

Research Spotlight

Multinational Enterprises and International Technology Transfer

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MULTINATIONAL enterprises are major producers of technological knowledge in the world economy. As gauged by their research and development (R&D) activity, they play a leading role in the development of new technologies for industrial applications. In the United States, for example, multinational enterprises accounted for more than three-quarters of the domestic R&D performed by all U.S. businesses in 2010.

Given their technological prowess, multinational enterprises should be expected to serve as major conduits for transfers of new technologies between countries. Such transfers, however, may be impeded by weak protection of intellectual property rights, by difficulties in communicating knowledge internationally, and by the costs incurred in integrating innovations that originate in different locations. This article summarizes recent studies on the effects of variations in these impediments on multinational enterprises.

The statistical work underpinning the studies described in this article was conducted at the Bureau of Economic Analysis (BEA) under a program that permits outside researchers to work onsite as unpaid special sworn employees of BEA for the purpose of conducting analytical and statistical studies using microdata collected by BEA under the International Investment and Trade in Services Survey Act. These data are collected in BEA's surveys of international direct investment for the compilation of the U.S. economic accounts and for the analysis of multinational enterprises. The firm-level data employed in the studies reviewed are from BEA's benchmark and annual surveys of U.S. direct investment abroad, which provide the most comprehensive and reliable data available on the activities of U.S. multinational enterprises.¹

1. For a discussion of data from the most recent benchmark survey, see Kevin B. Barefoot and Raymond J. Mataloni Jr., "Operations of U.S. Multinational Companies in the United States and Abroad: Preliminary Results From the 2009 Benchmark Survey," SURVEY OF CURRENT BUSINESS 91 (November 2011): 29–55. For a discussion of data from the most recent annual survey, see Raymond J. Mataloni Jr., "Activities of U.S. Multinational Enterprises in 2012," SURVEY 94; (August 2014).

This article summarizes the following:

- Four studies of firm-level changes in international technology diffusion and production in response to reforms in intellectual property rights protection
- A study on spatial constraints in the international diffusion of knowledge within firms
- A study that examines conditions that enhance multicountry collaboration in firm innovations

Firm Responses to Increased Patent Protection

One body of research on technology transfers between countries is concerned with firms' responses to differences in the degree of protection granted to intellectual property. In countries with weak patent protection, a multinational enterprise faces the risk that its

BEA Program for Outside Researchers

Recognizing that some research requires data at a more detailed level than that provided in its publicly disseminated tabulations, the Bureau of Economic Analysis maintains a program that permits outside researchers to work onsite as unpaid special sworn employees of the Bureau for the purpose of conducting analytical and statistical studies using the microdata that it collects under the International Investment and Trade in Services Survey Act. This work is conducted under strict guidelines and procedures that protect the confidentiality of company specific data as required by law. Because the program exists for the express purpose of advancing scientific knowledge and because of the legal requirements that limit the use of the data to analytical and statistical purposes, appointment to special sworn employee status under this program is limited to researchers. Appointments are not extended to persons affiliated with organizations that collect taxes, enforce regulations, or make policy. Additional information on the program is available on the BEA Web site at www.bea.gov/about/research_program.htm.

proprietary technologies will be imitated by local competitors, as employees exposed to the firm's internal trade secrets may defect to rival firms and may combine this internal information with the publicly available information provided in its unenforced patents. With strong patent protection, a firm is able to prevent rivals from using the patented components of its proprietary technology, without which imitation is not likely to succeed. Thus, multinational enterprises should be expected to engage in high-technology production in, and transfer proprietary technologies to, affiliates located in host countries that provide strong legal protections for intellectual property rights. Similarly, multinational enterprises should be expected to expand production in, and transfer technology to, countries that adopt reforms that strengthen intellectual property rights. Countries considering such reforms might be concerned that stronger protections will curtail the ability of local firms to imitate and build on the advanced technologies of foreign firms. Any costs of this kind, however, could be offset by the economic advantages of increased activity by multinational enterprises.

Early research on this topic focused on the response by multinational enterprises to differences in the strength of patent protection across host countries. Using publicly available BEA data on U.S. multinationals' financing of manufacturing affiliates in selected developing countries, Lee and Mansfield (1996) found that investment was discouraged by weakness in intellectual property protection. Using published BEA data on foreign manufacturing affiliate activity in 50 host countries, Smith (2001) found that stronger patent rights had a significant positive influence on both affiliate sales and R&D performed for affiliates. In a study based on firm-level data for a sample of firms that had undertaken direct investment in 24 economies in Eastern Europe and the former Soviet Union, Javorcik (2004) found that stronger patent protection increased the probability of investment in high-technology industries but not in other industries.

Using BEA's firm-level data on U.S. multinational enterprises, Branstetter, Fisman, and Foley (2006) and Branstetter, Fisman, Foley, and Saggi (2011) were able to more precisely isolate firm responses to host-country patent reforms. A key advantage of working with the BEA microdata is that these data allow researchers to trace changes in operations over time for the same firm. In addition, because each foreign affiliate is linked to an individual U.S. parent, changes in affiliate operations can be isolated for different groups of parents defined by particular characteristics. Working with the microdata, the authors were able to isolate

changes in technology flows and foreign affiliate operations for U.S. parent companies that are most likely to benefit from patent protection.

Branstetter, Fisman, and Foley (2006) examine changes in technology transfer between U.S. parent companies and their foreign affiliates in the wake of host-country patent reforms in the 1980s and 1990s. Specifically, they analyze changes in royalty payments to U.S. parents by affiliates in 16 host countries that had strengthened intellectual property rights protection sometime during 1982–1999. The statistical tests include an indicator for post-reform years for a given host country, which captures the increase in intellectual property rights protection in the country. A number of tests include a second variable that is constructed by multiplying the post-reform indicator by an indicator for host-country affiliates whose parents have a history of extensive patent use. This variable is known as an interaction term and is used here to determine if post-reform changes in technology transfer are concentrated among affiliates of firms that are predisposed to engage in patenting activity to protect their proprietary knowledge. To isolate the effect of the key explanatory variables, the authors also include a number of other firm-level and country-level variables that are expected to be related to the magnitude of intrafirm royalty payments.

Branstetter, Fisman, and Foley (2006) find that royalty payments by affiliates located in reforming countries increased significantly in the post-reform years, suggesting that strengthened patent rights lead to increases in multinational-firm technology transfers to affiliates in the reforming countries (table 1, column 1). Moreover, the increases in technology transfer are found to be concentrated among affiliates of firms that have a history of extensive patent use (table 1, column 2).

Branstetter, Fisman, and Foley (2006) also consider the impact of host-country patent reforms on R&D

Table 1. Qualitative Summary of Empirical Findings in Branstetter, Fisman, and Foley (2006)

	Dependent variable			
	Intrafirm royalty payments by affiliates to their parents		Affiliate R&D	
	Test 1	Test 2	Test 1	Test 2
Key explanatory variables:				
Positive relation with post-reform indicator for country-year?	Yes	No*	No*	No*
Post-reform effect stronger for firms with high patent use?		Yes		Yes

* Relation insignificant.

spending by affiliates, which for the countries in their sample are viewed as a complement to technology transfer from the parent because affiliate R&D often is devoted to the modification of parent-firm technology for the local market. As with the results for intrafirm royalty payments, they find that affiliate R&D increases in the wake of the host-country patent reforms for affiliates of firms that are most likely to engage in patenting activity (table 1, column 4).

In a followup study, Branstetter, Fisman, Foley, and Saggi (2011) examine changes in affiliate production activity in countries that undertake patent reforms. The authors examine whether the level of affiliate activity is related to increased intellectual property rights protection in the host country, as measured by the post-reform indicator used in the earlier study. Tests also include this indicator multiplied by an indicator for host-country affiliates whose parents have a history of extensive technology licensing to affiliates in other host countries. This interaction term is used to determine if the impact of reform is larger for affiliates of such firms. The authors also seek to isolate the effect of the key explanatory variables by including a number of other firm and host-country variables that could influence the level of affiliate activity.

Branstetter, Fisman, Foley, and Saggi (2011) find that over the period 1982-1999, affiliate activity expanded in post-reform years, even for affiliates of parents that did not make extensive use of intellectual property abroad (table 2). The results suggest that multinational firms respond to patent reform by increasing production in the reforming countries, with the increases being most pronounced for firms that are in a position to benefit the most from reform.

Relation to product lifecycle lengths

As established in the studies described above, multinational enterprises increase production in countries that reform intellectual property rights because intellectual property rights protection reduces potential losses from the risk of imitation by competitors. Building on

the results of these studies, Bilir (2014) advances the argument that the sensitivity of firms to this risk depends on the probability of successful imitation before the innovating firm’s product becomes obsolete, which will be lower for firms in industries with shorter product lifecycles, such as electronics. Thus, increases in patent protection may have relatively little impact on the production-location decisions of firms with short-lifecycle technologies.

Earlier research by Cohen, Nelson, and Walsh (2000), based on a questionnaire sent to R&D labs in U.S. manufacturing industries, revealed wide differences across industries in the importance and effectiveness of patent protection. By using the high level of industry detail in BEA’s microdata, Bilir is able to build on this insight by isolating a specific industry characteristic—its product lifecycle length—that affects the sensitivity of firms to intellectual property rights. In contrast to Branstetter, Fisman, and Foley (2006) and Branstetter, Fisman, Foley, and Saggi (2011), who limit their analysis to a select number of countries that undertook patent reforms that can be isolated from other changes, Bilir presents an analysis that can be applied to all countries, including those that experienced no reforms or that experienced reforms that cannot be separated from other changes. Her analysis—which requires production location information for a large number of countries, industries, and years—was made possible by exploiting the rich geographic and industry detail available from BEA’s firm-level data.

Bilir examines how the production-location decisions of innovating firms are influenced by production costs, patent protection, and product-lifecycle lengths. Innovating firms located in advanced countries must choose whether to manufacture their products at home or in developing countries that offer lower production costs but that do not fully enforce patent rights. If an innovating firm locates its manufacturing operations in a developing country, it enjoys higher profits from the lower production costs, but it exposes its proprietary technology to local producers who will seek to imitate the product and compete with the firm. The risk of successful imitation by local rivals increases with the product’s remaining economic lifetime and decreases with the quality of local patent enforcement.

The strategic objective of each firm is to balance the cost of potential imitation against the benefit of producing in a low-cost location. For a given level of patent enforcement, the optimal strategy for the innovating firms is to relocate manufacturing production of their products to the developing countries in order to lower production costs when the amount of

Table 2. Qualitative Summary of Empirical Findings in Branstetter, Fisman, Foley, and Saggi (2011)

	Dependent variable: Affiliate assets	
	Test 1	Test 2
Key explanatory variables:		
Positive relation with post-reform indicator for country-year?	Yes	Yes
Post-reform effect stronger for firms with extensive licensing abroad?		Yes

time remaining before product obsolescence falls below a certain threshold. In industries with product lifecycle lengths less than the threshold, manufacturing always will take place in developing countries. In other industries, manufacturing initially will take place in the home country but will be relocated to developing countries when the remaining time before obsolescence falls below the threshold. With an increase in the level of patent enforcement in developing countries, the time-to-obsolescence threshold for relocating manufacturing to the developing countries increases; as a result, in industries with product lifecycle lengths above the initial threshold, manufacturing will take place in the developing countries earlier in the lifecycle. The relocation of manufacturing production to developing countries following patent reform will be most pronounced in industries with intermediate lifecycle lengths, as these are the industries that have the largest shares of products whose remaining lifetimes fall between the old and new time-to-obsolescence thresholds.

To test these hypotheses, Bilir uses microdata from BEA's benchmark surveys of U.S. direct investment abroad to construct industry-country-year panels for several measures of foreign affiliate activity in 1982–2004. The variable to be explained is the level of affiliate activity in a given industry and host country. The factors used to explain variations in affiliate activity include the level of intellectual property rights protection and the product lifecycle length in the industry. In the statistical analysis, the first explanatory variable is the product of these two measures. This interaction term is used to determine if host-country increases in intellectual property rights protection result in increased affiliate activity in industries with longer lifecycle lengths (which would be indicated by a positive correlation with the level of affiliate activity). The second explanatory variable is the product of the measure of intellectual property rights protection and the square of the product-lifecycle-length measure. This interaction term is used to determine if the increases in affiliate activity are most concentrated in industries with intermediate lifecycle lengths (which would be indicated by a negative correlation with the level of affiliate activity). To isolate the effect of these explanatory variables, the author also includes other industry characteristics and country-year characteristics that might affect affiliate activity.

The statistical results support Bilir's hypotheses for each of the measures of affiliate activity examined (table 3). As predicted, the response by multinational firms to changes in host-country patent protection varies across industries with the length of the product

lifecycle: reforms that strengthen patent protection result in increased affiliate activity in industries with relatively long product lifecycles, with the increases being most pronounced in industries with intermediate-length lifecycles.

Impact of reforms on firm innovation effort

In the theoretical literature on the impact of intellectual property rights reform, some papers offer predictions about the effects of reform in developing countries on incentives for technological innovation by firms in advanced countries. Some of these papers predict that stronger intellectual rights protection in developing countries will reduce innovation effort in advanced countries, while other papers reach the opposite conclusion.² Using BEA's firm-level data on U.S. parent companies and foreign affiliates located in developed countries, Park (2012) is the first to test how innovation by developed-country firms responds to strengthened intellectual property rights protection in developing countries.

For U.S. parent companies and foreign affiliates, the information BEA collects on R&D performance provides a measure of innovative effort. Because U.S. multinational enterprises account for a large share of worldwide industrial R&D, BEA's firm-level data on U.S. parent companies and foreign affiliates in developed countries are used by Park (2012) to represent innovating firms in developed countries.³

2. For example, Helpman (1993) argues that by restricting imitation, increased intellectual property rights protections in developing countries will shift production to developed countries and thereby increase labor demand, which will reduce the labor available for innovation. In contrast, Lai (1998) argues that a resulting shift in production to developing countries from developed countries through foreign direct investment will reduce labor demand in the developed counties, freeing up labor for innovation.

3. Park (2012) states that the U.S. parent companies and developed-country foreign affiliates in his sample account for 42 percent of total business enterprise R&D performed in the developed member countries of the Organisation of Economic Co-operation and Development in 2004.

Table 3. Qualitative Summary of Empirical Findings in Bilir (2014)

	Dependent variable: Indicator for positive sales in country-industry-year		
	Test 1	Test 2	Test 3
Key explanatory variables:			
Positive relation with strength of patent protection in country-year?	No*		
Patent-protection effect stronger in industries with longer product lifecycles?		Yes	Yes
Patent-protection effect stronger in industries with intermediate-length product lifecycles?			Yes

* Relation insignificant.

In his test, Park (2012) examines changes in U.S. parent and developed-country affiliate R&D performance in 1982–2004 in response to changes in the level of foreign patent protection afforded to the firms. The measured level of foreign patent protections afforded to firms located in a given developed country in a given year is a weighted average of indexes of patent protection in each foreign country. For each developed country, separate measures of foreign patent protection are constructed for developing countries and other developed countries. To isolate the effect of the key explanatory variables, Park also includes own-country patent protection and a number of other firm- and country-level variables that are expected to influence firm R&D performance. Park finds that innovation effort by firms in developed countries is strongly correlated with the level of patent protection in other developed countries but that it is not significantly related to patent protection in developing countries (table 4). The reason offered for this finding is that developing countries account for only a small share of the innovating firms’ global market.

Spatial Barriers to Knowledge Transfer

The studies reviewed in the previous section are concerned with firms’ responses to policy changes that remove impediments to the production or transfer of technological knowledge across borders. These changes can be viewed as analogous to country reductions in tariffs that impede cross-border trade in goods. Outside of the realm of trade policy, international flows of goods also can be impeded by natural frictions, most notably the distance between trading partners, which gives rise to transportation costs. Does distance impede international knowledge flows as well? Stated another way, does the absence of proximity prevent knowledge flows that might otherwise take place by learning through demonstration? This question is considered by Keller and Yeaple (2013) in a novel study on knowledge transfers within multinational enterprises.⁴

Keller and Yeaple (2013) explore whether the ability of a parent company to transfer technological knowledge to its foreign affiliate either through direct communication of instructions for the production of intermediate inputs used in final assembly (disembodied knowledge transfer) or through shipment of the intermediate inputs from the parent to the affiliate (embodied knowledge transfer) depends on the production technology of the firm’s industry. In more

Table 4. Qualitative Summary of Empirical Findings in Park (2012)

	Dependent variable: R&D expenditures of firms in developed countries
Key explanatory variables:	
Positive relation with foreign patent rights in other developed countries?.....	Yes
Positive relation with foreign patent rights in developing countries?.....	No*

*Relation insignificant.

knowledge-intensive industries, the production of intermediate inputs requires noncodified knowledge that cannot easily be communicated when the inventors and users of the knowledge are in different locations, which results in efficiency losses if the inputs are produced by the affiliate. If instead the inputs are produced by the parent for shipment to the affiliate, these efficiency losses are avoided, but transportation and other trade costs are incurred. Because communication costs increase with the knowledge intensity of globalized production, technology transfer in more knowledge-intensive industries will tend to take the form of embodied transfer through trade in intermediate inputs, which is subject to trade costs.

Earlier studies had explored the idea that international knowledge flows can be traced through their embodiment in goods trade.⁵ For example, Coe and Helpman (1995) use bilateral trade data to show that a country’s domestic productivity increases with an indirect measure of knowledge embodied in its imports (the product of foreign R&D spending and imports of goods from the foreign country); however, this result was challenged by Keller (1998), who estimated the same correlation from randomly created trade patterns. Using BEA’s rich data on multinational enterprise production and trade, Keller and Yeaple (2013) are able to construct a direct measure of embodied knowledge diffusion—the ratio of foreign affiliate imports of goods from the parent country to total costs of the affiliate—that is observed in the data for individual firms.

In their model, Keller and Yeaple (2013) demonstrate that the share of affiliate production costs accounted for by imports of goods from the home country (embodied knowledge transfer) is greater in more knowledge-intensive industries. Moreover, the import share, which declines as trade costs increase, declines at a slower pace in the more knowledge-intensive industries. Given the heavier reliance on embodied knowledge transfer, affiliates in more knowledge-intensive industries are less able to substitute away

4. The study represents a departure from the canonical model of multinational production and trade developed by Helpman (1984) and Markusen (1984); this model holds that multinational firms can transfer their knowledge without cost to their foreign affiliates.

5. These studies are surveyed in Keller (2004) and Keller (2009).

from imported inputs as trade costs rise, so their competitiveness and therefore sales are more sensitive to trade costs. Increased trade costs result in reduced competitiveness and therefore lower sales for affiliates in general, but the rate of decrease in affiliate sales as trade costs increase is faster in more knowledge-intensive industries.

The two key predictions are (1) the rate of decline in the share of inputs imported from the home country as trade costs increase is slower in more knowledge-intensive industries, and (2) the rate of decrease in affiliate local sales as trade costs increase is faster in more knowledge-intensive industries. These hypotheses are tested using BEA’s data on U.S. parent companies and their majority-owned foreign affiliates for the benchmark survey years of 1994, 1999, and 2004.

For both hypotheses, the key explanations are trade costs measured at the industry-country-year level and the R&D intensity of the firm’s industry in a given year. The first hypothesis predicts that trade costs for all industries will have a negative impact on the import share of total costs for foreign affiliates, but for knowledge-intensive industries, the negative impact on the import share should be less pronounced. Evidence supporting the second part of this hypothesis would be indicated by a positive correlation between the import share and an interaction term constructed as the product of trade costs and the industry R&D intensity. The second hypothesis predicts that trade costs will have a negative impact on affiliate local sales for all industries but that the impact on affiliate local sales will be more pronounced for knowledge-intensive industries. Evidence supporting the second part of this hypothesis would be indicated by a negative correlation between local sales and the interaction term described above.

The statistical results support the predictions (table 5), which also hold when more explanatory variables are added to isolate the effects of the key explanatory variables. As trade costs rise, firms in more knowledge-intensive industries are less able to substitute away from embodied knowledge transfers than firms in

other industries, so the share of imported inputs in their foreign affiliates’ production costs falls more modestly than the affiliate import share for firms in other industries. In addition, their affiliates’ competitiveness, reflected in sales, falls more sharply than that for firms in less knowledge-intensive industries. Overall, the findings support the conclusion that knowledge transfers are subject to spatial barriers, similar to the effects of distance on trade.

Multicountry Knowledge Collaboration

Much of the research on technology transfers within multinational enterprises starts from the premise that technological innovations originate in the country of the firm’s headquarters, which transmits the knowledge abroad to affiliates engaged in industrial production. This premise is grounded in classic theoretical work on direct investment and in observed fact. In 2011, for example, U.S. multinational enterprises performed 83 percent of their global R&D in the United States, although this share has been declining over time. However, research has also recognized that affiliates can develop expertise when they perform research activities in foreign countries, which provide multinational enterprises with opportunities to combine their knowledge in order to generate new innovation. In a study that focuses on the growing trend in combinative knowledge generation within multinational enterprises, Berry (2014) examines both the conditions that enable multicountry collaborative knowledge generation within multinational enterprises and the benefits that these firms achieve from these types of innovation.

To quantify multicountry innovations, Berry (2014) merges BEA’s data on U.S. multinational firms with U.S. Patent and Trademark Office data on the firms’ worldwide patents, which include information on the country of residence for each inventor. Berry shows that foreign-invented patents (those with at least one foreign inventor) accounted for 11 percent of the total patents granted to U.S. multinational enterprises in manufacturing in 1989–2004. Although most of the patents with a foreign inventor came from a single foreign country, patents with inventors from multiple countries accounted for 36 percent of the foreign patent total in 2004, up substantially from a share of 23 percent in 1989.

In earlier research on multicountry innovations, Guellec and van Pottelsberghe de la Potterie (2001) used patent data from the European Patent Office to examine country-level and industry-level patterns in multicountry collaborative innovations, and Yamin and Otto (2004) analyzed international knowledge

Table 5. Qualitative Summary of Empirical Findings in Keller and Yeaple (2013)

	Dependent variable	
	Import share of total costs	Local sales
Key explanatory variables:		
Negative relation with trade costs?.....	Yes	Yes
Trade-costs effect weaker for industries with greater knowledge intensity?.....	Yes	No
Trade-costs effect stronger for industries with greater knowledge intensity?.....	No	Yes

flows based on patent data for a sample of multinational enterprises in the pharmaceutical and biotechnology industries. These studies, however, did not relate the patent information to other linkages across firm operations. By using the information in BEA's firm-level data on flows of goods across the operations of multinational enterprises, Berry (2014) is able to examine whether prior production linkages enable firms to achieve collaborative innovations that combine diverse knowledge.

Berry (2014) advances the hypothesis that multicountry foreign patents are more likely to be generated in foreign affiliate operations that have a high degree of manufacturing integration with other operations of the multinational enterprise because a common knowledge base, prior communication channels, and increased visibility from production sharing can enable foreign operations to play increasingly important roles in firm innovation processes. She also hypothesizes that these multicountry innovations are more likely to draw from a wider base of technological knowledge than single-country innovations because innovators from different countries would each be expected to have their unique knowledge perspective and ideas from their local environment. A third hypothesis is that multicountry innovations will spur further innovation within the multinational enterprise because the collaborators can generate subsequent extensions of the knowledge or extend the newly created knowledge within their own operations.

To test these hypotheses, Berry (2014) analyzes the incidence of new foreign patents granted in 1989–2004 that are associated with the foreign affiliate operations of U.S. multinational enterprises, aggregated by host country, with breakdowns for multicountry and single-country patents. The key explanations for the level of multicountry patenting by affiliates (which correspond to each of the three hypotheses) are (1) the degree of manufacturing integration between an affiliate and other parties in the multinational enterprise (measured by intrafirm-goods-trade flows), (2) the technological originality of the foreign patent (measured by the diversity of technology classes in a patent's citations), and (3) subsequent application of the created knowledge (measured by forward self-citations). To isolate the effects of the key explanatory variables, Berry also includes a number of other variables at the levels of the multinational firm, the firm's foreign host-country operations, and the host country. The statistical results support all three hypotheses (table 6). For U.S. multinational enterprises, foreign innovations that involve multicountry collaborations are fostered by relationships developed through cross-border man-

ufacturing integration. Moreover, they differ from single-country foreign innovations in that they are based on a more diverse body of technological knowledge and are more likely to be used by the firm in subsequent innovations.

Next Steps

Technology is widely viewed by economists to be a key determinant of economic growth, so it is important to understand the role of multinational enterprises in international technology diffusion. The studies reviewed in this article illustrate how BEA's data on multinational enterprises can be applied to address key questions on this topic.

BEA's microdata on multinational enterprises currently are being used to investigate a number of other questions concerned with international technology diffusion. On the relation between intellectual property rights and technology transfer, one question under investigation is whether patent protection in foreign countries influences the outward orientation of the countries' firms, resulting in technology transfers to the United States through foreign direct investment. Another project explores whether the sensitivity of firms to patent protection depends on the complexity of production processes in a firm's industry, a characteristic that is distinct from the industry's product life-cycle length. On the firm-level impact of technology diffusion within the multinational enterprise, research is being conducted to determine whether R&D performed by a firm in one country has a measurable productivity-enhancing effect on the firm's operations in other countries. Another project in progress is examining when transfers of parent company technological and managerial knowledge are value-creating for multinational enterprises by analyzing the impact of inherited parent company knowledge on the performance of foreign affiliates, contingent on the relative importance of technological innovation in the firm's home country versus the foreign country. Going forward, research based on BEA's firm-level data promises to shed light on several new questions on the role of multinational enterprises in international technology diffusion.

Table 6. Qualitative Summary of Empirical Findings in Berry (2014)

	Dependent variable: Probability of multicountry patents with U.S. inventors relative to single-country foreign patents
Key explanatory variables:	
Positive relation with affiliate manufacturing integration?	Yes
Positive relation with patent technological originality? ...	Yes
Positive relation with patent self-citation ratio?	Yes

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