American Economic Review 2012, 102(7): 3594–3627
http://dx.doi.org/10.1257/aer.102.7.3594

Innovation and Foreign Ownership†

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The pervasiveness of large and persistent productivity differences across firms within narrowly defined industries is a well-established fact that continues to intrigue researchers (see surveys by Syverson 2011; Ichniowski and Shaw forthcoming). One salient example that has attracted much attention in several different fields is that multinational subsidiaries generally outperform domestic firms.[1] Many have argued that this is because multinationals transfer superior technologies and organizational practices—in the form of new product and process innovation—to their foreign subsidiaries.[2] However, since the most prevalent form of multinational entry is through acquisition (89 percent of FDI flows in developed countries—Barba Navaretti and Venables 2004), rather than through greenfield investment, their superior performance could be due to the selection of higher-performing domestic firms. To date, little is known about the economic determinants of which domestic firms are selected to become foreign subsidiaries and the extent to which newly acquired subsidiaries increase their productivity by innovating—introducing technologies that are new to that firm.

In this article, we use a unique panel dataset to analyze both the selection and innovation decisions of multinational firms. We propose a new mechanism to explain how these decisions are jointly determined, highlighting how the market access provided by multinationals creates incentives for subsidiary innovation and, hence, acquisition. We argue that one cannot fully understand the relationship between foreign ownership and innovation without explicitly recognizing that the incentives for innovation—to increase firm productivity—and the incentives for foreign acquisition are inherently interdependent.

The data used in the article contain information on an array of internal technological and organizational choices, as well as on foreign ownership and productivity, for

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† To view additional materials, visit the article page at http://dx.doi.org/10.1257/aer.102.7.3594.

[1] Some examples in this literature are Caves (1974), Doms and Jensen (1998), Helpman, Melitz, and Yeaple (2004), Baldwin and Gu (2005), Ramondo (2009), Criscuolo and Martin (2009), and Arnold and Javorcik (2009).

[2] Prominent examples include Teece (1977), Caves (1996), Bloom and Van Reenen (2010), and Branstetter, Fisman, and Foley (2006). See the survey of recent empirical literature in Stiebale and Reize (2011).

approximately 2,800 Spanish manufacturing firms between 1990 and 2006.[3] The main distinguishing feature of our data is that we can directly observe different productivity-enhancing actions taken within the firm and, hence, do not have to rely on arguably imperfect productivity estimates to show the impact of acquisition. We are able to study precisely what types of innovation the acquired firms implement, such as whether they undertake product or process innovation, assimilate foreign technologies, purchase new machinery, or introduce new organizational practices. We identify our effects by looking at within-firm variation in innovation, using the panel structure of the dataset. In addition, to control for selection into acquisition based on time-varying observable characteristics, we implement a propensity score reweighting estimator to estimate the average treatment effect of foreign acquisition on innovation (Imbens 2004; Busso, DiNardo, and McCrary 2009).

We first analyze which domestic firms are more likely to be the target of acquisition, a largely unexplored question in the international economics literature.[4] Empirically, our data reveal clear evidence of positive selection: foreign firms buy the most productive firms within industries—i.e., they "cherry-pick."[5] Further, we find that accounting for the positive selection leads to a labor productivity premium associated with foreign acquisition that is one-third of the cross-sectional estimate. Nonetheless, after accounting for selection, firm sales increase by 18 percent and labor productivity by 11 percent following acquisition.

Next, we analyze the type of productivity-enhancing innovations acquired firms implement following acquisition. After controlling for selection using a number of different strategies (including, among others, firm fixed effects and the propensity score reweighting estimator), we find that acquisition leads to improvements in a firm's technology: Acquired firms are more likely to innovate.[6] We also explore a distinction that has long been present in the literature about different types of process innovation. Teece (1977) distinguishes between two types of technology transfer in his seminal study of 26 US multinational subsidiaries: the first is "hardware," such as tooling, equipment, and blueprints. The second is the information that must be acquired if this hardware is to be used effectively—the required

[3] Spain has a substantial foreign multinationals presence. In 2005, 16.5 percent of the firms surveyed in our data were foreign owned, representing 43 percent of total sales in Spanish manufacturing. The OECD reports that over 95 percent of foreign direct investment (FDI) in Spain in 2005 originated in another OECD country (OECD.StatExtracts). This is consistent with Markusen (2002) who reports that over 75 percent of all worldwide foreign direct investment is between developed countries.

[4] Existing literature in international economics focuses on which parent firms will choose to engage in FDI (Helpman, Melitz, and Yeaple 2004; Burstein and Monge-Naranjo 2009), and the determinants of the extent of FDI activity (Blonigen 2005). Nocke and Yeaple (2007, 2008) model FDI as the combination of complementary assets and inputs from firms located across different countries, and they evaluate empirical predictions about the parent firm's mode of foreign entry—greenfield or acquisition—as a function of parent firm characteristics. In contrast, we focus on the empirical question of which domestic firms are acquired.

[5] Relatedly, Criscuolo and Martin (2009) show that the observed US multinational productivity advantage is driven mainly by positive selection. In contrast, the corporate finance literature on US M&A activity has mixed evidence on the nature of selection, which reflects varying motives for acquisition. A strand of this literature asserts that low-performing firms are the most likely to be acquired (Lichtenberg and Siegel 1987).

[6] These findings are consistent with Arnold and Javorcik (2009) who analyze the effects of foreign ownership on Indonesian firms, controlling for selection. They find that total investment and investment in new machinery increase under foreign ownership, along with employment, wages, productivity, and sales. They also show that plants receiving foreign investment use more inputs from abroad and export a larger share of exports. Stiebale and Reize (2011), in contrast, find no evidence of an increase in innovation activity in foreign-acquired German firms.

methods of organization.[7] Our results indicate that firms do both simultaneously upon acquisition—i.e., they purchase new machines and adopt new methods of organizing production at the same time, rather than doing either on its own. This is consistent with the finding that it is optimal for firms to implement new information technology and organizational practices jointly, identified by a number of authors (Black and Lynch 2001; Bresnahan, Brynjolfsson, and Hitt 2002; Bartel, Ichniowski, and Shaw 2007), and also shown in the context of multinationals by Bloom, Sadun, and Van Reenen (2012).

The observed positive selection and technology upgrading upon acquisition are consistent with the predictions of a simple model in which the optimal amount of innovation upon acquisition depends on the costs and benefits of the innovation process and, hence, on the initial characteristics of the acquired subsidiary; in turn, the returns to innovation following acquisition determine which firms are acquired. We use the model to illustrate how the selection and innovation decisions are jointly determined. In showing empirical support for the model's predictions, we contribute to the existing literature by providing a new explanation for why some firms do not invest in technology and organizational upgrades (based on variation in the costs and benefits of innovation for heterogeneous firms), helping to explain the puzzle of persistent productivity heterogeneity.

In our model, there is a complementarity between the extent of innovation and the acquired firm's initial characteristics reflected in its initial productivity. This could arise for several reasons. For example, a product upgrade is more valuable when the acquired firm is able to sell more units of the good. Additionally, the benefits associated with a superior production process depend on the skill of the operators, and, more generally, on existing practices in the acquired subsidiary. We show in the model that the complementarity between innovation and the acquired firm's initial productivity is amplified when the foreign parent brings lower innovation costs or greater market access.[8] A foreign firm could bring with it lower innovation costs if it has a lower cost of capital (Desai, Foley, and Hines 2004; Desai, Foley, and Forbes 2008; Manova, Wei, and Zhang 2011) or access to proprietary technologies (Caves 1996; Antrás 2003; Antrás and Helpman 2004), but it could also bring larger benefits from innovation. Multinational firms are known to provide acquired subsidiaries with access to export markets (as shown by Hanson, Mataloni, and Slaughter 2005 for vertical, and by Ekholm, Forslid, and Markusen 2007 for horizontal foreign direct investment), thereby increasing firm scale. With either lower innovation costs or greater market access under foreign ownership, the surplus created by foreign acquisition is increasing in initial productivity. This explains both positive selection and increased innovation.

We empirically explore the relationship between the greater market scale granted by the foreign parent and subsidiaries' innovation decisions. We find that the higher

[7] In the literature on the market for corporate control, Jensen and Ruback (1983) argue that the potential synergies prompting efficient mergers could occur through the adoption of more efficient production or organizational technology. More recently, Bloom and Van Reenen (2010) show that the subsidiaries of multinational firms exhibit more sophisticated managerial practices than do domestic firms across the United States, Europe, and Asia.

[8] The complementarity between innovation and market scale is a major theme of the international economics literature. For example, the promise of greater sales in export markets creates an incentive for a firm to invest in productivity-enhancing technologies (Verhoogen 2008; Bustos 2011; Lileeva and Trefler 2010; Aw, Roberts, and Xu 2011; Atkeson and Burstein 2010).

levels of innovation by foreign subsidiaries are, in large part, driven by firms that export through a foreign parent. Process innovation, product innovation, and assimilation of foreign technologies are each associated with increased market access through the foreign parent. This is consistent with foreign ownership facilitating access to larger markets and thereby creating incentives to invest in firm technology. We are able to determine the role of the export channel, as distinct from export status, because firms in our data are asked how they access export markets and, specifically, whether they export through a foreign parent—which could reflect either using the parent's distribution channels or selling directly to another entity within the multinational. Our findings provide strong evidence that multinational subsidiaries innovate more because they enjoy greater benefits from innovation due to their existing market scale, and not just because their innovation costs are lower than domestic firms'. The fundamental link between foreign ownership—in particular, the increase in market access that comes with foreign ownership—and innovation is absent from the existing studies of trade and innovation, as well as from the literature on organizational structure and productivity.

Note that our empirical results about selection patterns rule out an alternative view of the process of technology transfer—namely, that multinational subsidiaries adopt the same technology level as the foreign parent independent of their initial productivity. If a multinational were able to transplant its own productivity to any acquired firm, the value added through acquisition would be largest for low-productivity firms, leading to negative selection; that is, multinationals would select to acquire the least productive firms.

Our results about positive selection and increased productivity upon acquisition have direct implications for the relationship between multinational activity and the evolution of the productivity distribution, and, hence, allocative efficiency. For firms that become foreign owned, the productivity distribution shifts to the right. Since our results suggest that multinationals do not purchase a random selection of firms but are likely to acquire the initially most productive firms, the results illustrate one channel through which productivity differences across firms in the economy can be amplified over time.[9]

Finally, accounting for the links between the innovation and acquisition decisions can shed light on why foreign multinationals acquire larger firms and on why some firms innovate more than others. Thus, we provide one possible explanation for the persistent productivity differences that have long puzzled researchers. Our study suggests that both acquisition patterns and innovation decisions are determined by the variable costs and benefits of technology transfer. When this is the case, our key insight is that differences in market access alone, and not just foreign firms' innovation-cost advantages or their superior technologies, can explain these phenomena. More generally, the fact that firms within an industry may have differential access to markets provides a new rationale for why initial differences in productivity persist, a fundamental question in organizational economics, strategy, and in other fields (Bloom and Van Reenen 2007; Syverson 2011).

[9] The presence of multinational subsidiaries in an economy is also likely to affect the overall productivity distribution through other channels—for example, by affecting the threshold level of productivity at which entering firms choose to remain in production. We have not examined these other channels in this paper.

The rest of the article proceeds as follows: Section I outlines a simple model illustrating the relationship between acquisition and investment to frame the empirical analysis. Section II describes the data. Section III presents the empirical strategy and results related to the acquisition decision. Section IV focuses on the innovation decision and explores the role of the market access mechanism in driving our main results. Section V analyzes the effect of foreign acquisition on productivity, and Section VI concludes.

I. Aquisition and Innovation Decisions

In this section, we set up a simple industry-level partial equilibrium model to illustrate (i) the endogenous choices of foreign acquisition and innovation when domestic firms differ in initial productivity, and (ii) the complementarities that can emerge among productivity, innovation, and acquisition.[10]

A. *Structure*

Consider a model with heterogeneous domestic firms (Melitz 2003) with a Constant Elasticity of Substitution (CES) demand structure and increasing returns to scale in a setting of monopolistic competition (Helpman and Krugman 1985). The initial productivity of firm i is given by φ_i. Forward-looking foreign firms select which domestic firms to acquire, and all firms choose a level of innovation or other productivity-increasing investment, γ_i. Production and profits reflect post-innovation productivity levels, $\gamma_i \varphi_i$, and the firm's marginal cost is given by $\frac{1}{\gamma_i \varphi_i}$.

The price set by each firm is a constant markup over marginal cost, and each variety in an industry is produced by a single firm. Firm i sets a price $\frac{1}{\rho \gamma_i \varphi_i}$, where ρ is the parameter in the CES utility function that defines the elasticity of substitution between varieties $\sigma = \frac{1}{1-\rho} > 1$, assumed to be constant across all markets.[11] Each firm sells $A_i \rho^{\sigma} (\gamma_i \varphi_i)^{\sigma}$ units, generating revenues of $A_i \rho^{\sigma-1} (\gamma_i \varphi_i)^{\sigma-1}$, where A_i is a measure of market size for the markets relevant to firm i. The profits generated by each firm are given by

$$\pi_i = A_i \left(\frac{1 - \rho}{\rho} \right) \rho^{\sigma} (\gamma_i \varphi_i)^{\sigma-1}.$$

To simplify, we denote $\chi = \left(\frac{1-\rho}{\rho}\right) \rho^{\sigma}$, and work with an increasing transformation of the innovation level $\lambda_i = \gamma_i^{\sigma-1}$ from now on. The value, V_i, of each firm operating in the domestic market (net of the fixed production cost) is equal to

[10] In the model, variation in investment levels across firms are optimal choices under complete information, so that persistent productivity differences are not based on any type of market failure, incomplete information, or X-inefficiency.

[11] The representative consumer's utility function is given by $U = \left[\int_0^N q(i)^{\rho} di\right]^{\frac{1}{\rho}}$, where $\rho \in (0, 1)$. The demand for a particular variety of the product sold by a given firm is $q(i) = \frac{E_i}{P_i}\left(\frac{p(i)}{P_i}\right)^{-\sigma}$, where E_i is total expenditure in the relevant market for good i on all varieties in the industry, and P_i is a weighted average of variety prices in the relevant market. The subindex i on E_i and P_i captures the fact that firms can sell in different markets. We assume that doing so does not incur transport costs. We define $A_i = E_i P_i^{\sigma-1}$. See Dixit and Stiglitz (1977) for further details.

the variable profit it earns, π_i, less the total cost of innovations to increase productivity $C_i(\lambda_i)$:

$$(1) \qquad V_i(\lambda_i) = A_i \chi \lambda_i \varphi_i^{\sigma-1} - C_i(\lambda_i).$$

B. *The Innovation Decision*

We allow the total cost of investment in productivity to be the sum of a fixed and a variable cost of innovation:

$$C_i(\lambda_i) = a_i + b_i f(\lambda_i),$$

where λ_i measures innovation—the improvement in the firm's productivity following the investment. We do not impose any specific functional form on $f(\lambda_i)$.[12]

The firm chooses a level of innovation λ_i^* that maximizes the value of the firm. When the optimal level of innovation is greater than zero, the firm innovates up to the level where the marginal benefit equals marginal cost:[13]

$$(2) \qquad A_i \chi \varphi_i^{\sigma-1} = b_i f'(\lambda_i^*).$$

Equation (2) shows that, ceteris paribus, at an interior solution, innovation, $\lambda_i^* = \lambda^*(A_i, b_i, \varphi_i)$, is increasing in initial productivity level φ_i, and market size A_i, and decreasing in the cost of technology investment, b_i.[14] Figure 1 provides an illustration of the positive relationship between λ_i^* and φ_i for two possible values of $\left(\frac{A_i}{b_i}\right)$.[15] When $\left(\frac{A_i}{b_i}\right)$ is higher, the optimal level of innovation, λ_i^*, is greater for any level of φ_i. This illustrates two important economic mechanisms: the complementarity between innovation and initial productivity, as well as the complementarity between larger market size (or lower innovation costs) and innovation. $\underline{\varphi}_D$ ($\underline{\varphi}_F$) is

[12] We require only that the technology total cost function $C_i(\lambda_i)$ has a continuous first derivative that is strictly positive whenever $\lambda_i > 1$. Note that we do not impose a technological complementarity between innovation and initial productivity, which could reflect an assumption that absorptive capacity (Cohen and Levinthal 1990) is increasing in φ_i. One way to do this would be to specify b_i as a decreasing function of φ_i. The current specification can be extended to include this possibility.

[13] To ensure positive innovation, a_i must be sufficiently low so that firm value under the optimal investment level is larger than firm value under no investment. This is true when $a_i \leq b_i((\lambda^* - 1) f'(\lambda^*) - f(\lambda^*)$. In the interior optimum $\lambda^* > 1$, (since $V'_\lambda|_1 = A_i \chi \varphi^{\sigma-1} - b_i f'(1) > 0$ as $f'(1) = 0$ where we have imposed marginal cost continuity). λ^* is guaranteed to be a maximum as long as marginal cost (or, equivalently, f') is a continuous increasing function of λ. For λ^* to be unique, f' should also be strictly increasing for $\lambda > 1$.

[14] It can be seen from the left-hand side of equation (2) that the model's predictions are robust to specifying post-innovation productivity as an additive function of initial productivity and innovation $(\gamma_i + \varphi_i)$ since the marginal benefit of innovation is also a positive function of φ_i in this case. The multiplicative setup used here is similar to the model in Bustos (2011), where the binary decision about technology investment is related to the export decision. In our case, firms choose whether to invest, but they also optimize over the level of investment as a function of innovation costs. Heterogeneous firm productivities could reflect variation in marginal costs or variation in the quality of output produced, allowing more productive firms to charge higher prices.

[15] The first-order condition (2) does not separately identify A_i and b_i. Access to larger markets and lower marginal costs of investment in technology have similar effects on the choice of λ_i.

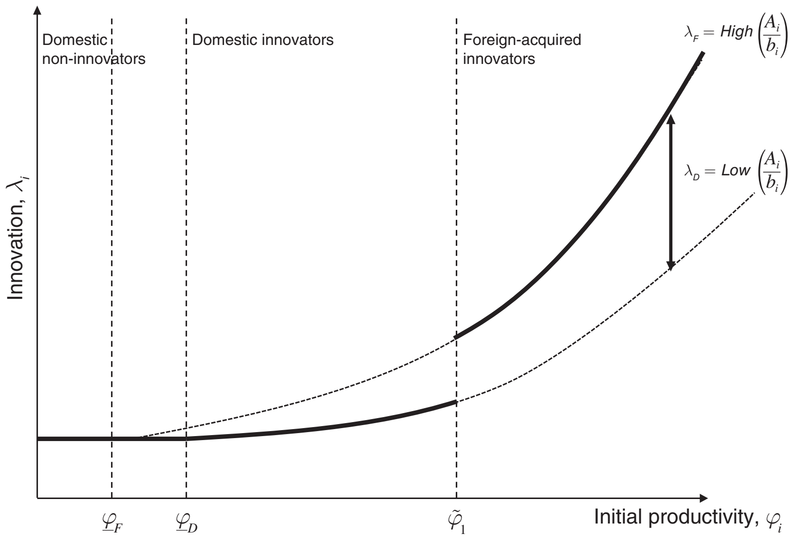

FIGURE 1. PRODUCTIVITY GROWTH AS A FUNCTION OF INITIAL PRODUCTIVITY

the value of φ_i at which a firm with a low (high) value of $\left(\frac{A_i}{b_i}\right)$ would find it worthwhile to invest in innovation.

The optimal amount of innovation, λ^*, given by equation (2), and, hence, the firm's post-innovation productivity level, depend on the costs and benefits of innovation and the firm's initial productivity.[16] However, in contrast, a common assumption in the literature on multinational production is that subsidiaries operate at the same productivity level as their parent, independent of their initial characteristics.[17] This assumption about technology transfer within a multinational firm could be modeled in our setting by allowing any acquired firm to find it optimal to innovate up to the "state of the art" technology level, denoting this technology as the productivity level $\Phi_{\max}$. This would imply that $\lambda_i = \left(\frac{\Phi_{\max}}{\varphi_i}\right)^{\sigma-1}$, so that innovation is a decreasing function of initial productivity.[18] In this case, the amount of innovation would, then, be independent of A_i.

[16] In practice, this represents a world in which the innovation process is costly, and achieving a higher productivity level requires greater expenditure. For example, installing a technology with better machinery or more talented managers is likely to be more expensive, and we might think that there is an increasing opportunity cost of allocating scarce multinational corporation (MNC) resources to a particular acquired firm.

[17] This alternative view of technology transfer is consistent with an assumption made in McGrattan and Prescott (2010), Burstein and Monge-Naranjo (2009), and Ramondo and Rodríguez-Clare (forthcoming) that all subsidiaries of a multinational firm operate with the same productivity (up to a discount factor, typically modeled as iceberg costs).

[18] Once $\Phi_{\max}$ is included in the model, upgrading the subsidiary's productivity to $\Phi_{\max}$ would be optimal if productivity-enhancing innovation incurred only a fixed cost—i.e., $b_i = 0$. When $\Phi_{\max}$ gives the upper bound on the feasible technology, the first-order condition in equation (2) gives the optimal level of investment when b_i is sufficiently high that the firm does not find it optimal to innovate up to $\Phi_{\max}$. This is for $b_i > \frac{A_i \chi \varphi_i^{\sigma-1}}{f'\left(\left(\frac{\Phi_{\max}}{\varphi_i}\right)^{\sigma-1}\right)}$.

C. *The Acquisition Decision*

We denote V_i^* as the value of the firm, given by equation (1), at the optimal investment level λ_i^* for firm *i*. We now turn to how foreign ownership affects innovation and firm value and, hence, how foreign firms select which firms to acquire.

We allow foreign acquisition to affect two model parameters. The trade literature has shown that foreign ownership often provides access to larger markets. If A_D measures the size of the market(s) a domestic firm can access, we allow foreign-acquired firms to have access to an additional market (denoted A^*), where access is granted via the parent firm's preexisting trade contacts and distribution networks in foreign markets. The total market that a foreign-acquired firm can access is, then, $A_F = A_D + A^*$, where $A_F \geq A_D$. Foreign ownership may also bring with it lower innovation costs (access to proprietary technologies, lower costs of financing, etc.), such that $b_F \leq b_D$ or $a_F \leq a_D$. We assume throughout that $0 \leq b_F \leq b_D$ and, for simplicity, that the domestic firm is always at the solution given by the first-order condition in equation (2).

Given the parameter values relevant to the firm's ownership structure, the optimal level of innovation under domestic ownership is λ_i^{*D} and under foreign ownership is λ_i^{*F} (note that the interests of the parent and the subsidiary are aligned in this model). Using equation (1) for firm value under each ownership structure, the incremental value of the firm under foreign acquisition can be written as

$$V_i^{*F} - V_i^{*D} = (A_F \lambda_i^{*F} - A_D \lambda_i^{*D}) \chi \varphi_i^{\sigma-1} - (a_F - a_D) - (b_F f(\lambda_i^{*F}) - b_D f(\lambda_i^{*D})). \tag{3}$$

$(V_i^{*F} - V_i^{*D})$ represents the value created by the acquisition. Under the assumptions that $A_F \geq A_D$, $b_F \leq b_D$ and $a_F \leq a_D$—and at least one of these inequalities is strictly true—expression (3) is positive.

We assume that the price a foreign firm would pay if it were to acquire firm *i*, R_i, divides the value created through the acquisition between the buyers and the sellers, where the buyer receives a share $\alpha_i \in [0,1]$. The acquisitions market can be modeled as a game in which homogeneous foreign parents compete with each other to acquire a subsidiary.[19] We assume that there is a fixed cost to a foreign firm of making an acquisition, *K*, which could include fixed search and transactions costs. Imposing a free-entry zero-profit condition in the acquisitions market implies that firm *i* is acquired whenever the incremental value of the firm under foreign acquisition, $(V_i^{*F} - V_i^{*D})$, exceeds *K*, so that there is a minimum threshold level of φ_i at which acquisition becomes efficient (Ravenscraft and Scherer 1987). Competition among potential foreign parents means that α_i adjusts so that each parent is indifferent between acquiring any domestic firm with an initial productivity above this threshold level.[20] The price paid by the acquirer, $R_i = V_i^{*D} + (1 - \alpha_i)(V_i^{*F} - V_i^{*D})$,

[19] The model could easily be extended to include heterogeneity among foreign parents. This would not change the predictions regarding which domestic firms are acquired but would provide additional predictions related to sorting between parents and subsidiary firms.

[20] Note that this implies $\alpha_i = 1$ for the acquired firm with the lowest initial productivity level, at the minimum threshold φ_i. That is, the surplus generated by the acquisition of the least productive acquired firm is equal to *K* in equilibrium.

varies with φ_i so that the share of the surplus generated going to the buyer, $\alpha_i(V_i^{*F} - V_i^{*D})$, is always equal to K. That is, the following condition holds for all acquisitions:

$$\alpha_i(V_i^{*F} - V_i^{*D}) = K. \tag{4}$$

Now, we can investigate the relationship between acquisition incentives and initial firm productivity.

The optimal amount of innovation satisfies the first-order condition given in equation (2). Applying the envelope theorem to the value of the firm under foreign and domestic control yields $\frac{d(V_i^{*F} - V_i^{*D})}{d\varphi_i^{\sigma-1}} = \chi(A_F\lambda_i^{*F} - A_D\lambda_i^{*D}) > 0$. That is, the value created by foreign acquisition is increasing in initial productivity, and more productive domestic firms are more likely to be acquired. This result arises from the complementarity between foreign firms' characteristics (larger markets and/or lower costs of innovation), innovation, and the acquired firm's productivity: A given innovation is more valuable in more productive firms; this value is greater under foreign control due to, for instance, the access to the foreign firm's distribution networks, which means that the innovation can be leveraged in a larger market and, hence, is more profitable.

A very different scenario emerges under the alternative assumption that multinationals find it optimal to transplant their own superior level of technology, $\Phi_{\max}$, regardless of whom they buy. Under this assumption, the value of the firm under foreign ownership, $V_i^{*F} = A_F\chi\Phi_{\max}^{\sigma-1} - a_F$, is independent of its initial characteristics and, in particular, independent of φ_i. This means that there are no sources of complementarity between the characteristics of the acquired firm and the implemented technology. Since the value of the firm, had it remained under domestic control, V_i^{*D}, is an increasing function of φ_i, the value added by acquisition is decreasing in φ_i, $\frac{d(V_i^{*F} - V_i^{*D})}{d\varphi_i^{\sigma-1}} = -A_D\chi\lambda_i^{*D} < 0$, and less productive domestic firms are more likely to be acquired. That is, the assumption of parent technology transfer generates the opposite prediction from the assumption that innovation is complementary to the acquired firm's initial productivity.

In our model, the identity of the acquiring firm is irrelevant to the optimal choice of innovation. We require only the possibility that the parent brings a lower cost of innovation and/or a larger market than the firm would have had under domestic control. Therefore, any heterogeneity among parents does not affect the model's predictions for innovation and acquisition decisions.

Figure 1 illustrates the predicted relationship between λ_i^* and φ_i when innovation is complementary to the acquired firm's initial productivity. It highlights the role played by selective foreign acquisition. The bold line shows the predicted relationship between initial productivity and innovation within an industry for a given K. In the figure, firms above $\tilde{\varphi}_1$ are acquired and innovate; firms between $\underline{\varphi}_D$ and $\tilde{\varphi}_1$ remain domestic and innovate; and firms below $\underline{\varphi}_D$ remain domestic and do not make any investments.

II. Data Description

The results in this paper are based on the *Encuesta Sobre Estrategias Empresariales* (ESEE), a panel dataset of Spanish manufacturing firms collected by the Fundación

SEPI (a nongovernment organization) and the Spanish Ministry of Industry every year since 1990. It is designed to be representative of the population of Spanish manufacturing firms and includes approximately 2,800 firms (with the intention of surveying all firms with more than 200 employees and a stratified sample of smaller firms). The response rate in the survey is 80 to 100 percent, and new firms are re-sampled over time to ensure that the panel remains representative.[21]

Our data span the years 1990 to 2006. In the first year they appear in the data, 83.5 percent of the firms are domestic, while 16.5 percent are foreign-owned. We define a firm as foreign-owned if it reports that a foreign company owns at least 50 percent of its capital. Ninety-one percent of firms report being either zero- or 100-percent foreign owned. Markusen (2002) defines foreign direct investment through acquisition as an investment in which the firm acquires a substantial controlling interest in a foreign firm. Since 50 percent is a sufficient indicator for foreign control, we have favored this definition of "acquisition" (the results are robust to specifying other thresholds). We restrict our sample to firms that are not owned by a foreign company in the first year they appear in the data, since the model generates predictions about which domestic firms will be acquired. The data do not record any further characteristics of the parent firm. However, our dataset is unique in that, in addition to recording ownership status, it reports a large number of variables that reflect each firm's productivity-enhancing innovation activity. The data include variables indicating whether the firm undertook process and/or product innovation and whether the firm made efforts to assimilate foreign technologies in a given year. These indicator variables reflect firm managers' answers to the survey questions.[22]

The variables recorded in our data allow us to distinguish between process innovation that introduces new machinery and process innovation that introduces new methods to organize production, reflecting the distinction in Teece (1977). The ESEE bases its survey questions on an OECD publication, the Oslo Manual, which was designed to formalize guidelines for collecting and using data on industrial innovation. It acknowledges the fine line between an organizational innovation and other types of process innovation by noting that "a starting point for distinguishing process and/or organizational innovations is the type of activity." In particular, "organizational innovations deal primarily with people and the organization of work." Accordingly, the ESEE asks respondents whether their firm has undertaken a process improvement that involves the use of new machines and/or the use of new methods to organize production. Some examples of the latter are "practices to improve knowledge sharing," "education and training systems," "new methods for distributing responsibilities and decision making," and "management systems for general production or supply operations." Although we do not have any further details on the nature of the technology implemented, when implementation coincides with acquisition, it

[21] Details on the survey characteristics and data access guidelines can be obtained at http://www.fundacionsepi.es/esee/sp/presentacion.asp.

[22] Product innovation could mean upgrading the quality of existing products or, as in Dhingra (2010), developing new products. See online Appendix Table S1 for the exact wording of the survey questions. Note that the questions do not ask whether the firm undertakes R&D activity but, rather, whether it implements an innovation. Salomon and Shaver (2005) and Salomon (2006) study the relationship among product innovation, patenting activity, and exporting activity.

Table 1—Descriptive Statistics

Variable	Mean	SD	Observations
Foreign	0.035	0.184	20,896
ln sales	15.372	1.862	20,845
Base year ln sales (demeaned by industry)	−0.563	1.723	20,845
ln labor productivity	10.399	0.680	20,527
Base year ln labor productivity (demeaned by industry)	−0.166	0.638	20,203
Process innovation	2.236	2.720	20,896
Product innovation	1.700	2.635	20,896
Assimilation of foreign technologies	0.350	0.694	5,555
New machines	0.980	1.550	20,896
New methods of organizing production	0.305	0.773	20,896
Both (new machines and new methods of organization)	0.837	1.677	20,896
Export	0.530	0.499	20,860
Export via foreign parent	0.016	0.125	5,543
Exports/sales	0.139	0.232	20,803
ln exports	14.106	2.614	11,024
ln average wage	10.029	0.447	20,841

Notes: The sample includes the observations from all firms in the ESEE (1990–2006) that are not foreign owned in their first year in the sample (potential acquisition targets). Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. ln sales is the natural logarithm of the firm's real sales. Base year ln sales is the natural logarithm of the firm's real sales, relative to the industry mean, in the first year the firm appears in the sample. ln labor productivity is the natural logarithm of real value added per worker (where value added is calculated by ESEE as the sum of sales plus change in inventory, less purchases and costs of goods sold). Base year ln labor productivity is the natural logarithm of real value added per worker, relative to the industry mean, in the first year the firm appears in the sample. Process innovation, product innovation, assimilation of foreign technologies, new machines, new methods of organizing production, and both are all defined in a similar way and reflect the stock of reported innovations of each type the firm has done during the sample period (see Section IV for more details). Export is an indicator variable that equals one if the firm exports any goods. Export via foreign parent is an indicator variable that equals one if the firm declares that it exports through a foreign parent. Exports/sales is the share of exports over total sales. ln exports is the natural logarithm of real exports. ln average wage is the natural logarithm of the real total wage bill per worker. All real variables are in 2006 euros (deflated using the equipment deflator for inputs into production function and the industry-level producer price index, Indice de Precios Industriales, for final goods).

is likely that some of these organizational practices, along with the assimilation of foreign technologies, reflect technology transfer from the parent.

The data contain other information on these firms' activities that allows us to shed light on the mechanisms at work in our model. In particular, we know whether a firm exports, as well as its volume of exports. We also observe whether the firm uses the foreign parent as a channel for its exports, or if it exports via other means (this information is available only every four years). We do not know of any other dataset that includes all these detailed variables for a large panel of firms over an extended period of time (17 years in our data).

We also use the ESEE data to define two different variables that measure firm productivity. The first is the natural log of the firm's real sales, relative to the industry mean (similar to Verhoogen 2008). The second is labor productivity defined as the natural logarithm of real value added per worker, relative to the industry mean (similar to Lileeva and Trefler 2010). The ESEE categorizes firms into 20 industries, based on the two-digit Classification of Economic Activities in the European Community (NACE) classification. Summary statistics are given in Table 1, and variable definitions are included in the notes to the table.

III. The Acquisition Decision

A. *Estimation Strategy*

The first set of predictions arising from the model reveals which domestic firms are likely to be the targets of foreign acquisitions. When there is a complementarity between a firm's initial productivity level and the amount of innovation, foreign firms acquire the most productive firms in the economy (those with higher φ_i), so that there is positive selection. In an alternative scenario, in which foreign firms transfer their own productivity level to the domestic firm regardless of which firms they buy, negative selection emerges: foreign firms acquire the least productive firms (those with lower φ_i).

We estimate the type of selection at work in the data in the following way: equation (4) says that the share of the surplus generated by the acquisition going to the acquiring firm is equal to K for all acquired firms, and the free entry condition for foreign firms in the acquisition market implies that acquisition takes place whenever $(V_i^{*F} - V_i^{*D}) \geq K$. Rearranging this inequality, we denote $F_{it}^* = (V_i^{*F} - V_i^{*D}) - K$. The binary outcome of the acquisition decision F_{it} can be seen as reflecting a threshold rule for the underlying latent variable F_{it}^*, so that $F_{it} = 1$ (foreign ownership) if $F_{it}^* \geq 0$, and $F_{it} = 0$ (domestic ownership) if $F_{it}^* < 0$. We also allow the average probability of acquisition to vary by year and industry by including year (d_t) and industry (d_s) dummies. Given these assumptions, the probability that a given firm i in industry s is acquired in year t can be estimated using the following linear approximation:

$$F_{it} = \alpha + \beta\varphi_{it-1} + d_t + d_s + \nu_{it}. \tag{5}$$

We first measure the productivity of firm i, φ_{i0}, in the base year (the first year the firm appears in the data, which we subsequently exclude from the analysis) and examine the probability in the data that a firm will ever be acquired (such that we use one observation per firm). We then allow for a time-varying measure of lagged productivity, φ_{it-1}, to examine the probability of being acquired in any given year, conditional on being domestically owned the year before. Empirically, lagged and initial productivity are highly positively correlated, but the ordering of firms based on lagged productivity may better reflect the attractiveness of any one firm at the time of potential purchase.

Under the assumptions of the model, $\hat{\beta}$ is predicted to be positive. In contrast, with negative selection, $\hat{\beta}$ is expected to be negative. Hence, the observed selection effect offers insight into the actual nature of the potential technology transfer from multinational parents to domestic subsidiaries.

B. *Foreign Firms Select the Most Productive Domestic Firms*

Before turning to the analysis, we use our dataset to explore the patterns of selection graphically. Figure 2 plots the distribution of initial productivity (as measured by ln sales) for two groups of firms: those that are acquired by a foreign firm four years after our baseline productivity is computed and those that remain domestic. One can clearly see that the distribution of acquired firms (solid line) lies to the right

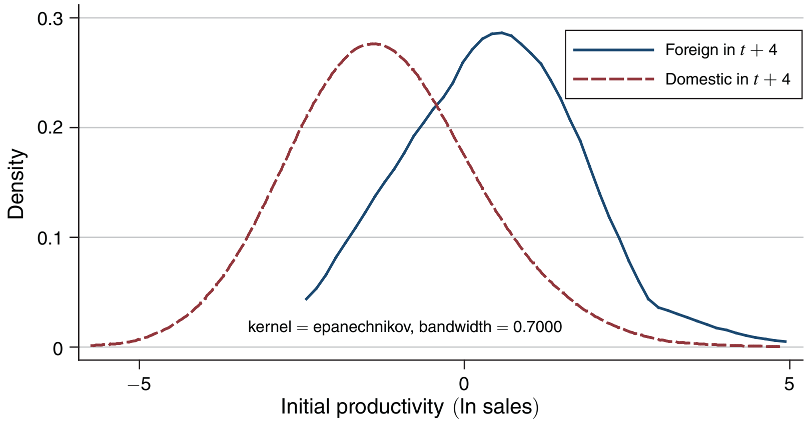

Figure 2. Distribution of Initial Productivity for Acquired and Nonacquired Firms

Notes: The dashed line shows the empirical probability density function (pdf) of initial productivity (measured by ln sales demeaned by industry over the sample period) of firms that are domestic at time t and will stay domestic at time $t + 4$. The bold line shows the empirical pdf of initial productivity of firms that are domestic at time t but will become foreign owned by time $t + 4$.

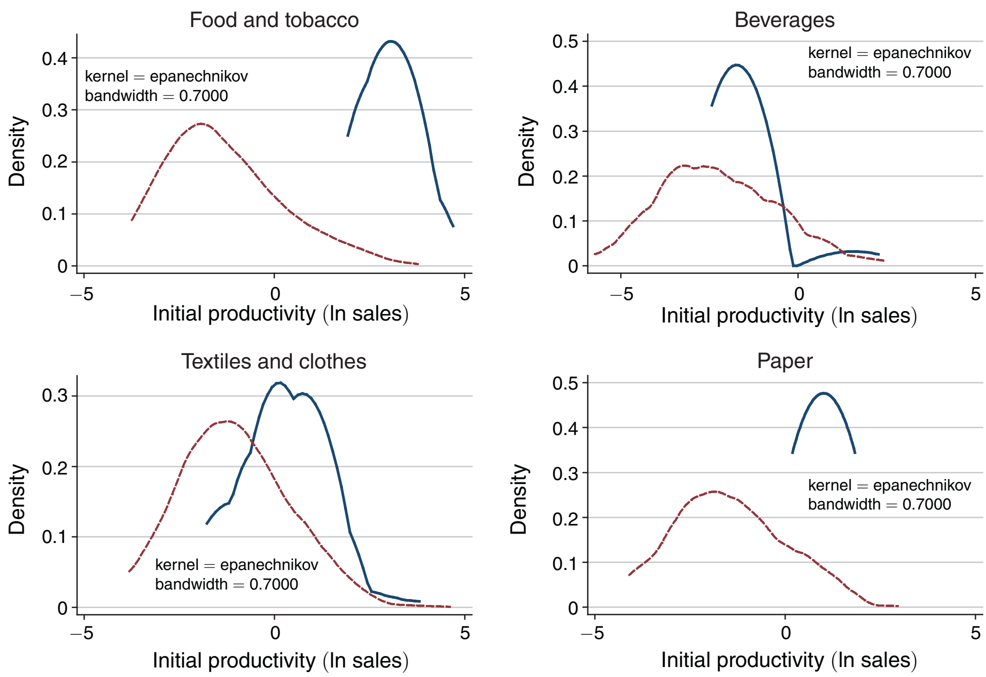

Figure 3. Selection by Industry

(*Continued*)

of those that remain domestic. Since our measure of productivity is demeaned relative to the industry, this does not reflect differences in firm size by industry. Figure 3 reproduces Figure 2 by industry. A striking pattern emerges: Positive selection is present in every industry. These two figures provide prima facie evidence that the positive selection predicted in our model dominates in the Spanish data.

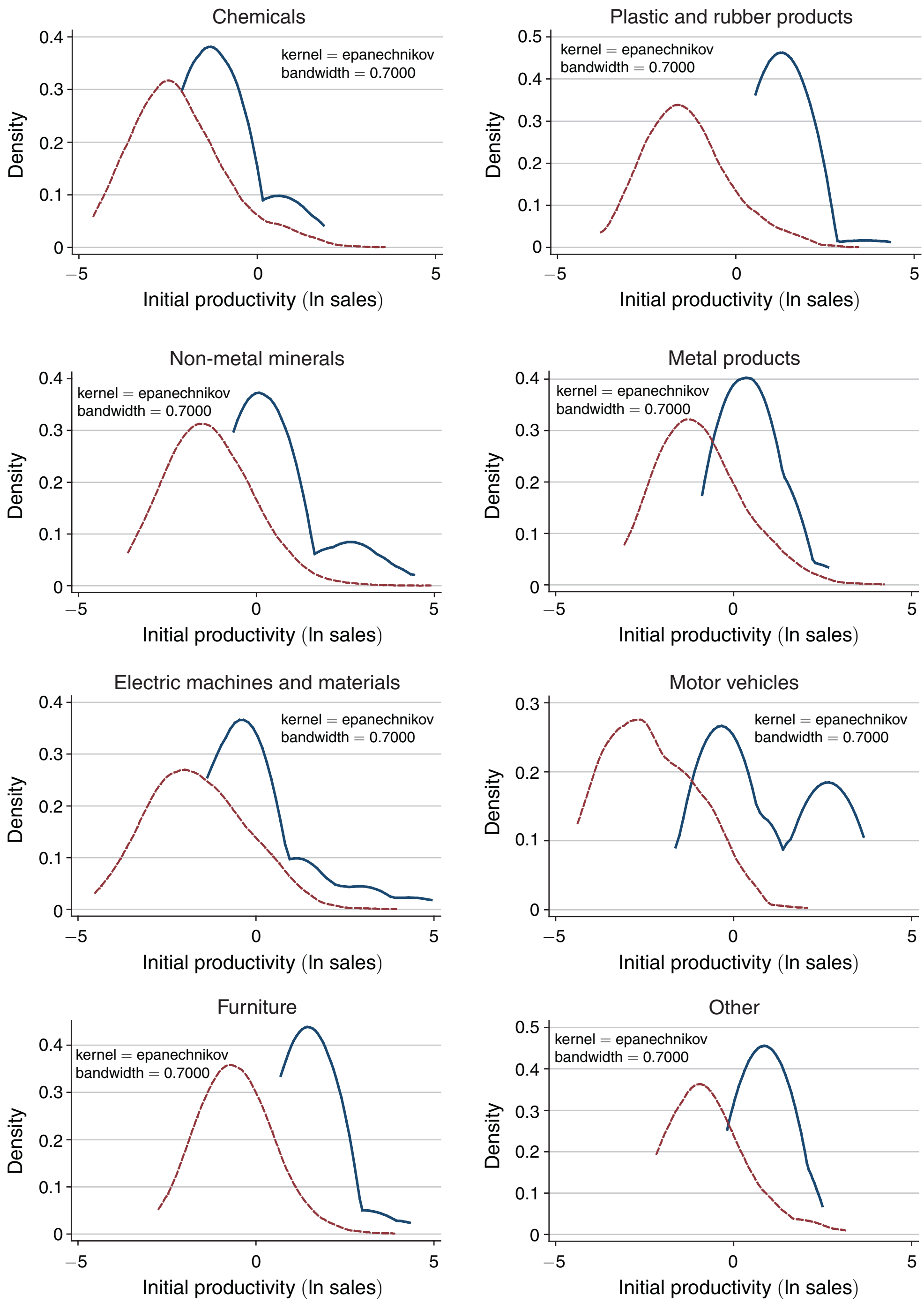

Figure 3. Selection by Industry (*Continued*)

Note: This figure reproduces Figure 2 by industry.

Table 2—The Selection Decision: Linear Probability Specification

	ln sales			ln labor productivity		
Productivity measure	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
Panel A. The probability of being acquired during the sample period						
Base year productivity	0.0351***		0.0279***	0.0300***		0.0222***
	(0.00303)		(0.00431)	(0.00548)		(0.00526)
2nd quartile base year productivity		0.0331***			0.0282***	
		(0.00625)			(0.00873)	
3rd quartile base year productivity		0.0478***			0.0323***	
		(0.00760)			(0.00894)	
4th quartile base year productivity		0.148***			0.0577***	
		(0.0124)			(0.0104)	
Exporting firm in base year			0.00816			0.0542***
			(0.0103)			(0.00828)
Exporting in base year × base year productivity			0.0136**			−0.00204
			(0.00615)			(0.0126)
Observations	3,402	3,402	3,402	3,313	3,313	3,313
R^2	0.093	0.087	0.095	0.029	0.029	0.044
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
Panel B. The probability of being acquired in a given year						
Lagged productivity	0.00630***		0.00502***	0.00772***		0.00513***
	(0.000651)		(0.000916)	(0.00146)		(0.00150)
2nd quartile lagged productivity		0.00449***			0.00276**	
		(0.00112)			(0.00135)	
3rd quartile lagged productivity		0.0109***			0.00786***	
		(0.00176)			(0.00179)	
4th quartile lagged productivity		0.0267***			0.0147***	
		(0.00276)			(0.00237)	
Lag exporting firm			0.000618			0.00883***
			(0.00205)			(0.00158)
Lag exporting firm × lagged productivity			0.00202			0.000960
			(0.00128)			(0.00276)
Observations	20,075	20,075	20,037	19,745	19,745	19,707
R^2	0.019	0.017	0.019	0.009	0.010	0.011
Industry FEs (both panels) and year FEs and industry trends (in panel B)	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. Base year (lagged) ln sales is the natural logarithm of firm's real sales, relative to the industry mean, in the first year the firm appears in the sample (one year prior to the dependent variable). Base year (lagged) labor productivity is the natural logarithm of real value added per worker, relative to the industry mean, in the first year the firm appears in the sample (one year prior to the dependent variable). Exporting firm in base year equals one if the firm was an exporter in the first year it appears in the sample. Lag exporting firm equals one if the firm was an exporter the previous year. The first year the firm appears in the sample is dropped from all regressions. Panel B regressions condition on the firm being not foreign owned in the previous year. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

We now turn to a more systematic analysis and estimate equation (5) to establish this first fact. The estimated coefficients using a linear probability model are shown in panels A and B of Table 2 (online Appendix Table S2 shows that results are similar when using a probit specification). The dependent variable in all columns is the indicator for foreign ownership, and this is regressed on our two proxies for initial productivity. These are the logarithm of real firm sales (columns 1 to 3) and the logarithm of labor productivity (columns 4 to 6), each relative to its industry mean. The regressions in panel A use baseline (initial) productivity measured by these two variables and one observation per firm to estimate the probability of ever being foreign acquired (within the sample). Panel B uses (time-varying) lagged productivity as an independent variable to estimate the probability of being acquired in any given year, conditional on being domestic the year before. All regressions include industry dummies. Additionally, panel B includes year dummies and industry trends, so the results can be interpreted as within-industry differences in the probability of acquisition as a function of initial productivity, controlling for possible differential trends in acquisitions by industry.

Regardless of the productivity measure used, we find that more productive firms are more likely to become foreign owned. For example, the coefficient in column 1a (0.0351) implies that, conditional on being domestic the year the firm enters the sample, a one standard deviation increase in initial productivity makes a firm 6 percentage points more likely to be acquired by the end of the sample. The same increase in lagged productivity is associated with a 1 percent higher yearly probability of being acquired (column 1b).[23]

Columns 2 and 5 replace the productivity variable with indicator variables for each productivity quartile. For example, in column 2a, being in the second sales quartile increases the probability of becoming foreign owned during the sample years by 3.3 percentage points relative to firms in the first quartile (corresponding to a yearly figure of 0.4 in column 2b); being in the third quartile by 4.8 percentage points (1.1 yearly, in column 2b); and being in the highest productivity quartile by as much as 14.8 percentage points (2.7 yearly, in column 2b). A similar pattern emerges when using labor productivity as the productivity measure. Therefore, firms at the upper end of the productivity distribution are substantially more likely to become foreign owned, and the effect is increasing in firm productivity, with firms in the upper quartile having a much higher probability of acquisition.

Finally, columns 3 and 6 explore the possibility that foreign firms are selecting exporters (because, for example, exporting firms have less exchange rate exposure), and exporting is positively correlated with initial productivity. We introduce a dummy variable for exporting status and interact it with initial productivity. Initial productivity always remains positively related to the probability of being acquired, regardless of export status. There is also some evidence that multinationals are more likely to target exporters, but we find no systematic evidence of differential positive selection among exporters. So, overall, even though some firms may be acquired because of their exporter status, positive selection persists, and multinationals are more likely to acquire the most productive firms among both exporters and nonexporters.

Table 2, therefore, reinforces the results from Figures 2 and 3 and shows that, within our cross-section of firms, the more productive domestic firms are more likely to become foreign owned—evidence of positive selection and the presence of "cherry-picking." These selection patterns are inconsistent with a model in which

[23] Table 1 shows that 3.5 percent of our observations are firms under foreign ownership. This corresponds to 165 firms (or 4.6 percent) being acquired during the sample.

foreign firms always find it optimal to transfer their superior technology across international (or firm) borders to any domestic firm, as is often assumed.

While the results in a number of papers point to the presence of positive selection by foreign firms in other countries (e.g., for Chile, Ramondo 2009; for Indonesia, Arnold and Javorcik 2009; for the UK, Criscuolo and Martin 2009), to the best of our knowledge, no prior studies have explained this empirical regularity. When viewed within the context of our model, our finding suggests that acquisition patterns reflect an underlying complementarity between the initial productivity of the acquired firm and the extent of innovation post-acquisition. As we will see later, this finding has significant implications for the relationship between multinational activity in a country and the evolution of the productivity distribution.

IV. The Innovation Decision

A. *Estimation Strategy: Fixed Effects and Propensity Score*

Having established that foreign firms positively select domestic firms as targets, we now test the set of predictions relating productivity-enhancing investments to acquisition—namely, that upon being acquired, foreign subsidiaries invest more in innovation than they would have done had they remained domestic. Our model suggests that acquired firms undertake more investment activity, controlling for the initial productivity of the acquired firm. This can be seen in Figure 1 as the difference between λf and λ_D.

The optimal level of investment under each ownership structure is determined by the first-order condition given in equation (2). In this case, innovation can increase upon acquisition for several reasons. The foreign firm could provide access to a larger market and/or bring with it lower innovation costs, such that $\left(\frac{A_i}{b_i}\right)^F > \left(\frac{A_i}{b_i}\right)^D$.

Our innovation variables are based on the firm-level responses to the questions about whether the firm made specific types of innovation in that year, which we interpret as improvements to firm technology. We are interested in how the firm's technology, which is the result of successive innovations, changes with foreign ownership. Since, at any point in time, the firm's technology can be characterized as the sum of innovations made up to that point, we use the yearly variables on firm-level innovation described in Section II to measure the firm's technology at time t as: $I_{it} = \sum_{j=t_0}^{t} I_{ij}$, where t_0 is the year the firm entered the data.[24] Any differences in technology across firms in the year they enter the data will be captured by the firm fixed effects in our empirical specifications.[25] As a result, all the variation in a firm's innovative activity—and the resulting technology level—that we relate to changes in the firm's ownership structure occurs within the sample.[26]

[24] We have allowed the stock of innovation to depreciate at different rates over time. The results are qualitatively similar to the ones presented with this—the simplest—specification.

[25] First differences specifications of the estimations with three different measures of the innovation stock (process innovation; product innovation; and process innovation that includes both new machines and new organizational practices) are presented as a robustness test in Appendix Table A1.

[26] Online Appendix Table S3 shows that each measure of the stock of innovation I_{it}, enters the production function as a significant shifter of productivity.

Empirically, we first estimate the effect of acquisition on technology using the panel structure of the dataset and including year fixed effects as follows:

$$I_{it} = \alpha + \gamma F_{it-1} + \sum_j \beta^j X^j_{it-2} + d_t + \eta_i + \epsilon_{it}, \tag{6}$$

where I_{it} is a proxy for productivity-enhancing innovation. The fact that the initial level of productivity affects investment directly for foreign-owned firms is absorbed by the firm fixed effects, η_i, along with any other permanent unobserved characteristics of firms. Including firm fixed effects implies that the estimated parameter $\hat{\gamma}$ is a measure of the change in investment after being acquired, controlling for the fact that foreign firms choose to acquire higher initial-productivity firms, and this is predicted to be positive.

The fixed effects specification controls for selection based on time-invariant firm characteristics (e.g., initial productivity). However, it is important in the context of our 17-year panel to acknowledge that firm characteristics may evolve differently over time (for reasons outside the model) and impact multinational selection decisions differentially. In particular, selection may be driven by lagged firm characteristics and decisions that could be correlated with future innovation. To address this and ensure that the estimates of the parameter γ reflect changes in innovation activity associated with acquisition, we use three different strategies. First, we include X^j_{it-2}, a set of j firm-level characteristics, lagged relative to the acquisition decision, that control for selection on time-varying observables.[27] Second, we include an indicator in equation (6) for whether the firm is acquired in the current period (F_{it}) and in the following period (F_{it+1}). This allows us to test directly in the data whether there was a change in the dependent variable that was already taking place prior to the acquisition (in which case, the coefficient on the lead variable should be different from zero).

Third, we use a propensity score estimator to reweight firms in equation (6) to reflect differences in the probability of being acquired based on prior characteristics. We calculate the propensity score for each firm in the following way. For each year, we consider firms acquired in that year as treated observations and firms that are never acquired as control observations. We pool treated and control observations across all years to estimate the probability that a firm is acquired as a function of a number of characteristics (see Lechner 1999). This estimated probability is the propensity score, $\hat{p}$. The characteristics used to obtain the propensity score are lagged productivity (measured by both log firm sales and log labor productivity), lagged log sales growth, lagged export status, lagged average wage, lag of the process innovation stock, innovation activity in the previous year, lagged log capital per employee, lagged log capital, and a year trend. We also allow for this relationship to vary across industries by estimating the propensity score separately for each industry.[28]

[27] The variables that may be correlated both with being acquired and with subsequent innovation activity that are included as controls are: (i) the log of the level of firm sales; (ii) the log of labor productivity (to control for time-varying selection on firm size and productivity); (iii) the log of sales growth (to control for time-varying selection on productivity growth); (iv) export status (to control for time-varying selection on the international presence of these firms and potentially related productivity effects not captured by other variables); (v) average wage (to control for potential selection on changes in the skill mix of firms); (vi) log capital per employee; and (vii) log capital (to control for potential selection on the evolving level of capital and capital intensity of firms).

[28] We also performed the standard tests to check that the balancing hypothesis holds within each industry. We found that all covariates are balanced between treated and control observations for all blocks in all industries. The

One can transform the propensity score estimates into weights such that the propensity score reweighted regression yields a consistent estimate of a parameter of interest (Dehejia and Wahba 1999; Busso, DiNardo, and McCrary 2009). Specifically, weighting each treated firm by $1/\hat{p}$, and weighting each control firm by $1/(1-\hat{p})$, provides an estimate of the Average Treatment Effect (ATE) of acquisition on innovation in a specification like equation (6).[29] We restrict the analysis to firms that fall within the common support. Busso, DiNardo, and McCrary (2009) show that the finite sample properties of this propensity score reweighting estimator are superior to the propensity score matching techniques (where each treated firm is matched to one or several controls).

The propensity score reweighting estimator obtained by reweighting observations in equation (6) allows us to control not only for selection into being acquired on time-invariant characteristics of firms (just like the equal-weighted fixed effects regression), but also for time-varying characteristics through the propensity score. The underlying assumption in the estimation is that, conditional on observable time-varying and any time-invariant characteristics that affect selection, treatment is random. Hence, outcomes for treated firms are attributable only to treatment status (this is typically referred to as the ignorability assumption, or selection on observables).

B. *Acquired Firms Undertake More Innovation*

Since we have detailed information on the types of innovation domestic firms undertake upon foreign acquisition, our data allow us to shed light on the actual process of technology adoption by domestic firms, and on precisely what types of innovations are more likely to be adopted/transferred.

Our measures of innovation are specific actions related to the implementation of product and process innovation, as well as the assimilation of foreign technologies. All the columns in Table 3 reflect regressions of an innovation variable on the lagged foreign ownership variable. As we will see, we observe empirically that innovations take place mainly with a one-year lag, reflecting the fact that it takes some time for firm strategies to change after acquisition. Lagging this independent variable also reduces possible concerns about reverse causality.

In Table 3, we report the results for each investment variable: process innovation (panel A), product innovation (panel B), and assimilation of foreign technologies (panel C). The first column in each panel includes only firm fixed effects; the second also includes industry-specific time trends; the third adds a large set of lagged controls (to control for possible differences in innovation related to previous firm characteristics); the fourth column also adds the lead and contemporaneous indicators of acquisition; the fifth column presents the propensity score reweighted estimates.[30]

relationships between each of these variables and the probability of being acquired are shown in online Appendix Table S4. Lagged ln firm sales is the most significant predictor of acquisition, consistent with our model.

[29] Since never-acquired firms may be used as controls more than once, we sum the control weights by firm to obtain the weight for the control firm (Lechner 1999). We also winsorize the weights at 1 percent because of extreme outliers in the weights. The results are not sensitive to the exact outlier cutoff.

[30] As we will see, the number of observations changes with the specification used, because of changes in the number of nonmissing observations as we include more variables and their lags. Online Appendix Tables S6 and S7 repeat all the analysis that follows, restricting the sample to only the nonmissing observations of the most restrictive sample. The results are similar, so we chose to provide the estimates on the unrestricted sample in the main body of the article.

TABLE 3—FOREIGN OWNERSHIP AND INNOVATION

	Process innovation				
	(1a)	(2a)	(3a)	(4a)	(5a)
Panel A					
Lag foreign	0.574***	0.419**	0.388*	0.411**	0.611**
	(0.190)	(0.180)	(0.223)	(0.172)	(0.244)
Foreign				0.0459	
				(0.109)	
Forward foreign				0.0663	
				(0.149)	
Observations	20,722	20,671	14,656	12,767	17,578
R^2	0.499	0.527	0.529	0.534	0.532
p-value of test lag foreign = forward foreign				0.0476	
	Product innovation				
	(1b)	(2b)	(3b)	(4b)	(5b)
Panel B					
Lag foreign	0.387*	0.293	0.0718	0.219	0.227
	(0.205)	(0.202)	(0.234)	(0.181)	(0.281)
Foreign				−0.0914	
				(0.113)	
Forward foreign				−0.0416	
				(0.162)	
Observations	20,722	20,671	14,656	12,767	17,578
R^2	0.368	0.410	0.406	0.412	0.399
p-value of test lag foreign = forward foreign				0.150	
	Assimilation of foreign technologies				
	(1c)	(2c)	(3c)	(4c)	(5c)
Panel C					
Lag foreign	0.144*	0.111	0.0565	−0.0318	0.123
	(0.0736)	(0.0705)	(0.0882)	(0.108)	(0.0817)
Foreign				0.151	
				(0.110)	
Forward foreign				0.108	
				(0.0750)	
Observations	5,434	5,434	4,100	2,886	4,348
R^2	0.160	0.200	0.213	0.226	0.188
p-value of test lag foreign = forward foreign				0.258	
Firm FEs	Yes	Yes	Yes	Yes	Yes
Industry trends		Yes	Yes	Yes	
Selection controls			Yes	Yes	
Propensity score weighting					Yes

Notes: Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. The dependent variables are our measures of innovation (see Section II for further details). Selection controls include lagged ln firm sales, lagged ln labor productivity, lagged sales growth, lagged export status, lagged average wage, lagged ln capital per employee, lagged ln capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

The fixed effects specifications in columns 1 to 3 of panel A show that process innovation is positively and significantly associated with foreign ownership. Column 1a shows that a foreign-acquired firm is 57 percent more likely to have undertaken a process innovation while foreign owned, relative to a firm that stays domestic. This estimate is robust to controlling for industry trends and lagged firm characteristics (columns 2a and 3a). Column 4a shows that the coefficient estimate on the lead indicator for acquisition is not significantly different from zero. Furthermore, it is significantly smaller than the coefficient of interest (as shown by the p-value of 0.048). Column 5a presents the propensity score reweighted regressions that allow us to control for time-varying selection. The coefficient 0.611 is similar to earlier columns and also highly significant, implying that firms undertake more process innovation upon acquisition.[31]

Turning to the second and third panels of Table 3, the estimated coefficients in column 1 reveal that product innovation and the assimilation of foreign technologies also increase after acquisition. However, the point estimates fall, and the standard errors are larger with further controls and in the propensity score estimation.[32] These results are the average over all types of acquired firms, and as we will see in Section IVC, there is evidence that these two types of innovation increase significantly in firms that export through the foreign parent after acquisition.

Table 4 shows the effect of foreign ownership on the disaggregated measures of process innovation. We distinguish between firms that report to have invested only in new machines (panel B), only in new methods of organizing production (panel C), or in both simultaneously (panel A). The results reveal some interesting contrasts. While foreign-acquired firms are not significantly more likely to only introduce new machinery or only introduce new ways of organizing production, the simultaneous introduction of new machinery and new organizational processes is significantly associated with foreign acquisition (Teece 1977). Panel A shows this result. Both the fixed effects specifications of columns 1a to 4a and the propensity score estimation of column 5a show that upon acquisition, firms are more likely to introduce new machines and new organizational methods simultaneously.[33] This is an interesting result since we might have expected that foreign firms would also be more likely to introduce either type of process innovation independently. The findings are consistent with the complementarities found by Black and Lynch (2001), Bresnahan, Brynjolfsson, and Hitt (2002), and Bartel, Ichniowski, and Shaw (2007) between different types of technology upgrading. Since firms appear to introduce both types of innovations jointly, it is important to allow for the effect of both actions when quantifying the multinational productivity advantage.[34]

[31] The results shown in the first differences specifications in Appendix Table A1 reveal that this increase occurs only one year after acquisition, with further increases in the second and third years.

[32] Note that the variable indicating the assimilation of foreign technologies is available only every four years, reducing the number of observations in these specifications and, thus, reducing the power of the fixed effects results since we have, at most, five observations within a firm for this variable.

[33] The first differences specification in Appendix Table A1 reveals that, for the subset of firms in that specification, the firms that are acquired are more likely to undertake both types of process innovation prior to acquisition, but are also even more likely to undertake both types of process innovation simultaneously after acquisition.

[34] All of our results are robust to the analysis of firms that report no change in reporting unit throughout the time they are in the sample, as well as restricting the sample to firms that report no changes in the number of establishments. This rules out the concern that the definition of the reporting unit changes following acquisition.

Table 4—Foreign Ownership and Innovation: New Machines and New Methods of Organizing Production

	Both (new machines and new methods of organizing production)				
	(1a)	(2a)	(3a)	(4a)	(5a)
Panel A					
Lag foreign	0.430***	0.360**	0.297*	0.321**	0.416**
	(0.156)	(0.144)	(0.159)	(0.136)	(0.209)
Foreign				0.0601	
				(0.0700)	
Forward foreign				0.0591	
				(0.0968)	
Observations	20,722	20,671	14,656	12,767	17,578
R^2	0.244	0.296	0.298	0.299	0.272
p-value of test lag foreign = forward foreign				0.0541	
	New machines				
	(1b)	(2b)	(3b)	(4b)	(5b)
Panel B					
Lag foreign	0.0273	−0.0126	0.0429	0.0346	−0.0193
	(0.0871)	(0.0891)	(0.118)	(0.0882)	(0.132)
Foreign				−0.0225	
				(0.0600)	
Forward foreign				−0.0187	
				(0.0919)	
Observations	20,722	20,671	14,656	12,767	17,578
R^2	0.346	0.368	0.368	0.370	0.382
p-value of test lag foreign = forward foreign				0.610	
	New methods of organizing production				
	(1c)	(2c)	(3c)	(4c)	(5c)
Panel C					
Lag foreign	0.117	0.0710	0.0481	0.0554	0.214**
	(0.0995)	(0.0929)	(0.118)	(0.0777)	(0.0914)
Foreign				0.00836	
				(0.0643)	
Forward foreign				0.0259	
				(0.0884)	
Observations	20,722	20,671	14,656	12,767	17,578
R^2	0.146	0.186	0.178	0.178	0.163
p-value of test lag foreign = forward foreign				0.669	
Firm FEs	Yes	Yes	Yes	Yes	Yes
Industry trends		Yes	Yes	Yes	
Selection controls			Yes	Yes	
Propensity score weighting					Yes

Notes: Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. The dependent variables are our measures of innovation (see Section II for further details). Selection controls include lagged ln firm sales, lagged ln labor productivity, lagged sales growth, lagged export status, lagged average wage, lagged log capital per employee, lagged log capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 5—Access to Export Channel and Process Innovation: Evidence from Panel Data and Propensity Score Weighting

	Process innovation							
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)
Panel A								
Export via foreign parent			0.617**	0.526*	0.869***	0.611**	0.623*	0.647**
			(0.287)	(0.273)	(0.303)	(0.271)	(0.318)	(0.289)
Export	0.172**	0.160**	0.201*	0.181	0.160			0.0803
	(0.0711)	(0.0715)	(0.112)	(0.111)	(0.119)			(0.138)
Lag foreign		0.579***	0.350	0.262	0.608		0.573	1.376*
		(0.193)	(0.510)	(0.441)	(1.038)		(0.482)	(0.779)
Export × lag foreign			0.183	0.0752	−0.248			−1.150
			(0.562)	(0.496)	(1.026)			(0.816)
Observations	20,860	20,686	5,422	5,422	4,096	4,913	4,839	4,839
R^2	0.498	0.500	0.482	0.513	0.543	0.514	0.520	0.552
	Both (new machines and new methods of organizing production)							
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)	(8b)
Panel B								
Export via foreign parent			0.520**	0.429*	0.759***	0.515**	0.536**	0.516**
			(0.254)	(0.234)	(0.255)	(0.220)	(0.256)	(0.205)
Export	0.0508	0.0444	0.0894	0.0707	0.0279			−0.0304
	(0.0491)	(0.0492)	(0.0734)	(0.0700)	(0.0765)			(0.0922)
Lag foreign		0.441***	−0.127	−0.218	−0.169		0.309	0.559
		(0.158)	(0.314)	(0.285)	(0.566)		(0.296)	(0.609)
Export × lag foreign			0.360	0.398	0.360			−0.395
			(0.367)	(0.338)	(0.577)			(0.635)
Observations	20,860	20,686	5,422	5,422	4,096	4,913	4,839	4,839
R^2	0.243	0.244	0.235	0.288	0.317	0.274	0.277	0.357
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry trends				Yes	Yes			Yes
Selection controls					Yes			
Propensity score weighting						Yes	Yes	Yes

Notes: Export is an indicator variable that equals one if the firm exports any goods. Export via foreign parent is an indicator variable that equals one if the firm declares that it exports through a foreign parent. Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. The dependent variables are our measures of innovation (see Section II for further details). Selection controls include lagged ln firm sales, lagged ln labor productivity, lagged sales growth, lagged export status, lagged average wage, lagged log capital per employee, lagged log capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

C. *The Role of Market Access Provided by the Foreign Parent*

These findings on increased process innovation following acquisition, together with our positive selection results, are consistent with a world in which multinationals choose to acquire the most productive firms since that is where the returns to their investment are highest. One explanation for this is that—as proposed in the literature on the sources of multinational advantage—the foreign firm gives access to technology at a lower cost (b_i) than the acquired firm would have faced had it remained under domestic control. However, we highlight an alternative reason for our findings, based on a key feature of multinationals: they often grant their subsidiaries access to a larger global market.

Tables 5 and 6 explore whether innovation decisions are related to the fact that foreign ownership provides access to foreign markets. We regress the innovation variables on indicator variables for whether the firm exports, and for whether the firm exports through the foreign parent. Exporting through the foreign parent may mean that the firm is using the parent's distribution channels and networks to export, or that it sells its goods directly to the foreign parent (as part of a global production system). The base category includes all the channels that were always available to the domestic firms (exporting through its own means, using a Spanish specialized intermediary, or cooperative export agreements with other firms).

Table 5 presents the results for overall process innovation (panel A) and for process innovation that involves the simultaneous introduction of new machines and new methods of organizing production (panel B). Column 1a reveals that exporting is positively associated with investment in process innovation, consistent with the findings of previous studies (Verhoogen 2008; Bustos 2011; Lileeva and Trefler 2010; Aw, Roberts, and Xu 2011). This result holds when controlling for foreign ownership (column 2a), which is also significant, suggesting that the ownership mechanism outlined in this article offers a separate explanation for acquired firms' increased process innovation.

Columns 3a to 5a introduce our key variable of interest, showing fixed effects regressions using process innovation as a dependent variable, where we include the indicator variable for whether the firm exports via the foreign parent. Notably, we find that starting to export through a foreign parent has a large and significant positive coefficient. Since this specification also includes the interaction between exporting and being foreign owned, this suggests that it is not exporting while foreign owned per se, but exporting through the foreign parent, that is associated with innovation.[35]

Since we can distinguish between different types of process innovation, we evaluate the type that exporters are more likely to undertake. Although exporting is, on average, not significantly associated with the simultaneous introduction of new machines and new forms of organizing production (column 1b), foreign-owned firms are more likely to engage in this type of process innovation (column 2b). Column 3b shows that, similar to the process innovation results in column 3a, innovation is driven mainly by the foreign-owned exporters that export via the foreign parent. In contrast, we find that exporting is significantly associated with the introduction of new machines exclusively, while exporting through a foreign parent is not (unreported). This reinforces our findings in Table 4, which suggest that foreign ownership leads to a specific type of process innovation, involving both new machines and new methods of organizing production.[36]

Columns 6 through 8 in Table 5 present the propensity score results for the market access channel, allowing us to better control for time-varying selection. Here, we consider the treatment to be starting to export through the foreign parent, and

[35] Consistent with the idea that foreign firms provide market access to exporting subsidiary firms in our data, Artopoulos, Friel, and Hallak (2011) document that firms with knowledge of business practices in foreign markets are more successful exporters. We argue that foreign firms can provide that knowledge.

[36] We find no evidence that exporting through a foreign parent leads to the introduction of new machines or new organizational practices separately (results unreported).

Table 6—Access to Export Channel, Product Innovation, and Assimilation of Foreign Technologies: Evidence from Panel Data and Propensity Score Weighting

	Product innovation						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)
Panel A							
Export via foreign parent	0.503**	0.477*	0.775***	0.463**	0.655***	0.655***	0.690***
	(0.242)	(0.250)	(0.275)	(0.227)	(0.242)	(0.249)	(0.242)
Export	0.0297	0.0506	0.0391			−0.0744	−0.0422
	(0.105)	(0.0982)	(0.112)			(0.126)	(0.117)
Lag foreign	−0.181	−0.239	−0.179		−0.206	−0.309	−0.248
	(0.290)	(0.253)	(0.451)		(0.384)	(0.319)	(0.295)
Export × lag foreign	0.250	0.179	−0.153			0.106	−0.116
	(0.398)	(0.378)	(0.514)			(0.334)	(0.314)
Observations	5,422	5,422	4,096	4,913	4,839	4,839	4,839
R^2	0.346	0.390	0.418	0.377	0.380	0.380	0.430
	Assimilation of foreign technologies						
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)	(7b)
Panel B							
Export via foreign parent	0.259***	0.241**	0.277**	0.187**	0.197*	0.204*	0.187**
	(0.0993)	(0.0970)	(0.115)	(0.0936)	(0.102)	(0.104)	(0.0938)
Export	0.0103	0.00820	0.0319			−0.00653	−0.00705
	(0.0219)	(0.0217)	(0.0243)			(0.0304)	(0.0284)
Lag foreign	0.0769	0.0655	0.132		0.0477	0.221**	0.217
	(0.0600)	(0.0595)	(0.103)		(0.0890)	(0.110)	(0.137)
Export × lag foreign	0.00849	−0.0108	−0.159			−0.182	−0.217
	(0.0906)	(0.0890)	(0.118)			(0.127)	(0.151)
Observations	5,410	5,410	4,096	4,913	4,839	4,839	4,839
R^2	0.167	0.207	0.221	0.227	0.226	0.226	0.271
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry trends		Yes	Yes				Yes
Selection controls			Yes				
Propensity score weighting				Yes	Yes	Yes	Yes

Notes: Export is an indicator variable that equals one if the firm exports any goods. Export via foreign parent is an indicator variable that equals one if the firm declares that it exports through a foreign parent. Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. The dependent variables are our measures of innovation (see Section II for further details). Selection controls include lagged ln firm sales, lagged ln labor productivity, lagged sales growth, lagged export status, lagged average wage, lagged log capital per employee, lagged log capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

we recalculate the propensity score and the associated weights for each firm as described in Section IVA. Column 6 shows that exporting through a foreign parent is associated with more process innovation (column 6a) and, in particular, with innovation that involves the simultaneous introduction of new machines and new organizational practices (column 6b). This result holds when controlling for lagged foreign ownership (column 7), exporting status, and their interaction, and industry time trends (column 8).

Table 6 shows the effect of market access through the foreign parent on product innovation and the assimilation of foreign technologies. Using both the fixed effects and the propensity score estimator, we find that exporting via a foreign parent leads

TABLE 7—FOREIGN OWNERSHIP, EXPORTS, AND WAGES

	Exports/sales				
	(1a)	(2a)	(3a)	(4a)	(5a)
Panel A					
Lag foreign	0.0422***	0.0422***	0.0403**	0.0400**	0.0666***
	(0.0155)	(0.0155)	(0.0178)	(0.0159)	(0.0247)
Foreign				0.0121	
				(0.0187)	
Forward foreign				0.0124	
				(0.0133)	
Observations	20,630	20,630	14,658	12,767	17,550
R^2	0.041	0.053	0.047	0.052	0.081
p-value of test lag foreign = forward foreign				0.0605	
	ln exports				
	(1b)	(2b)	(3b)	(4b)	(5b)
Panel B					
Lag foreign	0.201*	0.204*	0.174	0.243*	0.333*
	(0.119)	(0.119)	(0.111)	(0.136)	(0.201)
Foreign				0.00395	
				(0.271)	
Forward foreign				0.0840	
				(0.174)	
Observations	10,907	10,907	8,020	7,026	10,058
R^2	0.111	0.124	0.130	0.133	0.164
p-value of test lag foreign = forward foreign				0.266	
	ln average wage				
	(1c)	(2c)	(3c)	(4c)	(5c)
Panel C					
Lag foreign	0.0238	0.0274*	0.0263	0.0312	0.0360
	(0.0152)	(0.0152)	(0.0189)	(0.0215)	(0.0251)
Foreign				−0.00502	
				(0.0170)	
Forward foreign				−0.000806	
				(0.0180)	
Observations	20,667	20,667	14,660	12,771	17,574
R^2	0.211	0.215	0.209	0.204	0.245
p-value of test lag foreign = forward foreign				0.221	
Firm FEs	Yes	Yes	Yes	Yes	Yes
Industry trends		Yes	Yes	Yes	
Selection controls			Yes	Yes	
Propensity score weighting					Yes

Notes: Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. Exports/sales is the share of exports over total sales. ln exports is the natural logarithm of real exports. ln average wage is the natural logarithm of the real total wage bill per worker. Selection controls include lagged ln firm sales, lagged ln labor productivity, lagged sales growth, lagged export status (dropped for exports/sales and ln exports), lagged average wage (dropped for ln average wage), lagged log capital per employee, lagged log capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

to more product innovation and the assimilation of foreign technologies. These results shed light on those in Table 3, where we found a statistically weaker relationship between foreign ownership and these two variables. Once we distinguish between foreign-owned firms that export via a foreign parent and those that do not, we see that those that use the parent as an export channel also invest in new products and assimilate new foreign technologies.

Taken together, these results imply that when firms are acquired by a foreign parent, they increase innovation, especially when the parent firm provides access to export markets. The observed relationship between market access and innovation activity offers further support for the mechanism outlined in the model, as it highlights the role for market access as a driver of innovation decisions. It also indicates that market access can be a sufficient reason for acquisition (even when foreign and domestic firms face similar variable innovation costs), when larger market access increases the potential benefits from investment activity. Furthermore, to the extent that there is persistence in market access, it provides a rationale for persistent productivity differences among firms.

D. *Exports and Wages*

Finally, in Table 7, we show other changes that take place within firms as a consequence of foreign ownership. We study how the share of exports in total sales (panel A), the logarithm of total exports for exporters (panel B) and the logarithm of average firm wage (computed as the total wage bill divided by the number of employees, panel C) change with foreign acquisition. Columns 1 through 4 show the equal-weighted fixed effects specification, and column 5 shows the propensity score reweighted results.

We find that the proportion of exports in total sales increases significantly following foreign acquisition. The propensity score estimate in column 5a shows that the share of exports is, on average, 6.7 percentage points higher in each year for acquired firms than for similar firms that are not acquired. The fact that the sales increase is disproportionately large in foreign markets is consistent with subsidiaries having increased access to these markets after acquisition. We also find that the volume of exports for exporters is 33 percent higher for exporters under foreign ownership (column 5b). Finally, panel C provides some suggestive evidence of average wages increasing upon acquisition, although this is not statistically significant. While this could mean that firms are increasing their wages and/or upgrading the skill of the workforce, we cannot distinguish between these possibilities with the available data.

V. Foreign Ownership and Productivity Evolution

Section IIIB showed that there is positive selection of target firms by foreign multinationals; Section IVB established that, upon acquisition, firms upgrade their technology by doing more process innovation and, in particular, by investing simultaneously in new machines and new methods to organize production. Now, we investigate the effect of acquisition on firm productivity directly, as well as its consequences for the evolution of the distribution of productivity within industries.

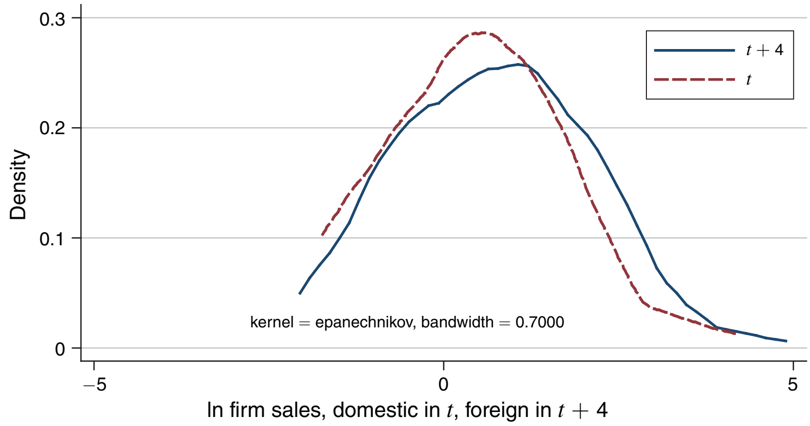

Figure 4. Distribution of Productivity for Acquired Firms, before and after the Foreign Acquisition

Notes: The dashed line shows the empirical probability density function (pdf) of initial productivity (measured by log sales demeaned by industry) of firms that are domestic at time t but will become foreign owned by time $t + 4$. The bold line shows the empirical pdf of productivity of these firms at time $t + 4$ (i.e., after acquisition).

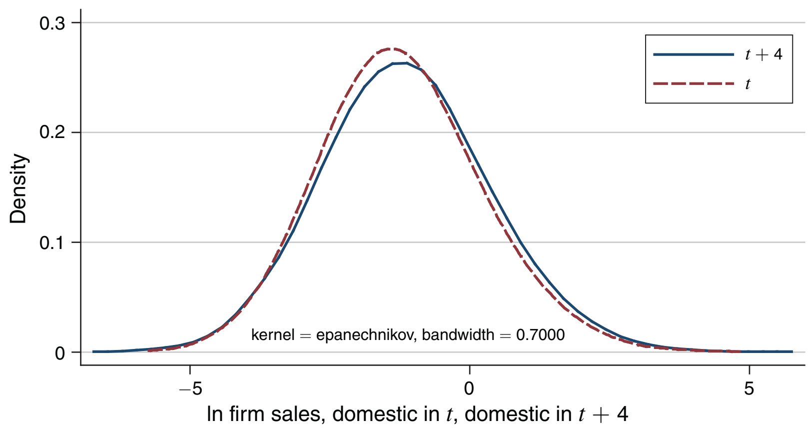

Figure 5. Distribution of Productivity for Nonacquired Firms, Change over Four Years

Notes: The dashed line shows the empirical probability density function (pdf) of initial productivity (measured by log sales demeaned by industry) of firms that are domestic at time t and are still domestic at time $t + 4$. The bold line shows the empirical pdf of productivity of these firms at time $t + 4$.

Under the assumption that the investment activities described above are, indeed, productivity enhancing, we predict that the increased levels of these activities upon acquisition lead to higher productivity for acquired firms. Figures 4 and 5 illustrate our basic productivity results. Figure 4 shows the distribution of firm productivity in the base year, and four years after that, for firms that are domestic in that first year but will be foreign owned four years later. The distribution is shifted to the right, indicating that productivity increased for acquired firms after acquisition over the whole distribution of firm initial productivity. Figure 5 shows the distribution of productivity in the base year and four years later for firms that remained domestic. While there is a slight increase in productivity, it is much less pronounced than for foreign-acquired firms.

Table 8—Foreign Ownership and Firm Productivity

	ln sales					
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
Panel A						
Lag foreign	2.042***	0.165***	0.120**	0.112*	0.0700*	0.182***
	(0.161)	(0.0621)	(0.0599)	(0.0582)	(0.0421)	(0.0540)
Foreign					0.0629	
					(0.0404)	
Forward foreign					−0.0104	
					(0.0646)	
Observations	20,671	20,671	20,671	16,867	14,760	17,578
R^2	0.169	0.100	0.147	0.275	0.284	0.130
p-value of test lag foreign = forward foreign					0.211	
	ln labor productivity					
	(1b)	(2b)	(3b)	(4b)	(5b)	(6b)
Panel B						
Lag foreign	0.367***	0.126***	0.109**	0.0877	0.109**	0.114**
	(0.0496)	(0.0466)	(0.0449)	(0.0538)	(0.0425)	(0.0487)
Foreign					0.0571	
					(0.0390)	
Forward foreign					−0.0218	
					(0.0425)	
Observations	20,359	20,359	20,359	16,639	14,567	17,338
R^2	0.185	0.014	0.031	0.029	0.035	0.016
p-value of test lag foreign = forward foreign					0.0119	
Firm FEs		Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes					
Industry trends			Yes	Yes	Yes	
Selection controls				Yes	Yes	
Propensity score weighting						Yes

Notes: Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership. ln sales is the natural logarithm of the firm's real sales. ln labor productivity is the natural logarithm of real value added per worker. Selection controls include lagged export status, lagged average wage, lagged log capital per employee, lagged log capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 8 shows the results of estimating equation (6) with our measures of productivity as the dependent variable. Column 1 in panels A and B (for each productivity measure) estimates equation (6) without firm fixed effects; columns 2, 3, 4, and 5 progressively add firm fixed effects, industry trends, further selection controls, and lead and contemporaneous indicators of acquisition. Column 6 shows the propensity score reweighting estimates.

The point estimates are much larger in the cross-sectional estimation of column 1 relative to any of the other columns that include fixed effects and better control for selection using the propensity score. This reflects the fact that the positive selection identified earlier will lead to substantial overestimation of the productivity advantage in cross-sectional analysis (as also demonstrated by Criscuolo and Martin 2009)—by as much as three times in the case of labor productivity. However, we also find that acquisition is significantly positively associated with increased productivity, controlling for selection. The propensity score reweighted specifications in column 6 imply that, after acquisition, real sales increase by 18 percent and labor productivity by 11 percent, on average.[37]

Finally, we discuss the implications of our findings for the evolution of the distribution of productivity within industries. We show that foreign firms are more likely to acquire the most productive firms within industries (Table 2), and that, upon acquisition, firms innovate (Tables 3 and 4), increasing productivity (Table 8). This set of results implies that acquisition activity can lead to an increase in the dispersion of the productivity distribution. This is an important consequence of our earlier findings since it has implications for the evolution of within-industry productivity distributions as more foreign firms enter an industry. Under this mechanism, foreign entry does not lead to productivity convergence, but, on the contrary, could lead to further divergence.[38] Of course, there could be other reasons (such as spillover effects or other externalities) why multinational entry may improve less productive firms' productivity. However, the direct effect of the foreign acquisition process is an increase in productivity heterogeneity.

VI. Conclusion

In this paper, we use rich and detailed data on Spanish manufacturing firms to establish that foreign firms acquire the best firms within industries ("cherry-picking") but also invest more in a number of innovation activities upon acquisition. In particular, controlling for the selection effect, firms increase their process innovation, with the simultaneous introduction of new machines and organizational practices. Acquired firms that export through their parent firm also report that they increase their product innovation and start to assimilate more foreign technologies.

We develop a simple model that illustrates how these two facts can be fundamentally related. The model relies on standard assumptions about production, firm heterogeneity, consumer demand and market competition (Helpman and Krugman 1985; Melitz 2003) and incorporates two well-known characteristics of multinational firms: multinationals grant access to larger markets and/or have lower technology-implementation costs. Since the incentives for innovation and acquisition are increasing in initial productivity, the surplus created by the acquisition is also increasing in initial productivity. Therefore, foreign firms find it more profitable to acquire the most productive firms and to innovate more on acquisition.

The observed positive selection suggests that there are complementarities between innovation activity and the initial characteristics of the acquired firm. Our results also suggest a complementarity between market access and innovation. Taken together, these findings can explain a number of important facts: first, why more productive

[37] Unlike the measures of innovation activity, the productivity measures are based on reported revenues. There may be incentives to change how revenues are reported within a multinational by adjusting transfer prices, affecting domestic firms once acquired. For example, reported revenues could reflect removal of double marginalization upon integration. This effect could lead to a decline in revenues, but this is not present in the data. The multinational may also face incentives to misreport the location of profits for tax purposes. We expect this problem to be small, given relative Spanish tax rates.

[38] If multinational entry also serves to raise the threshold level of productivity at which firms exit the domestic market (as in Helpman, Melitz, and Yeaple 2004), the lowest-productivity surviving firm in the distribution will have a higher productivity level. This general equilibrium effect will serve to offset the increase in dispersion described above.

firms innovate more; second, why foreign firms acquire the most productive firms within industries; and third, why foreign-owned firms increase their innovation upon acquisition.[39] Our contribution is to illustrate the drivers of the innovation process and to highlight that superior or proprietary technologies from the parent firm are not necessary to generate the prediction that a given firm finds it optimal to invest more under foreign control than under domestic control.

In addition, the observed complementarity between market scale and innovation offers one explanation for why all firms do not imitate the practices of high productivity firms in the market and why productivity differences persist. To the best of our knowledge, we are the first to link market scale to the jointly determined acquisition outcomes and innovation incentives. Finally, while we focus on the multinational firm's acquisition choice, the economic mechanism we emphasize should also be relevant for purely domestic integration decisions when the acquirer facilitates access to larger markets.

Appendix

Table A1—Foreign Ownership and Innovation: First Differences Specification

	Process innovation		Product innovation		Both (new machines and new methods of organizing production)	
	(1)	(2)	(3)	(4)	(5)	(6)
Lag foreign ($t-1$)	0.119***	0.195***	0.0363	0.0907	0.0731*	0.148***
	(0.0460)	(0.0638)	(0.0411)	(0.0632)	(0.0376)	(0.0504)
2 lag foreign ($t-2$)	0.124**	0.168***	0.0228	0.0355	0.103**	0.124**
	(0.0499)	(0.0617)	(0.0425)	(0.0566)	(0.0409)	(0.0507)
3 lag foreign ($t-3$)	0.0938**	0.0678	0.100**	0.0909*	0.0934**	0.0869*
	(0.0412)	(0.0524)	(0.0400)	(0.0521)	(0.0371)	(0.0489)
Foreign (t)		0.0703		−0.0129		0.0818*
		(0.0642)		(0.0589)		(0.0450)
Forward foreign ($t+1$)		0.0659		0.0358		0.0732*
		(0.0585)		(0.0510)		(0.0421)
2 forward foreign ($t+2$)		0.0341		−0.0247		0.0484
		(0.0467)		(0.0475)		(0.0377)
Observations	12,555	9,292	12,555	9,292	12,555	9,292
R^2	0.038	0.037	0.048	0.050	0.033	0.034
Industry trends	Yes	Yes	Yes	Yes	Yes	Yes
Selection controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: All specifications are in first differences. Foreign is an indicator variable that equals one if the firm has at least 50 percent foreign ownership in that year. The lags and leads of foreign reflect the ownership indicator in different time periods. The dependent variables are our measures of innovation (see Sections II and IV for further details). Selection controls include lagged ln firm sales, lagged ln labor productivity, lagged sales growth, lagged export status, lagged average wage, lagged ln capital per employee, lagged ln capital. All columns include year fixed effects. Standard errors are clustered by firm.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

[39] The article does not address why a foreign firm chooses to enter via acquisition rather than through an arm's length relationship, the subject of a large literature. As discussed in Blonigen (2005), this decision is thought to hinge on the value of internalizing firm-specific assets. Note that the model predictions evaluated in the data in this paper hold even without contractual incompleteness around the technology transfer between different parts of the firm.

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