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Matthew J. Slaughter
(Dartmouth College and NBER)

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Center for Economic Policy Analysis
New School University
80 Fifth Avenue, Fifth Floor, New York, NY 10011-8002
Tel. 212.229.5901 • Fax 212.229.5903
www.newschool.edu/cepa

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Matthew J. Slaughter
Dartmouth College and NBER

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Abstract

How do multinational firms affect both the demand for and supply of skills in host-country labor markets? On the demand side, inward can FDI stimulate demand for more-skilled workers in host countries through several channels. To date, most empirical evidence indicates that these channels work mainly within multinationals themselves, rather than through knowledge spillovers to domestic firms. On the supply side, the question of how inward FDI influences the development of human capital is much less clear, with possible links at both the micro- and macro-levels. This paper offers some new empirical evidence on the links between inward FDI and within-industry skill upgrading for a country-industry-year panel spanning both developed and developing countries. The main empirical finding is a robustly positive correlation between skill upgrading and the presence of affiliates of U.S. multinationals, with this correlation even stronger among the sub-sample of developing countries. This correlation is consistent with inward FDI stimulating skill upgrading in these developing countries.

*Tuck School of Business, Dartmouth College, 100 Tuck Hall, Hanover, NH, 03755. slaughter@dartmouth.edu. For helpful comments I thank David Howell, Will Milberg, and other participants at the New School University's CEPA Conference, "Labor and the Globalization of Production," March 8, 2002.

1. Introduction

An important part of globalization in recent years has been the ongoing rise in foreign direct investment (FDI). UNCTAD (2000) reports that from 1979 to 1999, the ratio of world FDI stock to world gross domestic product rose from 5% to 16% and the ratio of world FDI inflows to global gross domestic capital formation rose from 2% to 14%. One consequence is that an increasing share of countries' output is accounted for by foreign affiliates of multinational enterprises (MNEs). The foreign-affiliate share of world production is now 15% in manufacturing and other tradables (Lipsey, et al, 1998).

How do these multinational affiliates influence host labor markets in developing countries? In this paper, I offer some insights on this question by examining the issue of "skill upgrading," which I will define both in terms of labor demand and supply. Each side of the labor market will be addressed in turn.

On the demand side, the academic literature on multinationals suggests several channels by which inward FDI stimulates demand for more-skilled workers in host countries. These include technology transfer to host-country affiliates; technology flows—both market-mediated and via spillovers—to host-country firms; and investments in physical capital related to new technologies. I will discuss both the theoretical concepts and empirical evidence on these various channels. There is compelling evidence on the importance of within-firm technology transfer and capital investment as modes of boosting host-country demand for more-skilled workers. The evidence is much more mixed on technology flows to domestic firms, particularly via spillovers. But contrary to what is commonly assumed, I will argue that lack of spillovers is not necessarily a bad thing in light of the stronger evidence on the roles for within-firm technology transfer and capital accumulation.

On the supply side, the question of how inward FDI influences the development of human capital is much less clear. I distinguish two different modes by which MNEs can facilitate investments in human capital. One is the short-term, firm-level activities by which individual firms interact with host-country labor markets through on-the-job training, support for local educational institutions, and the like. The other is long-term, country-level activities by which MNEs collectively contribute to the overall macro environment in which fiscal policy drives education policy. To the extent that MNEs contribute to a good macro environment in host countries—through raising worker productivity, providing a relatively stable source of foreign capital, paying host-country taxes—they contribute to the ability of host countries to fund education. If successful generalizations of firm-level educational initiatives may be hard to come by, as these efforts continue sight should not be lost of the country-level contributions.

After laying out these supply-and-demand issues, I present some new empirical evidence on the links between inward FDI and within-industry skill upgrading for a country-industry-year panel that spans manufacturing disaggregated into seven industries for 16 countries—developed and developing—from 1982 through 1990. To construct this panel I combined information on host-country inputs and outputs with information on the presence in these countries of affiliates of U.S.-headquartered multinationals. The main empirical finding is a robustly positive correlation between skill upgrading and the presence of U.S. affiliates, with this correlation even stronger among the sub-sample of developing countries. This correlation is consistent with inward FDI stimulating skill upgrading in these developing countries.

The rest of this paper is organized as follows. Section 2 addresses the theory and empirical evidence on how MNEs affect the demand for skills in host countries. Section 3 turns to the supply-side issues. Section 4 presents the new empirical evidence, and Section 5 concludes.

2. Multinationals and the Demand for Skilled Labor

Theoretical Links

In what ways does the nationality of ownership influence the demand for labor of firms in developing countries? Note that if there were no such ways, then MNEs would merit no particular attention when thinking about skill upgrading. There is widespread agreement among researchers in many fields that a distinguishing feature of these firms is their possession of *knowledge assets*—patents, proprietary technology, trademarks, etc.—that can be deployed in plants outside the parent country. This knowledge intensity is important for understanding the nature of MNE labor demand in host countries.

From an industrial-organization perspective, Dunning (1981) formalized a framework in which MNEs are firms possessing three particular sets of advantages, known together as "OLI." First is the ownership advantage, i.e., the ownership of a firm-specific asset. Second is the location advantage, i.e., it must be cost efficient for the firm to exploit that asset abroad rather than in just the home country. And third is the internalization advantage, i.e., the firm must be better off using its asset itself rather than contracting with another independent firm.

In international trade, over the last two decades there has been substantial progress in modeling multinational firms in general equilibrium. This theoretical literature contains mostly uni-dimensional theories of multinationals, which focus on either *horizontal* or *vertical FDI*.

The vertical-FDI view is that multinationals arise to take advantage of international factor-price differences.[1] Firms engage in two activities: headquarter services to develop and maintain the firm's knowledge assets, and production of output. Headquarter services are intensive in physical and human capital, while production is intensive in manual labor. When factor prices

[1] See Helpman (1984) and Helpman and Krugman (1985). This view is also related to models of foreign outsourcing, in which the vertical separation of production occurs *without* multinationals.

differ across countries, firms become multinational by locating production in countries where manual-labor costs are low and headquarters in countries where skilled-labor costs are low. Even though these production activities may be low-skill intensive relative to headquarter services, for host countries they likely will be skill-intensive relative to their initial activity mix.

The horizontal-FDI view is that multinationals arise because trade barriers make exporting costly.[2] The formal setup is one in which firms have a high-fixed-cost headquarters and one or more production plants. When trade costs are low, a firm produces all output in domestic plants and serve foreign consumers through exports. When trade costs are high, a firm becomes multinational by building production plants at both home and abroad, each serving just that country's consumers. This type of FDI is called horizontal because the multinational does the same activities (here, production) in all countries.

One tell-tale sign that MNEs are knowledge-intensive firms is their intensity of research and development (R&D). In the aggregate, evidence consistent with this is the overlap between countries that perform lots of R&D and countries that headquarter lots of MNEs. It is commonly calculated that approximately 90% of the world's R&D is performed in just five countries: the United States, United Kingdom, France, Germany, and Japan (e.g., Keller, 2001). These five countries are also among the largest source countries for world FDI flows. At the firm level, Slaughter (1998) reports that over the past 20 years the U.S. parents of U.S.-headquartered MNEs—only 2,727 firms in 1994—have consistently performed over half of all U.S. R&D.

Having established that MNEs tend to be very knowledge-intensive firms, we can now elaborate on how this knowledge intensity can help raise host-country demand for skills. There are at least three important channels to identify.

One is technology transfer. The simple idea here is that MNE use of knowledge assets often entails the transfer of technology from parents to affiliates. Inward FDI, then, can mean new production technologies for the host country, which in turn can boost demand for more-skilled labor within host-country affiliates to the extent that the innovations are skill-biased. This can occur whether the inward FDI is horizontal or vertical in nature. In either case, FDI expansion is likely to entail skill-biased technological change (SBTC).[3]

A second demand channel is that these new technologies may also reach domestically owned firms in host countries. This may happen through market-mediated arrangements such as patent licensing, in which domestic firms pay MNEs for the right to use their technologies. New technologies may also reach domestic firms thanks to "productivity spillovers" via non-market channels. Either way, the presence of inward FDI may stimulate domestically owned firms to demand more more-skilled labor.

Spillovers of knowledge from affiliates to domestic firms are an often-claimed benefit to inward FDI, so it is worth outlining possible spillover channels. The general idea that interaction among firms can generate spillovers dates back to at least Marshall (1920). Caves (1974, 1996) has had an early and ongoing interest in analyzing this possibility for multinationals interacting with host-country firms. Mansfield and Romeo (1980) present some early survey evidence in which U.S. multinationals reported the frequency and pace at which their technology deployed in foreign affiliates reached host-country competitors, all consistent with multinational spillovers.

Theoretical work on the mechanics of spillovers ranges from general discussions, often leavened with anecdotes, to formal general-equilibrium models. Broadly speaking, spillovers are

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[2] See Markusen (1984), Horstmann and Markusen (1987, 1992), and Markusen and Venables (1998, 2000). Trade models of this variety are similar to older theories of tariff-jumping FDI. See Caves (1996) for a discussion. There have been some attempts to integrate models of horizontal and vertical FDI into a single framework. See, e.g., Markusen (2001).

commonly hypothesized to fall along industry or regional lines. An example of multinational spillovers along industry lines is Rodriguez-Clare (1996), in which affiliates increase a host country's access to specialized varieties of intermediate inputs, the improved knowledge of which raises the TFP of domestic producers. Less formally, it is often hypothesized that domestic firms learn from affiliates in the same industry via a range of informal contacts: e.g., trade shows; supplier/distributor discussions; exposure to affiliate products, marketing, and patents; technical support from affiliates; reverse engineering. Depending on how narrowly or broadly industries are defined, if the key contacts are between suppliers and/or distributors, then spillovers may be classified as intra-industry or inter-industry.[4]

Other spillover mechanisms may operate along regional lines. One commonly proposed avenue (since at least Marshall, 1920) is via labor turnover. If at least some of the knowledge particular to foreign affiliates is embodied in their labor force, then as affiliate employees leave to work for domestic firms this knowledge may move as well. For example, Song, et al (2001) use U.S. patent records to trace the movement of scientists between domestic and foreign firms (also see Motta, et al, 1999, and Moen, 2000). This knowledge need not be firm-specific (e.g., inventory-control or management techniques). If inter-regional labor mobility within a country is low, then these spillovers are likely to be concentrated within regions where the affiliates operate rather than dispersed country-wide. More generally, regional labor-market spillovers can

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[3] In general-equilibrium trade models with multiple sectors, the "sector bias" of technological change—i.e., what industries these innovations are occurring in—can matter for economy-wide labor-demand changes above and beyond any factor bias to these innovations. See Haskel and Slaughter (2002).

[4] For example, suppose that knowledge spills over from automobile producers, which fall within U.S. Standard Industry Code (SIC) 3711, to automobile-parts suppliers, which fall within U.S. SIC 3712. Then at the four-digit SIC level spillovers would be inter-industry, but at the two- or three-digit level they would be intra-industry.

be thought of as one important kind of agglomeration economy that can induce firms to locate near each other in space. Krugman (1991) offers some formal models of agglomeration issues.[5]

A third channel for boosting host-country skilled-labor demand, for both foreign and domestically owned firms alike, is capital investments. Implementing new technologies often entails making new capital investments (e.g., computers and office products). To the extent that capital and skills are complements in firms' factor demands, skill upgrading may arise not just directly from new technologies but also indirectly from the capital investments induced by these new technologies.

Empirical Evidence on These Links

For the empirical evidence on how MNEs influence the mix of host-country labor demand, consider in turn each of the three channels—within-MNE technology transfer, affiliate to local technology transfer, and capital investment.

An important implication of within-MNE technology transfer from parents to affiliates is that, relative to host-country domestic firms, this transfer and/or its resultant boost in demand for skilled workers should lead affiliates to pay higher wages. This implication enjoys a lot of empirical support. Many studies—of both developed and developing—have found that establishments owned by multinational firms pay higher wages than do than domestically owned establishments, even controlling for a wide range of observable worker and/or plant characteristics such as industry, region, and overall size.[6] To the extent that production

[5] Spillovers via labor turnover might hinge on the mobility of administrative workers—e.g., managers with knowledge of organizational techniques. But it might instead hinge on the mobility of production workers as well—e.g., assemblers with knowledge of production-line efficiencies.

[6] For example, Howenstine and Zeile (1994) and Doms and Jensen (1998) document these wage differentials among U.S. manufacturing plants. Globerman, et al (1994) present similar evidence for Canada; Aitken et al (1996) for Mexico and Venezuela; and Te Velde and Morrissey (2001) for five African countries.

technology is largely unobservable in these studies, the regularity of this "multinational wage premium" may stem from the superior technology and thus labor-demand mix of these firms.[7]

More-direct evidence on the transfer of technology and resultant labor-demand mix for MNEs can be obtained from data on U.S.-headquartered MNEs. Since the late 1970s, the Bureau of Economic Analysis (BEA) within the U.S. Department of Commerce has collected data on both the U.S. and foreign operations of these companies. One piece of evidence consistent with rising within-firm technology transfer is the rising share of MNE-wide R&D performed by foreign affiliates. In 1982 affiliates performed 6.4% of worldwide R&D for these firms; by 1994 that share had nearly doubled, to 11.5%. If one role of R&D is to facilitate technology transfer, then this rising R&D share suggests rising technology transfer.

As for the labor-demand mix, in its census years the BEA requires foreign affiliates in manufacturing to distinguish non-production from production employment. Following a number of studies in the trade-and-wages literature, one can define the former to be more-skilled and the latter to be less-skilled.[8] Table 1 reports the skill mix of affiliate employment in 1977 and again in 1994 (the most recent year for which these data are available) for the overall world and for a set of prominent developing countries.

The key message of Table 1 is a widespread shift in the skill mix of affiliate employment. In 1977, manufacturing affiliates of U.S. MNEs employed 2.37 million production workers worldwide. By 1994 this number had fallen to just 2.09 million. Over that same period non-

[7] The multinational wage premium may be caused by forces other than superior technology. For example, Budd, et al (2001) argue that if MNEs are, on average, more profitable than domestic firms, then international rent sharing within MNEs could explain this wage premium. For a panel of MNEs in Europe over the 1990s, they estimate a robust correlation between affiliate wages and parent profitability, consistent with this profit-sharing story. Other explanations might be compensating differentials due to perceived disamenities related to working for multinationals, or (especially for operations in lower-income countries) concerns about individual attitudes toward these firms as somehow "exploiting" host-country workers.

[8] Berman, et al (1994) document for the United States that employment trends for this job-classification measure track quite closely employment trends measured by the white-collar/blue-collar job classification--which in turn closely reflects the college/high-school classification. That said, this broad occupation classification is an admittedly imperfect measure of labor-

production employment actually increased slightly, from 1.40 million to 1.42 million. This means that the skilled-labor share of total manufacturing employment in affiliates has been rising, from 37.2% to 40.5%. This rise is matched in all individual countries in Table 1 but Mexico, regardless of whether the overall levels of affiliate employment was rising or falling.

To put these share changes in context, during this same period in the United States the skilled-labor share of employment across all manufacturing plants rose from 26.1% to 30.0%. This was a period of widespread SBTC in U.S. industries (e.g., Haskel and Slaughter, 2002), yet the share increase in the United States is only slightly larger than that in U.S. affiliates. And this share increase in affiliates does not simply reflect shifting relative size among industries of different but constant skill intensities. Slaughter (2000) reports that for the standard 32 BEA industry groups within overall manufacturing, 24 had rising skilled-employment shares over the period covered in Table 1.[9]

The shift in relative employment in Table 1 is suggestive of technology transfer that stimulates demand for more-skilled workers. More generally, this rising within-affiliate relative employment of more-skilled workers has been widely documented in many countries—both developed and developing—in recent decades (e.g., Berman, et al, 1998, Haskel and Slaughter, 2002; Berman and Machin, 2001). Such employment shifts in the face of flat or rising relative wages for more-skilled workers is commonly cited as evidence consistent with SBTC.[10]

Taken together, this evidence on affiliate wages, R&D, and skill-mix is all consistent with the idea that affiliates stimulate demand for more-skilled workers thanks to technology transfer

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market skills. In particular, the skill mix can change *within* each occupation group—and thus there may be skill upgrading within the separate pools of non-production and production workers.

[9] Also notable is the fact that many developing countries had non-production employment shares below that of the overall world. This broadly suggests that MNE employment demands respond to cross-country differences in factor prices.

[10] Many researchers (e.g., Berman, et al., 1994, 1998) have argued that SBTC has been a primary force behind rising income inequality across skills within countries. But this view is by no means unanimous. For research arguing the links among skill upgrading, SBTC, and wages is far from clear, see, e.g., Howell and Wieler (1998) and Card and DiNardo (2002).

from the parent firms. Hold for now the question of whether this technology somehow reaches other firms in host countries, and turn first to the issue of capital accumulation.

Many studies have documented how new technologies are often embodied in new capital goods (as opposed to simply changing production techniques for unchanging capital goods). The most prominent recent example of this is the recent surge in innovation in information and communication technology (ICT) products: desktop and laptop computers, fax machines, pagers, cell phones. In turn, there is also a large body of evidence (see the survey in Hamermesh, 1993) that capital investment stimulates firms' demand for more-skilled workers.

Data on U.S. MNEs are again consistent with this. From 1977 to 1994, the affiliate share of worldwide capital within these firms rose from about 19% to 23%. Within manufacturing, the affiliate capital share rose in 22 of the 32 primary BEA industries. The coincidence of affiliate capital deepening and shifting relative employment is consistent with capital-skill complementarity related to technology transfer. More generally, to the extent that FDI involves, by definition, host-country capital accumulation by foreign-owned firms, it is not surprising that affiliate expansion should be a force raising demand for more-skilled workers.

What about the transfer of technology from affiliates to domestic firms in host countries? Existing evidence on whether there are productivity spillovers is of three types. The first are case studies. Cases can offer rich description about episodes and exemplify general issues, but they do not always offer quantitative information and do not easily generalize.

Second, there are industry-level studies (e.g., Caves, 1974 and Blomstrom, 1986). Many have documented a positive correlation between FDI inflows and productivity. But the causal meaning of this industry-level correlation is unclear. It may be that inward FDI raises host-country productivity via spillovers. It may also be that inward FDI raises host-country

productivity by forcing the exit of low-productivity domestic plants, or simply by raising the market share of foreign firms who are, on average, more productive. Or it may be that multinationals tend to concentrate in high-productivity industries. This latter interpretation is consistent with the knowledge-capital models of multinational firms outlined above.

The third set of studies are micro-level analyses. These studies examine whether the productivity of domestic plants (or firms) is correlated with FDI presence in the industry and/or region of the domestic plants. These micro-level studies are the best suited for identifying productivity patterns consistent with spillovers that industry-level studies cannot.

For developing countries, however, there is very little micro evidence supporting knowledge spillovers. Haddad and Harrison (1993) find increased industry-level FDI is correlated with lower, not higher, domestic-plant productivity in Moroccan manufacturing plants. Aitken and Harrison (1999) find the same negative result for Venezuelan manufacturing. For developed countries the results are more mixed. Chung, et al (1998) report no evidence that Japanese automobile firms operating in the United States boosted the productivity of their American component-supplier firms via technology spillovers. Haskel, et al (2002) report some of the strongest micro-level evidence of FDI spillovers. For a panel of plants covering the entire U.K. manufacturing sector from 1973 through 1992, they estimate a significantly positive correlation between a domestic plant's TFP and the foreign-affiliate share of activity in that plant's industry.

Why is the evidence on FDI spillovers so mixed? One possible explanation is the pro-competitive effects of affiliate operations. It may be that foreign entrants take domestic firms' market shares as they stimulate product-market competition, and thereby force domestic incumbents up their average-cost curves. This argument is consistent with Baily and Solow (2001), who survey a wide range of micro evidence that international competition of many

forms—including both FDI and trade—tend to spur competitive responses in exposed firms. Another explanation may be that only certain kinds of inward FDI—e.g., greenfield construction of new facilities rather than mergers and acquisitions—matter for generating spillovers.

Still another explanation may simply be that domestic firms in developing countries do not have sufficient absorptive capacity to realize knowledge transfers from affiliates. But I know of only two micro-level spillover studies for developing countries, so it is unclear how generalizable these two data points are. This will be an important point of consideration when evaluating the empirical evidence in Section 4.

Summary of Empirical Evidence and Policy Implications

Consistent with standard models of MNEs, there is compelling evidence that affiliate demand for skilled labor is stimulated by their receipts of parent technology and their investments in physical capital. Purely through a compositional shift, then, more inward FDI can raise host-country demand for skilled workers. The evidence is mixed, however, as to whether affiliates also stimulate this host-country demand via technology transfer to domestic competitors.

The ambiguous evidence, at best, on knowledge spillovers from foreign to domestic firms may strike some as unfortunate. Such spillovers are an often-touted benefit of inward FDI. It is important to emphasize, however, that externalities of this kind are, by definition, market failures. In theory, if profit-maximizing MNEs are aware of their ability to generate spillovers, then their operational decisions may be endogenous to this possibility and thus may try to minimize spillovers' benefits to competitors.

The survey evidence on MNE expansion strategies in Mansfield and Romeo (1980) supports this minimization argument. For example, U.S. MNEs report they transfer older technologies to

affiliates that are joint ventures—and thus where knowledge spillovers are more likely—than they do technologies to wholly owned affiliates.

The analysis of Shaver and Flyer (2000) is also consistent with this story. They argue that when firms vary in their inherent technology abilities and other measures of firm performance, then these firms differ in the net benefits they realize from agglomerating near each other. "Best practice" firms have the least to gain and the most to lose from clustering: few other firms can offer them new ideas, yet their good ideas can benefit a large number of other firms. Thus, with heterogeneous firms agglomeration may be characterized by adverse selection, where the firms with the most to offer by clustering have the least incentive to do so. Their analysis of location choices of greenfield investments into the United States supports this idea: better-practice foreign plants, proxied by measures such as size, were less likely to locate near domestic firms.

An important policy implication of this endogeneity of knowledge spillovers is that host-country policies that aim to encourage knowledge transfer can have the paradoxical effect of aggravating rather than solving the underlying market failure—and thereby of reducing, not enhancing, the host-country benefits of foreign presence.

The recent work by Moran (2001) makes precisely this point. He carefully examines two industries with extensive global activity in FDI, automobiles and computers/electronics. For each industry he distinguishes two types of host countries. One is those that allow parents to maintain tight control over affiliate operations and thereby allow affiliates to be integrated into MNE-wide production networks as the firms see best. The other is countries that impose relatively stringent and/or widespread performance standards on affiliates—e.g., ownership caps, domestic-content requirements, and various technology-sharing mandates. Moran's (p. 32) description of the latter group presents a striking set of differences between the two types.

> The implications for the development prospects of the host are not favorable. Resources are wasted. Not only are host country consumers penalized, but so too are host country producers that rely on the use of the resulting goods and services to establish their own competitive positions in the marketplace … the plants utilize older technology, and suffer lags in the introduction of newer processes and products in comparison to wholly owned subsidiaries without such requirements. At considerable variance with the dynamic infant industry perspective, the plants are locked systematically into a position well behind the cutting edge of the industry.

Put differently, there is compelling evidence that inward FDI brings new technology and capital investment to host countries within the boundaries of affiliate operations. The evidence that this technology spills over to domestic firms is much more mixed. But one should not automatically assume that more of the latter would be better, because in general equilibrium it may come at the cost of less of the former. Policy makers need to keep this in mind. If policy makers care only about raising aggregate productivity, then they should be indifferent about the nationality of ownership of their more-productive firms.

Let me offer two examples of this point. First is a country, Ireland. Ireland enjoyed a booming economy throughout most of the 1990s, which has been widely touted as driven in large part by a surge in inward FDI—and thus in technologies and capital investment—concentrated in high-technology sectors like computers and pharmaceuticals. Today, foreign affiliates of U.S. firms account for about 16% of total Irish GDP, and within Irish manufacturing foreign affiliates of all firms account for about 75% of employment. Does it matter for Ireland whether its surge in output related to strong technology and investment gains has been largely or even entirely within the boundaries of foreign affiliates operating there? By extension, does it matter for any other country either?

My second example is an industry, ICT products. In recent years ICT industries have been central to the aggregate economic performance of the United States and other countries. For the

United States, about two thirds of the acceleration since 1995 in labor-productivity growth is accounted for by the combination of the production and the use of ICT products (Slaughter, 2002). Prominent ICT-producing firms such as Microsoft and Intel are widely regarded as world-wide best-practice firms, and policy makers worldwide profess their intention to host a rising share of worldwide ICT activity.

It is instructive to note the large and rising role for MNEs in these ICT sectors. Table 2 offers some evidence on this. For two key ICT industries, industrial machinery and electronic goods, it reports the share of total U.S. sales accounted for by the sales of goods of U.S. parents of MNEs whose main line of business is in those industries. Shares are reported for 1982, 1989, and 1996; similar shares for overall manufacturing outside these ICT industries are also reported.[11]

Over the 1980s and into the 1990s, U.S. parents of MNEs account for over 60 percent of total U.S. sales in these two prominent ICT industries. Moreover, the importance of these industries has generally been rising over time. In machinery this sales share rose from 54.8 percent in 1982 to 62.2 percent in 1996, . In electronics this sales share actually declined over the 1980s, but surged in the 1990s from 66.6 percent to 77.6 percent. This prominent presence for U.S. parents in these industries is far larger than their presence in the rest of manufacturing. The parent sales share for other manufacturing rose from 45.0 percent in 1982 to 49.3 percent in 1996. And

[11] Within the widely used Standard Industrial Classification (SIC), many studies term ICT sectors part or all of electrical and non-electrical machinery (SIC 36 and 35, respectively). These industries contain much of the ICT hardware such as computers and office products (SIC 357) and semiconductors (SIC 3674). Other ICT sectors include telecommunication services (SIC 48) and information services (SIC 737). Sales data for these industries in the overall United States come from the National Bureau of Economic Research (2001). Sales data for the U.S. parents of American companies with global operations come from the BEA. What is reported for these parents is their sales of goods only, not of goods and services. This is to maximize comparability with the U.S. industry-wide sales data. That said, one potential limitation of these parent data is they classify all of a parent's sales of goods into the single industry in which that parent is classified. To the extent that some parents span multiple lines of business, and thus sell goods across multiple industries, these data may be noisy. That said, for a smaller number of years sales data are also classified by industry of sales, rather than by industry of parent. Sales data across these two methods are very close to each other. In fact, for ICT industries parent sales by industry of sales are slightly larger than parent sales of goods by industry of parent, so this alternative sales measure would make U.S. parents look even more prominent than they already do in Chart A.

during the 1990s this share was virtually unchanged in the rest of manufacturing, while it was rising substantially in the two ICT industries.

All this suggests that MNEs account for a sizeable share of total U.S. ICT activity, a share which has been both rising over time—particularly over the 1990s—and which appears larger than in most other industries. It is also of interest to know how prominently foreign affiliates appear in the worldwide activity of these firms. Do MNEs in ICT industries look more global than those in other industries in terms of affiliates being a higher share of firm-wide activity?

Data answering this question are in Table 3. This reports the share of worldwide firm value added and employment accounted for by majority-owned foreign affiliates. These shares are reported for 1982, 1989, and 1997 for machinery, electronic goods, and all industries together. Table 3 shows that in 1997, foreign affiliates in these central ICT industries accounted for between 26 and 40 percent of worldwide firm value added and employment. These shares were generally rising by several percentage points over the 1980s and 1990s. They also are uniformly higher by 1997 than for the broad economy, where the increases were generally smaller.

The global presence of these ICT industries involves not just high-income but many middle- and low-income countries as well. The McGraw Hill Companies, et al (2000) reports that in many central ICT industries, many low-income countries such as Mexico, Malaysia, Philippines, and South Korea are large exporters running net trade surpluses. This is consistent with global production networks in which these countries tend to import ICT intermediates, add value to these intermediates, and then export them on to additional countries. There are also compelling studies of international production networks for very specific activities within ICT sectors—e.g., McKendrick's, et al (2000) coverage of producing hard-disk drives. A generation ago these disk drives were physically produced in the United States, but since then have migrated to lower-cost

regions in various lower-income countries primarily in Southeast Asia. Consistent with all this, Hanson, et al (2001) report that from 1982 through 1998, for affiliates of U.S. multinationals the fastest growing industry-region combination was computers/office products in Southeast Asia.

It is also important to emphasize that for many producers of ICT products, foreign customers may be served much more effectively through foreign affiliates rather than exports. This may be particularly true for ICT services, many of which require firms to interact on-site with customers. Affiliates of MNEs, then, can also figure prominently in terms of serving foreign markets.

Table 4 demonstrates this predominance of foreign-affiliate sales over U.S. exports for the key ICT industries of computer services, data-processing and network services, and electronic-information services. For these industries, this table reports both total foreign sales by majority-owned affiliates and total U.S. exports in three years over the 1990s—1992, 1994, and 1998.[12] Affiliate sales were about eight times larger than exports in 1992, and by 1998 this gap had grown to nearly 20 times. This shows that for many ICT services, foreign affiliates have become an increasingly important channel for serving foreign markets.

So not only do the U.S. parents of MNEs account for a high and rising share of U.S. activity in central ICT industries (Table 2), but within these firms in these industries a high and rising share of total activity (Table 3) and total foreign-market sales (Table 4) is accounted for by their foreign affiliates. Together, all this suggests that MNEs mediate an important share of total world ICT activity. Again, from the standpoint of policy makers interested in attracting ICT firms, does this matter? If these firms choose to minimize knowledge spillovers—a plausible assumption for such information-intensive sectors—does that mean that host countries should not try to attract them? Ideally, with micro panels covering many industries like ICT in many countries, more evidence could be brought to bear on these questions; see Section 4.

3. Multinationals and the Supply of Skilled Labor

On the supply side, the question of how inward FDI influences the development of human capital is much less clearly answered. This link is, correctly, at the center of this conference, as not a lot is known about it. I will distinguish two different modes by which MNEs can facilitate investments in human capital.

Multinationals and the Short-Term, Firm-Level Supply of Labor

MNEs can facilitate investments in skilled labor through the short-term, firm-level activities in which individual firms interact with host-country labor markets through on-the-job training, support for local educational institutions, and the like. MNEs might directly affect labor supplies, as their transferred knowledge might boost the skills of their employees (and, with spillovers, the skills of domestic employees as well). They might also indirectly affect labor supplies, for example, by influencing the educational infrastructure of host countries in terms of curriculum choices and vocational training. For example, Hanson (2000) reports that Intel recently chose to establish a large assembly and testing facility in Costa Rica, in part thanks to Costa Rica's agreement to expand high-school training in electronics and English.

There is recurring discussion of the "skills gaps" multinationals encounter in host-country labor markets. Knowing how individual firms try to overcome these gaps may hold lessons for the educational initiatives of host-country governments. At this conference, other participants more familiar with real-world cases can better speak to these approaches and policy lessons.

I just offer two related points. First, in the training literature it is well documented that educational initiatives by firms tend to be for firm-specific skills, not general skills (e.g., Lynch, 1992). This focus on firm-specific skills is understandable in light of the inability of firms to capture the returns on investment in general skills. Second, I reiterate that the knowledge of

[12] The ICT service industries in this chart together constitute SIC industry 737.

MNEs is often times of competitive value. Government initiatives to have this information flow beyond affiliates may have unintended consequences, as outlined in Section 2. Taken together, these two points are not to say that individual MNEs cannot engage the institutions of host-country labor markets to help build skills. But they are to say that the methods of MNE human-capital development are likely to often be firm-specific rather than aimed at general human-capital issues of numeracy, literacy, and problem-solving.

Multinationals and the Long-Term, National Supply of Labor

The other way in which MNEs can facilitate human-capital development is a set of long-term, country-level activities by which MNEs collectively contribute to the overall macro environment in which fiscal policy can support education policy. To the extent that MNEs contribute to a good macro environment in host countries, they contribute to the ability of host countries to fund education.

First, MNEs foster skills acquisition economy-wide to the extent that their affiliate activities of technology transfer and capital investment boost demand and thus wages for skilled workers. These labor-demand drivers were discussed in Section 2. Economy-wide, if MNEs contribute to rising demand and wages for skilled workers, then over the long-run they contribute to the general-equilibrium incentive of individuals in host countries to acquire skills through education and/or training. If individuals in host countries have access to these methods of skills acquisition, then they should respond to the price signals coming from the labor market.

Second, the rise in economic activity from MNE affiliates means a rise in host-country tax revenue (whether taxes are levied on labor, capital, or both). This broadening of host-country tax bases can allow greater government investment in education and training. Of course, FDI output and taxes therefrom do not automatically imply greater investment in human capital. But FDI

output and taxes therefrom do free up budget constraints and thereby make possible these greater investments. This broadly accords with the recent findings of Dollar and Kray (2000), who document for a large set of developing countries that overall economic growth tends to coexist with growth in incomes for countries' poorest groups.

Third, FDI inflows can improve not just the level of host-country economic activity but also its volatility. Many developing countries rely on foreign capital to help fund domestic investment opportunities. Table 5 (from World Bank, 2000) reports the composition of net capital flows into developing countries over the 1990s. One prominent fact is the declining relevance of official aid flows, whose share of the total fell from nearly 60% in 1990 to under 20% in 1999. A second prominent fact is that within private flows, FDI has grown in both absolute and relative importance. By 1999 FDI accounted for about two thirds of total capital inflows and nearly 80% of private inflows.

A notable feature of FDI relative to other forms of capital flows is its low volatility. For most of the world's developing countries over the 1990s, year-on-year variation in FDI flows has been much lower than in equity and debt flows. Table 5 shows this to be the case during the second-half of the 1990s with the run up and subsequent crash down of debt financing and, to a lesser extent, equity flows. In contrast, FDI flows grew steadily over the decade. This pattern in Table 5 has been documented in many studies. For example, World Bank (1999) reports that for a sample of 21 developing countries from 1978 through 1997, FDI inflows were less volatile (in terms of sample coefficient of variation, as a share of GDP) than were non-FDI capital inflows. Similar evidence can be found in Reisen and Soto (2001).

All this means that over time, for many countries a rising share of their total international capital inflows have been of relatively-stable FDI. From the standpoint of macroeconomic

policy, stable capital inflows are much easier to manage. Accordingly, these FDI inflows help foster macroeconomic stability in which educational investments can better flourish. Again, macro stability—like tax-revenue growth—may not be a sufficient condition for FDI to stimulate human-capital development. But it may, again, be a necessary condition.

A fourth issue is that FDI inflows may inhibit "brain drain." In many developing countries, an ongoing policy concern is the loss of highly educated natives to employment opportunities abroad (either as these people get education locally and then emigrate, or as they get education abroad and then do not return home). To the extent that FDI inflows bring to host countries those attractive employment opportunities, they may inhibit the brain drain.[13]

Again, consider the example of Ireland. The 1990s boom, due in large part to the inward FDI surge, is widely perceived as having boosted demand for skilled Irish workers—with a resulting surge in labor supply driven largely by reverse migration of young Irish back into the country from locations like England and the United States. Over the 1990s the Irish labor force rose by about 60%, with a commensurate rise in the population from 2.8 million in 1961 to 3.8 million today (Brumley, 2001). For several decades before the 1990s, annual net emigration out of Ireland was about 35,000 per year. During the 1990s this reversed to net immigration of about 45,000 per year, of which the majority were Irish returnees. Of course, the Irish experience may be somewhat unique, but is exemplifies well the general idea of the interaction between inward FDI reverse migration.

Summary of Multinationals and Labor Supply

To the extent that successful generalizations of firm-level educational initiatives may be hard to come by, as these efforts continue sight should not be lost of the country-level contributions

[13] I know of no empirical evidence on this issue. One concern may be that if multinationals in host countries attract highly talented locals, if those locals move on to employment within these firms in other countries then brain drain may be exacerbated.

that MNEs can make to human-capital development. This is particularly true for policy aimed at longer time horizons. High MNE wages as an important labor-market signal, higher and more-stable macroeconomic growth and tax revenue, and reduced emigration incentives: through all these channels MNE affiliates can stimulate long-term skills acquisition in host countries.

4. New Empirical Evidence on Inward FDI and Developing-Country Skill Upgrading

Sections 2 and 3 discussed the possible mechanisms by which inward FDI can stimulate skill upgrading in host countries. This section offers some new empirical evidence on this FDI-to-skill upgrading link for a country-industry-year panel that spans manufacturing disaggregated into seven industries for 16 countries—developed and developing—from 1982 through 1990.

To construct this panel I combined information on host-country inputs and outputs with information on the presence in these countries of affiliates of U.S.-headquartered MNEs. The data on host-country inputs and outputs by industry-country-year come from the United Nations (U.N.) General Industrial Data Base. In these U.N. data industries are defined at the three-digit ISIC level, of which there are 28 within manufacturing. The data on U.S. MNEs come from the BEA within the U.S. Department of Commerce, as described in Section 2. I choose to measure FDI presence in host countries by their total employment; results are very similar using alternative activity measures such as affiliate sales.

Matching these two data sets required aggregating the ISIC industries because the publicly-available BEA data by industry-country-year tend suppress a substantial amount of observations (to prevent disclosure of individual companies) as the BEA industries are sliced more finely, especially for smaller countries. I settled on aggregating the 28 up to seven. For the country dimension of the data, I included any middle-income or low-income country for which both the

U.N. and BEA data were available for most potential observations; I also chose a set of high-income countries as a comparison group. This left me with 16 countries. Finally, the time dimension of the data run 1982 through 1990. BEA data are not available annually for earlier years, and after 1990 the U.N. data stop distinguishing workers by occupation, which is essential for a measure of skill upgrading.

The overall country-industry-year panel contains 951 observations. It is an unbalanced panel due mainly to U.N. data missing for some country-years. Table 6 lists the industries and countries ordered by their 1985 per worker gross domestic product (GDP). In the empirical analysis I will distinguish two groups of developing countries. One group is defined simply as the eight below-median income countries in Table 6. The other group is defined more narrowly as the bottom five countries in Table 6, with this cut-off chosen based on the several-thousand-dollar jump in income above this point in the table.

I measure the skill intensity of each industry by its share of total wage bill accounted for by non-production workers. The results are virtually identical using the non-production share of total employment, but I choose the wagebill shares for greater comparability with many studies of skill upgrading in the SBTC literature that assume the underlying production technology to be translog, which is more flexible than Cobb-Douglas or CES (e.g., Berman, et al, 1994; Haskel and Slaughter, 2002). The sample mean for this variable is 0.476 (s.d. of 0.195). I measure the presence of MNEs in an industry by the share of its employment accounted for by U.S. affiliates. Ideally I would use data on affiliates from all source countries and not just from the United States, but such data simply do not exist. The sample mean for this variable is 0.052 (s.d. of 0.113). Thus, the typical observation in the data is a country-industry-year in which non-

production workers account for just under half of the total wagebill and in which U.S. affiliates account for about one in 20 jobs.

I estimate regressions of wage-bill shares on MNE presence and various other controls. In related skill-upgrading studies, these controls commonly include capital and/or output per worker. My results are robust to including or excluding these controls; as capital-stock data contain more missing observations and are probably of highly-variable quality across countries, I report results without these controls. Instead, I exploit the panel nature of the data to control for determinants of skill intensity across time, countries, and industries. In all specifications I include a time trend, as many SBTC studies have found the 1980s to be a decade of widespread skill upgrading in many countries. In all specifications I also include a full set of country fixed effects, to control for unobserved country-level forces—e.g., overall level of development, technology, and market transparency—that may influence skill intensity. I experiment with including and excluding a full set of industry fixed effects. Given the use of time and country controls, including industry controls as well does not leave much independent variation in the MNE regressor of interest.

Regressions are reported for OLS in levels. Results are robust to weighted least squares using, e.g., industry employment as weights. Results are also robust to first-differencing the data. Differenced specifications are common in the skill-upgrading literature, and control for all industry and country fixed effects. But time-differencing aggravates measurement error—an estimation issue that almost surely is important given the range of countries and data sources drawn together in this panel. Consistent with this, relative to the reported results differenced results have similar coefficient estimates but larger standard errors.

Table 7 reports estimation results, where each column is for a different specification and each row is for a particular regressor. Table cells report coefficient estimates and the corresponding t-statistics that are robust to arbitrary forms of heteroskedasticity. The main empirical finding of Table 7 is a robustly positive correlation between skill upgrading and the presence of U.S. affiliates, with this correlation even stronger among the sub-sample of developing countries. This result holds for the first five specifications, which include a full set of country effects, and for the second five as well, which control for both country and industry effects. It also holds for either the broad or narrow definition of developing countries. Note that in all specifications in Table 7 the coefficient on time is positive, significantly so in many cases. This is consistent with the finding in related studies of a secular trend in skill upgrading. In every specification, (unreported) F-tests indicate the industry effects and/or country effects are jointly significant.

The evidence in Table 7 suggests that inward FDI stimulates skill upgrading in developing countries. Again, Section 2 laid out several mechanisms by which this skill upgrading might arise. Without plant- and/or firm-level data these mechanisms cannot be sorted out. Nevertheless, the evidence in Table 7 suggests that attempts to obtain and analyze these sorts of micro panels could yield very interesting results.[14]

5. Conclusions

This paper has discussed how multinational firms affect both the demand for and supply of skills in host-country labor markets. On the demand side, multinational affiliates raise demand for more-skilled workers as they utilize firm-specific knowledge assets and as they invest in physical capital. All this may also occur in domestic firms in host countries if these knowledge assets are somehow transferred, but evidence on this—particularly for externality spillovers—is

rather mixed. On the supply side, multinationals can raise the supply of more-skilled workers both at the micro-level of individual affiliates training workers in-house and via interactions with host-country education and training institutions. They can also do this at the macro-level through channels such as helping raise and stabilize output and affecting migration decisions.

This paper also presented new empirical evidence that inward FDI is correlated with skill upgrading in developing countries. Data permitting, these results may merit closer research along several lines. On the demand side, the issue of how these firms control the within-firm and cross-firm flows of information may matter for how broadly these knowledge assets spread within host countries. At this point, there simply is not a large, systematic body of evidence on knowledge flows into FDI-host countries. This is in part because data requirements to distinguish alternative stories are high: micro-level data on plants, firms, and individuals are really needed. With greater data efforts, much may be learned.

In closing, it is important to point out that multinational firms and FDI are not the only channel by which countries can gain access to the technology and capital required for economic growth. It has been widely documented that in recent years most governments worldwide have made their policies much more friendly to foreign firms (e.g., UNCTAD, 2000). That said, history offers many examples of governments (e.g., Japan and South Korea) pursuing development strategies instead of or in tandem with an FDI strategy: joint ventures, licensing, and exporting have been common. The focus of this paper on the role of FDI in facilitating host-country skill upgrading is best seen in the broad context of all development strategies.

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[14] I did experiment with lagging the measure of FDI presence by one or two years, with the idea that if host-country skill-upgrading impacts take time to materialize, then lagged FDI presence might show even stronger correlations than those in Table 7. Such stronger correlations did not appear, however; the results were qualitatively unchanged.

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Table 1
The Skill Mix of Employment
in Foreign Affiliates of U.S.-Headquartered Multinationals

Country	1977 P Emp	1977 NP Emp	1977 NP Share	1994 P Emp	1994 NP Emp	1994 NP Share
World	2370.0	1400.0	0.37	2093.4	1422.6	0.41
Brazil	179.5	116.7	0.39	133.9	91.4	0.41
India	19.3	14.9	0.44	8.2	7.6	0.48
Malaysia	19.0	6.7	0.26	67.3	42.9	0.39
Mexico	103.1	68.1	0.40	284.2	131.0	0.32
Philippines	44.7	16.4	0.27	29.1	23.1	0.44
Singapore	27.4	5.1	0.15	44.5	24.6	0.36
Taiwan	45.3	13.0	0.22	22.3	15.7	0.41

Notes: "P Emp" indicates production-worker employment, in thousands. "NP Emp" indicates nonproduction-worker employment, in thousands. "NP Share" indicates the share of total employment accounted for by nonproduction workers. All data come from the Bureau of Economic Analysis.

Table 2
The Share of U.S. Sales in ICT Industries
Accounted for by the U.S. Parents of U.S.-Headquartered Multinationals

Industry	1982	1989	1996
Machinery	54.8	58.6	62.2
Electronics	73.2	66.6	77.6
Other Manufacturing	45.0	49.1	49.3

Notes: Cell entries report the share (in percentage terms) of each industry's U.S. sales accounted for by the sale of goods of U.S. parents of U.S.-headquartered multinationals whose main line of business is that relevant industry. Other manufacturing is all manufacturing less machinery and electronics.

Table 3
The Share of Worldwide Activity of U.S.-Headquartered Multinationals
Accounted for by Foreign Affiliates

Industry	Activity Measure	1982	1989	1997
Machinery	Value Added	28	39	38
Electronics		14	18	26
All Industries		22	23	25
Machinery	Employment	26	34	40
Electronics		23	26	33
All Industries		21	21	25

Notes: Cell entries report the share (in percentage terms) of worldwide activity of U.S.-headquartered multinationals accounted for by foreign affiliates (where data are available for majority-owned affiliates only).

Table 4
The Relative Importance for ICT Services Industries of U.S. Exports Versus
Sales by Foreign Affiliates of U.S.-Headquartered Multinationals

Year	1992	1994	1998
U.S. Exports	1,417	2,332	3,412
Affiliate Sales	11,545	25,859	65,056

Notes: Cell entries report the value of either total U.S. exports or total affiliate sales, in billions of current dollars, for the ICT industries of computer services, data-processing and network services, and electronic-information services (where data cover majority-owned affiliates only).

Table 5
The Relative Importance of FDI
In Developing-Country Net Capital Inflows

Year	1990	1995	1997	1999
Total	98.5	257.2	343.7	290.7
Official	55.9	53.9	39.9	52.0
Private	42.6	203.3	303.9	238.7
FDI	24.1	105.0	170.3	192.0
Equity	2.8	36.1	30.2	27.6
Debt	15.7	62.2	103.4	19.1

Notes: Cell entries report the value of various kinds of developing-country net capital inflows, in billions of U.S. dollars. These data come from World Bank (2000).

Table 6
List of Industries and Countries in Estimation Sample

Industries
Food and Kindred Products
Chemicals
Metals and Metal Products
Machinery
Electronics
Transportation Products
Miscellaneous Manufacturing

Notes: Industries are as classified by the U.S. BEA. See text for details.

Countries	Per Worker GDP (1985)
Canada	31,147
Sweden	26,504
Denmark	23,861
Finland	23,700
United Kingdom	22,987
Spain	21,169
Ireland	19,197
Japan	18,820
Venezuela	18,362
Mexico	17,036
Greece	16,270
South Korea	10,361
Panama	10,039
Chile	9,768
Columbia	9,276
India	2,719

Notes: Per worker GDP are in U.S. dollars as reported in the Penn World Tables.

Table 7
Estimation Results for the Effect of Foreign-Affiliate Presence on Skill Upgrading

Sample of Countries	All Countries (1)	Developing Countries, Broad Definition (2)	Developed Countries, Broad Definition (3)	Developing Countries, Narrow Definition (4)	Developed Countries, Narrow Definition (5)
Multinational Emp. Share	0.340 (2.99)***	0.638 (3.99)***	0.271 (2.05)**	0.530 (3.93)***	0.298 (2.31)**
Time	0.005 (2.98)***	0.007 (2.99)***	0.002 (1.03)	0.002 (0.98)	0.005 (2.97)***
Controls	Country	Country	Country	Country	Country
Observations	821	391	430	212	609
R-squared	0.63	0.70	0.61	0.63	0.63

Sample of Countries	All Countries (6)	Developing Countries, Broad Definition (7)	Developed Countries, Broad Definition (8)	Developing Countries, Narrow Definition (9)	Developed Countries, Narrow Definition (10)
Multinational Emp. Share	0.036 (0.61)	0.183 (2.13)**	0.025 (0.28)	0.118 (1.57)*	0.006 (0.09)
Time	0.004 (2.56)**	0.006 (5.18)***	0.001 (0.54)	0.001 (1.10)	0.004 (2.29)**
Controls	Country, Industry	Country, Industry	Country, Industry	Country, Industry	Country, Industry
Observations	821	391	430	212	609
R-squared	0.72	0.86	0.69	0.86	0.71

Note: Robust t-statistics in parentheses. * significant at 10% level; ** significant at 5% level; *** significant at 1% level. In each specification the dependent variable is the non-production share of total wagebill. The broad definition of developing countries consists of those in the bottom half of Table 6. The narrow definition of developing countries includes only the bottom five countries in Table 6. See text for details.