing firms across 3-digit NAICS industries. Columns 2 and 3 report the percent of firms in each industry that import and import using related parties respectively.

Table 2

Organizational Forms of Importing Firms in Industries of U.S. Manufacturing, 2002

NAICS industry	Percent of importers in industry	Percent of RP importers in industry	Percent of RP importers among importers
311 Food Manufacturing	7.98	1.53	19.19
312 Beverage and Tobacco Products	10.33	2.56	24.80
313 Textile Mills	23.35	5.60	24.01
314 Textile Product Mills	10.77	2.23	20.72
315 Apparel Manufacturing	17.07	3.14	18.37
316 Leather and Allied Products	33.15	5.68	17.13
321 Wood Product Manufacturing	4.23	0.83	19.52
322 Paper Manufacturing	15.62	4.15	26.60
323 Printing and Related Support	2.40	0.43	17.97
324 Petroleum and Coal Products	11.47	4.79	41.80
325 Chemical Manufacturing	23.53	8.67	36.83
326 Plastics and Rubber Products	18.99	5.63	29.65
327 Nonmetallic Mineral Products	9.55	1.94	20.31
331 Primary Metal Manufacturing	17.53	5.58	31.80
332 Fabricated Metal Products	6.67	1.59	23.92
333 Machinery Manufacturing	19.02	6.55	34.42
334 Computer and Electronic Products	29.80	10.34	34.69
335 Electrical Equipment, Appliance	28.37	9.54	33.63
336 Transportation Equipment	20.66	8.31	40.21
337 Furniture and Related Products	6.09	1.09	17.95
339 Miscellaneous Manufacturing	12.71	3.08	24.27
Aggregate Manufacturing	11.97	3.41	28.48

Sources: U.S. Census of Manufactures and U.S Customs.

Notes: Column 1 and column 2 demonstrate the percent of all importing firms and the percent of the RP importing firms respectively in each 3-digit NAICS industry. Column 3 reports the percent of the RP importing firms among all importing firms of the industry.

Table 3

Distribution of firm-country pairs with related-party trade in U.S. Manufacturing, 2002

NAICS industry	RP imports over 25% of imports value	RP imports over 50% of imports value	RP imports only
311 Food Manufacturing	0.68	0.57	0.24
312 Beverage and Tobacco Products	0.71	0.59	0.27
313 Textile Mills	0.64	0.50	0.29
314 Textile Product Mills	0.57	0.46	0.22
315 Apparel Manufacturing	0.59	0.47	0.23
316 Leather and Allied Products	0.55	0.44	0.27
321 Wood Product Manufacturing	0.59	0.47	0.25
322 Paper Manufacturing	0.69	0.58	0.28
323 Printing and Related Support	0.69	0.58	0.29
324 Petroleum and Coal Products	0.70	0.54	0.18
325 Chemical Manufacturing	0.79	0.69	0.33
326 Plastics and Rubber Products	0.73	0.63	0.29
327 Nonmetallic Mineral Products	0.71	0.61	0.26
331 Primary Metal Manufacturing	0.78	0.66	0.29
332 Fabricated Metal Products	0.72	0.61	0.29
333 Machinery Manufacturing	0.76	0.65	0.31
334 Computer and Electronic Products	0.75	0.63	0.29
335 Electrical Equipment, Appliance	0.74	0.64	0.29
336 Transportation Equipment	0.67	0.55	0.23
337 Furniture and Related Products	0.57	0.50	0.25
339 Miscellaneous Manufacturing	0.68	0.58	0.29
Aggregate Manufacturing	0.72	0.61	0.29

Sources: U.S. Census of Manufactures and U.S Customs.

Notes: Column1 shows the share of related-party firm-country pairs where the value of related-party imports exceeds 25% of total imports value in each 3-digit NAICS industry. Column 2 demonstrates the share of related-party firm-country pairs where the value of related-party imports exceeds 50% of total imports value. Column 3 reports the share of related-party firm-country pairs with related-party imports only.

Table 4

Conditional logit. The determinants of the organizational form for importing firms: skilled labor intensity and capital intensity

Panel A

	1992	1997	2002	1992-2006
ln S/L	0.246**	0.204**	0.253**	0.249**
	(0.032)	(0.029)	(0.029)	(0.024)
N	78,138	103,226	114,011	970,986

Panel B

	1992	1997	2002	1992-2006
ln K/L	0.482**	0.451**	0.478**	0.411**
	(0.008)	(0.008)	(0.007)	(0.002)
N	78,138	103,226	114,011	970,986

Panel C

	1992	1997	2002	1992-2006
ln S/L	0.191**	0.194**	0.269**	0.241**
	(0.032)	(0.030)	(0.029)	(0.024)
ln K/L	0.467**	0.439**	0.464**	0.391**
	(0.019)	(0.017)	(0.016)	(0.012)
N	78,138	103,226	114,011	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is IR_{ijc}, indicator variable for related-party imports. Firm-country pair is the unit of observation. The method of estimation is conditional logit with country-industry-year groups. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 5

OLS. The determinants of share of related-party imports: skilled labor intensity and capital intensity

Panel A

	1992	1997	2002	1992-2006
ln S/L	0.009**	0.008**	0.012**	0.010**
	(0.004)	(0.003)	(0.003)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.06	0.05	0.06	0.06
N	78,138	103,226	114,011	970,986

Panel B

	1992	1997	2002	1992-2006
ln K/L	0.054**	0.054**	0.055**	0.056**
	(0.003)	(0.003)	(0.002)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.07	0.07	0.08	0.08
N	78,138	103,226	114,011	970,986

Panel C

	1992	1997	2002	1992-2006
ln S/L	0.006**	0.007**	0.013**	0.008**
	(0.003)	(0.003)	(0.002)	(0.001)
ln K/L	0.054**	0.055**	0.056**	0.057**
	(0.002)	(0.002)	(0.001)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.08	0.07	0.08	0.08
N	78,138	103,226	114,011	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is SR_{ijc}, share of related-party imports. Firm-country pair is the unit of observation. The method of estimation is OLS. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 6

Conditional logit. The determinants of the organizational form for importing firms: productivity

Panel A

	1992	1997	2002	1992-2006
PROD	0.349**	0.597**	0.432**	0.511**
	(0.054)	(0.055)	(0.052)	(0.036)
N	78,138	103,226	114,011	970,986

Panel B

	1992	1997	2002	1992-2006
PROD	0.270**	0.376**	0.219**	0.375**
	(0.028)	(0.024)	(0.022)	(0.007)
ln S/L	0.277**	0.239**	0.309**	0.268**
	(0.016)	(0.013)	(0.012)	(0.004)
ln K/L	0.310**	0.309**	0.323**	0.302**
	(0.009)	(0.008)	(0.008)	(0.002)
ln TE	0.273**	0.312**	0.321**	0.312**
	(0.006)	(0.005)	(0.005)	(0.002)
N	78,138	103,226	114,011	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is IR_{ijc}, indicator variable for related-party imports. Firm-country pair is the unit of observation. The method of estimation is conditional logit with country-industry-year groups. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 7

OLS. The determinants of share of related-party imports: productivity

Panel A

	1992	1997	2002	1992-2006
PROD	0.026**	0.065**	0.040**	0.048**
	(0.008)	(0.007)	(0.007)	(0.003)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.06	0.05	0.06	0.06
N	78,138	103,226	114,011	970,986

Panel B

	1992	1997	2002	1992-2006
PROD	0.015**	0.041**	0.015**	0.028**
	(0.008)	(0.008)	(0.008)	(0.003)
ln S/L	0.013**	0.011**	0.017**	0.012**
	(0.003)	(0.003)	(0.002)	(0.001)
ln K/L	0.040**	0.042**	0.043**	0.045**
	(0.003)	(0.003)	(0.002)	(0.001)
ln TE	0.018**	0.020**	0.022**	0.021**
	(0.001)	(0.001)	(0.001)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.09	0.08	0.10	0.09
N	78,138	103,226	114,011	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is SR_{ijc}, share of related-party imports. Firm-country pair is the unit of observation. The method of estimation is OLS. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 8

Alternative measures of productivity, 1992-2006

Panel A

	Olley-Pakes	Levinsohn-Petrin	OLS
PROD	0.375**	0.373**	0.360**
	(0.007)	(0.007)	(0.007)
ln S/L	0.268**	0.271**	0.274**
	(0.004)	(0.004)	(0.004)
ln K/L	0.302**	0.301**	0.299**
	(0.002)	(0.002)	(0.002)
ln TE	0.312**	0.313**	0.316**
	(0.002)	(0.002)	(0.002)
N	970,986	970,986	970,986

Panel B

	Olley-Pakes	Levinsohn-Petrin	OLS
PROD	0.028**	0.029**	0.030**
	(0.003)	(0.003)	(0.003)
ln S/L	0.045**	0.045**	0.045**
	(0.001)	(0.001)	(0.001)
ln K/L	0.012**	0.012**	0.012**
	(0.001)	(0.001)	(0.001)
ln TE	0.021**	0.021**	0.022**
	(0.001)	(0.001)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes
R^2	0.09	0.09	0.09
N	970,986	970,986	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable for Panel A is IR_{ijc}, indicator variable for related-party imports. The dependent variable for Panel B is SR_{ijc}, share of related-party imports. Firm-country pair is the unit of observation. The method of estimation is conditional logit with industry groups for Panel A, and OLS for Panel B. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 9

Logit. The determinants of the organizational form for importing firms: interaction of productivity with capital intensity and skilled labor intensity

Panel A

	1992	1997	2002	1992-2006
PROD	0.094	0.074	0.240*	0.195**
	(0.127)	(0.110)	(0.101)	(0.042)
PROD_SL	1.141**	1.676**	1.584**	0.638**
	(0.408)	(0.376)	(0.325)	(0.237)
S/L	0.611	0.630	0.525	1.536**
	(0.785)	(0.678)	(0.608)	(0.185)
Country FE	Yes	Yes	Yes	Yes
Year FE				Yes
N	78,138	103,226	114,011	970,986

Panel B

	1992	1997	2002	1992-2006
PROD	0.290**	0.253**	0.017	0.235**
	(0.101)	(0.078)	(0.076)	(0.054)
PROD_KL	2.065**	2.212**	1.838**	1.426**
	(0.595)	(0.545)	(0.355)	(0.325)
K/L	-3.290**	-3.298**	-2.350**	-2.095**
	(0.595)	(0.982)	(0.062)	(0.583)
Country FE	Yes	Yes	Yes	Yes
Year FE				Yes
N	78,138	103,226	114,011	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Note: The dependent variable is IR_{ijc}, indicator variable for related-party imports. Firm-country pair is the unit of observation. The method of estimation is logit. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 10

OLS. The determinants of share of related-party imports: interaction of productivity with capital intensity and skilled labor intensity

Panel A

	1992	1997	2002	1992-2006
PROD	0.024	0.203**	0.022	0.062**
	(0.032)	(0.027)	(0.026)	(0.009)
PROD_SL	0.084**	0.187**	0.121**	0.062**
	(0.058)	(0.055)	(0.052)	(0.021)
S/L	0.405**	0.045	0.304**	0.262**
	(0.179)	(0.099)	(0.072)	(0.042)
Country FE	Yes	Yes	Yes	Yes
Year FE				Yes
R^2	0.05	0.04	0.05	0.05
N	78,138	103,226	114,011	970,986

Panel B

	1992	1997	2002	1992-2006
PROD	0.008	0.055**	0.031*	0.052**
	(0.032)	(0.029)	(0.025)	(0.009)
PROD_KL	0.281**	0.171**	0.139**	0.171**
	(0.089)	(0.073)	(0.055)	(0.022)
K/L	-0.647**	-0.199**	-0.092**	-0.180**
	(0.172)	(0.098)	(0.072)	(0.042)
Country FE	Yes	Yes	Yes	Yes
Year FE				Yes
R^2	0.04	0.03	0.04	0.03
N	78,138	103,226	114,011	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is SR_{ijc}, share of related-party imports. Firm-country pair is the unit of observation. The method of estimation is OLS. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 11

Conditional logit. The determinants of the organizational form for importing firms: productivity-ranked groups

	1992-2006
I_2	0.013
	(0.013)
I_3	0.042**
	(0.013)
I_4	0.095**
	(0.013)
I_5	0.128**
	(0.013)
I_6	0.166**
	(0.013)
I_7	0.206**
	(0.013)
I_8	0.258**
	(0.013)
I_9	0.397**
	(0.013)
I_{10}	0.491**
	(0.013)
Country FE	Yes
Year FE	Yes
N	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable for Panel A is IR_{ijc}, indicator variable for related-party imports. Firms are ranked according to productivity and divided into ten equal groups. I_k is a group dummy variable; k increases with productivity. Firm-country pair is the unit of observation. The method of estimation is conditional logit with industry groups. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 12

OLS. The determinants of share of related-party imports: productivity-ranked groups

	1992-2006
I_2	0.001
	(0.002)
I_3	0.001
	(0.002)
I_4	0.005**
	(0.002)
I_5	0.005**
	(0.002)
I_6	0.011**
	(0.002)
I_7	0.014**
	(0.002)
I_8	0.017**
	(0.002)
I_9	0.035**
	(0.002)
I_{10}	0.049**
	(0.002)
Country FE	Yes
Year FE	Yes
R^2	0.06
N	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is SR_{ijc}, share of related-party imports. Firms are ranked according to productivity and divided into ten equal groups. I_k is a group dummy variable; k increases with productivity. Firm-country pair is the unit of observation. The method of estimation is OLS. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 13

Conditional logit. The determinants of the organizational form for importing firms: transportation costs

Panel A

	1992	1997	2002	1992-2006
ln TR	-0.234**	-0.183**	-0.140**	-0.149**
	(0.010)	(0.009)	(0.008)	(0.006)
N	78,138	103,226	114,011	970,986

Panel B

	1992-2006	1992-2006	1992-2006	1992-2006
ln TR	-0.140**	-0.138**	-0.124**	-0.105**
	(0.006)	(0.006)	(0.006)	(0.002)
PROD	0.466**			0.354**
	(0.035)			(0.008)
ln S/L		0.205**		0.261**
		(0.022)		(0.005)
ln K/L		0.391**		0.293**
		(0.012)		(0.003)
ln TE			0.294**	0.275**
			(0.010)	(0.003)
N	970,986	970,986	970,986	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is IR_{ijc}, indicator variable for related-party imports. Firm-country pair is the unit of observation. The method of estimation is conditional logit with country-industry-year groups. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.

Table 14

OLS. The determinants of share of related-party imports: transportation costs

Panel A

	1992	1997	2002	1992-2006
ln TR	-0.028**	-0.022**	-0.020**	-0.021**
	(0.003)	(0.002)	(0.002)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.06	0.07	0.07	0.06
N	78,138	103,226	114,011	970,986

Panel B

	1992-2006	1992-2006	1992-2006	1992-2006
ln TR	-0.020**	-0.020**	-0.019**	-0.018**
	(0.001)	(0.001)	(0.001)	(0.001)
PROD	0.043**			0.024**
	(0.003)			(0.003)
ln S/L		0.006**		0.010**
		(0.001)		(0.001)
ln K/L		0.056**		0.045**
		(0.001)		(0.001)
ln TE			0.055**	0.041**
			(0.001)	(0.001)
Country-Industry-Year FE	Yes	Yes	Yes	Yes
R^2	0.08	0.07	0.08	0.09
N	970,986	970,986	970,986	970,986

Sources: U.S. Census of Manufactures, Annual Survey of Manufactures, and U.S. Customs.

Notes: The dependent variable is SR_{ijc}, share of related-party imports. Firm-country pair is the unit of observation. The method of estimation is OLS. Standard errors clustered at the firm level appear in parentheses. The symbols * and ** indicate significance at 1% and 5% level, respectively.