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Global Sourcing and Foreign Knowledge Seeking

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We develop and test a rigorous theoretical account of firm global sourcing decisions, distinguishing the antecedents of offshore integration from those of offshore outsourcing. Although traditional theories of global sourcing focus on lowering costs, we argue that as high-performing firms seek to develop new capabilities by tapping into foreign knowledge, they will increasingly turn to offshore integration to reap colocation benefits and overcome expropriation challenges. By contrast, offshore outsourcing will be preferred by less profitable firms seeking to tap into low-cost inputs, especially as investments in information technology lower monitoring costs. Empirical analysis of a comprehensive panel of cross-border product transfers by U.S. manufacturing multinational corporations from 1989 to 2004 reveals support for these arguments. Our study thus highlights the effect of foreign knowledge seeking on global sourcing and helps explain recent trends in this increasingly important phenomenon, especially the increasing reliance on offshore integration in technology intensive industries.

Keywords: offshore integration and offshore outsourcing; foreign knowledge seeking; research and development; multinational corporations (MNCs); colocation; organizational economics
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Introduction

Global sourcing—defined as the acquisition of components and products from international sources, including both internal subsidiaries and external suppliers (Kotabe and Omura 1989)—is an important and growing phenomenon (Feenstra 1998). Worldwide, global sourcing accounts for a substantial portion of overall international trade, with the intrafirm portion of the global sourcing of products accounting for one-third of all trade flows (Zeile 1997; United Nations Conference on Trade and Development 2012a, b). For U.S. multinational corporations (MNCs) in the manufacturing sector alone, global sourcing accounted for imports worth $268 billion in 2004, including $171 billion in imports from foreign affiliates (offshore integration) and $97 billion in imports from third parties (offshore outsourcing), according to official benchmark publications from the Bureau of Economic Analysis (BEA). As shown in Table 1, this represents a 6.7% and 5.3% compounded annual growth rate (CAGR) for offshore integration and offshore outsourcing, respectively, over a 15-year period starting in 1989. While sourcing from affiliates in developing countries grew more rapidly than sourcing from developed country affiliates, Table 1 shows that the latter still dominates, accounting for nearly 74% of all offshore integration in 2004. Table 1 also shows that the growth in offshore integration has been driven primarily by trade in technology-intensive industries, where sourcing from foreign affiliates grew by 8.1% per annum relative to 3.8% for other industries. Moreover, this increased growth in high-technology industry sourcing is specific to offshore integration; sourcing from third parties has grown at more or less the same rate across high- and low-technology industries over this same time period.

A growing body of work at the intersection of organizational economics and international trade has sought to examine the antecedents of the global sourcing phenomenon (Antràs and Rossi-Hansberg 2009), focusing on the roles of firm scale, headquarter intensity, and cost differences between countries as drivers of the extent of global sourcing and examining the role of contracting problems in explaining the choice between offshore integration and offshore outsourcing (Grossman and Helpman 2002, Antràs and Helpman 2004, Antràs 2005). These theoretical models have been partially validated by empirical work, with studies using cross-sectional trade data at the industry level to show that global sourcing is influenced by the dispersion of productivity (Yeaple 2006), contract enforcement (Nunn 2007), headquarter intensity (Nunn and Trefler 2008, Bernard et al. 2010), and financial constraints (Carluccio and Fally 2012). In addition, more recent work has stressed the role

Table 1 **Global Sourcing by U.S. MNCs, 1989–2004 (in Billions of Dollars)**

	1989	2004	CAGR (%)
Global sourcing	110.0	268.0	6.1
Offshore integration	65.0	171.0	6.7
Offshore integration by industry			
Hi-tech[a]	38.7	124.5	8.1
All other	26.3	46.5	3.9
Offshore integration by country			
Developed	51.7	126.5	6.1
Developing countries	13.3	44.5	8.4
Offshore outsourcing	45.0	97.0	5.3
Offshore outsourcing by industry			
Hi-tech[a]	23.8	52.5	5.4
All other	21.2	44.5	5.1

Note. Table based on official statistics published in the benchmark survey final results on U.S. direct investment abroad by the Bureau of Economic Analysis from 1989 and 2004.

[a]Hi-tech include all industries identified by the Organisation for Economic Co-operation and Development Directorate for Science, Technology and Industry, Economic Analysis and Statistics Divisions in high- and medium-high-technology industries that include nonsuppressed data for 1989 and 2004 in the BEA publications (and include the pharmaceuticals, electrical machinery and apparatus, automotive, chemical (nonpharmaceutical), and machinery and equipment industries).

of information technology in enabling greater use of third-party suppliers (Rangan and Sengul 2009).

Whereas this work offers valuable insights on global sourcing, its focus has been on the role of global sourcing in allowing firms to access low-cost inputs in foreign countries (Caves 1996, Yeaple 2003b), leveraging abundant labor pools and other resource endowments (Dunning 1998, Nachum et al. 2008) to lower worldwide production costs (Hanson et al. 2001, Kleinert 2003). Consistent with product-life-cycle models (Vernon 1966, Segerstrom et al. 1990), theoretical models in this work assume that it is primarily low-skill tasks that will be moved offshore (Antràs and Helpman 2004, Grossman and Rossi-Hansberg 2008). Such a low-cost-seeking perspective certainly explains the growing reliance on sourcing from developing countries documented in Table 1, as well as the growing use of third-party foreign suppliers to complete low-skill manufacturing in both high-technology and other industries. It does not explain, however, the disproportionate increase in offshore integration by firms in high-technology industries or the continued reliance of U.S. MNCs on subsidiaries in developed countries for the bulk of their internal sourcing.[1] Instead, these facts suggest that U.S. firms increasingly rely on subsidiaries in foreign countries for knowledge-intensive or high-skill tasks, contrary to the assumptions of existing models of global sourcing (Antràs and Helpman 2004, Grossman and Rossi-Hansberg 2008) but consistent with a growing body of strategy research on foreign knowledge-seeking motives for international expansion (Chung and Alćacer 2002; Alcácer 2006; Berry 2006, 2014).

In this paper, we examine the influence of foreign knowledge seeking on the global sourcing choices of firms to provide a more complete theory of global sourcing. We argue that as firms seek to develop new and diverse knowledge and capabilities abroad, they will increasingly rely on offshore integration to capture the full value of interdependencies between research and development (R&D) and production (Bergen and McLaughlin 1992, Adams and Jaffe 1996, Hatch and Mowery 1998, Alcácer and Delgado 2013) and overcome the monitoring and expropriation problems associated with undertaking knowledge-intensive tasks through third parties (Mayer and Nickerson 2005). By contrast, firms that are not pursuing foreign knowledge seeking, and who therefore face less severe contracting problems, may prefer offshore outsourcing as a means to tap into lower input costs abroad, especially as investments in information technology lower the difficulty of monitoring third-party suppliers (Rangan and Sengul 2009). To fully explore the effect of these multiple factors on firm global sourcing choices in a rigorous and integrated manner, we develop a formal model that compares the relative profitability of alternate organizational arrangements while incorporating both the separate and joint effects of knowledge-seeking and low-cost motives for global sourcing. Our model predicts that with growing availability of relevant foreign expertise, firms will increasingly invest in foreign R&D and that firms that do so will prefer offshore integration to overcome expropriation problems and to capture the benefits of colocating R&D and production, with this effect being stronger for high-capability firms.

We test the predictions of our model using confidential and comprehensive panel data from the BEA. These data allow us to study cross-border product transfers by U.S. MNCs from 1989 to 2004 longitudinally at the firm level while controlling for the endogeneity of the firm's decision to invest in foreign R&D. Consistent with our theory, we find that foreign knowledge seeking substantially alters a firm's global sourcing choices. Firms that pursue foreign R&D increase their offshore integration in response to growing foreign research expertise and increasing firm profitability, with this increase in intrafirm product flows coming primarily from developed countries. In contrast, firms that do not invest in R&D are more likely to pursue offshore outsourcing in response to cost pressures, especially where firm performance is

[1] Although prior models have analyzed foreign direct investment in developed countries as a means of serving local markets (see Brainard 1997, Yeaple 2003a), these studies do not consider firm sourcing from these locations.

weak and where increased investments in information technology make it easier to monitor third-party suppliers.

Overall, our study contributes to the global strategy literature by developing and testing a rigorous theoretical account of firm global sourcing decisions that incorporates both low-cost and knowledge-seeking motives while distinguishing between the antecedents of offshore integration and offshore outsourcing. In particular, this paper highlights both the direct and indirect role of foreign knowledge seeking in driving a preference for offshore integration, thus providing a partial explanation for the trends documented in Table 1 while also extending the literature on foreign knowledge seeking (Chung and Alcácer 2002, Alcácer 2006, Alcácer and Chung 2007, Berry 2014) by considering its effect on product sourcing choices. In addition, our study contributes to the organizational economics literature by highlighting the importance of colocation and integration of the firm's value chain in order to capture the full value of new capability development (Mayer and Nickerson 2005, Hsieh et al. 2010, Argyres and Zenger 2012, Kaul 2013). Finally, we contribute to the economics literature by incorporating foreign knowledge seeking into existing models of global sourcing, which to date focus on low-cost motives (Antràs and Helpman 2004, Grossman and Rossi-Hansberg 2008), and by providing a more rigorous empirical test of the antecedents of global sourcing using a longitudinal firm-level analysis.

Knowledge Seeking, Colocation Benefits, and Global Sourcing

The role of foreign knowledge seeking as a driver of a firm's multinational strategy has received growing attention in recent years. Multinational firms are in unique positions to access diverse sets of technical inputs (Singh 2005, Zhao 2006), and knowledge-seeking motives have been identified as a key driver of foreign direct investment (Nachum and Zaheer 2005, Alcácer 2006, Nachum et al. 2008). Firms locate foreign subsidiaries in areas with strong relevant knowledge (Chung and Alcácer 2002, Alcácer and Chung 2007, Chung and Yeaple 2008) to benefit from knowledge spillovers (Jaffe et al. 1993, Almeida and Kogut 1999) and draw from diverse clusters of knowledge and know-how. The diverse and complementary knowledge gained from these foreign locations can then be recombined with the firm's existing knowledge to develop and extend its capabilities (Penner-Hahn and Shaver 2005, Singh 2005) through a combination of intrafirm linkages (Almeida and Phene 2004, Alcácer and Zhao 2012) and multicountry collaboration (Berry 2014). Firms may thus use foreign R&D to create new knowledge and capabilities that enable them to compete globally (Gupta and Govindarajan 2000, Frost et al. 2002, Cantwell and Mudambi 2005), especially if they are technology leaders with strong preexisting research expertise themselves (Cantwell and Janne 1999, Penner-Hahn and Shaver 2005, Berry 2006). Foreign R&D aimed at developing global capabilities[2] is likely to be conducted internally (Alcácer and Zhao 2012), moreover, given the risk of ex post appropriation associated with the creation of specialized knowledge and capabilities (Williamson 1975, Teece 1986), especially in the context of weak intellectual property protection (Zhao 2006).

Increased foreign R&D will not only be accompanied by the transfer of knowledge from foreign R&D operations back to parent firm operations (Gupta and Govindarajan 2000, Almeida and Phene 2004, Singh 2005) but may also prompt firms to increase their global product sourcing from owned manufacturing operations abroad (Kotabe and Swan 1994). The transfer of knowledge between units is often difficult because of its "sticky" nature (von Hippel 1994, Szulanski 1996), and this difficulty is exacerbated by the geographic distance between units (Adams and Jaffe 1996, Hinds and Bailey 2003, Hansen and Løvås 2004), which may result in status differences (Levina and Vaast 2008) and increased conflict (Hinds and Mortensen 2005). Moreover, there are reciprocal interdependencies between R&D and production (Thompson 1967, Van de Ven et al. 1976) that create the potential for learning and synergy but require communication and collaboration across value chain activities to realize (Sobrero and Roberts 2001, Carlile and Rebentisch 2003, Alcácer and Delgado 2013). Greater proximity between R&D and production is thus likely to result in more efficient coordination across product and process innovation (Ettlie 1995, Murray et al. 1995, Datar et al. 1997) and therefore superior productivity and performance (Bergen and McLaughlin 1992, Adams and Jaffe 1996). Importantly, these colocation benefits include both lower costs as a result of improvements in manufacturing (Adams and Jaffe 1996) and superior product offerings as a result of enhanced innovation (Hatch and Mowery 1998).

Our discussion so far suggests that firms may source from abroad not only to tap into low-cost benefits but also to more fully capture the benefits from diverse foreign knowledge. Although this provides a rationale for global sourcing, it does not tell us how such sourcing is best organized, i.e., whether

[2] Some foreign R&D may be undertaken simply to modify products to suit local markets (Kuemmerle 1999). We consider foreign R&D to be knowledge seeking if it has the potential to develop global capabilities (Singh 2005, Alcácer and Chung 2007) as it is likely to be in the context of strong foreign knowledge.

the firm should undertake production through its own subsidiaries (offshore integration) or source from third parties (offshore outsourcing). Prior work on the optimal organizational form for global sourcing has focused on the trade-off between the lower overhead costs of offshore outsourcing on one hand and the difficulty of monitoring and supervising third-party suppliers in the presence of incomplete contracts on the other (Antràs and Helpman 2004, Feenstra and Hanson 2005). Factors that reduce the difficulty of contracting with third-party suppliers, such as stronger contract laws (Nunn 2007) and investments in information technology (Rangan and Sengul 2009), are thus seen to make offshore outsourcing more attractive.

Whereas stronger contract laws and better monitoring through information technology may enable outsourcing of low-knowledge-intensity tasks, they may be less effective when it comes to tasks involving high knowledge intensity (Rangan and Sengul 2009). Not only will greater knowledge intensity exacerbate the difficulty of monitoring third-party vendors, but knowledge-intensive tasks will also be associated with problems of expropriation resulting from specialized investments and interdependencies (Mayer and Nickerson 2005). To the extent that the knowledge and capabilities being developed through foreign R&D are firm specific, realizing the value of these capabilities is likely to require cospecialized investments in production that may lead to ex post holdup problems (Williamson 1975, Argyres and Zenger 2012), especially where the payoffs from these investments are uncertain (Langlois and Robertson 1995, Kaul 2013). Moreover, realizing the interdependencies between R&D and production will require cooperative and creative efforts that are ex ante noncontractible, so that these interdependencies will not be fully realized unless both parties share in the property rights (Grossman and Hart 1986, Hart and Moore 1990, Plambeck and Taylor 2005). Fully realizing these interdependencies may thus require integration under common ownership to enable the transfer and recombination of knowledge across units (Kogut and Zander 1992, Berry 2014). The issue here is not simply the difficulty of transferring knowledge from the parent and protecting it against appropriation (Teece 1986, Liebeskind 1996, Zhao 2006), as traditional theories of internalization have stressed (Hymer 1960, Dunning 1973); the challenge is to motivate and enable the creation of new and diverse knowledge and capabilities abroad.

To summarize, our central argument is that as firms undertake R&D abroad to tap into foreign knowledge, they will also increase offshore integration in order to capture the full value of interdependencies between R&D and production and overcome the expropriation problems associated with third-party production. In contrast, firms that are not pursuing foreign knowledge seeking will tend to prefer offshore outsourcing as a means to tap into lower input costs abroad, especially as investments in information technology lower the cost of monitoring third parties (Rangan and Sengul 2009).

A Formal Model of Global Sourcing

To lay out the argument above more fully, and to rigorously examine the relationships between various antecedents, we develop a formal model of firm global sourcing choices in the presence of foreign knowledge seeking, based on a modified version of the model developed by Antràs and Helpman (2004).

The Model

We consider the sourcing decision of a firm operating in a world with two countries, the North and the South. The firm sells finished goods in the North and faces a downward sloping demand curve such that total revenue R is given by

$$R = A^{1-\alpha} Q^{\alpha},$$

where Q is the total volume of finished goods[3] produced and A is a constant reflecting the demand schedule; $0 < \alpha < 1$ is a measure of product differentiation, where the elasticity of substitution σ is given by $\sigma = 1/(1-\alpha)$.

The firm's production function is modeled as $Q = \theta x$, where Q is the total volume of finished goods, x is the volume of inputs (chosen by the firm), and θ is a parameter that measures the firm's productivity, i.e., the units of output per unit input ($\theta > 0$). We assume that the firm's production technology is given, with the firm combining R&D and production inputs in fixed and equal proportion. Thus, x units of R&D are combined with x units of production to produce θx units of output.

Following Antràs and Helpman (2004), the firm undertakes production in location L, which could be either in the North (N) or in the South (S) (i.e., $L = N, S$), using production mode k, which could be either in-house (v) or outsourced to a third party (o) (i.e., $k = v, o$). Each unit of production costs w^L, where $w^N > w^S$. The cost of production is dependent solely on location; i.e., it is the same whether the production is done internally or outsourced. As in Antràs and Helpman, we assume these costs are exogenously

[3] For ease of exposition, we assume that the firm produces a single finished good; the analysis would be identical if we considered the sourcing decision for one among many finished goods, or a single component, holding the sourcing decisions of all other goods constant.

determined and unchanging. In addition, as with their model, we assume for simplicity that transportation is costless and that there are no tariffs (or equivalently, that transportation and tariff costs are included in w^S).

In addition to the variable input cost, w^L, production is associated with a fixed cost F_k^L. Modeling production costs in this way means that production costs are subject to economies of scale (Brainard 1997), with average costs falling as the firm's output levels increase. We follow Antràs and Helpman (2004) in assuming that fixed costs are higher in the South than they are in the North, and they are equal or higher for integration than for outsourcing. The higher fixed costs in the South are a reflection of the increased administrative difficulty of managing production in a foreign country. The higher fixed costs under integration reflect the need for integrated operations to achieve minimum efficient scale (Kobrin 1991, Adler and Hashai 2007), whereas outsourced operations may benefit from consolidation of volumes across multiple firms and therefore have lower fixed costs. Thus, $F_v^S \geq F_o^S > F_o^N$ and $F_v^S > F_v^N \geq F_o^N$.

In addition to these input costs, production is also associated with effort loss resulting from the difficulty of monitoring production operations. Following Antràs and Helpman (2004), these are modeled as a parameter $\beta_k^L \in (0, 1)$, which equals the fraction of potential production the firm is able to realize under each organizational form. Higher values of β_k^L thus correspond to lower monitoring problems. By assumption, monitoring problems are equal or more severe in the case of foreign production and under outsourcing; i.e., $\beta_v^N \geq \beta_v^S \geq \beta_o^S$ and $\beta_v^N \geq \beta_o^N \geq \beta_o^S$. For simplicity, we assume that $\beta_v^N = 1$, i.e., that there are no monitoring problems with domestic production, although firms may still face monitoring problems when undertaking in-house production abroad, i.e., $\beta_v^S \leq 1$ (Feenstra and Hanson 2005).

Since our primary interest in this study is the examination of the drivers of global sourcing, we make the further simplifying assumption that the cost of domestic production and domestic outsourcing are equal so that the firm is indifferent between the two domestic sourcing options. This is equivalent to assuming that third-party vendors pass on their scale advantages to the firm only to the extent necessary to offset the monitoring problems associated with outsourcing; i.e., any benefit from domestic outsourcing over domestic integration is captured by the third-party vendors and not by the firm. Based on this assumption, we ignore domestic outsourcing and focus on comparing domestic production to offshore integration and offshore outsourcing in what follows. Note that this assumption is made for convenience only; our main predictions are unchanged if we continue to consider domestic outsourcing as an option.

Turning to R&D, we assume that firms can perform R&D either in the North or in the South, but it is always undertaken internally. The cost of one unit of R&D in the North is r^N. Note that given our assumption that the production and R&D units are combined in fixed and equal proportions, the ratio of production costs to R&D costs in the home country $\eta = r^N/w^N$ reflects the relative knowledge intensity of the firm's overall activities, with higher values of η implying greater knowledge intensity of the firm's activities on average.

The North is assumed to have greater research expertise than the South, in line with the idea that the North has a comparative advantage in high-skill tasks. The lower expertise in the South may also reflect the additional cost of maintaining secrecy in a regime with weak intellectual property protection (Zhao 2006), or, equivalently, the risk of knowledge appropriation. Specifically, we define a parameter ϕ^L, which is the research expertise in country L. For convenience, we assume that $\phi^N = 1$ (effectively making research expertise in the North the numéraire) and that $0 < \phi^S \leq 1$. Thus, $r^S = r^N/\phi^S$. Unlike production, the firm can split R&D between the North and the South. This is based on the logic that R&D generally involves diverse, team-based activities with limited investments in capital equipment, so that the economies of scale in R&D are likely to be relatively limited, making it more feasible to split activities across countries. The split of R&D activities is reflected by the parameter λ_k^L, which is defined as the fraction of total firm R&D that is colocated with production, and $0 \leq \lambda_k^L \leq 1$. The average cost of R&D for the firm is then given by $r^N/(1-\lambda_k^L(1-\phi^L))$.

Although R&D in the South may be less efficient than that in the North, we need to distinguish between the level of expertise and its nature or type (Cantwell 1989, Cantwell and Janne 1999, Capron and Mitchell 2009). As discussed above, arguments for foreign knowledge seeking have stressed the diverse and complementary nature of foreign knowledge (Cantwell and Janne 1999, Chung and Alcácer 2002), arguing that firms can combine this knowledge with existing knowledge in order to boost the effectiveness of firm innovation (Almeida and Phene 2004, Singh 2005, Berry 2014). We account for this by introducing a parameter ρ where ρ is a measure of the increase in firm productivity as a result of tapping into diverse but complementary foreign knowledge, with $\rho^S \geq \rho^N = 0$. This effect is assumed to be proportional to the extent of R&D undertaken in the foreign location (λ_k^L). Foreign R&D thus has two competing effects: on the one hand, it lowers the efficiency of R&D because of the lower level of foreign research expertise (ϕ^S); on the other hand, it raises the effectiveness of R&D by tapping into complementary foreign knowledge (ρ^S).

In addition to the direct effect of foreign R&D on the efficiency and effectiveness of the firm's overall innovation efforts, the location of firm R&D may also result in colocation benefits arising from the proximity between production and R&D, which may improve the efficiency of production operations as discussed in the theory above. Specifically, we model the benefit of colocating R&D and production as a potential productivity improvement of $\delta > 0$, with the realized improvement in productivity from colocation being proportional to the share of R&D colocated with production (λ_k^L). Moreover, we assume that the productivity benefits from foreign knowledge and colocation will interact, so that the total increase in productivity for the firm will be $\lambda_k^L(\delta + \rho^L + \delta\rho^L)$.

Not all of these productivity benefits will be captured by the firm, however. The realization of these benefits will face two distinct problems: a monitoring problem (as with production) reflected in β_k^L and an expropriation problem resulting from specialization and interdependency, that we parameterize as γ_k, where γ_k is the proportion of productivity benefit realized by the firm after expropriation. Note that although both β_k^L and γ_k are measures of contracting effectiveness, they reflect two conceptually distinct problems: β_k^L reflects the difficulty of monitoring and holds for both low- and high-knowledge-intensity tasks, whereas γ_k applies only to high-knowledge-intensity tasks and reflects the expropriation challenges associated with ex post holdup arising out of specialized investments, as well as the difficulty of realizing interdependencies through noncontractible effort. Unlike monitoring problems, expropriation problems are unaffected by location in our model and depend solely on whether production is integrated or outsourced. We assume that $\gamma_v = 1 > \gamma_o$; i.e., the firm faces no expropriation problem so long as it integrates production.

Putting these assumptions together, the effective productivity of firm operations under each sourcing option is given by $\beta_k^L\theta(1 + \beta_k^L\gamma_k\lambda_k^L(\delta + \rho^L + \delta\rho^L))$, which captures both the benefits from tapping into complementary foreign knowledge and colocating production and R&D and the increased monitoring and expropriation challenges associated with foreign R&D.

Foreign R&D Choice

Given these assumptions, we can derive the profit-maximizing equilibrium for the firm under each organizational form and then compare the equilibrium profit to see which organizational form is optimal for the firm (Antràs and Helpman 2004). Note that to maximize profit for a given organizational form, the firm has two decisions to make: it must choose how to divide R&D activities between the North and South, and it must choose its level of input (and therefore its level of final output).

We begin by considering the first choice, i.e., the firm's choice of λ_k^L. The firm will choose the fraction of R&D undertaken in the country of production so as to minimize its variable cost per unit output VC_k^L, which is given by

$$VC_k^L = \frac{w^L + r^N/(1-\lambda_k^L(1-\phi^L))}{\beta_k^L\theta(1+\beta_k^L\gamma_k\lambda_k^L(\delta+\rho^L+\delta\rho^L))} = \frac{w^L(1+\eta^L/(1-\lambda_k^L(1-\phi^L)))}{\beta_k^L\theta(1+\beta_k^L\gamma_k\lambda_k^L(\delta+\rho^L+\delta\rho^L))}, \tag{1}$$

where $\eta^L = \eta \cdot (w^N/w^L)$. Thus, $\eta^N = \eta = r^N/w^N$ and $\eta^S = \eta \cdot w^N/w^S$. Clearly, $w^N > w^S \Rightarrow \eta^N < \eta^S$.

As (1) shows, λ_k^L has two effects on variable cost: on the one hand, it may raise the average input cost (the numerator term) as a result of the lower research expertise in the South; on the other hand, it raises the overall productivity of the firm (the denominator term) as a result of colocation benefits and foreign knowledge complementarity. Variable cost is then minimized where the increase in productivity is just offset by the increase in input cost. More specifically, we can derive the value $\lambda_k^{L^*}$ that minimizes variable cost. Taking the first-order condition from (1) and solving for $\lambda_k^{L^*}$, we get[4]

$$\lambda_k^{L^*} = \frac{1}{1-\phi^L}\cdot\left(1+\eta^L - \sqrt{\eta^{L^2}+\eta^L\left(1+\frac{1-\phi^L}{\beta_k^L\gamma_k(\delta+\rho^L+\delta\rho^L)}\right)}\right). \tag{2}$$

Note that since, by assumption, $\phi^N = 1$, we further assume $\lambda_k^{N^*} = 1$. Thus, if the firm locates production in the North, it also undertakes all R&D in the North.

Recall, moreover, that by definition, $0 \le \lambda_k^L \le 1$. Thus,

$$\lambda_k^{L^*} = \max\left(0, \min\left(1, \frac{1}{1-\phi^L}\cdot\left(1+\eta^L - \sqrt{\eta^{L^2}+\eta^L\left(1+\frac{1-\phi^L}{\beta_k^L\gamma_k(\delta+\rho^L+\delta\rho^L)}\right)}\right)\right)\right). \tag{3}$$

Two things about the expression in (3) are worth noting. First, between the values of 0 and 1, the value of $\lambda_k^{L^*}$ is strictly increasing in ϕ^L, implying that, conditional on the firm undertaking production in a country, an increase in the research expertise in that country is likely to result in an increase in the

[4] To show that this value corresponds to a minimum, we calculate the second-order condition and confirm that it is positive (not shown here, but available upon request).

proportion of R&D undertaken in that country. In particular, we can define the bound,

$$\phi^L_{k_{\min}} = \max\left(0, 1 - \frac{\beta^L_k \gamma_k (\delta + \rho^L + \delta\rho^L)(1+\eta^L)}{\eta^L}\right),$$

such that firms only choose to undertake R&D in a country if $\phi^L > \phi^L_{k_{\min}}$. Consistent with our expectations, $\phi^L_{k_{\min}}$ is declining in both δ and ρ^L; i.e., the stronger the knowledge complementarity and colocation benefits of foreign R&D, the greater the inefficiency of foreign R&D the firm can tolerate.

Second, between the values of 0 and 1, the optimal value of $\lambda^{L^*}_k$ in (3) is strictly increasing in both β^L_k and γ_k, meaning that the weaker the monitoring and expropriation problems associated with production, the greater the proportion of R&D colocated with production.

Together, these results imply that as research expertise in the South increases, the proportion of R&D undertaken in the South will rise, with the rise being greater under integration than under outsourcing. Firms are unlikely to undertake foreign R&D where research expertise is low ($\phi^S < \phi^L_{k_{\min}}$), but as research expertise rises, R&D will increasingly shift to the South, until for values of ϕ^S close to 1 (i.e., as research expertise in the South approaches that of the North), all R&D will be undertaken in the South. Moreover, between the values of 0 and 1, the optimal proportion of R&D in the South is always higher under offshore integration than under offshore outsourcing, with integrated firms starting to shift R&D to the South at lower levels of research expertise (since $\phi^S_{o_{\min}} \geq \phi^S_{v_{\min}}$), and undertaking a greater proportion of their R&D in the South for any given level of research expertise in the South—both effects driven by the increased monitoring and expropriation risks of outsourced production.

Profit-Maximizing Equilibrium

Having determined the optimal level of foreign R&D the firm will undertake, we can then examine its choice of input level. From the assumptions above, the firm's overall revenue is given by

$$R^L_k(x) = A^{1-\alpha}(\beta^L_k \theta(1 + \beta^L_k \gamma_k(\delta + \rho^L + \delta\rho^L)\lambda^L_k)x)^\alpha, \quad (4)$$

and its total profits are given by

$$\pi^L_k = R^L_k(x) - C^L_k \cdot x - F^L_k, \quad (5)$$

where $C^L_k = w^L + r^N/(1 - \lambda^L_k(1-\phi^L)) = w^L(1 + \eta^L/(1 - \lambda^L_k(1-\phi^L)))$ is the cost per unit input. Taking the first-order conditions for (5), setting $\lambda^L_k = \lambda^{L^*}_k$, and substituting from (4), we can derive an expression for the firm's equilibrium profit under each organizational form:

$$\pi^{L^*}_k = Z\psi^L_k - F^L_k, \quad (6)$$

where

$$Z = (1-\alpha)A(\alpha\theta)^{\alpha/(1-\alpha)},$$

$$\psi^L_k = \left\{ \frac{\beta^L_k(1 + \beta^L_k \gamma_k(\delta + \rho^L + \delta\rho^L)\lambda^{L^*}_k)}{w^L(1 + \eta^L/(1 - \lambda^{L^*}_k(1-\phi^L)))} \right\}^{\alpha/(1-\alpha)}.$$

The firm will choose the sourcing option that gives it the highest equilibrium profit.

Two things about the expression in (6) are worth noting. First, the Z term in (6) is independent of the choice of organizational form, being dependent only on the level of market demand (A), the extent of product differentiation (α), and the firm's baseline productivity (θ). The relative profitability of the different sourcing options thus hinges on the differences between ψ^L_k under the various options, as well as differences in their fixed costs (F^L_k).

Second, the ψ^L_k term suggests two location-related factors that might make ψ^S_k greater than ψ^N_k, thus making global sourcing more attractive. On the one hand, firms may source from abroad (through either integration or outsourcing) to benefit from the lower production costs ($w^S < w^N$). Indeed, where the firm undertakes no foreign R&D, this is the only rationale for foreign sourcing. On the other hand, firms that do undertake R&D abroad may also benefit from the knowledge recombination benefits of tapping into complementary foreign knowledge (ρ^S). In particular, even if there are no cost benefits to producing abroad (i.e., $w^S = w^N$), firms may still source from abroad for purely knowledge-seeking reasons, especially if foreign research expertise (ϕ^S) is high and when knowledge has high complementarity with a firm's own knowledge (i.e., high ρ^S). In extreme cases, then, the results from our formal model reduce to the purely low-cost-seeking or purely knowledge-seeking cases. More importantly, though, the model suggests a range of scenarios in between these two extreme cases, in which a combination of low-cost and knowledge-seeking drivers may be at play. We now turn to consider the factors that drive the choice of organizational form more closely.

The Choice of Organizational Form Without Foreign Knowledge Seeking

Let us begin by considering the case where knowledge-intensive tasks are limited to the North, i.e., the case where $\phi^S \leq \phi^S_{k_{\min}}$, and firms undertake no foreign knowledge seeking ($\lambda^{S^*}_v = \lambda^{S^*}_o = 0$). In that special case, our more general model reduces to a version of the Antràs and Helpman (2004) model. Specifically, in that case,

$$\psi^N_v = \left\{ \frac{(1+\delta)}{w^N + r^N} \right\}^{\alpha/(1-\alpha)}, \quad \psi^S_v = \left\{ \frac{\beta^S_v}{w^S + r^N} \right\}^{\alpha/(1-\alpha)},$$

$$\psi^S_o = \left\{ \frac{\beta^S_o}{w^S + r^N} \right\}^{\alpha/(1-\alpha)}.$$

Substituting these values in (6) and comparing equilibrium profits, offshore integration will be preferred to offshore outsourcing if

$$\left(1-\left(\frac{\beta_o^S}{\beta_v^S}\right)^{\alpha/(1-\alpha)}\right)\psi_v^S > \frac{F_v^S - F_o^S}{Z}, \tag{7a}$$

offshore integration will be preferred to domestic sourcing if

$$\left\{\frac{\beta_v^S}{w^S+r^N}\right\}^{\alpha/(1-\alpha)} - \left\{\frac{1+\delta}{w^N+r^N}\right\}^{\alpha/(1-\alpha)} > \frac{F_v^S - F_v^N}{Z}, \tag{7b}$$

and offshore outsourcing will be preferred to domestic sourcing if

$$\left\{\frac{\beta_o^S}{w^S+r^N}\right\}^{\alpha/(1-\alpha)} - \left\{\frac{1+\delta}{w^N+r^N}\right\}^{\alpha/(1-\alpha)} > \frac{F_o^S - F_v^N}{Z}. \tag{7c}$$

These inequalities suggest three things. First, increases in firm baseline productivity (θ) will tend to make global sourcing more attractive, since such an increase will raise Z, making both (7b) and (7c) more likely, with the effect being stronger for offshore integration than for offshore outsourcing since, by assumption, $F_v^S - F_v^N \geq F_o^S - F_v^N$ (Antràs and Helpman 2004). Second, the attractiveness of global sourcing increases relative to domestic sourcing as the firm becomes better at monitoring foreign operations (i.e., as β_o^S and β_v^S increase), with this result being stronger for offshore outsourcing than for offshore integration. In particular, (7a) suggests that where the difference in monitoring problems between outsourcing and integration is small (i.e., where β_o^S is close or equal to β_v^S), or where there is no monitoring problem (i.e., $\beta_o^S = \beta_v^S = 1$), offshore outsourcing will be preferred to offshore integration in the no R&D case. Third, (7b) and (7c) imply that the likelihood of global sourcing (either offshore integration or offshore outsourcing) increases as the relative production cost advantage of the South increases, i.e., as w^N/w^S rises. This reflects the low-cost motive of the firm for going abroad. Although these predictions are not entirely novel, they are important both because they confirm the consistency of our model with prior work and because they provide additional empirical tests of the validity of our model.

The Choice of Organizational Form with Foreign Knowledge Seeking

Having looked at the predictions from the model in the case where there is no foreign R&D, we now turn to consider the case where foreign research expertise is high enough to motivate firms to pursue foreign knowledge seeking (i.e., $\phi^S > \phi^S_{k_{\min}}$), which is the focus of our study. From (6) above, we can see that ψ_k^L is rising in β_k^L, γ_k, ρ^L, and ϕ^L. Moreover, (6) also shows that ψ_k^L increases with (endogenously determined) λ_k^{L*}, which, in turn, is increasing in β_k^L, γ_k, ρ^L, and ϕ^L. This means that, other things being equal, the equilibrium profit is higher the greater the research expertise in the country of production, the higher the complementarity of the county's knowledge with the firm, and the less severe the problems of monitoring and expropriation associated with the chosen organizational form. The two effects are multiplicative, moreover, with increases in research expertise and complementarity having a stronger effect on equilibrium profit the greater the values of β_k^L and γ_k. In other words, as the research expertise in the South increases, both offshore integration and offshore outsourcing become increasingly more profitable compared with domestic sourcing, with this increase being faster for offshore integration than for offshore outsourcing.

The relatively stronger effect of foreign research expertise on offshore integration is a result of three factors. First, as implied by (3), the equilibrium level of foreign R&D is always equal or higher under offshore integration than under offshore outsourcing ($\lambda_v^{S*} \geq \lambda_o^{S*}$), so that there is greater potential for productivity benefits from colocation and knowledge complementarity. Second, given the expropriation problems associated with offshore outsourcing of knowledge-intensive production ($\gamma_o < \gamma_v = 1$), the firm is able to realize more of these productivity benefits under offshore integration than under offshore outsourcing.[5] And third, for a given improvement in productivity, the integrated firm is able to capture more value than it can under outsourcing because of stronger monitoring ($\beta_v^S \geq \beta_o^S$). For all three reasons, we expect the equilibrium profits under offshore integration to rise faster than under offshore outsourcing.

A second key point to note about the foreign knowledge-seeking case, from (6), is that ψ_k^L has a multiplicative effect on the relation between firm productivity (θ) and equilibrium profit (π_k^{L*}), meaning that as ψ_v^S increases with increasing foreign knowledge seeking, it not only makes offshore integration more attractive per se but also accentuates the positive effect of firm productivity on the profitability of offshore integration. In other words, high-productivity firms are especially likely to choose offshore integration when they have invested in foreign knowledge seeking. The intuition for this result is that firms with stronger preexisting capabilities are able to realize greater colocation benefits, making offshore production more attractive for such firms and making

[5] The presence of these expropriation problems means that even if there were no monitoring problem (i.e., $\beta_o^S = \beta_v^S = 1$), offshore integration would be preferred to offshore outsourcing in the presence of foreign knowledge seeking.

Table 2 Summary of Model Predictions

Factor	Model parameter	Level of parameter	Empirical measure	Effect on offshore integration		Effect on offshore outsourcing	
				Foreign R&D	No-foreign R&D	Foreign R&D	No-foreign R&D
Foreign research expertise	ϕ^S	Industry	*Industry Foreign Knowledge*	Positive	N.S.	N.S.	N.S.
Firm productivity[a]	θ	Firm	*Parent ROA*	Positive	Positive	Negative	Negative
Monitoring effectiveness[b]	β_o^S	Industry	*Industry ICT*	N.S.	N.S.	Positive	Positive
Relative production cost	$\frac{w^N}{w^S}$	Industry	*Firm Developing Country PPE Proportion*	Positive	Positive	Positive	Positive

N.S., not significant.
[a]Effect is predicted to be stronger in the foreign R&D case than in the no foreign R&D case.
[b]Effect is predicted to be stronger in the no foreign R&D case than in the foreign R&D case.

the need for integration to capture the full value of these benefits more pressing.

Note that the increase in offshore integration with foreign knowledge seeking does not necessarily imply a decrease in the extent of offshore outsourcing. To the extent that firms are replacing knowledge-intensive production in their home country with knowledge-intensive production through foreign subsidiaries, offshore integration may increase with an offsetting decrease in domestic production, leaving offshore outsourcing unaffected. In general, the effect of foreign knowledge seeking on offshore outsourcing is ambiguous, since foreign knowledge seeking reduces the attractiveness of offshore outsourcing relative to offshore integration on the one hand, but increases its attractiveness relative to domestic sourcing on the other hand. Whether offshore outsourcing increases or decreases as a result of an increase in foreign research expertise thus depends on which of these effects dominates.

Table 2 summarizes some key predictions from the formal model that we test empirically below. Foreign research expertise (ϕ^S) is expected to drive an increase in offshore integration, but only for firms that have invested in foreign knowledge seeking, i.e., in foreign R&D. We expect increases in firm productivity (θ) to increase offshore integration and reduce offshore outsourcing as in prior work (Antràs and Helpman 2004), but, importantly, we predict that this effect will be stronger in the case of foreign knowledge seeking than otherwise, with firms that have invested in foreign R&D seeing greater benefit from offshore integration as their productivity increases. Foreign knowledge seeking is also predicted to dampen the effect of monitoring effectiveness on offshore outsourcing, with better monitoring having a strong positive effect on offshore outsourcing in the no-foreign-knowledge-seeking case but a weaker effect with foreign knowledge seeking. Finally, as other models have shown, both offshore integration and offshore outsourcing are expected to increase as the gap between production costs abroad and those at home widens (i.e., as w^N/w^S rises). Thus, the growing importance of cost pressures is expected to increase both offshore integration and offshore outsourcing at the expense of domestic sourcing.

Data and Methods

Data

Our primary source of data is the BEA. We use firm-level data collected in the BEA's benchmark surveys of U.S. direct investment abroad from 1989 to 2004 to construct our measures of offshore integration and offshore outsourcing as well as our explanatory variables, supplementing them with other data sources where necessary. Because the BEA surveys are mandatory, these data provide the most comprehensive information on the worldwide operations of U.S. MNCs available.[6] The BEA surveys are also unique in providing in-depth data on intrafirm, cross-border product transfers between affiliates and other firm operations as well as third-party imports to parent firm operations, making them ideal for our purpose. We include only the benchmark years (1989, 1994, 1999, and 2004) in our study because these surveys reflect as close to the population of U.S. MNCs as possible.

We restricted our sample to manufacturing industries (Standard Industrial Classification (SIC) codes 200–399) because product-flow measures are less meaningful for service industries. Although the BEA

[6] Specifically, the International Investment and Trade in Services Survey Act requires U.S. MNCs to report detailed information on the financial and operating activities of both U.S. parent companies and their foreign affiliates, as well as information on the value of transactions between the parents and affiliates. (See Mataloni and Yorgason 2006 for a thorough description of definitions and survey methodology used by the BEA.)

collects data on all foreign affiliates (defined as business enterprises in which the firm has 10% or greater ownership), we restrict our sample to majority-owned affiliates (more than 50% ownership), which we term *subsidiaries*. We do this because majority-owned affiliates are required to report more detailed information than minority-owned affiliates (50% or less ownership).[7] The vast majority of the subsidiaries in our sample are fully owned (with an average ownership percentage of 95%). Comparisons between our variables created using only subsidiaries with variables created using all affiliates show no statistical difference in sample means. This is not surprising since minority-owned affiliates make up less than 10% of all foreign affiliates of U.S. MNCs. After merging all data sources, we end up with an unbalanced panel of 437 MNCs that we analyze in our empirical results below.

The BEA data provide several advantages, but they also pose some limitations. In particular, whereas our formal model would suggest a country-by-country analysis of the drivers of global sourcing, the BEA does not record the origin of cross-border product flows from third parties, so we are unable to study offshore outsourcing on a country-by-country basis. As a result, we conduct our analysis by aggregating across countries within the firm, distinguishing only between domestic and foreign product flows and operations. In our empirical analysis, then, the South is really an aggregation of all foreign countries.[8] Although aggregating across foreign locations in this way definitely obscures some important heterogeneity between countries, it is consistent with prior work in this area (Kobrin 1991, Nachum and Zaheer 2005, Rangan and Sengul 2009). In addition, as described in more detail below, we conduct supplementary analyses to examine the country of origin for offshore integration, where the BEA data do capture the source of the product flows.

A second limitation of the data is that they include only MNCs, i.e., firms that have at least some foreign operations. Although our empirical results include firms that increase or decrease domestic production relative to global sourcing (with domestic production being the omitted category in the analyses that follow), they are unable to capture firms that rely exclusively on domestic production. The analysis that follows is thus best interpreted as relating to the choice of offshore integration and offshore outsourcing conditional on the firm undertaking some foreign direct investment (FDI).

[7] In particular, affiliates that are less than 50% owned do not consistently report foreign R&D expenditures over our time period.

[8] Aggregating across all foreign countries in this way is also consistent with the model's assumptions about relative production and research costs. Although there are certainly individual countries that may have higher production costs and/or higher research expertise than the United States, it is reasonable to assume that, on average, U.S. MNCs face higher production costs and enjoy greater research expertise at home than abroad.

Measures

Dependent Variables. In line with our theoretical arguments for offshore integration and offshore outsourcing being driven by different factors, we use two main dependent variables, one capturing intrafirm product transfers from owned foreign subsidiaries (*Offshore Integration*) and the other measuring imports from unaffiliated third parties (*Offshore Outsourcing*). As in prior work (Kobrin 1991, Kotabe and Swan 1994), we include both transfers from subsidiaries to the parent firm and transfers from subsidiaries to other subsidiaries in our measure of offshore integration to fully reflect the cross-border product flows from subsidiaries. Unlike that work, however, our offshore integration measure is constructed at the firm level, and we do not include product transfers from parents to subsidiaries (as Kobrin 1991 does) in our offshore integration measure; we include it separately as a control so as to keep our main dependent variable more clearly focused on firm sourcing from subsidiaries. Our second dependent variable, *Offshore Outsourcing*, measures imports from unaffiliated third parties to parent firm operations. As noted above, we are unable to include imports from unaffiliated third parties to subsidiaries to make our two dependent variables perfectly symmetric because the BEA surveys do not capture third-party imports to subsidiaries.

Both of our dependent variables are scaled by a common denominator of firm worldwide sales (Mauri and Phatak 2001). We use worldwide sales as the denominator because we are interested in studying not only the mix of offshore integration and offshore outsourcing in the firm's overall global sourcing but also the overall extent of global sourcing, i.e., the proportion of the firm's overall product that is sourced through either offshore integration or offshore outsourcing. Using worldwide sales as a denominator is also consistent with our theory, since it allows offshore integration and offshore outsourcing to vary independent of each other, in line with the predictions of our formal model. The precise definition of both our measures is spelled out in Table 3.

Independent Variables. Turning to independent variables, we use *Foreign R&D* expenditures to capture the foreign knowledge seeking activities of firms. Although foreign R&D expenditures are unavailable in most public data sets, the BEA surveys ask firms to report expenditures on the pursuit of new scientific knowledge in their foreign subsidiaries (see Yorgason 2007 for more discussion of the BEA survey questions). *Foreign R&D* thus provides a strong measure of

Table 3 Measures

No.	Variable	Description	Source
Second-stage dependent variables			
1	*Offshore Integration*	(Transfers from subsidiaries to parent and other subsidiaries)/(Firm worldwide sales)	BEA
2	*Offshore Outsourcing*	(Parent imports from unaffiliated parties)/(Firm worldwide sales)	BEA
First-stage (probit) dependent variable			
3	*Foreign R&D* (0/1)	Dummy variable where 1 indicates that the firm does foreign R&D	BEA
Independent variables			
4	*Industry Foreign Knowledge*	Stock of industry-relevant patents with non-U.S. inventors as a proportion of total industry-relevant patent stock	NBER, Silverman Concordance
5	*Parent ROA*	(Parent net income (defined as total income minus costs and expenses))/(Parent assets in the United States)	BEA
6	*Industry ICT*	Information and communication technology investments in the firm's main industry	Rangan and Sengul (2009)
7	*Firm Developing Country PPE Proportion*	(Plant, property, and equipment investments in developing countries)/(Total foreign plant, property, and equipment in all foreign countries)	BEA
8	*Parent Size*	Log of parent sales	BEA
9	*Firm Foreign Presence*	(Foreign assets)/(Worldwide assets)	BEA
10	*MNC Knowledge Intensity*	(Parent R&D expenditures)/(Total sales in the United States)	BEA
11	*Parent Exports to Foreign Affiliates*	(Parent sales of goods to foreign subsidiaries)/Firm worldwide sales)	BEA
12	*Firm Weighted RER Change*	Using International Monetary Fund (IMF) end-of-year real exchange rates, the weighted exchange rate growth over benchmark years ($RER_t - RER_{t-5}/RER_{t-5}$) for each firm using weights based on the percentage of total foreign assets the firm has in each focal country	IMF, BEA
13	*Firm-Weighted Tax Difference*	Using corporate tax rates differences from the host country to the United States, firm-weighted tax difference for each firm using weights based on the percentage of total foreign assets the firm has in each focal country	World Tax Database, University of Michigan
14	*Industry Growth Rate*	Average one-year industry sales growth (including MNC and non-MNC firms) in the United States	Compustat[a]
Instrumental variables			
	Foreign Patenting in U.S.	Industry-relevant patents with U.S. inventors assigned to non-U.S. firms as a proportion of total industry-relevant patents	NBER, Silverman Concordance
	Home Country Rivals Abroad	Herfindahl index of sales by U.S. firms outside the United States, by three-digit industry	BEA

[a]Numbers from Compustat are averages of all firms with primary SIC codes for the focal industry.

the extent of foreign knowledge development. Specifically, we construct a binary measure that takes the value of 1 if the firm undertakes any foreign R&D and 0 otherwise. This binary measure serves as the dependent variable for our first-stage regression and is then used to split the sample into foreign-knowledge-seeking and non-foreign-knowledge-seeking subsamples for our main analysis (as described in more detail below). We choose a binary rather than a continuous measure both because that is consistent with our theoretical distinction between firms who pursue foreign knowledge seeking and those who do not in Table 2 and because roughly three-quarters of the firms in our sample undertake no foreign R&D, so distinguishing between those who do and those who do not seems empirically appropriate.

We measure the available foreign research expertise using patent data from the National Bureau of Economic Research (NBER) patent data project.[9] Patent data have been widely used to study foreign innovation and knowledge seeking (Almeida and Phene 2004, Singh 2005, Berry 2014). We use a variant of the industry-foreign-knowledge measure developed by Chung and Yeaple (2008), which considers the proportion of foreign patents in total industry-relevant patents to capture foreign knowledge.[10] Specifically, we first calculate the ratio of the stock of non-U.S. patents to the stock of total patents in every patent class. Patent stocks are calculated using a 15% depreciation rate (Hall et al. 2005), and the country of patent origin is based on the country of the patent's first inventor. The ratio of non-U.S. patents for an SIC code is calculated as the weighted average of the ratio of non-U.S. patents in all patent classes, with the

[9] Data are available at https://sites.google.com/site/patentdataproject/ (accessed July 1, 2010).

[10] Chung and Yeaple (2008) construct their measure at the industry-country level rather than at the industry level. Their measure also differs from ours in that they use a different concordance between patent class and industries than the Silverman concordance we use (see Footnote 11). As they acknowledge, the two concordances are correlated at approximately 0.95. They also use a 20% depreciation rate for knowledge stock.

weights being the frequency with which a patent in a particular patent class maps to that SIC code, based on a convergence between patent classes and SIC codes developed by Silverman (1996).[11] Thus, *Industry Foreign Knowledge*$=\sum_j(p_j w_{ij})/\sum_j w_{ij}$, where subscript i refers to the industry, subscript j refers to the patent class, p_j is the proportion of non-U.S. patents in patent class j, and w_{ij} is the proportion of patents in class j that belong to industry i.

We measure firm productivity using *Parent ROA*, which is the return on assets (ROA) of the parent firm, based on BEA data. To measure monitoring effectiveness, we use an industry-level index of the information and communication technology (ICT) investments, called *Industry ICT*. Prior work has argued and shown that ICT investments lower monitoring and coordination costs, enabling greater use of third parties and reducing cross-border integration (Rangan and Sengul 2009). We follow this work, using measures for ICT investment reported in Rangan and Sengul (2009), which are calculated as ICT expenditures scaled by total employees within the industry and based on data from the U.S. Census Bureau's *Statistical Abstract of the United States*.

Since we do not have measures of production wages by industry for foreign countries, we proxy for foreign production costs by measuring *Firm Developing Country PPE Proportion*. Developing countries are generally lower-cost locations, so that a greater proportion of production capacity in developing countries would imply lower foreign production costs on average (Caves 1996, Dunning 1998). Specifically, we include a measure of each firm's investments in low-cost countries using the firm's proportion of plant property and equipment (PPE) located in developing countries (more specifically, the ratio of developing country PPE to total foreign PPE).[12] We classified countries into "developed" and "developing" using the World Bank country classification, including all countries in the high category as developed countries and the remaining countries as developing, since our home country is a highly developed one. Note that this measure is constructed at the firm level, since different firms in the same industry may locate production in different countries. The developing country PPE measure thus reflects the relative production costs of the countries in which the firm operates. As a robustness check, we also include an industry-level measure of foreign to domestic wages calculated using BEA data as an additional control. This measure is problematic because it reflects only wages paid by U.S. MNCs and may not be representative of local wage conditions. Results with this control included (available upon request) are consistent with those shown below, and the measure itself is never significant in our regressions.

Controls. In addition to the main independent variables above, which correspond to the predictions from our formal model (summarized in Table 2), we include a number of additional controls. First, we control for *Firm Size* (measured as the logged value of parent sales) to account for the positive effect of size on global sourcing (Brainard 1997, Yeaple 2006), as well as *Firm Foreign Presence* (operationalized as the proportion of foreign assets to total assets), to account for the fact that firms with greater foreign experience and size may have lower fixed costs when operating abroad. Second, since R&D intensity has been shown to impact global product integration in prior work (Kobrin 1991, Brainard 1997, Rangan and Sengul 2009) and is predicted to impact the pursuit of foreign R&D in our model, we include a measure for *MNC Knowledge Intensity* using the firm's worldwide R&D expenditures divided by worldwide sales (Caves 1996, Berry and Sakakibara 2006). Third, to account for the possibility that flows from foreign subsidiaries are influenced by the flows to foreign subsidiaries from the parent firm, we include a control for *Parent Exports to Foreign Affiliates*, scaled by worldwide sales.[13] Fourth, to account for alternative motives for global sourcing we include measures of relative real exchange rate (*Firm-Weighted RER Change*) and *Firm-Weighted Tax Difference*, based on the firm's foreign locations. Finally, we include a measure of industry growth, calculated as the average one-year growth in sales for firms in the industry (including domestic and multinational firms), to account for changing demand conditions on global sourcing.

Table 3 summarizes the various measures used, as well as the data sources used to construct them, and Table 4 provides summary statistics and correlations.

[11] The Silverman concordance maps patent classes (International Patent Classification, or IPC) to industries (SIC) by calculating the proportion of patents in each IPC class that belong to a particular SIC code using data from the Canadian patent office. This concordance has been widely used in the strategy literature (Silverman 1999, Alcácer and Chung 2007). More details are available at http://www.rotman.utoronto.ca/~silverman/ipcsic documentation_IPC-SIC_concordance.htm (accessed January 26, 2011).

[12] In countries where the firm has a subsidiary but no PPE is reported, we assume PPE to be zero. Our results are unaffected if we exclude such observations from our sample or if we use a measure of total assets instead of PPE.

[13] In robustness checks (not shown, but available upon request), we also include controls for offshore integration in our offshore outsourcing regressions and offshore outsourcing in our offshore integration regressions. Our main findings are robust to the inclusion of these variables, which are never significant in their respective models.

Table 4 Summary Statistics

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1 *Offshore Integration*	0.03	0.05	1.00												
2 *Offshore Outsourcing*	0.025	0.02	0.11	1.00											
3 *Foreign R&D* (0/1)	0.23	0.04	0.08	0.03	1.00										
4 *Industry Foreign Knowledge*	0.46	0.09	0.13	0.07	0.18	1.00									
5 *Parent ROA*	0.05	0.13	0.03	−0.06	0.02	0.07	1.0								
6 *Industry ICT*	2.85	0.72	0.09	0.23	0.05	0.27	−0.02	1.0							
7 *Firm Developing Country PPE Proportion*	0.11	0.17	−0.02	0.01	0.05	−0.02	0.04	−0.19	1.0						
8 *Parent Size*	13.05	1.79	0.11	0.08	−0.01	0.13	0.15	0.20	0.03	1.00					
9 *Firm Foreign Presence*	0.17	0.05	−0.07	0.06	0.05	0.05	0.02	0.06	−0.02	−0.20	1.00				
10 *MNC Knowledge Intensity*	0.035	0.06	0.13	0.11	0.05	0.21	0.06	−0.20	−0.01	0.14	0.05	0.10			
11 *Parent Exports to Foreign Affiliates*	0.02	0.04	0.19	−0.04	0.13	0.04	0.03	0.04	−0.13	0.06	0.11	0.18	1.00		
12 *Weighted RER Change*	0.03	1.02	0.07	−0.02	0.01	0.03	0.01	0.08	0.08	0.06	−0.02	−0.03	0.02	1.00	
13 *Firm-Weighted Tax Difference*	0.03	0.11	−0.03	0.08	0.01	0.05	−0.02	−0.01	0.09	−0.07	−0.03	0.01	0.06	−0.03	1.0
14 *Industry Growth Rate*	0.13	0.13	0.07	0.08	−0.02	−0.04	−0.01	−0.01	−0.02	0.08	−0.09	−0.04	0.04	0.01	0.04

Method

To test the predictions from our model, we need to compare the effect of our main predictors in the foreign R&D and no-foreign R&D cases. Yet, as our formal model itself shows, the choice of whether or not to undertake foreign R&D is itself driven by many of the same predictors that also drive global sourcing decisions. To account for this endogeneity, we estimate a switching regression model (Hamilton and Nickerson 2003, Mayer and Nickerson 2005). Specifically, we run a first-stage predicting the decision to undertake foreign R&D and then use this model to calculate the nonselection hazards for the foreign R&D and no-foreign R&D cases. In the second stage, we then estimate separate ordinary least squares (OLS) regressions (with firm and period fixed effects), splitting our sample into those firms that undertake foreign R&D and those who do not and controlling for the appropriate nonselection hazard. We use a switching regression model rather than a treatment effects model because switching regression models do not restrict the independent variable coefficients in the second stage to be the same across choices. We run these split-sample second-stage regressions separately for each of our two main dependent variables, i.e., one set of regressions for offshore integration and a second set for offshore outsourcing.

Although the nonlinear nature of the first-stage regression is technically sufficient to identify the second stage (Mayer and Nickerson 2005), we include two instrumental variables in the first stage to strengthen the identification of the second stage. First, we include a measure of foreign firm patenting in the United States as an instrument, on the logic that increased investments by foreign firms in U.S. R&D will prompt U.S. firms to undertake more R&D abroad in order to counter the move by their foreign competitors. Second, we include a measure of the extent to which U.S. firms face competition from other U.S. MNCs in foreign markets, on the logic that firms facing greater foreign competition in foreign markets will be driven to invest more aggressively in foreign R&D to maintain local competitiveness in those markets. Both instruments thus capture the impact of competition on a firm's decision to undertake foreign R&D, with the expectation that firms will be driven to invest in foreign knowledge seeking in order to maintain competitive parity (Knickerbocker 1973, Hennart and Park 1994, Alcácer 2006). In each case, moreover, we see little reason to believe that these measures would impact firm global sourcing decisions except through their effect on foreign R&D. It is hard to see why the U.S. patenting activities of foreign firms would impact the global sourcing choices of U.S. firms, and it is unclear why more local competition in foreign markets would make U.S. firms prefer different sourcing options to meet domestic demand. Both instruments are measured at the industry level. As we show in our empirical results, both instruments have a positive and significant effect on the propensity of the firm to undertake foreign R&D. Further analysis (available upon request) confirms that these instruments are uncorrelated with the residuals from our second-stage models and thus meet the exclusion restriction.

Results

The results of our main empirical analyses are presented in Table 5. Table 5 shows the results from our switching regression models, with Model I showing the first-stage probit results predicting foreign R&D; Models II and III showing the results for offshore integration for firms that do and do not undertake foreign R&D, respectively; and Models IV and V reporting the results for offshore outsourcing for firms that do and

Table 5 Main Results

	First stage:	Second stage			
Dependent variable =	*Foreign R&D*	*Offshore Integration*		*Offshore Outsourcing*	
		Foreign R&D	No-foreign R&D	Foreign R&D	No-foreign R&D
Estimation =	Probit	OLS, FE	OLS, FE	OLS, FE	OLS, FE
Model =	I	II	III	IV	V
Industry Foreign Knowledge	1.37**	0.96*	0.13	−0.12	0.03
	(0.65)	(0.31)	(0.11)	(0.09)	(0.09)
Parent ROA	0.08**	0.18**	0.06**	−0.04**	−0.03*
	(0.04)	(0.08)	(0.03)	(0.02)	(0.01)
Industry ICT	0.03**	0.01	0.01	0.01	0.01*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Firm Developing Country PPE Proportion	−0.25	−0.06	−0.01	−0.01	0.03**
	(0.18)	(0.05)	(0.04)	(0.00)	(0.01)
Parent Size	0.13*	0.08	0.01	0.05†	0.01
	(0.04)	(0.05)	(0.01)	(0.03)	(0.01)
Firm Foreign Presence	3.55*	−0.14	−0.08	0.12	0.09†
	(0.72)	(0.09)	(0.06)	(0.11)	(0.05)
MNC Knowledge Intensity	1.76*	0.22	0.13	−0.13	−0.03
	(0.49)	(0.38)	(0.14)	(0.09)	(0.02)
Parent Exports to Foreign Affiliates	1.44†	0.08	0.08	−0.01	−0.01
	(0.80)	(0.07)	(0.05)	(0.04)	(0.02)
Weighted RER Change	−0.01	0.01	0.01	−0.01	−0.01
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Firm-Weighted Tax Difference	−0.01	−0.01	−0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Industry Growth Rate	0.24	0.10†	0.02	0.06**	0.02†
	(0.25)	(0.06)	(0.02)	(0.03)	(0.01)
Intercept	0.52	0.24	−0.04	0.05	−0.08
	(0.33)	(0.18)	(0.11)	(0.04)	(0.08)
Foreign Patenting in U.S.	7.01†				
	(4.03)				
Home Country Rivals Abroad	0.34**				
	(0.15)				
Inverse Mills ratio		0.07**	0.01	0.04	0.02
		(0.035)	(0.05)	(0.03)	(0.01)
N	1,123	196	649	201	655
Firm fixed effects	No	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes
Pseudo *R*-squared	0.22				
R-squared (within)		0.49	0.15	0.19	0.27
R-squared (overall)		0.32	0.07	0.08	0.12

Notes. In switching regression models, all independent variables are lagged by one period. All models include robust standard errors and Prob > 0 of less than 0.01%. FE, fixed effects.
$^{\dagger}p < 10\%$; $^{*}p < 5\%$; $^{**}p < 1\%$ (two-sided).

do not undertake foreign R&D, respectively. These four second-stage models (Models II–V) thus map directly to the four sets of predictions from our theoretical model in Table 2, which also lists the empirical measures being used to test each prediction. All of our second-stage models include fixed effects and period dummies.

Before discussing our switching regression results, we begin by considering the factors that drive firms to undertake foreign R&D. Recall from our theory—specifically, expression (3)—that foreign R&D is expected to increase with foreign research expertise (ϕ^S) and with monitoring effectiveness (β_o^S). Model I in Table 5 confirms these predictions, showing a positive and significant effect of both *Industry Foreign Knowledge* and *Industry ICT* on the probability of foreign R&D. Model I also shows that larger, more productive firms, with higher knowledge investments in the United States and greater foreign presence are more likely to pursue foreign R&D, consistent with prior work (Berry 2014). Further, our instrumental variables to capture competition in foreign markets are both positive and significant, although foreign patenting in the United States is significant only at the 0.10 level. In addition to strengthening the identification of our second-stage regressions, the effect of these competitive variables is interesting because it confirms that competitive pressures from both home and foreign firms push firms to invest in foreign R&D in order to remain competitive (Alcácer 2006, Alcácer et al. 2015). We use the predicted probabilities from Model I to generate the nonselection hazards for use with our subsequent models.

We now turn to the results from our switching regression models.[14] Our main theoretical prediction is that the increasing importance of foreign knowledge seeking will drive an increase in offshore integration—more specifically, that an increase in foreign research expertise will have a positive effect on offshore integration but only for firms that pursue foreign R&D. Table 5 shows support for this prediction, with the coefficient for *Industry Foreign Knowledge* being positive and significant in the case of firms that undertake foreign R&D (Model II) but insignificant for firms that do not invest in foreign R&D (Model III), with the two coefficients being significantly different ($Z = 2.50, p < 0.01$). Turning to offshore outsourcing, we see no significant effect of foreign knowledge, with the coefficient of *Industry Foreign Knowledge* being negative and insignificant in the foreign R&D case and positive and insignificant in the no foreign R&D case, consistent with our theoretical predictions. Overall, that foreign knowledge has a positive and significant effect only on offshore integration in the case of firms that undertake foreign R&D strongly supports our primary prediction that foreign knowledge seeking is accompanied by an increase in offshore integration, and it is consistent with the theory that firms respond to growing foreign expertise by shifting high-skill manufacturing tasks abroad.

Table 5 also provides support for several other predictions from the formal model. First, consistent with our prediction that firm productivity will have a positive effect on offshore integration and a negative effect on offshore outsourcing, we find a positive and significant effect of *Parent ROA* on offshore integration (Models II and III) and a negative and significant effect of *Parent ROA* on offshore outsourcing. As predicted, the effect of firm productivity on offshore integration is stronger in the foreign R&D case, with the point estimate of the coefficient in Model II being three times as high as the coefficient in Model III, although the difference between the two is only marginally significant.

[14] Because of the inclusion of firm fixed effects, firms that do no offshore integration in our study period drop out of Models II and III, and those that do no offshore outsourcing drop out of Models IV and V.

Second, our model predicted that an improvement in monitoring effectiveness would be associated with an increase in offshore outsourcing, with this effect being stronger (or only being true) in the low-knowledge-intensity case. Table 5 shows partial support for this prediction, with *Industry ICT* showing a positive and significant effect on offshore outsourcing in the no-foreign R&D case and a positive but insignificant effect in the foreign R&D case (although the difference between the two is not statistically significant). This suggests that investments in information technology do, in fact, make offshore outsourcing more attractive by lowering the costs of monitoring third-party suppliers but that these investments may be unable to overcome the expropriation problems associated with knowledge-intensive foreign production, and they may therefore be helpful only for firms that are focused on low-cost motives when sourcing from abroad, rather than on foreign knowledge seeking.

And finally, our formal model predicted that firms would increasingly turn to global sourcing as the cost differential between domestic and foreign production increased. Interestingly, Table 5 suggests that this is the case only for offshore outsourcing by firms with no foreign R&D, with the coefficient of our measure of cost differential (*Firm Developing Country PPE Proportion*) being positive and significant in Model V but insignificant in the other cases. We interpret this to mean that firms pursuing global sourcing for primarily low-cost motives generally prefer offshore outsourcing, a result our model predicts would be true if the difficulty of monitoring foreign operations were generally low. Consistent with this, Table 5 also shows a positive and marginally significant effect of firm foreign presence on offshore outsourcing in the no-foreign R&D case, which may reflect the role of foreign subsidiaries in enabling better monitoring and coordination with third parties abroad through their extended social networks (Rangan 2000), with MNCs using their local units to partner with external providers (Zaheer and Hernandez 2011).

Together, the results in Table 5 confirm that foreign knowledge seeking has a substantial impact on the firm global sourcing decisions. Firms that pursue foreign knowledge seeking show a preference for offshore integration, especially as relevant foreign expertise increases, and as their profitability improves and are less likely to increase offshore outsourcing in response to improved monitoring. On the other hand, firms that do not invest in foreign knowledge seeking are driven to pursue offshore outsourcing in response to increasing cost pressures and reduced monitoring problems as a result of information technology investments. Taken together, these findings provide strong empirical evidence in support of our formal model,

Table 6 Supplemental Results on Offshore Integration

	Panel A				Panel B		Panel C			
	Offshore integration: Developed countries		Offshore integration: Developing countries		Offshore integration: Countries with/without R&D		Offshore integration: High rule of law countries		Offshore integration: Low rule of law countries	
Sample =	Foreign R&D	No-foreign R&D	Foreign R&D	No-foreign R&D	R&D and manufacture	Manufacture only	Foreign R&D	No-foreign R&D	Foreign R&D	No-foreign R&D
Model =	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Industry Foreign Knowledge	0.91*	0.09	0.11	0.04	0.92*	0.08	0.50*	0.13	0.18	0.05
	(0.27)	(0.07)	(0.10)	(0.03)	(0.25)	(0.09)	(0.19)	(0.06)	(0.12)	(0.04)
Parent ROA	0.28**	0.04**	0.11*	0.06**	0.28**	0.06**	0.25**	0.05	0.10*	0.06**
	(0.11)	(0.02)	(0.04)	(0.03)	(0.12)	(0.03)	(0.13)	(0.03)	(0.05)	(0.03)
Industry ICT	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm Developing Country PPE Proportion	−0.11	−0.05	0.04**	−0.01	−0.12	−0.02	−0.11	−0.05	0.04	−0.01
	(0.09)	(0.04)	(0.02)	(0.01)	(0.09)	(0.02)	(0.09)	(0.04)	(0.04)	(0.02)
Controls (included but not reported)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	0.48**	0.09	0.16	0.03	0.45**	0.10	0.48**	0.09	0.16	0.03
	(0.24)	(0.06)	(0.11)	(0.02)	(0.22)	(0.03)	(0.24)	(0.06)	(0.11)	(0.02)
Inverse Mills ratio	0.24†	0.01	0.21**	0.01	0.23†	0.01	0.25†	0.05	0.17*	0.03
	(0.13)	(0.02)	(0.10)	(0.01)	(0.12)	(0.01)	(0.14)	(0.07)	(0.07)	(0.02)
N	196	649	196	649	196	196	196	649	196	649
R-squared (within)	0.52	0.11	0.46	0.11	0.51	0.12	0.48	0.13	0.46	0.10
R-squared (overall)	0.40	0.08	0.32	0.07	0.39	0.06	0.38	0.10	0.30	0.07

Notes. Second-stage switching regressions correspond to Models II and III in Table 5 (OLS with firm and period fixed effects). The full set of controls reported in Table 5 were included in each model in this table (with the full set of results available upon request). All independent variables are lagged by one period. All models include robust standard errors and Prob > 0 of less than 0.01%.

$^{\dagger}p < 10\%$; $^{*}p < 5\%$; $^{**}p < 1\%$ (two-sided).

with the predictions from the model being consistently upheld.

Supplementary Analyses

Our results so far have aggregated product flows from all countries into a single measure; we now explore the sources of these flows by splitting our offshore integration dependent variable based on the source country in various ways, as reported in Table 6.[15] Note that we are unable to undertake a similar analysis for offshore outsourcing since the BEA does not capture the source country for third-party product flows.

Panel A in Table 6 shows the effect of predicting intrafirm flows from developed country and developing country subsidiaries separately (using the developed and developing country definitions we used to construct our developing country PPE proportion measure above). Models VI and VIII in Table 6 show that the effect of foreign knowledge seeking is to drive offshore integration from developed countries but not from developing countries, with the coefficient of *Industry Foreign Knowledge* being positive and significant in Model VI and significantly greater than the same coefficient in Model VIII ($Z = 2.76$, $p < 0.01$). Moreover, panel A shows that the effect of *Parent ROA* is strongest in the case of intrafirm flows from developed countries in the presence of foreign R&D, with the coefficient of *Parent ROA* in Model VI being significantly greater than that in Model VII ($Z = 2.94$, $p < 0.01$). Together, these results suggest that, consistent with our prediction, firms seeking to benefit from foreign knowledge seeking will disproportionally source from owned subsidiaries in more developed countries, especially if their overall performance is high.

Panel B in Table 6 then offers a more stringent test of the colocation argument by separating intrafirm product flows from countries where the firm undertakes both R&D and manufacturing from those where the firm undertakes only manufacturing. Consistent with our argument that firms pursuing foreign R&D will seek to benefit from the colocation of R&D and (owned) production, we see that the coefficient of *Industry Foreign Knowledge* is positive and significant

[15] We continue to account for the endogeneity of foreign R&D choice in these supplemental analyses using the predicted values reported in Model I in Table 5.

for countries where the firm colocates R&D and production (Model X) but insignificant for countries where it locates only manufacturing activities (Model XI), with the difference between these coefficients being significant ($Z = 3.16$, $p < 0.01$).

Finally, panel C in Table 6 explores our theoretical distinction between the monitoring and expropriation challenges associated with global sourcing. Recall from expression (7a) that in the absence of foreign knowledge seeking, the effect of productivity on the firm's preference for offshore integration is proportional to the relative monitoring cost of the two options (β_o^S/β_v^S) and that this effect grows weaker as monitoring becomes easier. We provide a partial test of this empirically in panel C by distinguishing between intrafirm product flows from high and low rule of law countries.[16] Consistent with our theoretical prediction, we see that the effect of firm ROA in the absence of foreign R&D is only significant in low rule of law countries (Nunn 2007). At the same time, for firms that do undertake foreign R&D, the effect of ROA is positive and significant irrespective of the rule of law, with the effect being strongest in Model XII, i.e., for flows from high rule of law countries for firms pursuing foreign R&D. Panel C thus highlights the importance of distinguishing between monitoring and expropriation challenges, with firms continuing to prefer offshore integration even in high rule of law countries when undertaking foreign R&D, but not otherwise.

Discussion

In this study, we examine the antecedents of firm global sourcing choices, focusing on the effect of foreign knowledge seeking on global product sourcing. We argue that firm investments in foreign knowledge seeking will in turn drive an increase in product sourcing from abroad to benefit from the colocation of R&D and production. Our formal model predicts that firms that pursue knowledge seeking will prefer offshore integration over offshore outsourcing because of both monitoring and expropriation challenges associated with outsourcing knowledge-intensive tasks, with this effect being stronger for high-capability firms. Firms that do not pursue foreign knowledge seeking face much less of a problem with third-party contracting and are therefore more likely to choose offshore outsourcing in response to cost pressures, especially where their performance is weak and where investments in information technology have made monitoring easier. Results from a longitudinal within-firm analysis of the global sourcing choices of U.S. MNCs from 1989 to 2004 confirm these predictions, highlighting the effect of foreign knowledge seeking on firm global sourcing choices by showing that firms that pursue foreign knowledge seeking make very different global sourcing decisions from firms that do not.

The findings of our study emphasize the need to distinguish between offshore integration and offshore outsourcing as two distinct forms of global sourcing by showing distinct antecedents across these two approaches. As our theory and findings suggest, offshore integration is driven more by high-capability, technology-intensive firms seeking to develop, exploit, and protect new technological capabilities abroad while continuing to benefit from lower input costs. On the other hand, offshore outsourcing is driven more by low-capability firms that seek to benefit from the lower costs of sourcing from third-party vendors abroad while using information technology investments to overcome monitoring problems. These findings thus go a long way toward explaining the trends in global sourcing over the last two decades that are shown in Table 1, explaining both the greater reliance on offshore integration in knowledge-intensive industries and the continued importance of internal sourcing from developed countries, despite advances in information technology.

In addition to explaining trends in the phenomenon of global sourcing, our study also contributes to the existing international business and global strategy literatures in several ways. Whereas traditional theories in international business (Hymer 1960, Dunning 1973) focus on the need for internalization to monitor and protect parent knowledge, we highlight the role of internalization in enabling the creation of subsidiary knowledge and capabilities by helping to overcome problems of both ex ante noncontractibility and ex post cospecialization. Our study thus extends the literature on foreign knowledge seeking (Alcácer 2006, Alcácer and Chung 2007, Nachum et al. 2008, Berry 2014) by examining the impact of foreign knowledge seeking on firm global product sourcing decisions—a topic that has remained largely unexplored. In addition, our study links work on foreign knowledge seeking to the organizational economics literature, highlighting the need for integration when developing new organizational capabilities (Mayer and Nickerson 2005, Argyres and Zenger 2012, Kaul 2013) and capturing internal synergies (Hsieh et al. 2010, Alcácer and Delgado 2013). Moreover, these contributions to existing theory are backed by a rigorous formal model that integrates a diverse set of antecedents of global sourcing while distinguishing between offshore integration and offshore outsourcing, and thus it offers a theoretical basis for future research.

[16] We use the Kaufmann et al. (1999) Rule of Law index from the Worldwide Governance Indicators Project from the World Bank to assign countries to above and below median values within our sample to perform this analysis.

In addition to highlighting the relationship between foreign knowledge seeking and global sourcing choices, our study also provides a more nuanced understanding of several other antecedents of those choices identified in extant literature. Whereas prior literature suggests that more productive firms are more likely to choose offshore integration (Antràs and Helpman 2004, Yeaple 2006), our study argues and shows that this effect is stronger for firms undertaking foreign R&D and for firms sourcing from developed countries. Similarly, whereas prior work has documented a negative relationship between offshore integration and the ease of monitoring as reflected in the strength of contract enforcement (Nunn 2007) and information technology investments (Rangan and Sengul 2009), our study shows that this effect varies with the nature of the task being performed, with our results revealing a weaker relationship for high-knowledge-intensity tasks.

Finally, our study also contributes to the economics literature on global sourcing. From a theoretical standpoint, prior work in economics has seen global sourcing primarily as a means to access low-cost inputs (Antràs and Helpman 2004, Antràs and Rossi-Hansberg 2009), distinguishing between knowledge-capital-exploiting horizontal FDI and low-cost-seeking vertical FDI (Carr et al. 2001, Yeaple 2003a). Our study relaxes this assumption by developing a model that allows the R&D location to be determined endogenously, resulting in a more general model. In particular, our model allows for the joint role of low cost seeking and knowledge seeking, so that even in cases where neither foreign research expertise nor foreign production cost advantage alone is sufficient to warrant global sourcing, the firm may still source from abroad if both together provide a sufficient advantage. In addition, our study advances prior empirical work that has generally depended on cross-sectional analyses using international trade data at the industry level (Kotabe and Swan 1994, Yeaple 2006, Nunn 2007, Nunn and Trefler 2008, Bernard et al. 2010) by conducting a firm-level longitudinal analysis using a comprehensive database of U.S. manufacturing multinationals with detailed, statutory data on cross-border product flows. The use of this unique database not only makes for a better test of our base prediction but also allows us to test the predictions of prior economic models, such as the preference of more productive firms for offshore integration (Antràs and Helpman 2004, Antràs and Rossi-Hansberg 2009), in a more rigorous way.

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References

Adams JB, Jaffe AB (1996) Bounding the effects of R&D: An investigation using matched establishment-firm data. *RAND J. Econom.* 27(4):700–721.

Adler N, Hashai N (2007) Knowledge flows and the modelling of the multinational enterprise. *J. Internat. Bus. Stud.* 38(4): 639–657.

Alcácer J (2006) Location choices across the value chain: How activity and capability influence colocation. *Management Sci.* 52(10):1457–1471.

Alcácer J, Chung W (2007) Location strategies and knowledge spillovers. *Management Sci.* 53(5):760–776.

Alcácer J, Delgado M (2013) Spatial organization of firms and location choices through the value chain. HBS Working Paper 13-025, Harvard Business School, Boston.

Alcácer J, Zhao M (2012) Local R&D strategies and multilocation firms: The role of internal linkages. *Management Sci.* 58(4): 734–753.

Alcácer J, Dezső C, Zhao M (2015) Location choices under strategic interactions. *Strategic Management J.* 36(2):197–215.

Almeida P, Kogut B (1999) Localization of knowledge and the mobility of engineers in regional networks. *Management Sci.* 45(7):905–917.

Almeida P, Phene A (2004) Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation. *Strategic Management J.* 8(8–9):847–864.

Antràs P (2005) Incomplete contracts and the product cycle. *Amer. Econom. Rev.* 95(4):1054–1073.

Antràs P, Helpman E (2004) Global sourcing. *J. Political Econom.* 112(3):552–580.

Antràs P, Rossi-Hansberg E (2009) Organizations and trade. *Annual Rev. Econom.* 1:43–64.

Argyres NS, Zenger TR (2012) Capabilities, transaction costs, and firm boundaries. *Organ. Sci.* 23(6):1643–1657.

Bergen SA, McLaughlin CP (1992) The R&D/production interface: A four country comparison. *Internat. J. Oper. Production Management* 8(7):5–13.

Bernard AB, Jensen JB, Redding SJ, Schott PK (2010) Intrafirm trade and product contractability. *Amer. Econom. Rev.* 100(2):444–448.

Berry H (2006) Leaders, laggards and the pursuit of foreign knowledge. *Strategic Management J.* 27(2):151–168.

Berry H (2014) Global integration and innovation: Multi-country knowledge generation within MNCs. *Strategic Management J.* 35(6):869–890.

Berry H, Sakakibara M (2006) Resource accumulation and overseas expansion by Japanese multinationals *J. Econom. Behav. Organ.* 65(2):277–302.

Brainard SL (1997) An empirical assessment of the proximity-concentration trade-off between multinational sales and trade. *Amer. Econom. Rev.* 87(4):520–544.

Cantwell J (1989) *Technological Innovation and Multinational Corporations* (B. Blackwell, Cambridge, MA).

Cantwell J, Janne O (1999) Technological globalization and innovative centres: the role of corporate technological leadership and locational hierarchy. *Res. Policy* 28(2):119–144.

Cantwell J, Mudambi R (2005) MNE competence-creating subsidiary mandates. *Strategic Management J.* 26(12):1109–1128.

Capron L, Mitchell W (2009) Selection capability: How capability gaps and internal social frictions affect internal and external strategic renewal. *Organ. Sci.* 20(2):294–312.

Carlile PR, Rebentisch ES (2003) Into the black box: The knowledge transformation cycle. *Management Sci.* 49(9):1180–1195.

Carluccio J, Fally T (2012) Global sourcing under imperfect capital markets. *Rev. Econom. Statist.* 94(3):740–763.

Carr DL, Markusen JR, Maskus KE (2001) Estimating the knowledge-capital model of the multinational enterprise. *Amer. Econom. Rev.* 91(3):693–708.

Caves R (1996) *Economic Analysis and the Multinational Corporation*, 2nd ed. (Cambridge University Press, Cambridge, UK).

Chung W, Alcácer J (2002) Knowledge seeking and location choice of foreign direct investment in the United States. *Management Sci.* 48(12):1534–1554.

Chung W, Yeaple S (2008) International knowledge sourcing: Evidence from U.S. firms expanding abroad. *Strategic Management J.* 29(11):1207–1224.

Datar S, Jordan C, Kekre S, Rajiv S, Srinivasan K (1997) New product development structures and time-to-market. *Management Sci.* 43(4):452–464.

Dunning JH (1973) The determinants of international production. *Oxford Econom. Papers* 25(3):289–336.

Dunning JH (1998) Location and the multinational enterprise: A neglected factor? *J. Internat. Bus. Stud.* 29(1):45–66.

Ettlie JE (1995) Product-process development integration in manufacturing. *Management Sci.* 41(7):1224–1237.

Feenstra RC (1998) Integration of trade and disintegration of production in the global economy. *J. Econom. Perspect.* 12(4):31–50.

Feenstra RC, Hanson G (2005) Ownership and control in outsourcing to China: Estimating property rights theory of the firm. *Quart. J. Econom.* 120(2):729–761.

Frost TS, Birkinshaw JM, Ensign PC (2002) Centers of excellence in multinational corporations. *Strategic Management J.* 23(11):997–1018.

Grossman SJ, Hart OD (1986) Costs and benefits of ownership: A theory of vertical and lateral integration. *J. Political Econom.* 94(4):694–719.

Grossman GM, Helpman E (2002) Integration versus outsourcing in industry equilibrium. *Quart. J. Econom.* 117(1):85–120.

Grossman GM, Rossi-Hansberg E (2008) Trading tasks: A simple theory of offshoring. *Amer. Econom. Rev.* 98(5):1978–1997.

Gupta AK, Govindarajan V (2000) Knowledge flows within multinational corporations. *Strategic Management J.* 21(4):473–496.

Hall B, Jaffe A, Trajtenberg M (2005) Market value and patent citations. *RAND J. Econom.* 36(1):16–38.

Hamilton BA, Nickerson JA (2003) Correcting for endogeneity in strategic management research. *Strategic Organ.* 1(1):53–80.

Hansen MT, Løvås B (2004) How do multinational companies leverage technological competencies? Moving from single to interdependent explanations. *Strategic Management J.* 25(8–9): 801–822.

Hanson GH, Mataloni R Jr, Slaughter MJ (2001) Expansion strategies of U.S. multinational firms. NBER Working Paper 8433, National Bureau of Economic Research, Cambridge, MA.

Hart OD, Moore J (1990) Property rights and the nature of the firm. *J. Political Econom.* 98(6):1119–1958.

Hatch NW, Mowery DC (1998) Process innovation and learning by doing in semi-conductor manufacturing. *Management Sci.* 44(11, Part 1):1461–1477.

Hennart J-F, Park Y-R (1994) Location, governance, and strategic determinants of Japanese manufacturing investment in the United States. *Strategic Management J.* 15(6):419–436.

Hinds PJ, Bailey DE (2003) Out of sight, out of sync: Understanding conflict in distributed teams. *Organ. Sci.* 14(6):615–632.

Hinds PJ, Mortensen M (2005) Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organ. Sci.* 16(3):290–307.

Hsieh C, Lazzarini SG, Nickerson JA, Laurini M (2010) Does ownership affect the variability of the production process? Evidence from international courier services. *Organ. Sci.* 21(4):892–912.

Hymer S (1960) *The International Operations of National Firms: A Study of Direct Investment* (MIT Press, Cambridge, MA).

Jaffe A, Trajtenberg M, Henderson R (1993) Geographic localization of knowledge spillovers as evidenced by patent citations. *Quart. J. Econom.* 108(3):577–598.

Kaufmann D, Kraay A, Zoido-Lobatón P (1999) Governance matters. Working Paper 2196, World Bank Development Research Group, Washington, DC.

Kaul A (2013) Entrepreneurial action, unique assets, and appropriation risk: Firms as a means of appropriating profit from capability creation. *Organ. Sci.* 24(6):1765–1781.

Kleinert J (2003) Growing trade in intermediate goods: Outsourcing, global sourcing, or increasing importance of MNE networks? *Rev. Internat. Econom.* 11(3):464–482.

Knickerbocker FT (1973) *Oligopolistic Reaction and Multinational Enterprises* (Harvard Business School Press, Boston).

Kobrin SJ (1991) An empirical analysis of the determinants of global integration. *Strategic Management J.* 12(S1):17–31.

Kogut B, Zander U (1992) Knowledge of the firm, combinative capabilities, and the replication of technology. *Organ. Sci.* 3(3):383–397.

Kotabe M, Omura GS (1989) Sourcing strategies of European and Japanese multinationals: A comparison. *J. Internat. Bus. Stud.* 20(1):113–130.

Kotabe M, Swan KS (1994) Offshore sourcing: Reaction, maturation, and consolidation of U.S. multinationals. *J. Internat. Bus. Stud.* 25(1):115–140.

Kuemmerle W (1999) The drivers of foreign direct investment into research and development: An empirical investigation. *J. Internat. Bus. Stud.* 30(1):1–24.

Langlois RN, Robertson PL (1995) *Firms, Markets and Economic Change: A Dynamic Theory of Business Institutions* (Routledge, New York).

Levina N, Vaast E (2008) Innovating or doing as told? Status differences and overlapping boundaries in offshore collaboration. *MIS Quart.* 32(2):307–332.

Liebeskind JP (1996) Knowledge, strategy, and the theory of the firm. *Strategic Management J.* 17(S2):93–107.

Mataloni RJ Jr, Yorgason DR (2006) Operations of U.S. multinational companies: Preliminary results from the 2004 benchmark survey. *Survey Current Bus.* 86(November):37–68.

Mauri AJ, Phatak AV (2001) Global integration as inter-area product flows: The internalization of ownership and location factors influencing product flows across MNC units. *Management Internat. Rev.* 41(3):233–249.

Mayer KJ, Nickerson JA (2005) Antecedents and performance implications of contracting for knowledge workers: Evidence from information technology services. *Organ. Sci.* 16(3): 225–242.

Murray JY, Kotabe M, Wildt AR (1995) Strategic and financial performance implications of global sourcing strategy: A contingency analysis. *J. Internat. Bus. Stud.* 26(1):181–202.

Nachum L, Zaheer S (2005) The persistence of distance? The impact of technology on MNE motivations for foreign investment. *Strategic Management J.* 26(8):747–767.

Nachum L, Zaheer S, Gross S (2008) Does it matter where countries are? Proximity to knowledge, markets and resources, and MNE location choice. *Management Sci.* 54(7):1252–1265.

Nunn N (2007) Relationship specificity, incomplete contracts and the pattern of trade. *Quart. J. Econom.* 122(2):569–600.

Nunn N, Trefler D (2008) The boundaries of the multinational firm: An empirical analysis. Helpman E, Marin D, Verdier T, eds. *The Organization of Firms in a Global Economy* (Harvard University Press, Cambridge, MA), 55–83.

Penner-Hahn J, Shaver JM (2005) Does international research and development increase patent output? An analysis of Japanese pharmaceutical firms. *Strategic Management J.* 26(2):121–140.

Plambeck EL, Taylor TA (2005) Sell the plant? The impact of contract manufacturing on innovation, capacity, and profitability. *Management Sci.* 51(1):133–150.

Rangan S (2000) Search and deliberation in international exchange: Microfoundations to some macro patterns. *J. Internat. Bus. Stud.* 31(2):205–222.

Rangan S, Sengul M (2009) Information technology and transnational integration: Theory and evidence on the evolution of the modern multinational enterprise. *J. Internat. Bus. Stud.* 40(9):1496–1514.

Segerstrom PS, Anant TCA, Dinopoulos E (1990) A Schumpeterian model of the product life cycle. *Amer. Econom. Rev.* 80(5): 1077–1091.

Silverman BS (1996) Technological assets and the logic of corporate diversification. Ph.D. dissertation, Haas School of Business, University of California at Berkeley, Berkeley.

Singh J (2005) Collaborative networks as determinants of knowledge diffusion patterns. *Management Sci.* 51(5):756–770.

Sobrero M, Roberts EB (2001) The trade-off between efficiency and learning in interorganizational relationships for product development. *Management Sci.* 47(4):493–511.

Szulanski G (1996) Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management J.* 17(S2):27–43.

Teece DJ (1986) Transaction cost economics and the multinational enterprise: An assessment. *J. Econom. Behav. Organ.* 7(1):21–45.

Thompson JD (1967) *Organizations in Action* (McGraw-Hill, New York).

United Nations Conference on Trade and Development (2012a) Trade and development report, 2012: Policies for inclusive and balanced growth. Report, United Nations, New York.

United Nations Conference on Trade and Development (2012b) World investment report, 2012: Towards a new generation of investment policies. Report, United Nations, New York.

Van de Ven AH, Delbecq AL, Koenig R Jr (1976) Determinants of coordination modes within organizations. *Amer. Sociol. Rev.* 41(2):322–338.

Vernon R (1966) International investment and international trade in the product cycle. *Quart. J. Econom.* 80(2):190–207.

von Hippel E (1994) "Sticky information" and the locus of problem solving: Implications for innovation. *Management Sci.* 40(4):429–439.

Williamson OE (1975) *Markets and Hierarchies: Analysis and Anti-Trust Implications* (Free Press, New York).

Yeaple SR (2003a) The complex integration strategies of multinationals and cross country dependencies in the structure of foreign direct investment. *J. Internat. Econom.* 60(2):293–314.

Yeaple SR (2003b) The role of skill endowments in the structure of U.S. outward foreign direct investment. *Rev. Econom. Statist.* 85(3):726–734.

Yeaple SR (2006) Offshoring, foreign direct investment, and the structure of U.S. trade. *J. Eur. Econom. Assoc.* 4(2–3):602–611.

Yorgason D (2007) Research and development activities of U.S. multinational companies: Preliminary results from the 2004 benchmark survey. *Survey Current Bus.* (March):22–39.

Zaheer A, Hernandez E (2011) The geographic scope of the MNC and its alliance portfolio: Resolving the paradox of distance. *Global Strategy J.* 1(1–2):109–126.

Zeile WJ (1997) U.S. intrafirm trade in goods. *Survey Current Bus.* 77(February):23–38.

Zhao M (2006) Conducting R&D in countries with weak intellectual property rights protection. *Management Sci.* 52(8):1185–1199.