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Does Service Offshoring Lead to Job Losses?
Evidence from the United States

Mary Amiti and Shang-Jin Wei

7.1 Introduction

A relatively new dimension of economic globalization is exports and imports of services, which used to be quintessential nontradables in a typical textbook on international economics. One of the authors once wanted to change his United Airlines flight while in Paris, but ended up talking to a service representative in Ireland after dialing a Parisian phone number. An American company may also find it most cost-efficient to farm out a computer programming task to a firm in India instead of doing it in-house or buying it from another firm in the United States. This phenomenon, known as either "service offshoring" or "international outsourcing of services," has gathered enormous attention in news media and political circles, especially in times leading up to national elections in industrialized countries. For example, in a recent presidential election year in the United States, from January 1 to November 2, 2004 (the day of the election), there

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were 2,850 news reports on service offshoring that used the term "offshoring." The interest in the subject has not disappeared and is likely to grow again in future national elections. In the first five months of 2006, there were 876 news reports in the United States that used the term "offshoring."[1] In fact, there were many more news reports on the subject, but perhaps they used the word "outsourcing" instead of "offshoring."

With rapid technological progress in computers, telecommunication, and other areas, more information and other business services can now be relocated from rich countries to lower-cost overseas sites and imported back. The amount of media and political attention in rich countries presumably has to do with the fear that service offshoring may lead to job losses at home. The newspapers are full of estimates on the effects of offshoring on jobs, which primarily come from management consultants. For example, management consultants at McKinsey forecast offshoring to grow at the rate of 30 to 40 percent a year over the next five years. They report that a leading IT analyst, Forrester, projects that the number of U.S. jobs that will be offshored will grow from 400,000 jobs to 3.3 million jobs by 2015, accounting for $136 billion in wages. Of this total, 8 percent of current IT jobs will go offshore over the next twelve years. The report goes on to say that fears of job losses are being overplayed, but it is unclear how their numbers are derived. Blinder (2006) provides a sector-by-sector guess on which types of service jobs may move offshore based on whether they can be delivered electronically. While the gross job loss is likely to be bigger than the Forrester estimate, he asserts that the net loss is likely to be small. Krugman (1995) argues that foreign trade in general is unlikely to have contributed significantly to the rising skill premium in the United States, although Krugman (2008) conjectures that this might have changed in more recent years. A rigorous study of job market effects in the United States is by Feenstra and Hanson (1996, 1999) but their focus is on material offshoring and its effects on the skill wage premium. They do not consider the effects of service offshoring, nor do they consider the effects on employment. Feenstra and Hanson (1996, 1999) found that material offshoring explained over 40 percent of the increase in nonproduction wages in the 1980s. Jensen and Kletzer (2005) find that a significant number of service industries are tradable, and displaced service sector workers tend to have higher skills and better predisplacement pays than displaced manufacturing workers.[2]

In this chapter, we study the employment effect of service offshoring for

1. Authors' calculation based on FACTIVA, an eletronic news database.

2. More recently, a number of studies have analyzed employment effects of offshoring in Europe. For example, Ekholm and Hakkala (2005) disentangle the employment effects by skill, using Swedish data; and Lorentowicz, Marin, and Raubold (2005) analyze the wage skill premium in Austria and Poland.

the United States during the period 1992 to 2000.[3] The results show that service offshoring has no significant effect on employment when manufacturing industries are aggregated to ninety-six industries. However, at a more disaggregated division of the manufacturing sector of 450 industries, we were able to detect a statistically significant negative effect. Service offshoring reduced manufacturing employment by around 0.4 of a percent. So, to examine whether service offshoring leads to net job losses, the level of aggregation is important. Because the U.S. labor market is reasonably flexible, one does not need to aggregate sectors very much to find that this employment effect washes out.

The rest of the chapter is organized as follows. Section 7.2 sets out the model and estimation strategy. Section 7.3 describes the data. Section 7.4 presents the results and section 7.5 concludes.

7.2 Model and Estimating Framework

This section describes a conceptual framework that motivates the empirical specification.

7.2.1 Model

The production function for an industry i is given by:

$$Y_i = A_i(oss_i, osm_i)\, F(L_i, K_i, M_i, S_i), \tag{1}$$

where output, Y_i; is a function of labor, L_i; capital, K_i; materials, M_i; and service inputs, S_i. The technology shifter, A_i, is a function of offshoring of services (oss_i), and offshoring of material inputs (osm_i).[4]

We assume that a firm chooses the total amount of each input in the first stage and chooses what proportion of material and service inputs will be imported in the second stage. The fixed cost of importing material inputs, F_k^M, and the fixed cost of importing service inputs, F_k^S, vary by industry k. This assumption reflects that the type of services or materials required are different for each industry, and hence importing will involve different amounts of search costs depending on the level of the sophistication of the inputs.

Cost minimization leads to the optimal demand for inputs for a given level of output, Y_i. The conditional labor demand is given by:

3. A crucial part of the data, the input-output tables from the Bureau of Labor Statistics, is available only up to year 2000. Therefore, it is not straightforward to extend the measure of offshored services beyond 2000 on a consistent basis.

4. Mann (2004) provides a back-of-envelope calcuation suggesting that offshoring in the IT industry led to an annual increase in productivity of 0.3 percentage points for the period 1995 to 2002. For the entire U.S. manufacturing sectors, Amiti and Wei (2006) show that offshoring increased productivity between 1992 and 2000.

$$L_i = g(w_i, r_i, q^m, q^s, Y_i)/A_i(oss_i, osm_i). \quad (2)$$

It is a function of wages, w_i; rental, r_i; material input prices, q_i^m; service input prices, q_i^s; and output. Offshoring can affect the labor demand through three channels. First, there is a substitution effect through the input price of materials or services. A fall in the price of imported services would lead to a fall in the demand for labor if labor and services are substitutes. Second, if offshoring leads to a productivity improvement then firms can produce the same amount of output with less inputs. Hence, conditional on a given level of output, offshoring is expected to reduce the demand for labor. Third, offshoring can affect labor demand through a scale effect. An increase in offshoring can make the firm more efficient and competitive, increasing demand of its output and hence labor. To allow for the scale effect, we substitute in for the profit-maximizing level of output, which is also a function of offshoring, then the labor demand function is given by

$$L_i = g(w_i, r_i, q^m, q^s, p_i, oss_i, osm_i)/A_i(oss_i, osm_i), \quad (3)$$

where p_i is the price of the final output, which is also a function of factor prices. Thus, offshoring may have a positive or negative effect on employment depending on whether the scale effect outweighs the negative substitution and productivity effects.

7.2.2 Estimation

The conditional labor demand, equation (2), will also be estimated in first differences as a log-log specification as is common in the empirical literature (see Hamermesh 1993; and Hanson, Mataloni, and Slaughter 2003) as follows:

$$\Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss_{it} + \gamma_2 \Delta osm_{it} + \gamma_3 \ln \Delta w_{it} + \gamma_4 \Delta \ln Y_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}. \quad (4)$$

The source of identification of employment in these type of industry labor demand studies is the assumption that the wage is exogenous to the industry. This would be the case if labor were mobile across industries. However, if labor were not perfectly mobile and there were industry-specific rents then wages would not be exogenous. Provided these rents are unchanged over time, they would be absorbed in the industry fixed effects and the results would be unbiased.

In general, an increase in output would be expected to have a positive effect on employment and an increase in wages a negative effect; whereas an increase in the price of other inputs would have a positive effect if the inputs are gross substitutes.

The question arises as to which input prices to use for imported inputs. If the firm is a multinational firm deciding on how much labor to employ at home and abroad then it should be the foreign wage. But not all offshoring takes place within multinational firms, and also with imported inputs sourced from many countries it is unclear which foreign wage to include, if any. Firms that import inputs at arm's length do not care about the foreign wage per se but instead are concerned about the price of the imported service. We assume that all firms face the same price for inputs, such as imported inputs and the rental on capital, which we assume is some function of time, $r = f(t)$.[5] In this time-differenced equation, these input prices will be captured by the time fixed effects, δ_t. In a conditional demand function, we expect that if offshoring increases productivity, then this will have a negative effect on the demand for labor since less inputs are needed to produce the same amount of output.

Substituting in the price of output for the quantity of output, we allow for scale effects:

$$(5) \quad \Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss_{it} + \gamma_2 \Delta osm_{it} + \gamma_3 \ln \Delta w_{it} + \gamma_5 \Delta \ln p_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}.$$

In this specification it is unclear what the net effect of offshoring is on labor demand (see equation [3]) as it will depend on whether the scale effects are large enough to outweigh the substitution and productivity effects. In some specifications we will estimate a more reduced form of equation (5), omitting p_{it}, which is a function of input prices.

This first difference specification controls for any time-invariant industry-specific effects such as industry technology differences. In this time-differenced specification, we also include year fixed effects, to control for unobserved time-varying effects common across all industries that affect employment growth, and in some specifications we also include industry fixed effects. Some industries may be pioneering industries that are high-growth industries and hence more likely to offshore inputs, and some industries might be subject to higher technical progress than others. Adding industry fixed effects to a time differenced equation takes account of these factors, provided the growth or technical progress is fairly constant over time. We estimate this equation using ordinary least squares (OLS), with robust standard errors corrected for clustering. We also include one period lags of the offshoring variables to take into account that productivity effects may not be instantaneous.

There may also be a problem of potential endogeneity of offshoring. A firm that is shedding jobs in response to declining demand may also choose to import business services to save cost. In this example, service offshoring

5. Note that in Amiti and Wei (2005), which estimates a labor demand equation for the United Kingdom, the offshoring intensity is interpreted as an inverse proxy of the price of imported service inputs (i.e., the lower the price of imported service inputs, the higher the offshoring intensity). Similarly, in this specification, the offshoring intensity may be picking up the productivity effect and/or the substitution effect.

does not cause the change in employment even if there is a correlation between the two. We also use the Arellano-Bond GMM estimator, which uses lags as instruments, to address the potential endogeneity of offshoring.

7.3 Data and Measurement of Offshoring

We estimate the effects of offshoring on employment for the period 1992 to 2000. Service offshoring ($oss_{i,t}$) for each industry i at time t is defined as the share of imported service inputs and is calculated analogously to the material offshoring measure in Feenstra and Hanson (1996, 1999) as follows:

$$(6)\quad oss_{it} = \sum_j \left(\frac{\text{input purchases of service } j \text{ by industry } i, \text{ at time } t}{\text{total non-energy inputs used by industry } i, \text{ at time } t} \right) \cdot \left(\frac{\text{imports of service } j, \text{ at time } t}{\text{production}_j + \text{imports}_j - \text{exports}_j \text{ at time } t} \right).$$

The first term in parenthesis is calculated using annual input/output (I/O) tables from 1992 to 2000 constructed by the Bureau of Labor Statistics (BLS), based on the Bureau of Economic Analysis (BEA) 1992 benchmark tables. The BEA uses standard industrial classification (SIC) 1987 industry disaggregation, which consists of roughly 450 manufacturing industries. These are aggregated up to ninety-six input/output manufacturing codes by the BLS.[6] We include the following five service industries as inputs to the manufacturing industries: telecommunications, insurance, finance, business services, and computing and information.[7] Business services is the largest component of service inputs, with an average share of 12 percent in 2000, then finance (2.4 percent), telecommunications (1.3 percent), insurance (0.5 percent), and the lowest share is computing and information (0.4 percent).

The second term in parenthesis is calculated using international trade data from the IMF Balance of Payments yearbooks. Unfortunately, imports and exports of each input by industry are unavailable and so an economy-wide import share is applied to each industry. As an example, the U.S. economy imported 2.2 percent of business services in 2000—we then assume that each manufacturing industry imports 2.2 percent of its business service that year. Thus, on average, the offshoring of business services is

6. We were unable to use the more disaggregated BEA I/O tables because the next available year is 1997 and this is under a different classification system, called North American Industry Classification System (NAICS). Unfortunately, the concordance between SIC and NAICS is not straightforward, thus there would be a high risk that changes in the input coefficients would reflect reclassification rather than changes in input intensities. In contrast, the BLS I/O tables use the same classification throughout the sample period.

7. The service categories were more disaggregated in the input/output tables but we aggregated them up to match the service categories in the IMF Balance of Payments statistics.

Table 7.1 **Material and service offshoring 1992–2000**

	Material offshoring—OSM		Service offshoring—OSS	
Year	%	%Δ	%	%Δ
1992	11.72	—	0.18	—
1993	12.68	5.25	0.18	4.88
1994	13.41	5.06	0.20	6.39
1995	14.18	4.65	0.20	4.10
1996	14.32	1.75	0.21	6.64
1997	14.55	1.75	0.23	6.97
1998	14.94	2.97	0.24	6.57
1999	15.55	3.49	0.29	16.73
2000	17.33	10.12	0.29	–2.23
1992–2000		4.38		6.26

equal to 0.12 * 0.022 = 0.3 percent. We aggregate across the five service inputs to get service offshoring measure for each industry, oss_{it}. An analogous measure is constructed for material offshoring, denoted by osm_{it}.

Table 7.1 presents average material and service offshoring, weighted by industry output. The average service offshoring in 2000 is only 0.3 percent, whereas the average materials offshoring is 17.4 percent. Both types of offshoring have been increasing over the sample period, with higher growth rates for service offshoring at an annual average of 6.3 percent, compared to an average growth rate of 4.4 percent for material offshoring.

The breakdown of the two components of the service offshoring for each service category is provided for 1992 and 2000 in table 7.2. The first column shows the average share of each service category (the first term in equation [6]), and the last column gives the average import share of each service category (the second term in equation [6]). We see from column (1) that business services is the largest service category used across manufacturing industries, and this has grown from an average of 9.7 percent in 1992 to 12 percent in 2000. There is also much variation between industries. For example, in the household audio and video equipment industry, business services only accounted for 2 percent of total inputs in the year 2000 whereas in the greeting cards industry it was 45 percent. From the last column, we see that the import share of all service categories, except communications, increased over the period.

There are a number of potential problems with these offshoring measures that should be noted. First, they are likely to underestimate the real value of offshoring because the cost of importing services is likely to be lower than the cost of purchasing them domestically. While it would be preferable to have quantity data rather than current values, this is unavailable for the United States. Second, applying the same import share to all

Table 7.2 Service inputs, by type: 1992 and 2000

	Share of service inputs (%)				
Services	Mean	Standard deviation	Min	Max	Import of services (%)
(1992)					
Communication	1.16	0.79	0.25	4.82	2.47
Financial	1.91	0.63	0.93	4.72	0.25
Insurance	0.43	0.18	0.16	1.39	1.82
Other business service	9.69	7.16	1.87	37.93	1.47
Computer and information	0.55	0.44	0.02	2.53	0.16
(2000)					
Communication	1.27	0.94	0.28	5.45	1.18
Financial	2.37	0.86	0.71	5.28	0.51
Insurance	0.47	0.22	0.10	1.36	2.84
Other business service	12.02	8.55	1.89	44.99	2.23
Computer and information	0.38	0.31	0.01	2.01	0.62

Source: BLS, Input-Output Tables, and IMF, *Balance of Payments Statistics Yearbook.*

industries is not ideal, but given the unavailability of imports by industry this is our "best guess." The same strategy was used by Feenstra and Hanson (1996, 1999) to construct measures of material offshoring. This approach apportions a higher value of imported inputs to the industries that are the biggest users of those inputs. Although this seems reasonable, without access to actual import data by industry it is impossible to say how accurate it is. Despite these limitations, we believe that combining the input use information with trade data provides a reasonable proxy of the proportion of imported inputs by industry.

The employment equations are estimated at two different levels of aggregation: (a) BLS I/O categories comprising ninety-six manufacturing industries; and (b) SIC categories comprising 450 industries. In order to aid comparison between these different levels of aggregation, the employment equations all use data from the NBER Productivity Database (Bartelsman and Gray 1996), which provides input and output data at the 4-digit SIC level up to the year 1996. We extend this data to 2000 using the same sources as they do, which include the BEA and Annual Surveys of Manufacturers (ASM), and the same methodology wherever possible. See the appendix for details of the data sources. All the summary statistics are provided in table 7.3.

7.4 Results

We estimate equations (4) and (5) at the industry level for the period 1992 to 2000. All variables are entered in log first differences, except those vari-

Table 7.3 Summary statistics

Variable	Observations	Mean	Standard deviation	Min	Max
BLS I/O classifications					
$oss_{i,t}$	864	0.239	0.162	0.040	1.071
$\Delta oss_{i,t}$	768	0.016	0.032	–0.145	0.411
$osm_{i,t}$	864	14.949	9.808	1.220	69.255
$\Delta osm_{i,t}$	768	0.694	1.950	–16.173	21.220
ln(value-added per worker)$_{i,t}$	864	–2.591	0.480	–4.034	–0.526
Δln(value-added per worker)$_{i,t}$	768	0.043	0.070	–0.231	0.364
ln(real output)$_{i,t}$	864	10.112	0.953	6.549	12.979
Δln(real output)$_{i,t}$	768	0.036	0.074	–0.256	0.443
ln(materials)$_{i,t}$	864	9.032	1.034	5.577	12.498
Δln(materials)$_{i,t}$	768	0.031	0.103	–0.567	0.544
ln(services)$_{i,t}$	864	7.060	1.025	3.892	9.875
Δln(services)$_{i,t}$	768	0.045	0.075	–0.316	0.418
ln(labor)$_{i,t}$	864	11.834	0.847	8.618	13.836
Δln(labor)$_{i,t}$	768	–0.001	0.038	–0.165	0.139
ln(capital stock)$_{i,t}$	844	9.175	1.030	5.979	11.701
Δln(capital stock)$_{i,t}$	748	0.029	0.043	–0.809	0.301
htech (ex post)$_{i,t}$	864	10.070	6.302	2.574	24.112
Δhtech (ex post)$_{i,t}$	768	0.265	0.959	–2.899	4.410
htech (ex ante)$_{i,t}$	860	9.738	5.961	2.508	23.149
Δhtech (ex ante)$_{i,t}$	764	0.107	0.338	–0.729	1.512
import share$_{i,t}$	855	0.257	0.486	0.000	3.408
Δ(import share)$_{i,t}$	760	0.014	0.050	–0.375	0.579
(SIC aggregated to BLS I/O)					
employment	823	181,824	158,096	4,936	838,385
Δln(employment)	728	–0.00005	0.048	–0.2496	0.2541
wage	823	32,581	8,068	14,709	56,506
Δln(wage)	728	0.0299	0.0235	–0.0796	0.1464
real output, $1M	823	39,023	49,277	785	495,348
Δln(real output)	728	0.0322	0.069	–0.323	0.4424
price (1987 = 1.00)	823	0.983	0.096	0.37	1.99
Δln(price)	728	0.010	0.047	0.34	0.28
(SIC 4-digit level)					
employment	4,018	37,548	54,458	100	555,063
Δln(employment)	3,565	–0.0077	0.0937	–0.803	0.7368
wage	4,018	31,115	8,947	12,350	72,157
Δln(wage)	3,566	0.0307	0.0476	–0.2826	0.6219
real output, $1M	4,018	8,613	52,802	24	2,292,522
Δln(real output)	3,566	0.0222	0.1086	–1.100	0.84
price (1987 = 1.000)	4,018	1.2218	0.1682	0.0407	2.012
Δln(price)	3,567	0.0113	0.0469	–0.4854	0.405

Note: "htech" is defined as high-tech capital services/total capital services.

ables that are constructed as ratios (such as offshoring) are entered as differences in the ratios. All estimations include year fixed effects and some specifications also include industry fixed effects. The errors have been corrected for clustering at the I/O industry level, which is the aggregation level of the offshoring variables.

The results show that service offshoring has no significant effect on manufacturing employment when the manufacturing sector is divided into ninety-six industries.[8] In columns (1) to (3) of table 7.4, we present results from estimating the conditional employment equation, and allow for scale effects, with one period differences using OLS. All of these specifications show that the contemporaneous and the lagged service offshoring variables are individually and jointly insignificant. Material offshoring has a positive effect on employment, but this is only significant in column (3), which allows for scale effects. In some specifications, import share (defined as the ratio of total imports to total output in that industry i) is negative and significant, showing that increasing imports displaces employment in that industry.

Robustness checks for potential endogeneity using the GMM estimator are presented in columns (4) and (5) of table 7.4. These specifications also show that service offshoring has an insignificant effect on employment, and that material offshoring has a significant positive employment effect. This finding is consistent with Hanson, Mataloni, and Slaughter (2003), who find that expansion in the scale of activities by foreign affiliates appears to raise demand for labor in U.S. parents.[9]

7.4.1 More Disaggregated Effects

It is possible that any negative effects from offshoring could be washed away within broadly defined industry classifications. To explore this possibility, we reestimate equations (4) and (5) using the more disaggregated 4-digit SIC categories of 450 manufacturing industries. Note that it was only possible to construct the offshoring measures at the BLS I/O classification comprising ninety-six industries, hence we cluster standard errors at the BLS I/O industry category.

In fact, we do see a negative effect from service offshoring on employment in table 7.5 using the more disaggregated industry classifications, with OLS in columns (1) to (3) and GMM in columns (4) and (5). Service offshoring has a significant negative effect in all specifications in table 7.5, and there are no offsetting scale effects. That is, the size of the negative coefficients on service offshoring are of similar magnitude in all columns,

8. All of the employment specifications exclude the tobacco industry; and all include year and industry fixed effects.

9. Harrison and McMillan (2005) report correlations between U.S. multinational employment at home and abroad. Their preliminary findings also suggest a positive correlation between jobs at home and abroad.

Table 7.4 Offshoring and employment

	OLS			GMM	
Dependent variable: $\Delta\ln(\text{employment})_t$	(1)	(2)	(3)	(4)	(5)
$\Delta oss_{i,t}$	0.015	–0.123	–0.129	–0.040	–0.123
	(0.106)	(0.131)	(0.134)	(0.094)	(0.121)
$\Delta oss_{i,t-1}$	–0.035	0.079	0.055	–0.104	0.024
	(0.077)	(0.094)	(0.090)	(0.072)	(0.086)
$\Delta osm_{i,t}$	0.002	0.003	0.003*	0.003**	0.005***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
$\Delta osm_{i,t-1}$	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{wage})_{i,t}$	–0.498***	–0.327***	–0.325***	–0.425***	–0.28***
	(0.092)	(0.109)	(0.109)	(0.084)	(0.108)
$\Delta\ln(\text{wage})_{i,t-1}$	0.071	0.161*	0.163*	0.128	0.185*
	(0.077)	(0.093)	(0.093)	(0.095)	(0.110)
$\Delta\ln(\text{real output})_{i,t}$	0.489***	—	—	0.509***	—
	(0.060)	—	—	(0.054)	—
$\Delta\ln(\text{real output})_{i,t-1}$	0.066	—	—	0.046	—
	(0.042)	—	—	(0.062)	—
$\Delta\ln(\text{price})_{i,t}$	—	0.060	—	—	–0.002
	—	(0.042)	—	—	(0.053)
$\Delta\ln(\text{price})_{i,t-1}$	—	0.089	—	—	0.066
	—	(0.056)	—	—	(0.063)
$\Delta(\text{htech})_{i,t}$	–0.002	–0.004	–0.004	0.000	–0.002
(ex post rental prices)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
$\Delta(\text{htech})_{i,t-1}$	–0.004	–0.003	–0.004	–0.001	–0.001
(ex post rental prices)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
$\Delta(\text{impshare})_{i,t}$	0.000	–0.002***	–0.002***	0.000	–0.002***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)

(continued)

Table 7.4 (continued)

	OLS			GMM	
Dependent variable: $\Delta\ln(\text{employment})_t$	(1)	(2)	(3)	(4)	(5)
$\Delta(\text{impshare})_{i,t-1}$	0.000	–0.000	–0.000	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{employment})_{i,t-1}$				0.063	0.152**
				(0.051)	(0.066)
Joint significance tests					
$\Delta oss_{i,t} + \Delta oss_{i,t-1} = 0$	F(1,93) = 0.02	F(1,93) = 0.05	F(1,93) = 0.15	$\chi^2(1) = 1.18$	$\chi^2(1) = 0.34$
	p-value = 0.89	*p*-value = 0.82	*p*-value = 0.69	*p*-value = 0.28	*p*-value = 0.56
$\Delta osm_{i,t} + \Delta osm_{i,t-1} = 0$	F(1,93) = 1.98	F(1,93) = 2.87	F(1,93) = 2.47	$\chi^2(1) = 2.74$	$\chi^2(1) = 8.8$
	p-value = 0.16	*p*-value = 0.09	*p*-value = 0.12	*p*-value = 0.10	*p*-value = 0.00
$\Delta(\text{htech})_{i,t} + \Delta(\text{htech})_{i,t-1} = 0$	F(1,93) = 1.57	F(1,93) = 1.73	F(1,93) = 2.50		
(ex post rental prices)	*p*-value = 0.21	*p*-value = 0.19	*p*-value = 0.12		
$\Delta(\text{impshare})_{i,t}$ +	F(1,93) = 0.71	F(1,93) = 8.17	F(1,93) = 8.02		
$\Delta(\text{impshare})_{i,t-1} = 0$	*p*-value = 0.40	*p*-value = 0.01	*p*-value = 0.01		
H_0: no 2nd order autocorrelation				z = –0.35	z = –0.21
				p-value = 0.72	*p*-value = 0.83
				Sargan test	
				$\chi^2(20) = 29.8$	$\chi^2(20) = 32.3$
				p-value = 0.07	*p*-value = 0.01
Observations	626	626	626	529	529
R^2	0.63	0.44	0.44		

Notes: Robust standard errors in parentheses. Import shares for metal coating and engraving (I/O code 36) are missing. All columns have year and industry fixed effects.

OLS = ordinary least squares; GMM = generalized method of moments.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 7.5 Offshoring and employment: more disaggregated manufacturing industries (450 industries- SIC)

	OLS			GMM	
Dependent variable: $\Delta\ln(\text{employment})_t$	(1)	(2)	(3)	(4)	(5)
$\Delta oss_{i,t}$	–0.069	–0.253**	–0.278**	–0.224	–0.392*
	(0.084)	(0.119)	(0.111)	(0.147)	(0.179)
$\Delta oss_{i,t-1}$	–0.175*	–0.007	–0.047	–0.341***	–0.159
	(0.105)	(0.114)	(0.106)	(0.121)	(0.149)
$\Delta osm_{i,t}$	0.002	0.000	0.000	0.003	0.002
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)
$\Delta osm_{i,t-1}$	0.001	–0.001	–0.001	0.001	0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{wage})_{i,t}$	–0.646***	–0.531***	–0.527***	0.662***	–0.557***
	(0.083)	(0.090)	(0.090)	(0.073)	(0.08)
$\Delta\ln(\text{wage})_{i,t-1}$	0.039	0.075**	0.077**	0.018	0.042
	(0.039)	(0.033)	(0.034)	(0.06)	(0.065)
$\Delta\ln(\text{real output})_{i,t}$	0.523***	—	—	0.517***	—
	(0.029)	—	—	(0.034)	—
$\Delta\ln(\text{real output})_{i,t-1}$	0.050***	—	—	0.052	—
	(0.017)	—	—	(0.032)	—
$\Delta\ln(\text{price})_{i,t}$	—	0.113**	—	—	0.136**
	—	(0.045)	—	—	(0.053)
$\Delta\ln(\text{price})_{i,tt-1}$	—	0.072	—	—	0.095
	—	(0.063)	—	—	(0.090)
$\Delta(\text{htech})_{i,t}$	–0.003	–0.006*	–0.006**	–0.002	–0.005*
(ex post rental prices)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
$\Delta(\text{htech})_{i,t-1}$	–0.006**	–0.007**	–0.007**	–0.004	–0.004
(ex post rental prices)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
$\Delta(\text{impshare})_{i,t}$	–0.000	–0.001***	–0.001***	–0.0002**	–0.0009***
	(0.000)	(0.000)	(0.000)	(0.00001)	(0.0001)
$\Delta(\text{impshare})_{i,t-1}$	0.000	–0.000	–0.000	0.0002**	–0.0002**
	(0.000)	(0.000)	(0.000)	(0.0001)	(0.0001)

(*continued*)

Table 7.5 (continued)

	OLS			GMM	
Dependent variable: $\Delta\ln(\text{employment})_t$	(1)	(2)	(3)	(4)	(5)
$\Delta\ln(\text{employment})_{i,t-1}$				–0.334	–0.002
				(0.037)	(0.003)
Joint significance tests					
$\Delta oss_{i,t} + \Delta oss_{i,t-1} = 0$	F(1,93) = 2.37	F(1,93) = 1.52	F(1,93) = 2.82	$\chi^2(1) = 5.9$	$\chi^2(1) = 3.88$
	p-value = 0.12	*p*-value = 0.22	*p*-value = 0.10	*p*-value = 0.01	*p*-value = 0.05
$\Delta osm_{i,t} + \Delta osm_{i,t-1} = 0$	F(1,93) = 1.43	F(1,93) = 0.02	F(1,93) = 0.14	$\chi^2(1) = 1.65$	$\chi^2(1) = 0.74$
	p-value = 0.23	*p*-value = 0.88	*p*-value = 0.70	*p*-value = 0.2	*p*-value = 0.39
$\Delta(\text{htech})_{i,t} + \Delta(\text{htech})_{i,t-1} = 0$	F(1,93) = 3.36	F(1,93) = 5.37	F(1,93) = 5.87		
(ex post rental prices)	*p*-value = 0.07	*p*-value = 0.02	*p*-value = 0.10		
$\Delta(\text{impshare})_{i,t}$ +	F(1,93) = 0.22	F(1,93) = 28.0	F(1,93) = 28.8		
$\Delta(\text{impshare})_{i,t-1} = 0$	*p*-value = 0.64	*p*-value = 0.00	*p*-value = 0.00		
H_0: no 2nd order autocorrelation				z = –0.57	z = –0.89
				p-value = 0.57	*p*-value = 0.37
Sargan test					
				$\chi^2(20) = 29.35$	$\chi^2(20) = 32.55$
				p-value = 0.08	*p*-value = 0.04
Observations	3,018	3,018	3,018	2,581	2,581
R^2	0.55	0.33	0.33		

Notes: Robust standard errors in parentheses. There are 13 SICs with missing import data, and several SICs that have missing employment data for various years. All columns have year and industry fixed effects. OLS = ordinary least squares; GMM = generalized method of moments.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

with and without controlling for output. However, the material offshoring effect has now become insignificant.

Using estimates from table 7.5, the effect from service offshoring on employment is equal to 0.3. Since service offshoring in the manufacturing sector grew by 0.1 percentage point over the sample period, this implies an average loss of 3 percent employment. However, since more service offshoring occurs in industries with relatively small employment, weighted by employment shares of each sector, these estimates imply a fall of total manufacturing employment by only 0.4 of a percent.

7.5 Conclusions

Sourcing service inputs from abroad by U.S. firms is growing rapidly. Although the level of service offshoring is still low compared to material offshoring, this business practice is expected to grow as new technologies make it possible to access cheaper foreign labor and different skills. This has led to concerns that jobs will be transferred from the United States to developing countries. To see if these concerns have any foundation, we estimate the effects of service and material offshoring on manufacturing employment in the United States between 1992 and 2000.

We find there is a small negative effect of less than half a percent on employment when industries are finely disaggregated (450 manufacturing industries). However, this effect disappears at the more aggregated industry level of ninety-six industries, indicating that there is sufficient growth in demand in other industries within these broadly defined classifications to offset any negative effects. This probably reflects the relatively flexible nature of the U.S. labor market that allows for reallocation of labor between industries. The employment effect could be different for other countries with a less flexible labor market.

Our analysis suggests a number of possible avenues for future research. First, improvements in the collection of data at the firm level with information distinguishing between domestic input purchases from imports, combined with detailed skill level data would be a major step forward in making this type of analysis possible. Second, our sample ends in 2000. Because the BLS annual input-output tables were provided up to 2000, extending the measure of service offshoring beyond that year on a consistent basis is not straightforward. However, more could be happening in more recent years, including a continued rise in the share of imported service inputs. When relevant data become available, updating the analysis can provide additional insight. Third, offshoring is likely to have income distribution effects. Feenstra and Hanson (1999) found that material outsourcing explained about 40 percent of the increase in the skill premium in the United States in the 1980s. Given that service offshoring is likely to be more skill-intensive than material offshoring, it will be interesting to see what effects, if any, service offshoring has on the wage skill premium. Disaggregated data by skill would also make it possible to study whether any particular skill groups are relatively more affected.

Appendix

Table 7A.1 Data sources

Variable	Code	Years available	Source
Input/output tables	BLS	1992–2000	BLS
Trade (manufacturing)	HS10 digit	1992–2001	Feenstra
Trade (services)	Balance of Payments	1992–2001	IMF
Output (manufacturing)	SIC 4 digit	1992–2001	BEA
Output (services)	SIC 3 digit	1992–2001	BEA
Value-added per worker	BLS	1992–2000	BLS
Employment	SIC 4 digit	1992–2001	ASM
Payroll	SIC 4 digit	1992–2001	ASM
Capital stock	SIC 4 digit	1992–1996	NBER Productivity Database
	SIC 4 digit	1996–2001	Constructed using investment perpetual method
Capital expenditure	SIC 4 digit	1996–2001	ASM
Investment deflators	SIC 2 digit	1996–2001	BLS
Materials	SIC 4 digit	1992–2001	ASM
Material deflators	SIC 4 digit	1992–1996	NBER Productivity Database
	SIC 4 digit	1997–2001	BEA output deflators with 1992 BEA I/O table

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Comment Robert C. Feenstra

This chapter by Mary Amiti and Shang-Jin Wei carries forward from a line of research the authors have been engaged in for several years. In Amiti and Wei (2005) they point out that a number of industrial countries—including the United States—are net *exporters* of business services, so that they should certainly benefit from this activity. In Amiti and Wei (2006), they estimate that the import of business services has enhanced productivity in those industries making the greatest use of service imports. This chapter takes the final step in estimating the employment impact of service imports for the United States.

Before commenting on the specifics of the chapter, I would like to suggest that the nature of outsourcing has changed in the United States, especially when we compare the 1980s with the 1990s. In figure 7C.1, I show the relative wage of nonproduction workers and their relative employment in U.S. manufacturing, from 1979 to 1989. The annual earnings of nonpro-

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