# Foreign sourcing and productivity: evidence at the firm-level

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## Abstract

The objective of this paper is to explore the relationship between foreign sourcing and productivity at the firm level. To organize the empirical work, we rely on the model of Antràs and Helpman (2004), which predicts that high-productivity firms engage in trade (foreign sourcing) and low-productivity firms do not source abroad. The paper performs productivity comparisons between groups of firms sourcing abroad and firms which do not source abroad, applying non-parametric procedures to a sample of Spanish manufacturing firms. Our results indicate the existence of large and significant differences in productivity between firms sourcing abroad and not sourcing abroad. The productivity premium of foreign sourcing firms is robust to other characteristics that are associated with firm productivity. Furthermore, the evidence reported is consistent with self-selection of the most productive firms into the practice of sourcing abroad. The ex-ante productivity distribution of firms that engage in foreign sourcing stochastically dominates the distribution of firms which do not source abroad. Finally, our estimates suggest that changing the intensity of foreign sourcing is a technology shifter for firms, which has a direct impact on their total factor productivity.

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## 1. Introduction

According to models of industry dynamics proposed, among others, by Jovanovic (1982), Hopenhayn (1992) and Ericson and Pakes (1995), the path of entry, growth and failure that characterize micro data is driven to a large extent by firm productivity differences. The empirical side of this literature, that has been nicely reviewed by Caves (1998), Bertelsman and Doms (2000), Foster et al. (2001), shows that productivity heterogeneity at the firm level is particularly relevant to explain various aspects of industry dynamics.

A research area that has received special attention is the relationship between opening to foreign markets and firm productivity. The theoretical model of Melitz (2003) integrates the basic ingredients of industry dynamics models of firm heterogeneity in an open economy context, which permits us to evaluate the impact of trade. In Melitz's model, the assumption of sunk entry costs is crucial to predict the self-selection of most productive firms into the foreign markets as well as the reallocation of resources within an industry following the exposure to trade (see review articles on this literature by Helpman, 2006, Greenaway and Kneller, 2007, Bernard et al., 2007). Another strand of the literature interested in the relationship between trade and firm productivity combines the intraindustry heterogeneity setting of Melitz (2003) with a property right plus an incomplete contracting approach of the Grossman and Hart (1986) type. The model by Antràs and Helpman (2004) is an example of this literature, which provides a set of predictions concerning the relationship between imports and firm productivity. In this framework, companies make two endogenous organizational choices: the first one concerns an integration decision and the second one a location decision. One of the key results coming out of this model is that high-productivity firms source in foreign markets and low-productivity firms do not source abroad.

This paper makes an exploration of the relationship between foreign sourcing and firm productivity. We address this issue empirically, taking a sample of Spanish manufacturing firms as a reference, and testing the prediction of Antràs and Helpman (2004) model that high-productivity firms engage in arm's length trade (firms sourcing abroad) while low-productivity firms do not source abroad (firms which do not source abroad).

The paper uses the methodology proposed by Delgado et al. (2002) and Fariñas and Ruano (2005), which permits the comparison of the entire distribution of firm productivity rather than just marginal moments, typically means. In particular, we are interested in comparing the cumulative distribution function of total factor productivity for the group of firms sourcing abroad and the group of firms which do not source abroad. The paper implements a testing procedure based on the concept of stochastic dominance for ranking differences between productivity distributions.

Our results indicate the existence of large and significant differences in productivity between firms sourcing abroad and firms which do not source abroad. These differences are consistent with the predictions of Antràs and Helpman (2004) model. Previous papers that find evidence of a link between foreign sourcing and productivity include, among others, Girma and Görg (2004), Görg and Hanley (2005), Amiti and Wei (2006), Tomiura (2007) and Görg et al. (2008).

The paper is organized as follows. Section 2 summarizes the theoretical framework that we take as a reference to organize the empirical work. Section 3 describes the testing procedure that has been implemented. Section 4 presents the characteristics of the data set and the measurement of both, firm productivity and foreign sourcing. Section 5 presents the main empirical results. Section 6 addresses the

relationship between foreign sourcing intensity and productivity. Finally, Section 7 provides the main conclusions.

## 2. Theoretical framework

This section briefly summarizes the predictions of Antràs and Helpman (2004) model that we take as a reference to organize our empirical work. The characteristics of the model are quite specific: a world of two countries, with a factor of production and monopolistic competition. The model integrates two elements. The first one is firm heterogeneity as in Melitz (2003): each final-good producer of a given variety draws a productivity level $\lambda$ from a known distribution $M(\lambda)$. The second element comes from the incomplete contract approach literature (Grossman and Helpman, 2002) which allows for addressing the choice between outsourcing and integration. By the term outsourcing, the model means the acquisition of an intermediate input or service from an unaffiliated supplier. Integration means the production of the intermediate input or service within the boundaries of the firm. Both choices, outsourcing and integration, can be carried out either in the home country of the firm or in the foreign market.

Two agents are engaged in production: final-good producers, who provide headquarter services, are located at home (D), and firms producing components that can be located either at home or in a foreign market (F). Therefore, in this setting, firms make two endogenous organizational choices. The first one concerns the ownership structure of the firm, which can decide to integrate the activity within the boundaries of the firm –vertical integration (V)– or, alternatively, to engage in some kind of outsourcing (O). The second refers to the location decision: the production of components can be located at home or in the foreign market.

The production combines two specialized inputs: intermediate inputs and headquarter services. Sectors differ in relative their input intensity and firms differ in their productivity level. Fixed organizational costs of search, monitoring and communication are ranked as follows:

$$f_V^F > f_O^F > f_V^D > f_O^D,$$

which says that regardless of the ownership structure of the firms, fixed costs are higher in the foreign country. The fixed costs of integrating or outsourcing abroad, $f_V^F, f_O^F$ respectively, are higher than the costs of integrating or outsourcing at home, $f_V^D, f_O^D$ respectively. Furthermore, for a given location, fixed costs of a V-firm are higher than the fixed costs of an O-firm. With respect to this latter assumption, on one hand the integration of the production of components implies additional supervision costs, and on the other hand economies of scope may reduce the costs of integration relative to outsourcing. The model assumes that the first component is higher than the second and overall the ranking of fixed costs is as in the expression above.

The industry equilibrium predictions coming out of the model indicate that the location and integration decisions will depend on both the level of firm productivity (λ) and the relative input intensity of the industry. The pattern of results can be summarized according to the following criteria:

$$\lambda_{O,V}^D < \lambda_{O,V}^F$$

First, firms with productivity higher than $\lambda_{O,V}^F$ engage in foreign sourcing. These firms either outsource in a foreign country or choose to integrate the production of components in a foreign country within the boundaries of the firm (intra-firm trade). Second, firms with productivity levels higher than $\lambda_{O,V}^D$ but lower than $\lambda_{O,V}^F$ do not engage in foreign sourcing. These firms either integrate or outsource at home.

The main prediction we want to test is whether firms sourcing abroad outperform firms which do not source abroad. In Antràs and Helpman (2004) model foreign outsourcing refers to the acquisition of intermediate inputs from a non-affiliated firm in foreign markets. When the acquisition is from an affiliated firm, the model refers to this activity as intra-firm trade. As we cannot distinguish if the import of intermediate inputs comes from an affiliated or a non-affiliated firm, we restrict the analysis to the more general prediction that firms sourcing from abroad, including both firms that outsource and firms that insource within the boundaries of the firms, dominate the productivity distribution of firms which do not source abroad. This prediction holds both for component-intensive and headquarter-intensive industries, although in the later case foreign sourcing may include also intrafirm-trade. The next section defines a procedure for testing this prediction.

## 3. Testing procedure

The empirical implications that have to be tested can be performed comparing productivity distributions of different groups of firms. In this section, we describe a procedure for testing differences between distribution functions. The procedure is based on non-parametric techniques, which have been previously used by Delgado et al. (2002) and Fariñas and Ruano (2005). See both references for more details.

To perform the comparison between two productivity distributions, the procedure we use relies on the notion of first-order stochastic dominance. Let us define two cumulative distribution functions such that the first one corresponds to the productivity distribution of firms sourcing abroad, which we denote by F, and the second one corresponds to the group of firms which do not source abroad, denoted by G. According to the predictions of the Antràs and Helpman (2004) model, the

productivity distribution of foreign sourcing firms, F, should dominate the distribution of firms which do not source abroad, G. Stochastic dominance of F relative to G requires two statistical conditions to be satisfied: first, both distributions are not identical, i.e., the null hypothesis $H_0$: F(z)-G(z) = 0 can be rejected; second, the sign of the difference is as expected, i.e., the null hypothesis $H_0$: F(z)-G(z) ≤ 0 cannot be rejected. These two-sided and one-sided tests can be performed respectively by the following Kolmogorov-Smirnov test statistics:

$$\delta_N = \sqrt{\frac{n.m}{n+m}} \sup_{z \in Z} \left| F_n(z) - G_m(z) \right| \qquad \eta_N = \sqrt{\frac{n.m}{n+m}} \sup_{z \in Z} \left( F_n(z) - G_m(z) \right),$$

where n and m are, respectively, the size of the sample of firms corresponding to the distribution F, the group of firms sourcing abroad, and m is the size of the sample drawn from the distribution G. The limiting distributions of both test statistics are known under independence between the sample of firms drawn from distributions F and G (see Delgado et al., 2002).

To further illustrate the comparisons between different groups of firms, we have graphed the estimates of the distribution functions for these groups. In particular, we have computed the smooth, or perturbed, sample distribution function rather than the sample distribution function itself, which provides nice smooth distribution estimates. Since the purpose here is to produce graphical representations of the differences between two groups of firms, we represent these distributions for the whole population of firms (See the Appendix for details).

## 4. Data and descriptive evidence on foreign sourcing

The data set we employ is a longitudinal survey of Spanish manufacturing firms that comes from the Encuesta sobre Estrategias Empresariales (ESEE). This data set is collected by the Fundación Empresa Pública and sponsored by the Spanish Ministry of

Industry. This database contains a longitudinal sample of firms from 1990 to 2002. The panel of firms contains 19,007 observations that correspond to an average number of 1,462 firms per year.

A characteristic of the data set is that firms participating in the survey were chosen according to a selective sampling scheme. The sample of firms includes almost all Spanish manufacturing firms with more than 200 employees (large firms) in 1990. In fact, the rate of participation of firms in this size category was 67.6% of the population of large firms in 1990. Firms employing between 10 and 200 employees (small firms) were chosen according to a stratified random sampling procedure. Three point nine percent (3.9%) of the population of firms within this size category was randomly sampled in 1990. Given the procedure used to select firms participating in the survey, both samples of small and large firms can be considered as samples that permit us to estimate the distribution of any of the characteristics of the population of Spanish manufacturing firms with available information in the data set.

The first variable of interest is firm productivity. This is defined by an index of total factor productivity for each firm over the period 1990-2002. The index follows the framework developed by Aw et al. (2001) and it is an extension of the multilateral total factor productivity index proposed by Caves et al. (1982). The index takes a hypothetical firm as a reference and measures productivity in each year relative to this reference firm. In particular, the index uses the average firm of the industry and the size group the firm belongs to as the reference point, and then chain-links the average firm for both size groups to preserve transitiveness between firms of different size groups within the same industry. Reference firms are defined in terms of the industry and the size group the firm belongs to in order to take advantage of the characteristics of the data set.

Let each firm $i$ produce a single output $y$ using the set of inputs $x$; then the expression of total factor productivity for firm $i$, at time $t$, in a given industry is:

$$\ln \lambda_{i\tau t} = \ln y_{i\tau t} - \overline{\ln y_{\tau}} - \frac{1}{2}\sum_{r=1}^{R}(\varpi_{i\tau t}^{r} + \overline{\varpi_{\tau}^{r}})(\ln x_{i\tau t}^{r} - \overline{\ln x_{\tau}^{r}}) + \\ + \overline{\ln y_{\tau}} - \overline{\ln y} - \frac{1}{2}\sum_{r=1}^{R}(\overline{\varpi}_{\tau}^{r} + \overline{\varpi^{r}})(\overline{\ln x_{\tau}^{r}} - \overline{\ln x^{r}}) \qquad [1]$$

where $x_{i\tau t}^{r}$ is the quantity of input $r$, and $\varpi_{i\tau t}^{r}$ is the cost share of input $r$. Firms are classified in two size groups of small and large firms. A bar over a variable indicates the arithmetic mean of the variable. The average value of variables with index $\tau$, refers to a given size group of firms; otherwise, the average refers to the entire sample of small and large firms. The details of the definition of output and inputs can be found in the Appendix.

The index measures the proportional difference of total factor productivity for firm $i$ at time $t$ relative to a given reference firm. The reference firm varies across industries and therefore, when observations of different industries are pooled, average productivity differences across industries are removed. Firms are classified in twenty manufacturing industries corresponding to the NACE classification at the two-digit level. To be more precise about the meaning of expression [1], the first line on the right hand side compares the productivity of firm $i$ with the productivity of an average firm of the same size group and industry as firm $i$. Therefore, comparisons between observations corresponding to the same size group are transitive. The second set of terms measures productivity differences between the reference firm for the size group of either small or large firms, and the average firm of the entire sample of small and large firms in a given industry. This second set of terms preserves transitiveness of firms across the two size groups of small and large firms.

The second variable of interest is foreign sourcing. To measure foreign sourcing, we follow the definition of Feenstra and Hanson (1996), who identify this term with the practice of domestic firms of importing intermediate inputs. We measure foreign sourcing intensity as the ratio of imported intermediate inputs to total purchases of intermediate inputs, thus giving a measure of the importance of imported intermediates in the production process. Görg and Hanley (2005) use the same ratio as a measure of international outsourcing intensity for Irish electronics firms.

The estimates of foreign sourcing are based on information reported directly by manufacturing firms in the survey Encuesta sobre Estrategias Empresariales (ESEE). Firms report the value of total imports as well as additional information on the value of total intermediate purchases, production and other characteristics. This set of information permits the estimation of the value of intermediate materials and service inputs imported from abroad. In the following paragraphs we explain this estimation procedure briefly.

Firms report information directly on three different concepts. First, they report the value of their total imports. Second, firms report the percentage of capital goods that have been manufactured abroad and used by the firm, as well as the annual value of investment in capital goods. Multiplying both measures we calculate the value of imports of capital goods. The third piece of information supplied by the firm is the value of imports of goods that are similar to those produced by the firm in the domestic market coming from affiliated companies or subcontracted abroad with unaffiliated companies.

Given the previous information, we estimate the value of imports of intermediate inputs as equal to the value of total imports minus the value of imports of capital goods and minus the value of imports of similar goods from affiliated companies or

subcontracted abroad. Our definition of imports of intermediate inputs includes both raw materials and components (materials) and services inputs, but energy is excludes.

Considering that goods that are similar to those produced by the firm are imported and additionally processed in the domestic market by the firm that provides marketing, quality control services, etc., it may be argued that removing imports of similar goods from the estimation of intermediate import underestimates foreign sourcing. However, it is not completely clear whether the activity of importing similar goods falls within the definition of foreign sourcing or not. Therefore, we have decided to maintain the previous definition of foreign sourcing, excluding imports of similar goods, while at the same time controlling that the results presented in section 5 are also robust to the inclusion of similar imports in the definition of foreign sourcing.

Finally, we illustrate the breakdown produced by the application of the previous definitions with some numbers. 23.7 percent of total imports corresponds to imports of capital investment goods, 7.6 percent are imports of similar goods form affiliated companies and 68.7 percent are imports of intermediate inputs, foreign sourcing according to our definition.

In the rest of this section, we offer some descriptive statistics on the evolution and magnitude of the practice of sourcing intermediate inputs from overseas suppliers by Spanish manufacturing firms over the period 1990-2002.

Table 1 shows a large increase in the percentage of manufacturing firms directly importing intermediate inputs from abroad. Between 1990 and 2002, the proportion of manufacturing firms performing foreign sourcing increased from 43.6 percent to 55.0 percent. The magnitude and timing of this increase are similar to those observed for total imports and total exports. Therefore, in terms of the proportion of firms, foreign

sourcing has expanded by a large amount during the period and this increase is similar to the change observed in the number of exporting firms.

The intensity of foreign sourcing has also increased over the period 1990-2002. Table 2 shows that the share of imported intermediate inputs in the total purchase of intermediate inputs increases from 19.9 percent in 1990 to 22.3 percent in 2002. Both measures refer to foreign sourcing by firms with positive imports of intermediate inputs. Therefore, foreign sourcing has expanded through two channels: first, the participation rate in foreign sourcing has increased over the period and, second, the intensity of foreign sourcing within this group of firms is also larger. This confirms that foreign sourcing has evolved at two margins. First, firms already performing foreign sourcing have increased its intensity (intensive margin) and, second, it has increased through the channel of new firms engaging in foreign sourcing (extensive margin).

Table 2 shows two additional measures related to foreign sourcing. The first one refers to the share of imported intermediate inputs over the value of production. Foreign sourcing intensity has increased over the period 1990-2002 at a greater rate than production: the share of imported intermediate inputs in production has increased 3.4 percentage points. Finally, it is worth noting that there has been a large increase in the share of imports of intermediate inputs in the total value of imports: from 74.5 percent to 78.1 percent.

Table 3 shows a strong positive relationship between foreign sourcing and the size of firms. Small firms with 200 or fewer employees perform foreign sourcing with a lower probability (36.6 percent) than larger firms with more than 200 employees, where the rate of participation is 80.2 percent. After conditioning on foreign sourcing, the difference in the intensity of foreign sourcing between small and large firms is not too

large. Small firms source from abroad 18 percent of the total purchase of intermediate inputs, and for large firms, the intensity is 19 percent.

The previous estimates measure foreign sourcing at the firm level. Two recent papers offer estimates of foreign sourcing at the industry level for Spanish manufacturing. The first one, by Canals (2006), estimates a share of imported intermediate inputs in the total value of non-energy intermediate inputs that amounts to 27 percent; the second one, by Díaz-Mora et al. (2007), estimates a share of imported intermediate inputs in the total value of production equal to 18 percent. Consequently, our estimates, which are based in firm level data, are very similar to the estimates reported at the industry level using the Feenstra and Handson (1996) approach.

Foreign sourcing reported for the whole sample of manufacturing firms obscures the fact that particular industries exhibit a high degree of heterogeneity in the propensity to source abroad. This is illustrated in Figure 1, where the participation rate in foreign sourcing by industries is plotted against the intensity of foreign sourcing by industries. The set of industries that are near the upper right corner corresponds to those activities where the propensity to source abroad is higher. The list of industries includes Office machinery, computers and precision instruments, Electrical machinery and communication equipment, Motor vehicles, Other transport equipment and Chemicals and chemical products. As Feenstra and Hanson (1996) indicate, this set of industries with the highest propensity to source abroad shares the characteristic that their production processes can be separated into various stages. This characteristic favors the sourcing of different components across space.

## 5. Empirical results: foreign sourcing and productivity

In this section, we present the results on productivity differences between the group of firms sourcing abroad and the group which do not source abroad. The data set we use to test for these differences corresponds to a sample of Spanish manufacturing firms over the period 1990-2002. The results reported have been obtained by applying the non-parametric tests described in Section 3.

Figure 2 illustrates the difference between the productivity distributions of firms sourcing abroad and firms which do not source abroad. These graphs show the kernel estimates of the cumulative distribution functions for both groups of firms for years 1990, 1994, 1998 and 2002, weighting the cumulative distribution functions of small and large firms (see Appendix for details). The position of the productivity distribution of firms sourcing abroad is, in all years, to the right of the distribution of firms which do not source abroad. This position indicates that for any quartile of the distribution, firms sourcing abroad have higher productivity than firms which do not source abroad and therefore the productivity distribution of foreign sourcing firms stochastically dominates the distribution of firms which do not source abroad.

Given the assessed differences, we formally test to learn whether productivity differences between firms sourcing abroad and firms which do not source abroad depicted in Figure 2 are significant. One and two-sided tests, as described in Section 3, are applied to compare the productivity of the two groups of firms.

Table 4 summarizes the hypothesis test statistics for the whole set of firms. First, the productivity of firms sourcing abroad is higher than the productivity of firms which do not source abroad. Over the period, the average difference at the median of the distribution is 7.5 percent. At the first and the third quartiles, the differences are 8.6 percent and 6.2 percent, respectively. Second, the null hypothesis that the difference is as expected –higher productivity for foreign sourcing firms- cannot be rejected at any reasonable significance level. Third, the null hypothesis of equality between both distributions can be rejected at the 0.01 percent level for all years. Therefore, we confirm the hypothesis that the distribution of the productivity of

firms sourcing abroad stochastically dominates the distribution of firms which do not source abroad. We have checked if results presented in Table 4 hold when the definition of foreign sourcing includes the value of imports of similar goods from affiliated companies or subcontracted. Results are almost identical to those reported in Table 4

Finally, Table 5 presents the results of various comparisons between the ex-ante productivity distributions of firms that engage in foreign sourcing and the productivity distribution of firms which do not source abroad. The industry equilibrium predictions of the model by Antràs and Helpman (2004) indicate that the location and integration decisions of firms will depend on the level of firm productivity. The group of most productive firms self-select in the activity of sourcing in foreign markets. Therefore, we can test for this prediction by comparing the productivity distribution of future foreign sourcing starters and future non-foreign sourcing firms a year before some of them begin to perform foreign sourcing. The results indicate that the ex-ante productivity difference between entering and non-entering firms is 4.4 percent at the median of their distributions. The group of firms engaging in a foreign sourcing activity has a higher productivity than the group of non-entering firms. This difference exists before they start their sourcing activity in foreign markets. Formal tests of this difference indicate that it is not too large for some cohorts of starting firms. In particular, two-sided tests of equality of the distributions of both groups of firms cannot be rejected in six cohorts of entering firms, although the difference is favorable to firms engaging in foreign sourcing. These changes over the period may be indicating the existence of some heterogeneity coming from the fact that the composition of cohorts of firms starting their sourcing activity in foreign markets is too different across years.

To investigate further the differences in productivity between firms sourcing abroad and firms which do not source abroad, we report a robustness check on the magnitude of the productivity difference. In particular, we check whether the productivity premium of firms sourcing abroad is robust to other characteristics that are associated with firm productivity. Furthermore, the regressions we estimate permit the computation of the so-called foreign

sourcing productivity premia, defined as the ceteris paribus percentage difference of productivity between firms sourcing abroad and firms which do not source abroad. (See for a similar application to exporting, Fariñas and Martín-Marcos, 2007, and The International Trade Study Group on Exports and Productivity, 2007).

The foreign sourcing TFP premium is computed from a regression of $\ln TFP$, measured by the same index that has been used in the previous section, on the current foreign sourcing status and a set of control variables

$$\ln TFP_{it} = \alpha + \beta FS_{it} + \gamma Z_{it} + e_{it} \qquad [2]$$

where i is the index of the firm, t is the index of the year; $\ln TFP$ is measured by $ln\ \lambda_{it}$ where average productivity differences across industries are removed; $FS_{it}$ is a dummy variable for the current foreign sourcing status (1 if firm i sources abroad in year t, 0 otherwise); $Z_{it}$ is a vector of control variables that includes the log of number of employees and its squared value to measure firm *Size*, a dummy variable indicating *Foreign ownership* (1 if the firm has 50 percent or more of the equity owned by foreign capital), the log of firm *Age*, a full set of year dummies to control for common shocks to all firms, the log of wages and salaries per employee to proxy *Human capital intensity*, and a dummy variable of *Product/Process innovation* (1 if the firm obtains product and/or process innovations in the current year). The foreign sourcing productivity premium, computed from the estimated coefficient ß as 100*(exp(ß)-1), shows the average percentage difference in TFP between firms sourcing abroad and firms which do not source abroad controlling the characteristics included in the vector $Z_{it}$ and productivity differences across industries that are removed by the definition of the index of TFP. Additionally, to control for unobserved firm heterogeneity due to time-invariant firm characteristics which might be correlated with the variables included on the right hand side of the model and which might lead to a biased estimate of the foreign sourcing productivity premia, a variant of [2] is estimated with fixed firm effects, too. As the control variables *Foreign ownership* and *Product/Process innovation* are almost fixed effects, we drop them from the fixed effects estimation.

Results for these estimated foreign sourcing productivity premia from empirical models with and without fixed firm effects are reported in Table 6. Looking at the results in the upper part of the table, we find that the estimated premia are always significantly different from zero, and higher for pooled data. If fixed firm effects are added to control for unobserved heterogeneity, the estimated premia are still statistically significant, but the estimates are smaller compared to the results based on pooled data only. The magnitude of the premium is around one percentage point when the fixed effects are included. Unobserved firm heterogeneity does matter, and, therefore, in the rest of this section, we will concentrate on the results from the model including fixed effects.

The pattern of the signs of the estimated coefficients for the set of control variables is as expected. *Size* exhibits a "+/-" pattern in its two terms, which indicates that productivity is increasing in size in general, as the minimum of the parabola is a rather low level of employment. *Foreign ownership*, *Age* and *Human capital intensity* are all positively associated with productivity, although the significance of *Foreign ownership* and *Age* vanishes when *Human capital* is included in the set of control variables. *Product/Process innovation* is not statistically significant.

In the lower part of Table 6, the results of a slightly modified version of model [2] are presented. The foreign sourcing productivity premia is estimated through the interaction of two dummy variables: Foreign sourcing and Foreign ownership. This decomposition permits the estimation of the foreign sourcing productivity premia for the group of foreign owned firms and the group of domestically owned firms. The estimates indicate that the productivity premium is higher for foreign owned firms than for domestically owned firms. The premium is 1.8 percent for the first group and 0.8 percent for the second group (with a p-value of 0.08 percent when FE are included). Given that foreign owned firms are multinationals that are usually engaged in intra-firm trade, the productivity difference between foreign and domestically owned firms shown in Table 6 is consistent with the one of the results of Antràs and Helpman (2004) model predicting that firms integrating through intra-firm trade are at the top of the ranking of productivities. Therefore, this difference in foreign sourcing productivity premia between

multinationals and domestic owned firms is consistent with the model if our interpretation is correct: foreign owned firms were conducting their sourcing abroad through intra-firm trade. However, the data set we are using does not permit the observation of the channels through which firms engage in foreign sourcing.

## 6. Foreign sourcing intensity and productivity

In Section 5 we report evidence on the existence of large and significant differences in productivity between firms sourcing abroad and firms which do not outsource abroad. Furthermore, this productivity premium is robust to other characteristics associated with firm productivity, either observed and unobserved. In this section we investigate the relationship between the intensity of foreign sourcing and productivity.

The empirical literature which has investigated the effect of foreign sourcing on productivity has considered that the practice of outsourcing abroad can be identified as a "shifter" of the production function. This interpretation implies that a change in the intensity of foreign sourcing is a technology shifter for firms, which has a direct impact on their total factor productivity. For example, Görg and Hanley (2005) and Amiti and Wey (2006) follow this approach to justify the existence of an empirical relationship between the intensity of foreign sourcing and productivity. These authors have identified two channels through which foreign sourcing can affect productivity. First, the reallocation of production within the firm due to foreign sourcing may have a positive effect on the level of productivity. Amiti and Wei (2006) consider this effect a "compositional change", given that firms reallocate relatively inefficient parts of their production process to a foreign supplier. Second, productivity can increase due to the use of new internationally traded materials, which may be available at lower cost or at higher quality than those available in the domestic market, and, more generally, outsourcing makes it possible for firms to restructure their activities in such a way to increase the productivity of the remaining labour force.

An alternative explanation of the relationship between productivity and the intensity of foreign sourcing derives from the literature of heterogeneous firms and international trade (see

Helpman, 2006). If fixed organizational costs are larger the more foreign countries the firm chooses to outsource from and, furthermore, this number of foreign countries is directly associated with the intensity of foreign sourcing, then a positive association is also expected between productivity and the intensity of foreign sourcing at the firm level. As in the case of the decision to engage in foreign sourcing analysed by Antràs and Helpman (2004), the link between productivity and the intensity of foreign sourcing arises is a self selection mechanism.

To address this issue we introduce an additional variable in equation [2]: the intensity of foreign outsourcing for those firms already performing this activity. Then, equation [2] is rewritten as follow:

$$\ln TFP_{it} = \alpha + \beta_1 FSI_{it} + \beta_2 NFS_{it} + \gamma Z_{it} + e_{it} \qquad [3]$$

where, $FSI_{it}$ represents foreign sourcing intensity and $NFS_{it}$ is a dummy variable that takes the value 1 for those firms not performing sourcing abroad in year t, and 0 otherwise. This specification allows the distinction between the effect on productivity of the decision to source abroad and the effect of the intensity of this phenomenon. This distinction is consistent with our finding that there are large and significant differences in productivity between firms sourcing abroad and firms which do not outsource abroad. $Z_{it}$ is the same vector of control variables as in equation [2].

Table 7 presents the results for the estimation of equation [3]. Results in the two first columns correspond to OLS estimates, while the third column corresponds to GMM estimates. The sample of firms used in the estimation includes all firms with information available at least three consecutive years.

OLS estimates, both controlling and not controlling for unobserved heterogeneity, confirm a positive relationship between the intensity of foreign sourcing and the productivity premia: the higher is the intensity of sourcing abroad the higher the productivity premium is. The estimated coefficient of foreign sourcing intensity is 0.1 when including fixed effects in the model.

An econometric concern of previous estimates is the potential endogeneity of foreign outsourcing. More productive firms might self select into foreign outsourcing, as theoretical arguments suggests and empirical evidence confirms, and therefore we can expect a downward bias in estimating the effect of foreign sourcing intensity and productivity. The OLS fixed effect coefficient attached to the intensity of foreign sourcing can be biased due to the endogeneity of this decision.

As unobserved heterogeneity might be present, equation [3] is estimated in differences using GMM techniques. The estimation in differences implies that any level time-invariant individual effect is eliminated. Given that differences of the dummy variable $NFS_{it}$ (non-foreign sourcing decision) take de values:

$$dNFS_{it} = \begin{cases} 1, & \textit{if the firm stops sourcing abroad} \\ 0, & \textit{if the firm does not change their decision} \\ -1, & \textit{if the firm starts sourcing abroad} \end{cases}$$

a convenient way to specify equation [3] in first differences is to distinguish between the change in outsourcing intensity and the change in the decision to outsource abroad. Therefore, for the variable capturing *Foreign sourcing intensity*, first differences are defined as follows:

$$dFSI_{it} = \begin{cases} FSI_{it} - FSI_{it-1}, & \textit{if the firm continues sourcing abroad} \\ 0, & \textit{otherwise} \end{cases}$$

And secondly, the change in the decision to outsource abroad is defined by two dummy variables: *Stop foreign sourcing dummy*, with value 1 if the firm ceases to outsource abroad (i.e. $d\,NFS_{it}$ =1), and 0 otherwise; and *Start foreign sourcing dummy*, with value 1 if the firm begin to outsource in foreign markets (i.e. $d\,NFS_{it}$ =-1), and 0 otherwise.

The third column of Table 7 presents the results of a GMM estimation of model [3] in differences including the three variables measuring foreign outsourcing intensity. The estimated equation is a linear equation with predetermined and endogenous

variables. The estimation is carried out taking the proxy for *Human capital intensity* as a predetermined variable, and we use the lagged level of the variable as the instrument. The variable *Foreign sourcing intensity* is assumed to be an endogenous variable, and we use the lagged levels t-2, t-3 and t-4 as instruments. The Sargan test of overidentifying restrictions is reported and test statistics for first and second-order serial correlations ($m_1$ and $m_2$) are also reported (see Arellano and Bond, 1991).

As expected, the coefficient attached to the variable *Foreign sourcing intensity* is positive and significant at the 5 percent level. The magnitude of the coefficient is larger than the OLS estimate, confirming the downward bias. Furthermore, it is not only that the intensity of foreign sourcing has a positive effect on firm productivity, but also the foreign sourcing decision. As expected, the signs of *Start and stop foreign sourcing dummies* are positive and negative respectively. In the first case, the decision to start foreign sourcing has a positive influence on productivity and the opposite in the case of firms that decide to stop sourcing abroad. The impact on firm productivity produced by the decision to start sourcing in foreign markets favors the "compositional change" hypothesis, which considers that this decision permits a reallocation of production within the firm that has a positive affect on the level of productivity

The reported specification tests confirm the validity of the estimation: Sargan test indicates the validity of the moment conditions, and $m_1$ and $m_2$ test statistics show a significant negative first-order autocorrelation and the absence of second-order correlation.

The GMM estimated coefficient (0.164) permits to get an idea of the magnitude of the effect of foreign sourcing on firm productivity. As foreign sourcing increased by almost 0.025 percentage points on average over the period, from 0.165 to 0.188, the estimated coefficient implies that foreign sourcing leads to an average increase of 0.4

percent of total factor productivity at the firm level. Given that firms increased their average total factor productivity by 18 percent over the period, foreign sourcing accounted for almost 2.5 percent of the growth of total factor productivity at the firm level.

## 7. **Conclusions**

This paper examines the relationship between foreign sourcing and productivity at the firm level using a panel of Spanish manufacturing firms. We follow the tradition of Feenstra and Hanson (1996) in defining foreign sourcing as the practice by domestic firms of importing intermediate inputs.

Section 4 offers descriptive evidence on the evolution and magnitude of foreign sourcing by Spanish manufacturing firms. We are able to identify some characteristics that can be summarized as follows. First, there is a large increase in the number of manufacturing firms directly importing intermediate inputs from abroad over the period 1990-2002. The increase is of more than 10 percentage points, with 55 percent of manufacturing firms performing foreign sourcing at the end of the period. The intensity of foreign sourcing also increases. The propensity to source abroad increases through two channels: the proportion of firms performing foreign sourcing increases (extensive margin) and the intensity of foreign sourcing within this group of firms is also larger (intensive margin). Second, foreign sourcing is positively related to the size of firms. Small firms perform foreign sourcing with a lower probability (36.6 percent) than larger firms, where the rate of participation is 80.2 percent. However, after conditioning on the realization of foreign sourcing, the intensity of this is very similar for small and large firms. Third, foreign sourcing exhibits a high degree of heterogeneity across industries. Sectors with the highest propensity to source abroad include Office machinery,

computers and precision instruments, Electrical machinery and communication equipment, Motor vehicles, Other transport equipment and Chemicals and chemical products. This set of industries shares the characteristic that their production processes can be separated into various stages, which favors the sourcing of different components across space.

Section 5 reports evidence on the relationship between firm productivity and foreign sourcing. We apply non-parametric procedures to compare the productivity distributions of various groups of firms. The evidence reported is consistent with Antràs and Helpman (2004) model, which predicts that high-productivity firms source intermediate inputs in international markets, whereas low-productivity firms acquire them at home. Firms sourcing abroad have greater TFP than firms which do not outsource abroad. Therefore, the main conclusion is that high-productivity firms are more likely to engage in global production strategies.

Three additional results have been obtained concerning the previous conclusion. First, the evidence reported is consistent with the self-selection of the most productive firms engaged in the practice of sourcing abroad. The ex-ante productivity distribution of firms that engage in foreign sourcing stochastically dominates the distribution of firms not sourcing abroad. Second, we confirm that the productivity premium of firms sourcing abroad is robust to other characteristics that are associated with firm productivity. Third, our IV estimates suggest that foreign sourcing accounted for 2.5 percent of total factor productivity growth at the firm level over the period.

Our analysis suggests a number of possible avenues for future research. The first one is based on Antràs and Helpman (2004) model, which suggests the possibility of testing additional predictions regarding vertical integration of firms through foreign direct investment and intra-firm trade. Therefore, the testing procedure can also be

applied to the ranking of productivities of integrated firms vs. outsourcing firms in domestic/foreign markets. The second one refers to the notion that self-selection is not inconsistent with the fact that firms engage in foreign sourcing with the expectation that it will improve productivity. Foreign sourcing permits firms to reallocate the relatively inefficient parts of their production process to other countries where they can be produced more cheaply. Our work has concentrated on productivity-level differences between firms sourcing abroad and firms which do not source abroad, but it can equally be applied to the analysis of productivity growth as in section 6. A more structural model is required to estimate this effect more precisely allowing to address more completely the potential endogeneity of foreign sourcing.

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## Appendix

### Data

The data set is a longitudinal survey of Spanish manufacturing firms that comes from the Encuesta sobre Estrategias Empresariales (ESEE), collected by the Fundación Empresa Pública and sponsored by the Spanish Ministry of Industry. This data set contains a longitudinal sample of firms from 1990 to 2002. As we mention in the text, the panel of firms contains 21,098 observations that correspond to an average number of 3,462 manufacturing firms. From this set of firms, 19,007 observations that correspond to 1,462 firms on average were available for estimation. The units included for estimation were required to contain information on the whole set of the variables that were used in the analysis. The definition of the variables used in the analysis is as follows:

*Total factor productivity*: firm productivity is defined by an index of total factor productivity for each firm over the period 1990-2002. Total factor productivity for firm *i*, at time *t*, in a given industry is estimated according to expression [1] in section 4 in the text. The definition of output and inputs in expression [1] is as follows:

The output $y_{it}$ is measured by the annual value of gross production of goods and services expressed in real terms using price indexes for each firm reported by the ESEE. The estimation of the index considers three inputs ($x_{it}^r$): labor, materials and the stock of capital. Labor input is measured by the number of effective hours of work per year, which is equal to normal hours plus overtime hours minus non-working hours. Material inputs are measured by the cost of intermediate inputs, including raw materials purchases, energy and fuel costs and other services paid for by the firm. The value of material inputs is measured in real terms using individual price indexes in the three categories of intermediate inputs for each firm reported by the ESEE. The stock of capital is calculated according to the perpetual inventory formula for each firm:

$$k_{it} = I_{it} + k_{it-1}(1 - d_{it})\frac{P_t}{P_{t-1}}$$

where $I_{it}$ corresponds to the value of investment in equipment of firm *i* at time *t*, $d_{it}$ stands for depreciation rates, and $P_t$ is an aggregate price index for equipment investment published by the Spanish Institute of Statistics. Finally, input cost shares, $\omega_{it}^r$, are defined as the fraction of the cost of each input in total input costs. Total input costs are defined by the sum of labor costs, intermediate input costs and the cost of capital. The cost of labor is measured by the sum of wages, social security contributions, and other labor costs paid by the firm. The cost of intermediate inputs is measured by the sum of costs of raw materials purchases, energy and fuel

costs and other services paid for by the firm. The user cost of capital is measured for each firm by the cost of the long-term external debt of each firm as reported by the ESEE plus the depreciation rate, $d_{it}$, minus the variation of the aggregate price index for capital goods.

*Age*: firm age is computed as the difference between the calendar year at t and the birth-year reported by the firm.

*Exporting firm:* dummy variable indicating that the firm exports in the current year.

*Foreign ownership:* dummy variable indicating that foreign ownership is 50 per cent or more of total equity.

*Human capital intensity:* proxied by the log of the ratio of labor cost to the number of yearly effective hours of work. The labor cost is measured by the sum of wages, social security contributions, and other labor costs paid for by the firm.

*Product and/or process innovation:* dummy variable with value equal to 1 if during the year the firm obtained product innovations (completely new products or with such modifications that they are different from those produced earlier) and/or introduced a process innovation (some important modification in the process).

*Size:* log of employment defined by the average number of workers.

**Smooth cumulative distribution functions**

In this section, we describe the approach that has been used for the estimation of the univariate cumulative distribution functions represented in Figure 2. Let *F* be the distribution function of TFP of a sample of firms of size N, where the sample is a combination composed of two random samples of small firms and large firms of sizes NS and NL (NS+NL=N), respectively. Given the characteristics of the data set, we can distinguish between large and small firms. For a given group of firms (say firms sourcing abroad), the cumulative distribution function for the whole population, *F*(.), can be defined in terms of the conditional cumulative distribution functions for the two size groups, $F(.|\tau)$, where τ is a dummy variable equal to 0 for small firms and equal to 1 for large firms. *F*(.) can be expressed as

$$F(.) = p \times F(.|\tau = 0) + (1-p) \times F(.|\tau = 1),$$

where p represents the probability of being a small firm in the group of importing firms. Therefore, the cumulative distribution function of the whole population of firms is a mixture of the conditional cumulative distribution functions corresponding to the two size groups of firms, where the parameter of the mixture is the probability of being a small firm in the corresponding population group. Then, the univariate cumulative distribution function for the whole population of firms can be estimated as a weighted average of some estimators of the cumulative distribution functions corresponding to both size groups. The weighted kernel distribution

estimate, $\hat{F}_h$, of a univariate cumulative distribution function for the whole population of firms, $F$, can be expressed as:

$$\hat{F}_h(z_0) = \hat{p}\int_{-\infty}^{z_0}\left(\frac{1}{N_S}\sum_{i=1}^{N} \cdot K\left(\frac{z - Z_i}{h}\right)\right)dz + (1-\hat{p})\int_{-\infty}^{z_0}\left(\frac{1}{N_L}\sum_{i=1}^{N} \cdot K\left(\frac{z - Z_i}{h}\right)\right)dz$$

where $h$ is the bandwidth and $K(.)$ is the kernel function, and $\hat{p}$ represents the estimated probability of being a small firm in the considered group[1].

[1] The estimation of marginal probabilities for the population of firms takes into account the sampling proportions of the data set. For the group of non-foreign outsourcing firms, the estimated probability of being a small firm is $\hat{p} = 0.995$ and the probability of being a large one is $(1-\hat{p}) = 0.005$. For the group of foreign outsourcing firms, the estimated probability of being a small unit is $\hat{p} = 0.934$ and the probability of being a large one is $(1-\hat{p}) = 0.066$.

**Table 1: Firms and foreign trade: 1990-2002**

| Year | Participation rate in foreign sourcing | Participation rate in imports | Participation rate in exports |
|---|---|---|---|
| 1990 | 43.6 | 51.8 | 50.3 |
| 1991 | 42.8 | 50.8 | 50.5 |
| 1992 | 45.2 | 52.6 | 51.8 |
| 1993 | 45.4 | 52.8 | 52.4 |
| 1994 | 49.6 | 56.3 | 55.1 |
| 1995 | 50.4 | 58.1 | 58.6 |
| 1996 | 50.7 | 58.4 | 58.7 |
| 1997 | 51.2 | 60.2 | 60.7 |
| 1998 | 53.8 | 62.1 | 63.5 |
| 1999 | 53.7 | 63.1 | 62.4 |
| 2000 | 54.7 | 63.9 | 64.3 |
| 2001 | 55.0 | 63.6 | 64.0 |
| 2002 | 55.0 | 64.4 | 63.4 |
| Average 1990-2002 | 50.3 | 58.6 | 58.5 |

Sources: ESEE and owned calculations.

**Table 2: Foreign sourcing intensity**
(Only firms sourcing abroad, weighted averages)

| Year | Imported intermediate inputs/ Total intermediate inputs (%) | Imported intermediate inputs/ Production (%) | Imported intermediate inputs/ Total imports (%) |
|---|---|---|---|
| 1990 | 19.9 | 13.2 | 74.5 |
| 1991 | 17.9 | 12.3 | 66.2 |
| 1992 | 19.7 | 13.8 | 74.2 |
| 1993 | 20.7 | 14.6 | 71.7 |
| 1994 | 21.0 | 15.0 | 67.0 |
| 1995 | 21.6 | 15.6 | 63.6 |
| 1996 | 25.1 | 17.9 | 72.8 |
| 1997 | 22.5 | 16.9 | 64.5 |
| 1998 | 29.2 | 22.3 | 83.6 |
| 1999 | 32.2 | 24.9 | 81.6 |
| 2000 | 30.2 | 23.8 | 80.3 |
| 2001 | 24.1 | 18.8 | 75.0 |
| 2002 | 22.3 | 16.6 | 78.1 |
| 1990-2002 | 25.3 | 18.9 | 75.4 |

Sources: ESEE and owned calculations.

**Table 3: Foreign sourcing and firm size**

| | Participation rate in foreign sourcing | Foreign sourcing intensity * (Only firms sourcing abroad) |
|---|---|---|
| Firms with ≤ 200 employees | 36.6 | 18.0 |
| Firms with > 200 employees | 80.2 | 19.0 |

* Note: Weighted averages of the ratios of the firms sourcing abroad.
Sources: ESEE and owned calculations

**Table 4: Productivity level differences between firms sourcing abroad and firms which do not source abroad: hypotheses test statistics**

| Year | Number of firms | | Percent difference in productivity level between firms sourcing abroad and firms which do not source abroad: | | | Equality of distributions[1] | Differences favorable to firms sourcing abroad[2] |
|---|---|---|---|---|---|---|---|
| | Sourcing abroad | Non-sourcing abroad | Median | 25th Percentile | 75th Percentile | P-value | P-value |
| 1990 | 477 | 618 | 4.8 | 6.4 | 4.9 | 0.000 | 0.826 |
| 1991 | 574 | 768 | 8.7 | 10.4 | 4.8 | 0.000 | 0.814 |
| 1992 | 687 | 833 | 7.7 | 8.8 | 6.9 | 0.000 | 0.960 |
| 1993 | 655 | 787 | 7.5 | 7.5 | 4.4 | 0.000 | 0.939 |
| 1994 | 720 | 731 | 8.7 | 10.3 | 5.5 | 0.000 | 0.988 |
| 1995 | 690 | 678 | 8.6 | 10.7 | 7.4 | 0.000 | 1.000 |
| 1996 | 702 | 682 | 9.5 | 10.9 | 8.8 | 0.000 | 0.998 |
| 1997 | 820 | 782 | 8.8 | 8.6 | 8.5 | 0.000 | 1.000 |
| 1998 | 858 | 738 | 8.4 | 8.0 | 5.6 | 0.000 | 0.996 |
| 1999 | 858 | 741 | 9.0 | 8.9 | 7.7 | 0.000 | 0.986 |
| 2000 | 910 | 754 | 8.2 | 8.7 | 7.9 | 0.000 | 0.962 |
| 2001 | 824 | 674 | 5.5 | 6.2 | 4.2 | 0.000 | 0.969 |
| 2002 | 795 | 651 | 4.3 | 6.4 | 4.3 | 0.000 | 0.985 |

Notes:

[1] P-value of the Kolmogorov-Smirnov equality of distributions test statistic. The null hypothesis is $H_0$:$F(z)-G(z)=0$

[2] P-value of the Kolmogorov-Smirnov test statistic. The null hypothesis is $H_0$:$F(z)-G(z) \leq 0$

**Table 5: Ex-ante productivity level differences between firms entering into a foreign sourcing activity and firms which do not source abroad: hypotheses test statistics**

| | Number of firms | | Percent difference in ex-ante productivity level between firms entering and firms which do not source abroad: | | | Equality of distributions[1] | Differences favorable to entering firms[2] |
|---|---|---|---|---|---|---|---|
| Year | Entering firm | Non-sourcing abroad | Median | 25th percentile | 75th percentile | P-value | P-value |
| 1990 | 74 | 516 | 4.6 | 0.7 | 3.8 | 0.403 | 0.936 |
| 1991 | 102 | 644 | 8.0 | 1.8 | 6.2 | 0.009 | 0.882 |
| 1992 | 81 | 620 | 0.8 | 5.1 | -1.6 | 0.807 | 0.793 |
| 1993 | 106 | 552 | 6.4 | 3.7 | 4.6 | 0.044 | 0.883 |
| 1994 | 59 | 574 | 1.2 | 3.9 | -0.7 | 0.516 | 0.862 |
| 1995 | 67 | 546 | 3.7 | 4.4 | 1.0 | 0.129 | 0.720 |
| 1996 | 74 | 548 | 5.8 | 3.8 | 3.4 | 0.018 | 0.998 |
| 1997 | 118 | 585 | 7.8 | 7.9 | 6.6 | 0.000 | 0.919 |
| 1998 | 78 | 590 | 4.8 | 4.3 | 6.6 | 0.080 | 0.968 |
| 1999 | 86 | 595 | 2.6 | 5.3 | 2.2 | 0.319 | 0.984 |
| 2000 | 76 | 587 | 3.9 | 5.5 | 0.5 | 0.064 | 0.954 |
| 2001 | 105 | 542 | 3.2 | 2.8 | 3.9 | 0.139 | 0.911 |

Notes:

[1] P-value of the Kolmogorov-Smirnov equality of distributions test statistic. The null hypothesis is $H_0$:$F(z)-G(z)=0$

[2] P-value of the Kolmogorov-Smirnov test statistic. The null hypothesis is $H_0$:$F(z)-G(z) \leq 0$

**Table 6: Foreign sourcing productivity premia by type of firm ownership**

| | Firm dummies | | | Control variables: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model | Foreign sourcing firms | Multinational firms performing foreign sourcing | Domestically owned firms performing foreign sourcing | Log(Size) | $(\text{Log(Size)})^2$ | Foreign ownership | Log (Age) | Log (Human capital intensity) | Product and/or process innovation | **N. observation**<br>**R- squared** |
| Pooled | 3.418 | | | 0.054 | -0.004 | 0.054 | 0.021 | | | 19,007 |
| | (0.000) | | | (0.000) | (0.000) | (0.000) | (0.000) | | | 0.165 |
| Pooled | 1.568 | | | 0.026 | -0.004 | 0.001 | 0.002 | 0.227 | 0.010 | 19,007 |
| | (0.000) | | | (0.000) | (0.000) | (0.900) | (0.267) | (0.000) | (0.000) | 0.036 |
| FE | 1.026 | | | -0.066 | 0.004 | | 0.023 | | | 19,007 |
| | (0.022) | | | (0.004) | (0.098) | | (0.003) | | | 0.130 |
| FE | 0.984 | | | -0.020 | 0.002 | | 0.010 | 0.202 | | 19,007 |
| | (0.028) | | | (0.370) | (0.374) | | (0.165) | (0.000) | | 0.280 |
| Pooled | | 7.928 | 2.993 | 0.057 | -0.004 | | 0.022 | | | 19,007 |
| | | (0.000) | (0.000) | (0.000) | (0.000) | | (0.000) | | | 0.163 |
| Pooled | | 1.463 | 1.596 | 0.025 | -0.004 | | 0.002 | 0.227 | 0.010 | 19,007 |
| | | (0.004) | (0.000) | (0.000) | (0.000) | | (0.278) | (0.000) | (0.001) | 0.287 |
| FE | | 2.180 | 0.803 | -0.066 | 0.004 | | 0.004 | | | 19,007 |
| | | (0.005) | (0.089) | (0.004) | (0.004) | | (0.095) | | | 0.041 |
| FE | | 1.820 | 0.822 | -0.020 | 0.002 | | 0.011 | 0.201 | | 19,007 |
| | | (0.019) | (0.081) | (0.368) | (0.367) | | (0.163) | (0.000) | | 0.279 |

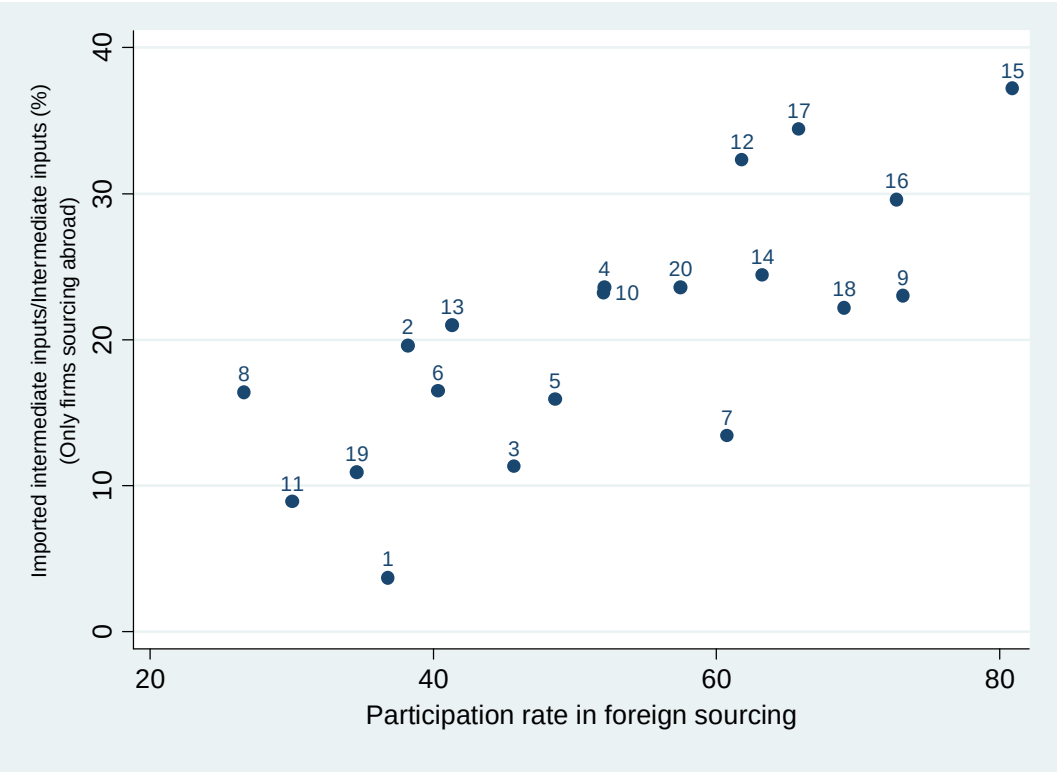
Notes: this table presents the estimated coefficients from an OLS-regression of lnTFP on dummy variables for foreign sourcing firms and some control variables. All regressions include a full set of year dummies. Numbers in parentheses are probability values. The fixed effect model adds firm fixed effects. In order to facilitate the interpretation, the estimated coefficients for the foreign sourcing dummies have been transformed by $100(\exp(\beta)-1)$ where $\beta$ is the OLS-regression coefficient.

**Table 7: Importer premia and foreign sourcing intensity**

| | OLS (Pooled) | OLS (FE) | GMM (Differences) |
|---|---|---|---|
| Foreign sourcing intensity | 0.033<br>(0.057) | 0.109<br>(0.000) | 0.164<br>(0.054) |
| Non-sourcing abroad dummy | -0.010<br>(0.082) | -0.005<br>(0.384) | |
| $(\text{Log(Size)})^2$ | 0.022<br>(0.077) | -0.031<br>(0.330) | -0.123<br>(0.001) |
| $(\text{Log(Size)})^2$ | -0.003<br>(0.015) | 0.004<br>(0.207) | 0.011<br>(0.005) |
| Log (Age) | 0.001<br>(0.715) | 0.044<br>(0.000) | 0.019<br>(0.244) |
| Log (Human capital intensity) | 0.226<br>(0.000) | 0.216<br>(0.000) | 0.167<br>(0.000) |
| Foreign ownership | -0.005<br>(0.595) | | |
| Product and/or process innovation | 0.010<br>(0.021) | | |
| Start foreign sourcing dummy | | | 0.011<br>(0.062) |
| Stop foreign sourcing dummy | | | -0.012<br>(0.042) |
| Sargan test (P-value) | | | 42.840 (0.310) |
| $m_1$ (P-value) | | | -10.992 (0.000) |
| $m_2$(P-value) | | | -0.961 (0.337) |
| N. of observations (firms) | 17,480 (2,405) | 15,075 (2,405) | 12,670 (2,405) |

Notes: this table presents the estimated coefficients from the model [3]. All regressions include a full set of year dummies. Numbers in parentheses are probability values. The instruments used in GMM estimation are: for *Human capital intensity,* the lagged level of the variable as instrument and lagged levels t-2, t-3 and t-4 for *Foreign sourcing intensity.*

**Figure 1: Participation rate in foreign sourcing vs. foreign sourcing intensity by industry**




Notes:

-Foreign sourcing intensity by industry is computed by the weighted averages of the individual ratios of the firms sourcing abroad.
- The list of industries is:

| | |
|---|---|
| 1. Meat and meat products | 11.Non-metallic mineral products |
| 2. Manufacture of food products | 12. Basic metals |
| 3. Beverages | 13. Metal products |
| 4. Textiles and clothing | 14. Machinery and equipment |
| 5. Leather and footwear | 15. Office machinery, computers and precision instruments |
| 6. Products of wood, except furniture | 16. Electrical machinery and communication equipment |
| 7. Paper products | 17. Motor vehicles |
| 8. Publishing and printing | 18. Other transport equipment |
| 9. Chemicals and chemical products | 19. Manufacture of furniture |
| 10. Rubber and plastic products | 20. Manufacturing n.e.c. and recycling |

**Figure 2: Productivity differences between firms sourcing abroad and firms which do not source abroad.** (Smooth sample distribution function)