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The Contribution of Multinational Corporations to U.S. Productivity Growth, 1977–2000

Carol Corrado, Paul Lengermann, and Larry Slifman

10.1 Introduction and Background

Concomitant with the surge in productivity growth in the United States since 1995 has been a surge in research on productivity. Before the productivity step-up had become fully evident, Corrado and Slifman (1999) focused attention on productivity by major sector as well as on problems in measuring productivity and their implications for the performance of productivity in the mid-1990s.[1] Later, others began to concentrate on the role of information technology (IT)—examining the productivity of the producers of IT equipment as well as the users of IT equipment. The research often used growth accounting as the organizing principle for analysis, and was conducted using both detailed industry-level data (Jorgenson and Stiroh 2000) and macroeconomic time series data at only the broadest levels of disaggregation (Oliner and Sichel 2000).

But IT is not the only important economic force that has been influenc-

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The views expressed in this paper are those of the authors and should not be attributed to the Board of Governors of the Federal Reserve System or other members of its staff.

1. The research by Corrado and Slifman was initially circulated in late 1996.

ing productivity growth in recent years. In particular, many companies reportedly have been able to achieve significant efficiencies by reorganizing the way they conduct their operations. Meanwhile, business has become increasingly global in its nature, with globalization arguably a significant part of the enhanced organizational efficiencies.[2]

Many studies that have examined the link between globalization and productivity have looked at the productivity of multinational corporations (MNCs). The emphasis in this literature is on foreign-owned MNCs in the host country. Using microeconomic data, two questions often addressed are whether the host-country operations of foreign-owned firms are more productive than the operations of domestically owned firms in the host country and whether the higher productivity creates favorable spillovers in the host country (see Keller 2004 for a review of the recent literature).[3] Doms and Jensen (1998a and 1998b) broadened the scope of this research strain to look at both foreign-owned and domestically owned MNCs and to inquire whether country of ownership matters.[4] Their results, which are based on microeconomic data, suggest that for productivity growth country of ownership does not matter: "It is not the fact that the plants are foreign owned that is important . . . rather, it is the fact that the plants are owned by multinational corporations that seems important." (251)[5]

In this chapter, we attempt to merge these research strains by measuring the contribution of MNCs to the aggregate productivity record of the United States. While we cannot examine the causal linkages between specific characteristics of MNCs and their higher productivity as carefully as most microlevel studies, we can move beyond such studies—which typically focus on the manufacturing sector—to assess the importance of MNCs in the macroeconomy. Toward this end, we first develop a consistent database of information from 1977 to 2000 on the activities of foreign-owned operations in the United States and the domestic activities of U.S.

2. Lipsey, Blomstrom, and Rumstetter (1998) document the growth of internationalized production in world output.

3. Mechanisms by which this might occur include learning externalities through labor training and turnover (Fosfurie, Motta, and Rønde 2001), technology transfer (Griffith, Harrison, and Van Reenen 2004), and the provision of high-quality intermediates (Rodriguez-Clare 1996). Haskel, Pereira, and Slaughter (2004) present evidence in support of a positive spillover effect in the United States, though the implied economic magnitudes are fairly small relative to the subsidies paid to attract foreign direct investment (FDI). Keller and Yeaple (2003) find that spillovers are much larger, accounting for 11 percent of U.S. manufacturing productivity growth between 1987 and 1996. In the United Kingdom, Griffith, Redding, and Simpson (2003) conclude there is a significant positive spillover from FDI, while Aitken and Harrison (1999) find a negative relationship between FDI and the productivity of domestic plants in Venezuela.

4. Howenstein and Zeile (1994) use similar data but focus on comparing foreign-owned establishments to U.S.-owned establishments. While foreign-owned establishments pay higher wages and are more productive, this appears to be due largely to differences in industry mix, plant scale, and occupational mix.

5. More recently, Criscuolo and Martin (2003) document a similar "MNC effect" in the U.K. manufacturing sector, while Griffith, Redding, and Simpson (2004) provide evidence of an MNC productivity advantage in the U.K. service sector.

firms that have foreign operations. Then we integrate that database with a more standard productivity database covering all establishments of all industries operating in the United States (Bartelsman and Beaulieu 2003, 2007) and examine the contribution of the MNC sector to overall labor productivity growth in the United States. We look at labor productivity *growth* because, even though studies of MNC performance based on microeconomic data have tended to identify effects on the *level* of productivity, if these underlying productivity-enhancing effects are spreading and/or filtering in over time, productivity aggregates will be affected in terms of growth rates (as well as levels).

Although our final analysis is relatively straightforward—indeed, most of the hard work of this study involved the integration of the various data sets—we nevertheless believe our findings are quite striking. Specifically, although the MNC sector accounts for only 40 percent of the output of nonfinancial corporations (NFCs) between 1977 and 2000, MNCs appear to have accounted for *more than three-fourths* of the increase in NFC labor productivity over this period. Moreover, MNCs account for *all* of the NFC sector's pickup in labor productivity growth in the late 1990s; accordingly, they account for *more than half* of the much-studied acceleration in aggregate productivity.[6] And, while MNCs involved in the production of IT contributed significantly toward this acceleration, MNCs in other manufacturing and nonmanufacturing industries contributed significantly as well.

10.2 Why Might MNCs Have Better Productivity Performance than Other Firms?

Although the aggregate nature of our analysis does not allow for an examination of the specific sources of the MNC productivity advantage, there has recently been a great deal of microlevel research on the link between global engagement and firm productivity. Such work has focused mostly on two main factors—characteristics of the plants and cross-border integration of operations.

In terms of plant characteristics, MNCs tend to be larger than domestic plants, they are more capital intensive, and they use more advanced technology (Doms and Jensen 1998). All else equal, these characteristics tend to be associated with higher labor productivity—in part because of the greater amount of capital per worker and in part because size and technology can enhance the organizational efficiency of a plant.[7] Several

6. "Aggregate" refers to all U.S. nonfarm private businesses.

7. In a similar vein, Bernard and Jensen (1995) document the superior productivity of exporters. Bernard and Jensen (1999) examine whether highly productive firms select into export markets or whether exporting boosts productivity, and find more compelling evidence for the former. Baldwin and Gu (2003), however, find that export participation in Canada *is* associated with improved productivity and argue this is due to a learning effect associated with export activity.

recent general equilibrium models propose that global engagement—either through trade or as an MNC—is a consequence rather than a cause of higher productivity. In these models, heterogeneity in firm productivity is exogenously determined (Melitz 2003; Helpman, Melitz, and Yeaple 2004). As such, only the most highly productive firms can afford the costs of becoming a multinational by establishing a foreign affiliate.

Alternatively, MNCs may be able to enhance their organizational efficiency through their ability to integrate their operations across borders. Indeed, intra-MNC trade by U.S.-owned MNCs has risen steadily over time, accounting for 22 percent of total U.S. exports in 2002, and 16 percent of total imports (Mataloni 2004).[8] Such vertical integration between parents and affiliates allows MNCs to take advantage of international factor price differentials as a means of holding down unit costs of production.[9] In addition, outsourcing to foreign affiliates may also allow the parent to organize overall production processes more efficiently (Hanson, Mataloni, and Slaughter 2001).

Finally, internationalized production by MNCs may serve as a conduit for the transfer of knowledge between parents and affiliates, thereby contributing to higher productivity.[10] For instance, Criscuolo, Haskel, and Slaughter (2005) find that MNCs generate more ideas than their purely domestic counterparts, not only because they use more researchers, but also because they draw on a larger stock of ideas through their "intra-firm worldwide pool of information." More generally, cross-border integration enables firms to spread firm-specific intangible assets (R&D, for example) across geographical boundaries. Blomström, and Ramstetter (1998) make this point.[11] This spreading of intangible assets, input production, and final processing across borders occurs prominently, for example, in industries that manufacture electronic and electrical equipment.

10.3 The Data

Overview

The primary data on U.S. multinational companies come from two surveys conducted by the Bureau of Economic Analysis (BEA). The survey of

8. All trade by U.S.-owned MNCs—that is, trade with unrelated entities as well as with affiliates—as a share of total exports and imports was 58 percent and 37 percent, respectively, in 2002 (Mataloni 2004). Hanson, Mataloni, and Slaughter (2001), Borga and Zeile (2004), and Bernard, Jensen, and Schott (2005) all provide evidence of the increasing use of parent-to-affiliate outsourcing over time.

9. For example, Hanson, Mataloni, and Slaughter (2005) discuss how the growth of overall world trade has been driven in large part by the rapid growth of trade in intermediate inputs by MNCs. Among their main findings are that demand for imported inputs is higher when affiliates face lower trade costs, lower wages for less-skilled labor, and lower corporate income tax rates.

10. Coe, Helpman, and Hoffmaister (1997) make a similar point with regard to the productivity benefits of international trade.

11. See also Grossman and Helpman (1991), Howitt (2000), and Griffith, Redding, and van Reenan (2005).

U.S. Direct Investment Abroad (USDIA) provides information on the operations of U.S.-headquartered multinational companies (parents), while the survey of Foreign Direct Investment in the United States (FDIUS) provides information on operations of foreign companies operating in the United States (affiliates). The surveys contain much data on the domestic activities of parents and affiliates—data such as total sales, gross product (value added), capital spending, R&D spending, compensation of employees, and employment. The BEA tabulates the data by industry of the parent or affiliate. Periodically, BEA also shows the sales and employment of parents (or affiliates) by industry of sales.

One major advantage of the data from these surveys is that they are designed to yield measures aligned with National Income and Product Account (NIPA) concepts. For example, the published figures for the gross product of nonbank parents of U.S. multinational companies are conceptually consistent with the NIPA figures for the gross product, or value added, of all businesses.[12] Because of the conceptual consistency, therefore, these data can be integrated with other relevant productivity data in order to conduct growth accounting exercises.

Creating a Multinational Corporate (MNC) Sector

Corrado and Slifman (1999) highlighted the value of looking at the economy not only by industry but also by sector—for example, corporate and noncorporate, financial and nonfinancial. In particular, they focused their analysis on productivity trends in the *nonfinancial corporate (NFC) sector.* This chapter carries that approach one step further by dividing the nonfinancial corporate sector into two distinct sectors: MNCs and domestically oriented firms. These sectoral data are then disaggregated into key industry sub-divisions. Each survey's results were therefore first adjusted to be conceptually consistent with this general approach. Results for nonbank finance and insurance MNCs were excluded to obtain data on nonfinancial activities, and results for real estate were excluded to approximate results for corporations.[13]

Because we are interested in creating an MNC sector and studying its contribution to overall U.S. productivity growth, the published BEA survey data need further development, and they need to be integrated with broader aggregates to perform growth accounting for the overall U.S. economy. Fortunately, a tool exists to readily carry out the development and integration: the Federal Reserve Board Productivity Data System (Bartelsman and Beaulieu 2003, 2007). This is a system that contains all

12. Indeed, these data are inputs to the NIPAs; see Mataloni 1995.

13. The BEA reported to us that in the USDIA survey for 2000, corporate gross product and compensation was 99 percent of total gross product and virtually all of compensation. For FDIUS, corporations accounted for 91 percent of gross product and 95 percent of total compensation.

the aggregate and industry-level data typically used by productivity researchers, organized within a highly structured database. The system also contains specialized tools to manipulate and analyze the data. After adding the relevant USDIA and FDIUS data issued by BEA to the productivity data system, we used many of its tools to help carry out such tasks as balancing, concording, deflation, and aggregation.[14] The routines in the system also facilitate the calculation of capital stocks and capital services, although we do not create such measures for the MNC sector in this study.

Before the USDIA and FDIUS data could be combined and used for productivity analysis, we had to deal with several important measurement issues. The Appendix describes the methods we used in full. Here we present a brief overview.

Survey Overlap

As we define it, the MNC sector refers to the U.S. activities of multinational corporations operating in the United States. Accordingly, we need to combine data on the activities of parents from the USDIA survey with data on activities of U.S. affiliates from the FDIA survey. In the spirit of the Doms and Jensen results, the combined data from the USDIA and FDIUS surveys provide information on the activities of MNCs in the United States regardless of country of ownership.

However, some firms that are technically U.S. parents are actually under the control of a foreign parent company. Accordingly, some firms in the USDIA data are also captured in the FDIUS survey. The overlap of firms in the two surveys prevents us from simply adding together the results of the two surveys. Because we want to combine the data from both surveys, we need to adjust for the overlap.

The overlap arises because some U.S. affiliates of foreign companies engage in foreign direct investment that is attributed to U.S. affiliates. For survey purposes this makes some U.S. affiliates both a U.S. parent and a U.S. affiliate; accordingly, the company is counted in both the FDIUS survey (as a U.S. affiliate of a foreign company) and in the USDIA survey (as a U.S. parent of a foreign affiliate.) As an example, suppose a Japanese automaker sets up a foreign affiliate in the United States. That U.S. affiliate then sets up a parts-producing subsidiary in Canada that only serves the U.S. affiliate. The Canadian parts-producing facility is considered to be foreign direct investment by a U.S. entity, which, by definition, makes the U.S. affiliate of the Japanese company a U.S. parent of the Canadian affiliate. As a result, the U.S. affiliate will be counted in both surveys: as a U.S. affiliate of a Japanese parent in the FDIUS survey, and as a U.S. parent of a Canadian affiliate in the USDIA survey.

14. For example, we used the biproportional balancing tools to help fill in missing observations and the concordance tools to put all the industry estimates on a consistent industry classification basis.

How big is the overlap? As it turns out, a substantial number of foreign affiliates operating in the United States have their own foreign affiliates. According to BEA, when measured in terms of gross product, about 45 percent of the activities of U.S. affiliates during 2000 took place at companies that had their own foreign affiliates. These U.S. parent foreign affiliates, however, represent only a small part of the overall number of U.S. parents. Again using gross product as the metric, the activities of U.S. parent foreign affiliates were only 11 percent of the gross product of all U.S. parents.[15] Moreover, these ratios have been relatively unchanged over time (see Appendix table 10A.3).

In order to adjust for the overlap, we obtained from the BEA special tabulations of the activities of those U.S. parents that are also affiliates of foreign companies and, hence, counted in both surveys. Because of concerns at the BEA regarding the disclosure of information about individual survey respondents, the data on overlap firms are only available for all nonbank industries and all manufacturing industries, and only for 1990 on. However, the BEA also provided us with industry-level information on the number of U.S. parent companies that are also foreign affiliates. As described in the Appendix, we used the information from these special tabulations and the concording and balancing tools of the FRB productivity system to create industry-level overlap data so that U.S. parent-foreign affiliates are only counted once when we combine the results of the two surveys.

Level of Consolidation

Another issue with these data is that they are collected at the overall company level. For many multinational corporations, the company level is a very aggregate level of consolidation by industry. Most industry-level data used for productivity analysis are collected at the establishment (or plant) level. Thus, the activities of a company that produces in more than one industry (say, home appliances and jet engines) will have the activities of its individual plants allocated to the relevant industry. In contrast, data for the MNC surveys are collected for a group of enterprises under common control (referred to as "a consolidated business enterprise"). This can lead to serious problems in classifying the data by industry, because in most tabulations, all of the operations of a given U.S. parent or foreign affiliate are assigned to one primary industry, even if the parent or affiliate has secondary activities in other industries. In order to get around this problem, we constructed our own establishment estimates from the consolidated MNC data. The method is described in detail in the Appendix.

15. According to the BEA, "in 2000, U.S. parents that were in turn controlled by foreign parents accounted for 9 percent of the gross product of all U.S. parents." (Mataloni 2002, 117, footnote 8.) The difference between the published number and the 11 percent figure that we cite reflects that, in our calculations, a foreign affiliate is defined as a U.S. business with 10 percent or more foreign ownership, whereas the figure cited by Mataloni is for majority-owned foreign affiliates.

Essentially, however, we use the periodic information provided by BEA on sales and employment of affiliates or parents (as appropriate) by industry of sales. As noted by Zeile (1999, 29), "these data . . . approximate the disaggregation of the data for all U.S. businesses by industry of establishment." We apply the employment/sales shares to the consolidated data to create establishment estimates.

Industry Classification

The BEA's USDIA and FDIUS survey data for recent years use the North American Industry Classification System (NAICS) to group results by industry, whereas data for earlier periods apply various issues of the Standard Industrial Classification (SIC) system. We converted the more recently published NAICS-based data to the SIC system, which (as of the initial writing of this paper) BEA still used for its U.S. industry-level data on gross product and gross product prices.

Deflators

The data in the two MNC surveys are collected in current dollars (except, of course, employment). However, for productivity analysis it is necessary to have data measured in real terms, that is, adjusted to remove the effects of price changes. Mataloni (1997) describes one method for deflating current dollar figures that relies on producer prices indexes (PPIs) by industry. However, PPIs alone are imperfect as deflators for industry gross product; PPIs are appropriate for gross *output,* but a gross *product* price should represent an implicit price for gross output less intermediate inputs. As an alternative, therefore, we used the deflators published by the BEA for gross product originating by industry. Real GDP by industry is computed using the double-deflation method, in which separate estimates of real gross output and intermediate inputs are combined in a Fisher chain-type quantity-index-number formula (Yuskavage 1996). These deflators are for all establishments in an industry, not just those owned by MNCs. By applying these deflators to the data from the MNC surveys, we are assuming that within a given industry establishments owned by MNCs and non-MNCs had the same product composition, input composition, and price behavior over time.

10.4 Method of Analysis

Much of the recent literature on the post-1995 pickup in U.S. productivity growth disaggregates the data into IT-producing and IT-using sectors. This chapter adds a new dimension: specifically, we consider the role of MNCs. As indicated previously, we do this by looking separately at the role of U.S. parents and foreign affiliates. Then, in the spirit of the findings in Doms and Jensen, we combine the data to create a single MNC sector for

Table 10.1 **U.S. gross domestic product of nonfarm private businesses,* by sector (percent of total)**

	1977	1989	1995	2000	2002
Nonfinancial corporations	70.5	68.8	67.7	66.7	65.6
MNC Sector**	25.5	24.2	24.7	28.6	26.2
Parents**	23.5	19.3	19.4	22.1	19.7
Affiliates of foreign companies	2.0	4.9	5.3	6.6	6.5
Domestically oriented	45.0	44.6	43.0	38.1	39.3
Financial corporations	4.6	6.3	7.4	9.0	9.2
Noncorporate business	25.0	24.9	24.9	24.3	25.3

*Calculated using gross domestic income, excludes government enterprises.
**Excludes U.S. parent companies that are also affiliates of foreign companies.

the U.S. economy. As far as we know, this is the first time the data have been combined consistently to create time series for a single MNC sector.

Following the approach of Corrado and Slifman (1999), we disaggregate the overall U.S. economy into an economically meaningful group of sectors and subsectors. We do this to examine the contribution of individual sectors to overall productivity growth. The ratios of each sector's gross product to the gross product of all U.S. nonfarm private businesses—the sector's contribution to the total (unduplicated) value of production by business—help unravel the role of each sector in the productivity decomposition. As may be seen in table 10.1, we estimate that the MNC sector accounts for about 25 percent of U.S. nonfarm private business (NFPB) gross product (or value added). Although the MNC share fell off a bit in the early 1990s, it subsequently rebounded and, all told, has been relatively stable for the period shown.

The relative stability in the MNC share masks important developments within both the MNC and corporate sectors, however. As may be seen, the value added by financial corporations has been rising steadily over the period, whereas the share of overall value added accounted for by nonfinancial corporations has fallen off. The drop is in the domestically oriented share: it was 45 percent in 1977 but was under 40 percent by 2002, with much of the drop occurring after 1995. Within the MNC sector, the share of value added accounted for by U.S. parents has declined, while the share attributed to foreign affiliates increased from 2 percent in 1977 to 6.5 percent in 2002. All told, the MNC sector currently is about 40 percent of the nonfinancial corporate sector.

Table 10.2 looks deeper within the nonfinancial corporate and MNC sectors. As may be seen, 43 percent of MNC gross product in 2000 originated in manufacturing. This is nearly 20 percentage points below the share observed in 1977, with the decline being offset by rising MNC concentration in services industries and in wholesale and retail trade. While the proportion of output originating in manufacturing is roughly equiva-

Table 10.2 Nonfinancial corporate gross product by industry* (percent of total)

	MNCs				
	Parents	Foreign affiliation	Total	Domestically oriented	Total
2000	100.0	100.0	100.0	100.0	100.0
Manufacturing	42.5	44.9	43.0	15.5	19.2
High tech	5.7	3.1	5.1	0.6	1.7
Manufacturing, except high tech	36.8	41.7	38.0	14.9	17.5
Nonmanufacturing	57.5	55.1	57.0	84.5	80.8
Wholesale and retail trade	13.6	24.5	16.1	34.4	20.0
Services	15.9	13.3	15.3	26.9	21.4
Transp., commun., and util.	18.9	9.5	16.8	10.1	10.2
Other	9.1	7.8	8.8	13.1	29.3
1995	100.0	100.0	100.0	100.0	100.0
Manufacturing	49.9	49.8	49.8	20.9	22.2
High tech	5.4	3.8	5.0	1.7	2.0
Manufacturing, except high tech	44.5	46.0	44.8	19.2	20.2
Nonmanufacturing	50.1	50.2	50.2	79.1	77.8
Wholesale and retail trade	11.4	22.5	13.8	32.5	19.8
Services	12.0	9.2	11.4	23.8	19.6
Transp., commun., and util.	19.8	8.7	17.4	12.3	11.0
Other	7.0	9.8	7.6	10.6	27.4
1989	100.0	100.0	100.0	100.0	100.0
Manufacturing	53.7	52.4	53.5	22.6	23.8
High tech	5.9	4.2	5.6	1.3	1.9
Manufacturing, except high tech	47.8	48.2	47.9	21.3	21.8
Nonmanufacturing	46.3	47.6	46.5	77.4	76.2
Wholesale and retail trade	9.5	21.8	12.0	32.4	20.0
Services	9.5	7.3	9.0	19.8	17.9
Transp., commun., and util.	19.5	4.8	16.5	12.9	10.9
Other	7.8	13.7	9.0	12.3	27.4
1977	100.0	100.0	100.0	100.0	100.0
Manufacturing	61.1	59.6	61.0	28.5	29.1
High tech	3.4	5.5	3.5	0.9	1.3
Manufacturing, except high tech	57.7	54.1	57.5	27.6	27.8
Nonmanufacturing	38.9	40.4	39.0	71.5	70.9
Wholesale and retail trade	10.4	26.3	11.6	31.0	21.0
Services	4.4	2.6	4.3	12.7	12.3
Transp., commun., and util.	15.7	3.7	14.8	14.4	11.3
Other	8.3	7.9	8.3	13.4	26.3

*Excludes corporate farms

lent for U.S. parents and affiliates of foreign companies, it appears that U.S. parents maintain a somewhat larger presence in IT equipment. In nonmanufacturing, however, a larger proportion of the output of foreign affiliates is concentrated in wholesale and retail trade, while the proportion of output originating in the transportation, communications, and public utilities group is larger for U.S. parents.

10.5 Results for Labor Productivity

Our results for the sectoral decomposition of labor productivity are shown in tables 10.3 through 10.6. Labor productivity estimates were calculated as follows. In each year, sectoral labor productivity levels (LP_i) were defined as real value added (Y_i) per total hours worked of all persons (H_i): $LP_i = Y_i/H_i$. Aggregate labor productivity growth can therefore be decomposed as follows:

$$d \ln LP = \underbrace{\sum_i \overline{w}_i d \ln LP_i}_{\text{direct contributions}} + \underbrace{\left(\sum_i \overline{w}_i d \ln H_i - d \ln H \right)}_{\text{reallocation of hours}}$$

where $\overline{w}_i$ is the two-period average of each industry's share of nominal gross product. The first term on the right hand side measures the direct contributions to aggregate labor productivity, that is, the share weighted sum of the labor productivity growth rates for individual industries and sectors. The second term on the right-hand side captures an indirect contribution owing to the reallocation of hours across sectors. This contribution is positive when, on balance, the change in hours is positive for sectors where gross product shares exceed hours shares (Stiroh 2002).

As may be seen in table 10.3, the rate of change in NFPB output per hour averaged 1.5 percent per year from 1977 to 2000 in the United States.[16] We estimate that the growth of output per hour in the MNC sector averaged 3.2 percent per year during the same period, or more than twice the NFPB average. As indicated in table 10.4, the MNC sector accounted for more than half of the overall gain in labor productivity.

The sectoral decomposition by subperiod also reveals interesting developments: From 1977 to 1989 and, to a lesser extent, from 1989 to 1995, gains in MNC sector productivity accounted for a goodly portion of the overall increase in output per hour. The pickup in productivity in the late 1990s, however, was generally widespread across the individual sectors shown. Even so, according to our sectoral hierarchy, and as can be seen by comparing the two right-hand columns, the MNC sector contributed significantly (about .75 percentage point) to the 1.2 percentage point pickup in NFPB output per hour during the late 1990s.

Because output per hour varies by industry, part of the MNC productivity story in the late 1990s could be explained by differences between the industry mix of the MNC sector compared with that of all nonfinancial corporations or total nonfarm businesses. As is well known, the production of IT equipment was a major source of the rapid gains in U.S. productivity in the late 1990s (see Jorgensen and Stiroh 2000, Oliner and Sichel

16. This figure differs slightly from the official figures for U.S. labor productivity issued by the BLS in that our measure is derived from the income side of the national accounts while the BLS measure is derived from the product side. In addition, our measure excludes the output of government enterprises.

Table 10.3 **Growth of labor productivity—nonfarm private businesses, by sector (percent change, average annual rate)**

	1977–1989	1989–1995	1995–2000
Nonfarm private business	0.9	1.6	2.8
Nonfinancial corporations	1.2	1.6	2.6
MNCs	2.5	2.7	5.6
Parents	2.8	2.8	6.0
Affiliates of foreign companies	0.6	2.4	4.5
Domestically oriented	0.6	1.0	0.5
Financial corporations	–0.0	0.3	0.4
Nonfarm noncorporate businesses	0.1	0.4	0.7

Note: Nonfarm private business output is calculated using gross domestic income.

Table 10.4 **Contributions to the growth of labor productivity—nonfarm private businesses, by sector (percentage points, annual rate)**

	1977–1989	1989–1995	1995–2000
Nonfarm private business	0.9	1.6	2.8
Nonfinancial corporations	0.9	1.1	1.8
MNCs	0.6	0.7	1.5
Parents	0.6	0.5	1.2
Affiliates of foreign companies	–0.0	0.1	0.3
Domestically oriented	0.3	0.4	0.2
Financial corporations	–0.0	0.3	0.4
Nonfarm noncorporate businesses	0.1	0.4	0.7
Memo: Reallocation of Hours	0.0	0.0	–0.1

Note: Nonfarm private business output is calculated using gross domestic income.

2000, among others), and the IT equipment-producing sector has a relatively large MNC share.

Tables 10.5 and 10.6 present a broad industry cut of the productivity results for nonfinancial corporations. As may be seen, this decomposition is consistent with the extraordinary productivity change in the production of IT equipment accounting for part of the story for the pickup in MNC and nonfinancial corporate labor productivity in the late 1990s. The decomposition also shows, however, that the pickup in MNC productivity was based more broadly in other manufacturing and nonmanufacturing industries. Meanwhile, the aggregate domestically oriented sector did not contribute to the pickup in nonfinancial corporate labor productivity in the late 1990s, a result driven mainly by the poor performance of its manufacturing component.[17] Moreover, while there is some evidence that reallocation of hours contributed to the pickup, its contribution is nevertheless quite small.

17. As shown in table 10.2, domestically oriented manufacturers have a very small IT share, and the IT versus non-IT decomposition of this sector is not shown.

Table 10.5 **Growth of labor productivity—Nonfinancial corporations, by subsector and industry (percentage change, average annual rate)**

	1977–2000	1977–1989	1989–1995	1995–2000
Nonfinancial corporations	1.6	1.2	1.6	2.6
MNCs	3.2	2.5	2.7	5.6
Manufacturing	4.1	3.3	2.5	7.8
IT equipment	25.0	20.0	19.5	45.3
Other manufacturing	2.0	1.8	0.8	3.9
Nonmanufacturing	2.3	1.4	2.9	3.6
Domestically oriented	0.7	0.6	1.0	0.5
Manufacturing	1.0	1.6	2.6	–2.3
Nonmanufacturing	0.3	0.0	0.5	1.1

Table 10.6 **Contributions to the growth of labor productivity—Nonfinancial corporations, by subsector and industry (percentage points, annual rate)**

	1977–2000	1977–1989	1989–1995	1995–2000
Nonfinancial corporations	1.6	1.2	1.6	2.6
MNCs	1.3	0.9	1.0	2.2
Manufacturing	0.8	0.7	0.5	1.4
IT equipment	0.4	0.3	0.4	0.9
Other manufacturing	0.4	0.3	0.1	0.6
Nonmanufacturing	0.4	0.2	0.5	0.8
Domestically oriented	0.4	0.4	0.6	0.3
Manufacturing	0.1	0.3	0.4	–0.3
Nonmanufacturing	0.2	0.0	0.2	0.5
Memo: Reallocation of hours	0.1	0.1	0.0	0.2

Of course, some of the MNC contribution to the productivity pickup could be due to the reallocation of value added among MNC components rather than a faster rate of productivity growth for the underlying MNC subsectors and industries. As shown in table 10.1 and table 10.2, the MNC share of nonfinancial corporate value added rose during the late 1990s owing to the ongoing expansion of MNCs into nonmanufacturing industries. Table 10.7 shows a standard decomposition of the pickup in nonfinancial corporate labor productivity during this period into "within" and "between" effects. The within effect measures how much of the pickup in labor productivity growth can be attributed to faster productivity growth for individual sectors when their weights are held fixed at the average for the two periods, while the between effect measures how much of the pickup can be attributed to rising weights for sectors with above-average labor productivity growth in both periods.[18]

18. Specifically, the within effect is calculated as $\sum_i 0.5 * (\overline{w}_{i,1989–1995} + \overline{w}_{i,1995–2000}) * (d \ln LP_{i,1995–2000} - d \ln LP_{i,1989–1995})$ and the between effect as $\sum_i 0.5 * (d \ln LP_{i,1995–2000} + d \ln LP_{i,1989–1995}) * (\overline{w}_{i,1989–1995} - \overline{w}_{i,1995–2000})$.

Table 10.7 **Decomposition of the acceleration of labor productivity growth—Nonfinancial corporations, by sector and industry (percentage points, annual rate)**

	Acceleration	Within effect	Between effect
Nonfinancial corporations	1.05	1.05	0.00
MNCs	1.26	1.10	0.16
Manufacturing	0.96	0.97	–0.01
IT equipment	0.54	0.50	0.04
Other mfg.	0.50	0.50	–0.01
Nonmanufacturing	0.28	0.15	0.13
Domestically oriented	–0.30	–0.27	–0.03
Manufacturing	–0.61	–0.60	0.00
Nonmanufacturing	0.29	0.30	–0.01

As may be seen, about half of the contribution of nonmanufacturing MNCs to the productivity acceleration in the late 1990s can be attributed to their rising weight (the between effect).[19] The absolute size of this effect, however, is quite small, and suggests that the reallocation of value added is not a big part of the MNC productivity story.

To summarize, between 1977 and 2000, labor productivity growth in the MNC sector consistently outpaced that of the nonfinancial corporate sector as a whole, with the gap widening noticeably during the second half of the 1990s. A final question, therefore, is whether the pickup in MNC productivity growth has continued more recently. Unfortunately, at this stage it is not possible to know for sure. Although more recent, consistent data for both U.S. parents and foreign affiliates are available through 2005, methodologically consistent industry-level estimates only extend through 2001.[20] As such, only "back-of-the-envelope" estimates can currently be made based on an extrapolation of the output and hours series for major sectors (i.e., nonfinancial corporations and nonfarm business) using published estimates from the BEA and BLS and making an assumption about the survey overlap and growth rate of deflators.[21]

With this caveat in mind, the results in tables 10.8 and 10.9 suggest that MNCs were disproportionately affected by the onset of the 2001 recession. Indeed, we estimate that output per hour in the MNC sector fell at an an-

19. Also note that, although the average rate of labor productivity growth for nonmanufacturing MNCs was below that of manufacturing MNCs, it still exceeded the average rate for the nonfinancial corporate sector as a whole.

20. The FRB productivity database that we use was built from the BEA's previous system of GDP-by-industry data, which extends only through 2001 and is not methodologically consistent with BEA's more recently released measures; see Moyer et al. (2004).

21. Specifically, the back-of-the-envelope estimates derive real value added for our consolidated MNC sector by holding the overlap share constant from 2002 on and extrapolating changes in the price deflator for MNC gross product and major subcomponents by BEA's deflator for all nonfinancial corporations. Substituting reasonable, alternative assumptions does not materially alter the resulting back-of-the-envelope estimates.

Table 10.8 **Growth of labor productivity—Nonfinancial corporations, by subsector (percentage change, average annual rate)**

	2000–2005	2000–2002	2002–2005
Nonfinancial corporations	3.0	3.0	2.9
MNCs	2.9	–1.5	6.0
Parents	2.1	–3.6	6.0
Affiliates	5.9	5.9	6.0

Note: These MNC figures are not integrated with those for nonfinancial corporations at the industry level, as are figures for prior years shown in previous tables.

Table 10.9 **Contributions to the growth of labor productivity—Nonfinancial corporations, by subsector (percentage points, annual rate)**

	2000–2005	2000–2002	2002–2005
Nonfinancial corporations	3.0	3.0	2.9
MNCs	1.2	–0.8	2.5
Parents	1.0	–0.5	1.9
Affiliates	0.2	–0.3	0.6

Note: These MNC figures are not integrated with those for nonfinancial corporations at the industry level, as are the figures for prior years shown in previous tables.

nual rate of 1.5 percent between 2000 and 2002, even while productivity for the nonfinancial corporate sector as a whole continued to rise briskly. Interestingly, the weakness in the MNC sector appears to have been driven entirely by U.S. parents. Indeed, labor productivity growth for foreign affiliates accelerated further between 2000 and 2002. The productivity declines for U.S. parents have proved temporary, however, and probably reflected particular circumstances in a number of industries where U.S. parents have a significant presence. This includes the cyclically sensitive durable goods manufacturing industries—such as motor vehicles and high-tech—as well as telecommunications services. In contrast, the activities of foreign affiliates are more highly concentrated in less cyclical industries, such as retail and wholesale trade. In summary, the extended back of the envelope results do not change our findings for 1977 to 2000—namely, that multinational corporations have made outsized contributions to the growth of aggregate labor productivity in the United States.

10.6 Conclusions

In this chapter we have begun to investigate the role played by the U.S. operations of multinational corporations in the overall performance of the U.S. economy, especially in the late 1990s. We identify these corporations as a separate segment of the economy—we call it the MNC sector—and we develop labor productivity estimates for this sector.

While progress has been made regarding the contribution of MNCs to aggregate trade flows and employment growth, much less is known about the significance of MNCs for overall productivity growth. This omission from the literature seems particularly glaring when one considers the substantial body of microlevel research on the link between global engagement and productivity at the firm level. We therefore hope that the results in this chapter will complement this microlevel work by placing the superior performance of MNCs into a broader perspective.

Using the tools and procedures in the FRB productivity data system, the new productivity estimates were developed by integrating information from BEA's surveys of multinational operations with conventional productivity data in a consistent fashion. The resulting data set permits the decomposition of labor productivity along MNC/non-MNC, legal form of organization, and major industry lines for the period 1977 to 2000. The results clearly slice the U.S. aggregate productivity data in a novel way and, we hope, confirm the utility of our approach.

The results, which were foreshadowed by the Doms and Jensen findings, confirmed the important role played by multinational corporations in the *aggregate* productivity record of the U.S. economy. The sector (as we define it) accounts for more than 25 percent of the gross product of all nonfarm private businesses and about 40 percent of nonfinancial corporate gross product. Nonetheless, the sector accounted for more than *half* of the increase for all nonfarm private businesses and *all* of the increase in the labor productivity of nonfinancial corporations in the late 1990s.

Of course, our estimates may be sensitive to some of the assumptions we were forced to make when constructing our integrated data set. For example, by applying the industry-level deflators published by the BEA to both MNCs and domestically oriented firms, we are implicitly assuming that, within a given industry, establishments owned by MNCs and non-MNCs had the same product composition, input composition, and price behavior over time. If, instead, value-added deflators actually rose less rapidly for MNCs, then clearly our estimate of real output growth for MNCs would be too low, meaning their contribution to productivity growth could be even larger. Given the literature on the organizational efficiencies afforded by the integration of MNC operations across borders, such a scenario certainly seems plausible.

Another issue that merits further investigation is the extent to which transfer pricing may influence BEA's measures of value added and thereby the interpretation of our results.[22] Transfer pricing is not supposed to dis-

22. Because profits data are used in the construction of value added, any tendency for foreign-owned affiliates to underreport profits by shifting them out of the United States via transfer pricing will lower our estimate of the contribution of MNCs to productivity growth. By the same logic, if U.S. parents use transfer pricing to shift profits from abroad back to the United States, then our productivity results for MNCs will be overstated.

tort official statistics because tax regulations generally require that intrafirm transactions be valued at arms-length prices. Nevertheless, intercountry differences in tax rates almost certainly create incentives to deviate from this standard. Moreover, intra-MNC trade in intermediates accelerated in the second half of the 1990s, suggesting the possibility of at least some role for distortions due to transfer pricing. However, Mataloni (2000) finds little evidence that transfer pricing has unduly impacted BEA's industry-level profits data for MNCs.[23] Although Mataloni's results are not dispositive on the issue, we do not think that our results are being *systematically* biased by transfer pricing.[24]

In sum, our work establishes new stylized facts about the contribution of multinational corporations to the growth of aggregate labor productivity. Previous research finds that the cross-border integration of business operations and certain MNC characteristics—namely, organizational efficiencies in inputs and large investments in firm-specific intangible assets such as R&D—confer a productivity advantage to MNCs at the firm level. By establishing the quantitative significance of this finding in a broader context (the growth of output per hour in the overall economy), we underscore the importance of the operations of multinational corporations—for example, their growing role in trade in services—in the overall economic performance of the United States.

Data Appendix

Overview and Data Sources

As described in the text, the data on U.S. multinationals come from two surveys conducted annually by the Bureau of Economic Analysis (BEA). The survey of U.S. Direct Investment Abroad (USDIA) provides information on the operations of U.S.-headquartered multinationals (parents), while the survey of Foreign Direct Investment in the United States (FDIUS) provides information on the operations of U.S.-based affiliates of foreign-owned multinationals (affiliates). Throughout our analysis, a foreign affiliate is defined as a U.S. business with 10 percent or more foreign

23. Mataloni (2000) considers the relationship between the share of sales accounted for by intra-MNC imports and the gap between the rate of return on assets of foreign-owned nonfinancial companies and that of U.S.-owned companies, under the logic that that the greatest opportunities to shift profits using transfer prices exists for foreign-owned affiliates, with a larger share of sales accounted for by intra-firm imports.

24. Even at the more-detailed company level, Mataloni (2000) finds only limited results. A recent study that looks at microdata for *exports alone* finds significant differences between prices for arms-length versus related-party sales (Bernard, Jensen, and Schott 2006), but we have no way of determining the overall impact of this finding on BEA's measures of *profits and value added* for MNCs.

ownership. Information on majority-owned foreign affiliates is also available in more recent BEA publications but does not appear in the earlier surveys. See Mataloni (2002) and Zeile (1999) for detailed descriptions of the methodologies for the two surveys.

We used the following variables in our analysis: gross product (value added), employment, compensation, and sales. Hours worked by employees are not measured in either survey and had to be estimated (see section on establishment-level estimates for U.S. parents and foreign affiliates, following). Table 10A.1 presents the source for each of these variables in each survey and in each year. As shown in the table, while most of these data can be downloaded directly from the BEA website, several older series are only available as tables in selected BEA publications; a subset of these are only available in paper format and therefore had to be scanned into the FRB Productivity Data System.

Our analysis was performed for the period of 1977 to 2000. An annual time series is available for 1994 to 2000. Prior to this, the variables of interest are only available for both surveys in 1977, 1982, and 1989. Although data now exist for both surveys through 2004, the Bartelsman and Beaulieu database with which we integrate the MNC surveys ends in 2001.[25] Because 2001 is a recession year, we chose not to include it in our analysis.

Industrial Classification and Concordances

The industrial classification of both surveys varies over time, complicating efforts to combine them into a consistent time series. For example, the FDIUS survey switched away from the 1987 Standard Industrial Classification system (SIC87) to the 1997 North American Industry Classification System (NAICS) beginning with its 1997 Benchmark Survey. The USDIA survey transitioned to NAICS in its 1999 Benchmark Survey. In addition, the level of industry detail varies over time, across variables, and across surveys.

Because of these classification issues, considerable effort was spent concording the data to a level of detail common to both surveys in all years under consideration. The standard that we ultimately chose is based on the BEA's SIC87-based Gross Product Originating (GPO) industry data. These data also formed the basis of the work by Bartelsman and Beaulieu. In that work, the authors broke out computers (SIC 357), communications equipment (SIC 366), and semiconductors (SIC 367) from Industrial Machinery and Equipment (SIC 35) and Electronic and Other Electric Equipment (SIC 36) in order to permit an improved focus on the high-tech sector. We adopted the resulting industrial hierarchy, which they called the "GPO87HT" hierarchy, and which is shown in table 10A.2. The sixty-four industries in the first column are the "atoms," or finest level of detail,

25. The Bartelsman and Beaulieu database (2007) is consistent with the 2002 Annual Revision to the National Income and Product Accounts.

Table 10A.1 **Data sources and industrial classification**

Variable	Year	Source for U.S. parents (USDIA Survey)	Source for foreign affiliates (FDIUS Survey)
Gross product	1977, 1982, 1989	*Survey of Current Business,* Feb. 1994	Survey of Current Business, June 1990
	1994–2000	BEA website	BEA website
Employment	1977	*U.S. Direct Investment Abroad,* 1977	BEA website
	1982	*U.S. Direct Investment Abroad: 1982 Benchmark Survey*	BEA website
	1989, 1994–2000	BEA website	BEA website
Sales	1977	*U.S. Direct Investment Abroad,* 1977	BEA website
	1982	*U.S. Direct Investment Abroad: 1982 Benchmark Survey*	BEA website
	1989, 1994–2000	BEA website	BEA website
Compensation	1977	*U.S. Direct Investment Abroad,* 1977	BEA website
	1982	*U.S. Direct Investment Abroad: 1982 Benchmark Survey*	BEA website
	1989, 1994–2000	BEA website	BEA website
Sales and employment by industry of sales	1980	None	BEA website
	1982	*U.S. Direct Investment Abroad: 1982 Benchmark Survey*	none
	1989	*U.S. Direct Investment Abroad: 1989 Benchmark Survey*	BEA website
	1992	None	BEA website
	1993	None	BEA website
	1994	*U.S. Direct Investment Abroad: 1994 Benchmark Survey*	BEA website
	1995	None	BEA website
	1996	None	BEA website
	1997	None	BEA website
	1998	None	BEA website
	1999	*U.S. Direct Investment Abroad: 1999 Benchmark Survey*	BEA website
	2000	None	BEA website

Table 10A.2 The "GPO87HT" industrial hierarchy for the nonfarm private business (NFPB) sector

Level 1 Code and description	Level 2	Level 3	Level 4	Level 5
E10 Metal mining	**Mining**	xxx	Non-Mfg.	NFPB
E12 Coal mining	**Mining**	xxx	Non-Mfg.	NFPB
E13 Oil and gas extraction	**Mining**	xxx	Non-Mfg.	NFPB
E14 Nonmetallic minerals, except fuels	**Mining**	xxx	Non-Mfg.	NFPB
E24 Lumber and wood products	**Lumber, wood and furniture**	Mfg. excl. High Tech	Mfg.	NFPB
E25 Furniture and fixtures	**Lumber, wood and furniture**	Mfg. excl. High Tech	Mfg.	NFPB
E32 Stone, clay, and glass products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E33 Primary metal industries	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E34 Fabricated metal products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E35X Other machinery	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E36X Other electrical machinery	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E371 Motor vehicles and equipment	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E372T9 Other transportation equipment	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E38 nstruments and related products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E39 Miscellaneous manufacturing industries	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E20 Food and kindred products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E21 Tobacco products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E22 Textile mill products	**Textile and apparel**	Mfg. excl. High Tech	Mfg.	NFPB
E23 Apparel and other textile products	**Textile and apparel**	Mfg. excl. High Tech	Mfg.	NFPB
E26 Paper and allied products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E27 Printing and publishing	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E28 Chemicals and allied products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E29 Petroleum and coal products	xxx	Mfg. excl. High Tech	Mfg.	NFPB
E30 Rubber and miscellaneous plastics products	**Rubber and leather**	Mfg. excl. High Tech	Mfg.	NFPB
E31 Leather and leather products	**Rubber and leather**	Mfg. excl. High Tech	Mfg.	NFPB
E15T7 Construction	xxx	xxx	Non-Mfg.	NFPB
E49 Electric, gas, and sanitary services	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E40 Railroad transportation	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E41 Local and interurban passenger transit	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E42 Trucking and warehousing	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E44 Water transportation	**Transportation and communications**	xxx	Non-Mfg.	NFPB

E45	Transportation by air	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E46	Pipelines, except natural gas	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E47	Transportation services	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E481A2A9	Telephone and telegraph	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E483A4	Radio and television	**Transportation and communications**	xxx	Non-Mfg.	NFPB
E50A1	**Wholesale trade**	xxx	Trade	Non-Mfg.	NFPB
E52T9	**Retail trade**	xxx	Trade	Non-Mfg.	NFPB
E60	Depository institutions	**Finance**	FIRE	Non-Mfg.	NFPB
E61	Nondepository institutions	**Finance**	FIRE	Non-Mfg.	NFPB
E62	Security and commodity brokers	**Finance**	FIRE	Non-Mfg.	NFPB
E63	**Insurance carriers**	xxx	FIRE	Non-Mfg.	NFPB
E64	Insurance agents, brokers, and service	xxx	FIRE	Non-Mfg.	NFPB
E65hs	Nonfarm housing services	**Real estate**	FIRE	Non-Mfg.	NFPB
E65re	Other real estate	**Real estate**	FIRE	Non-Mfg.	NFPB
E67	**Holding and other investment offices**	xxx	FIRE	Non-Mfg.	NFPB
E70	Hotels and other lodging places	**Services**	xxx	Non-Mfg.	NFPB
E72	Personal services	**Services**	xxx	Non-Mfg.	NFPB
E73	Other business services	**Services**	xxx	Non-Mfg.	NFPB
E75	Auto repair, services, and parking	**Services**	xxx	Non-Mfg.	NFPB
E76	Miscellaneous repair services	**Services**	xxx	Non-Mfg.	NFPB
E78	Motion pictures	**Services**	xxx	Non-Mfg.	NFPB
E79	Amusement and recreation services	**Services**	xxx	Non-Mfg.	NFPB
E80	Health services	**Services**	xxx	Non-Mfg.	NFPB
E81	Legal services	**Services**	xxx	Non-Mfg.	NFPB
E82	Educational services	**Services**	xxx	Non-Mfg.	NFPB
E83	Social services	**Services**	xxx	Non-Mfg.	NFPB
E86	Membership organizations	**Services**	xxx	Non-Mfg.	NFPB
E84A7A9	Other services	**Services**	xxx	Non-Mfg.	NFPB
E357	**Computers and related equipment**	High Technology	xxx	Mfg.	NFPB
E366	**Communications equipment**	High Technology	xxx	Mfg.	NFPB
E367	**Semiconductors**	High Technology	xxx	Mfg.	NFPB
E91b	Federal government enterprises	Govt. enterprises	xxx	Non-Mfg.	NFPB
E92b	State and local government enterprises	Govt. enterprises	xxx	Non-Mfg.	NFPB

Note. Bold industries represent the finest level of detail available in our final MNC database.

available in the GPO87HT hierarchy. The tools of the FRB Productivity Data System permit values associated with these atoms (for instance, gross product or employment) to be aggregated to higher level subaggregates (columns 2 through 5) as well as the total for the entire nonfarm private business sector (column 6).

Using the tools of the FRB Productivity Data System, we created numerous industrial hierarchies, called "metadata," to analyze the MNC surveys and ultimately concord all variables of interest to industries contained within the GPO87HT hierarchy. Often this was accomplished by first concording variables to an intermediate industrial hierarchy common to a subset of years or surveys.[26]

Unfortunately, while the level of detail we created for the manufacturing sector is typically at the two-digit level, we could not carve out a correspondingly fine level of detail for the services, mining, or transportation and communications industries. As such, the atom-level industries in our final MNC database do not always correspond to those in the GPO87HT hierarchy. Rather, the twenty-nine shaded industries in table 10A.2 denote the MNC-level atoms that ultimately fed into our analysis.

Sectoral Classification

Corrado and Slifman (1999) highlighted the importance of studying productivity not only by industry but also by legal form of organization, specifically along noncorporate, nonfinancial corporate, and financial corporate lines. Bartelsman and Beaulieu (2007) adopted this sectoral approach as well but implemented it for each industry in the GPO data. In this chapter, we make the additional step of breaking out the nonfinancial corporate sector into two distinct parts: an MNC sector and a domestically oriented sector. The MNCs are further divided into parents and foreign affiliates. Figure 10A.1 shows the sectoral hierarchy that we developed for each industry in the nonfarm private business sector:

Data on nonbank finance and insurance companies were excluded from our MNC database so that we could focus on the nonfinancial activities of multinationals. The real estate industry was also excluded in order to focus more directly on multinational corporations. The number of noncorporate multinationals is small but concentrated in this industry.

Constructing a Database for U.S. Parents

As noted in the text, the 1999 and 2000 USDIA surveys are classified on a NAICS97 basis, meaning it was necessary to concord these data to an SIC87 basis in order to make them time-series compatible with the older surveys. Before doing this, however, a few additional steps were necessary.

26. The complete metadata for any of these hierarchies and concordances are available upon request.

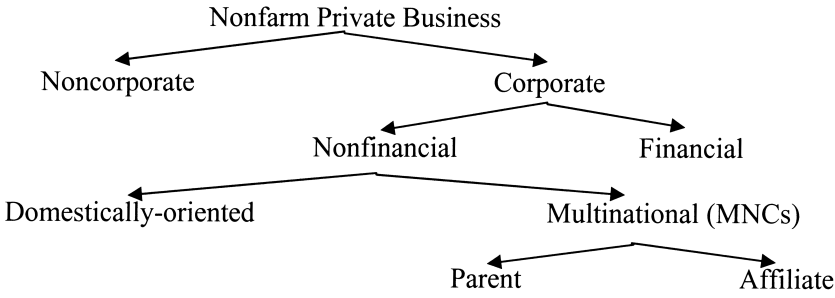

Fig. 10A.1 Sectoral hierarchy

First, beginning with the release of the revised 1999 survey, BEA began including U.S. parents with very small affiliates abroad, that is, affiliates with assets, sales, and net income less than $7 million (Mataloni 2002). These new parents represented 3.8 percent of gross product, 6.1 percent of the employment, and 2.7 percent of the capital expenditures in 1999. We rescaled the industry level data in 1999 to remove the published aggregate contribution of small parents. These level-adjusted values were then extrapolated forward to 2000 based on the growth rate of the unadjusted (i.e., officially published) estimates. In doing this, we implicitly assumed that small parents grew at the same rate as the larger parents.

Second, we corrected an apparent reclassification of an unnamed firm (or firms) from the computers and peripheral equipment manufacturing industry (N334) to the computer systems design and related services industry (N5415). Recall that the BEA assigns all of the operations of a U.S. parent to a primary industry based on a breakdown of the parent's sales. It appears that the primary industry designation of a large company (or several companies) with sales in both N334 and N5415 changed between the initial release for 1999 and when the 1999 data were revised as part of the 2000 release.[27]

Finally, we addressed the overlap issue. As noted in the text, the BEA provided us with special tabulations for 1990 to 2002 of the activities of those U.S. parents that are also affiliates of foreign companies and thus counted in both surveys. Because of concerns about the disclosure of information about individual survey respondents, these tabulations were made at a highly aggregate level, specifically all nonbank industries, manufacturing, and non-manufacturing.

Table 10A.3 presents these tabulations expressed as a percentage of the published values for the USDIA survey. For example, in 2000 the activities

27. Specifically, we averaged the absolute difference for each series between the original and revised 1999 values, subtracted this from computer systems, and added it to computers. For 2000, we followed the same procedure, using the 1999 shares to apply to the 2000 values.

Table 10A.3 **U.S. parent companies also affiliates of foreign companies (percent of USDIA survey values)**

	Sales	Capital expenditures	R&D expenditures	Gross product	Employee compensation	Employment
			All industries			
1990	13.0	15.8	12.8	n.a.	10.4	9.9
1991	12.9	14.1	11.3	n.a.	10.6	10.2
1992	13.0	14.4	11.5	n.a.	10.7	9.9
1993	12.7	13.7	11.7	n.a.	10.2	9.1
1994	13.8	12.9	10.7	10.3	10.6	9.1
1995	13.3	12.7	9.9	10.0	10.2	9.1
1996	13.6	13.3	9.8	10.2	10.4	9.1
1997	13.5	13.0	10.1	10.3	10.5	8.9
1998	14.7	17.3	11.8	10.9	11.6	9.8
1999	14.8	18.5	13.9	10.8	11.8	9.8
2000	15.4	17.1	14.8	11.3	13.3	10.6
			Manufacturing			
1990	17.1	24.3	13.9	n.a.	13.5	13.4
1991	16.9	21.1	n.a.	n.a.	13.6	13.6
1992	16.4	19.5	n.a.	n.a.	13.5	13.4
1993	15.8	17.2	12.4	n.a.	13.1	12.3
1994	15.9	16.2	11.5	13.7	13.0	12.3
1995	14.7	14.8	10.5	12.8	12.1	11.5
1996	15.4	14.5	9.7	12.6	11.8	11.4
1997	15.1	15.8	10.2	13.0	12.1	11.9
1998	17.9	26.2	12.2	15.1	14.7	13.8
1999	18.4	26.0	15.1	14.4	14.9	14.4
2000	16.8	18.2	16.2	12.1	15.3	14.5
			Nonmanufacturing			
1990	9.1	9.1	5.9	n.a.	6.0	6.0
1991	9.3	8.8	n.a.	n.a.	6.5	6.4
1992	9.7	10.7	n.a.	n.a.	6.7	6.0
1993	9.7	11.0	6.0	n.a.	6.4	5.6
1994	12.0	10.4	6.0	6.5	7.5	6.0
1995	12.1	10.9	5.4	6.9	7.8	6.7
1996	11.9	12.4	10.1	7.6	8.6	7.0
1997	12.2	11.3	8.8	7.7	8.6	6.6
1998	12.0	11.4	8.6	6.9	8.4	6.7
1999	11.8	13.1	7.8	7.4	9.0	6.8
2000	14.2	16.3	9.0	10.5	11.4	8.0

Note: n.a. = not applicable.

of foreign affiliates that are also counted as U.S. parents accounted for 11 percent of the gross product and 13 percent of the employee compensation in the USDIA survey. The BEA also provided us with more detailed industry-level information on the number of U.S. parent firms in 2000 that were also foreign affiliates. After reviewing these data, we made a few additional adjustments, roughly doubling the overall manufacturing share

for motor vehicles and parts, chemicals, petroleum refining, and stone, clay, and glass, and halving the overall manufacturing share for semiconductors, miscellaneous manufacturing, and furniture. We then made overlap adjustments for 1977, 1982, 1989, and 1994 to 1998 using the same special tabulations. Overlap adjustments for 1977, 1982, and 1989 were based on the tabulations for 1994.

Constructing a Database on Foreign Affiliates

For 1977, 1982, and 1989, all key variables except for gross product were concorded to the GPO87HT hierarchy. Gross product data for this period are organized according to a different industrial hierarchy, which in turn is different from the one used for all variables from 1992 to 1996. Moreover, the level of industry detail for 1977 to 1986 is limited (sixteen categories) compared to 1987 to 1989 (seventy-seven categories). We therefore used the detailed industry shares for 1987 to fill in the gaps in 1986, and then repeated this process back to 1977. All data were then concorded to the GPO87HT hierarchy.

For 1992 to 1996, data for all key variables were published at a slightly more disaggregate level than the corresponding USDIA estimates for 1994 to 1998. This necessitated an additional concordance in order to ultimately convert them to the GPO87HT hierarchy.

Data for 1997 to 2000 were published on a NAICS basis, and it was necessary to concord them to an SIC87 basis in order to make them time-series compatible with the pre-1997 FDIUS surveys. We used the same time-invariant concordance that was applied to the USDIA surveys in 1999 and 2000. The data were then concorded to the GPO87HT hierarchy.

Establishment-Level Estimates for U.S. Parents and Foreign Affiliates

We constructed our establishment-level estimates using periodic information from the BEA on sales and employment of affiliates or parents broken out by industry of sales. As shown in table 10A.1, for the USDIA survey, these data are only available in the benchmark surveys years for 1982 forward. For the FDIUS survey, the data are available annually for 1987 to 2000 but are not available in any previous years except for 1980.[28]

Unfortunately, unlike the firm-level data, the data on sales- and employment-by-industry-of-sales include information on banking, meaning the total values in the two types of files do not match. In addition, two categories—central administrative offices and a residual, "not specified" industry—only exist for the sales- and employment-by-industry-of-sales variables. We therefore implemented an iterative biproportional fitting or "RASing" procedure to adjust these values and ensure that they matched

28. In addition, because no data on high-tech industries are available in 1980, they were estimated using weights derived from the 1987 file.

the totals implied by the firm-based data. Ratio variables were then constructed of employment (or sales) in the industry of sales to employment (or sales) at the firm level.

Because data for sales- and employment-by-industry-of-sales were published on a NAICS97 basis in 1999 for the USDIA and in 1997 to 2000 for the FDIUS, we first had to remove the contributions of the additional parents that began to appear in the USDIA survey in this year, following the same approach described previously before concording them to a GPO87HT basis.

Finally, we applied the establishment-to-firm ratios to the firm-level, overlap-adjusted estimates in order to generate our establishment-level estimates. For the USDIA data, because these ratios only exist for 1982, 1989, and 1999, we applied the 1982 ratio to the 1977 firm-level data, the 1994 ratio to the 1995 and 1996 firm-level data, and the 1999 ratio to firm-level data to 1997 to 2001. For the FDIUS data, because these ratios do not exist in 1977 and 1982, we applied the 1980 ratios to both years.

Combining the Parent and Affiliate Databases

Having concorded both surveys to a single, time-series-consistent industrial hierarchy, addressed the overlap problem in the USDIA survey, and generated estimates on an establishment basis, we combined the data from the two surveys into a consolidated MNC database. We then merged this dataset with the Bartlesman and Beaulieu industry-level estimates for the nonfinancial corporate sector. Thus, for each industry, the resulting data set contained values for parents, affiliates, and the entire nonfinancial corporate sector. We estimated hours worked for parents and affiliates as the product of their employment and the average workweek in the corresponding industry for the nonfinancial corporate sector as a whole.[29] Values for the entire MNC sector in each industry are simply the sum of the corresponding parent and affiliate values. Values for domestically oriented nonfinancial corporations were calculated residually.[30]

As discussed in the text, we applied the gross product deflators generated by Bartlesman and Beaulieu for industries in the nonfinancial corporate sector to the *atom-level* parent, affiliate, and domestically oriented industries in our MNC database (i.e., the twenty-nine shaded industries in table 10A.2). Thus, in our analysis, chain aggregation of these atom-level deflators to higher-level subaggregates such as high tech, manufacturing excluding high tech, and nonmanufacturing provides the sole source of price

29. These hours estimates were then controlled to published totals for the nonfinancial corporate sector.

30. In a very small number of cases, the resulting values for the non-MNC sector were actually negative. In such instances, we calculated the domestically oriented as a very small fraction of the total nonfinancial corporate value and adjusted the MNC values accordingly.

Table 10A.4 Sectoral estimates of employee hours and real gross product

	Parents	Affiliates	MNC	NMNC	NFC	FC	COR	XCOR	BUS
1977									
Employee Hours:									
Gross domestic product	30,863	2,230	33,093	56,479	89,572	4,010	93,582	29,672	123,254
Nonfarm Business	30,863	2,230	33,093	56,479	89,572	4,010	93,582	24,438	118,020
Manufacturing	18,871	1,475	20,346	19,492	39,838	0	39,838	1,283	41,121
High Technology Industries	1,011	110	1,121	539	1,660	0	1,660	20	1,679
Manufacturing, except High Tech	17,860	1,365	19,225	18,953	38,178	0	38,178	1,264	39,442
Nonmanufacturing	11,992	755	12,748	36,987	49,734	4,010	53,745	23,154	76,899
Real Gross Product:									
Gross domestic product	685,616	60,335	747,995	1,457,904	2,210,918	305,990	2,499,951	1,065,389	3,553,215
Nonfarm Business	685,616	60,335	747,995	1,457,904	2,210,918	305,990	2,499,951	985,165	3,473,079
Manufacturing	368,429	34,716	405,980	366,936	772,022	0	772,022	16,960	788,267
High Technology Industries	1,030	633	1,389	991	2,309	0	2,309	1	2,236
Manufacturing, except High Tech	473,076	36,367	507,024	416,161	922,311	0	922,311	20,369	941,145
Nonmanufacturing	315,840	25,596	340,649	1,085,459	1,428,398	305,990	1,712,391	964,091	2,668,746
2000									
Employee Hours:									
Gross domestic product	36,032	12,028	48,060	95,276	143,336	5,481	148,817	38,249	187,066
Nonfarm Business	36,032	12,028	48,060	95,276	143,336	5,481	148,817	33,220	182,036
Manufacturing	15,171	5,643	20,814	19,617	40,431	0	40,431	1,395	41,826
High Technology Industries	1,385	382	1,767	655	2,422	0	2,422	62	2,484
Manufacturing, except High Tech	13,786	5,260	19,047	18,962	38,009	0	38,009	1,333	39,342
Nonmanufacturing	20,861	6,385	27,246	75,658	102,905	5,481	108,386	31,824	140,210
Real Gross Product:									
Gross domestic product	1,752,905	503,859	2,256,787	2,871,566	5,121,125	637,192	5,761,391	1,846,462	7,605,677
Nonfarm Business	1,752,905	503,859	2,256,787	2,871,566	5,121,125	637,192	5,761,391	1,754,303	7,513,077
Manufacturing	807,780	228,800	1,035,219	464,266	1,493,420	0	1,493,420	72,202	1,566,247
High Technology Industries	333,765	36,626	368,978	60,177	429,452	0	429,452	11,111	440,516
Manufacturing, except High Tech	593,233	201,627	794,918	407,271	1,200,331	0	1,220,331	64,395	1,264,933
Nonmanufacturing	943,762	274,797	1,218,581	2,405,737	3,625,490	637,192	4,264,410	1,683,942	5,946,905

Note: Employee hours reported in thousands; real gross product reported in thousands of 1996 dollars. NMNC = Domestically Oriented; NFC = Nonfinancial Corporations; FC = Financial Corporations; COR = Corporate Business; XCOR = Nonfarm Corporate Business; BUS = Nonfarm Private Business. Parents + Affiliates = MNC; MNC + NMC = NFC; NFC + FC = COR; COR + XCOR = BUS.

variation across parents, affiliates, and domestically oriented firms in any given industry in the nonfinancial sector.

Because the deflators are Fisher indexes, chain aggregation requires values for both prices and quantities in adjoining years. This posed a problem because, prior to 1994, we only have nominal gross product data for parents and affiliates at infrequent intervals. It was therefore necessary to estimate nominal gross product in years adjacent to 1977, 1982, and 1989. To do so, we implemented an iterative proportional fitting procedure that ensured these estimates summed to known totals (i.e., nonfinancial corporate gross product in each atom-level industry) and were consistent with the various accounting identities in our sectoral hierarchy (i.e., MNC = Parent + Affiliate; Nonfinancial Corporate = MNC + domestically oriented). We exploited the availability of nonfinancial corporate gross product and gross product deflators in the adjacent years and used values for parents and affiliates in 1977, 1982, and 1989 as starting values. Finally, we combined all relevant data on MNCs and nonfinancial corporations with data on the noncorporate, financial corporate, and government sectors to complete our analysis dataset.

Table 10A.4 presents our sectoral estimates of employee hours and real gross product in both 1977 and 2000 for selected aggregates and subaggregates. Estimates for all other years and variables as well as for atom-level industries are available on request.

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