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

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Abstract

Does sourcing service inputs from overseas suppliers lead to less employment at home? This paper estimates the effects of offshoring on employment in U.S. manufacturing industries between 1992 and 2000. It finds that service offshoring has a small negative effect of less than half a percent on employment when industries are finely disaggregated (450 manufacturing industries). However, this affect disappears at more aggregate industry level of 96 industries indicating that there is sufficient growth in demand in other industries within these broadly defined classifications to offset any negative effects. Thus, there is no net job losses from service offshoring.

Keywords: outsourcing, employment

JEL Classification: F1 F2

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1. Introduction

A relatively new dimension of economic globalization is exports and imports of servies, which used to be quintessential "non-tradables" 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 programing 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 the last presidential election year in the United States, from January 1 to November 2, 2004, the day of the election, there were 2850 news reports on service offshoring and used the term "offshoring." The interest in the subject has not disappeared and is likely to grow again at the next national election. 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 a lot more news reports on the subject but perhaps they used the word "outsourcing" instead of "offshoring."

With rapid technological progress in computer, 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 has presumably 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

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

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 12 years. The report goes on to say that fears of job losses are being overplayed, but it is unclear how their numbers are derived. The only 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.[2]

In this paper, we study the employment effect of service offshoring for the United States during the period 1992-2000. The results show that service offshoring has no significant effect on employment when manufacturing industries are aggregated to 96 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 US labor market is reasonably flexible, one does not need to aggregate sectors very much to find that this

[2] More recently, a number of studies have analysed 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.

employment effect washes out.

The rest of the paper is organized as follows. Section 2 sets out the model and estimation strategy. Section 3 describes the data. Section 4 presents the results and Section 5 concludes.

2. Model and Estimating Framework

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

2.1. Model

The production function for an industry i is given by:

$$Y_i = A_i(oss_i, osm_i)F(L_i, K_i, M_i, S_i), \tag{2.1}$$

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).[3]

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.

[3] Amiti and Wei (2006) show that offhsoring increased productivity in manufacturing industries between 1992 and 2000.

The conditional labor demand is given by:

$$L_i = g(w_i, r_i, q^m, q^s, Y_i)/A_i(oss_i, osm_i). \tag{2.2}$$

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 for 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

$$L_i = g(w_i, r_i, q^m, q^s, p_i, oss_i, osm_i)/A_i(oss_i, osm_i), \tag{2.3}$$

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.

2.2. Estimation

The conditional labor demand, equation (2.2), 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, 2004), as follows:

$$\Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss_{it} + \gamma_2 \Delta osm_{it} + \gamma_3 \ln \Delta w_{it} + \gamma_4 \Delta \ln Y_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}. \qquad (2.4)$$

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 then 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 other inputs, such as imported inputs and the rental on capital, which we assume is some function of time, $r = f(t)$.[11] In this time differenced

[11] 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. Similiarly, in this specification, the offshoring intensity may be picking up the productivity effect and/or the substitution effect.

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:

$$\Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss_{it} + \gamma_2 \Delta osm_{it} + \gamma_3 \ln \Delta w_{it} + \gamma_5 \Delta \ln p_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}. \tag{2.5}$$

In this specification it is unclear what the net effect of offshoring is on labor demand (see equation (2.3)) 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 (2.5), 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 any unobserved time-varying effect 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 OLS, with robust standard errors corrected for clustering. We also include one period lags of the offshoring variables to take account that productivity effects may not be instantaneous.[4]

[4] Longer lags were insignificant.

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 does not cause the change in employment even if there is a correlation between the two. In addition, the extent of offshored activities is likely to be measured with errors which also contributes to the downward bias. To address these concerns, we follow the instrumental variable strategy developed in Amiti and Wei (2006). Specifically, the number of internet users in America's major trading partners is used as a source of exogenous variation in the extent of U.S. service imports across partner countries. These time-varying country measures are interacted with the share of services in total sectoral output in the United States at the beginning of the period to provide time/industry varying instruments. We also use the Arellano-Bond GMM analysis, with additional exogenous instruments, which we describe below. We estimate equations (2.4) and (2.5) using OLS, with robust standard errors corrected for clustering.

3. Data and Measurement of Offshoring

We estimate the effects of offshoring on employment for the period 1992 to 2000. The offshoring intensity of services ($oss_{i,t}$) 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:

$$oss_i = \sum_j \left[\frac{\text{input purchases of service } j \text{ by industry } i, \text{ at time } t}{\text{total non-energy inputs used by industry } i, \text{ at time } t}\right] * \left[\frac{\text{imports of service } j\text{, at time } t}{\text{production}_j + \text{imports}_j - \text{exports}_j \text{ at time } t}\right]. \tag{3.1}$$

The first square bracketed term is calculated using annul input/output 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 use SIC 1987 industry disaggregation, which consist of roughly 450 manufacturing industries. These are aggregated up to 96 input/output manufacturing codes by the BLS.[5] We include the following five service industries as inputs to the manufacturing industries: telecommunications, insurance, finance, business services, and computing and information. These service industries were aggregated up to match the IMF Balance of Payments statistics. Business services is the largest component of service inputs with an average share of 12% in 2000; then finance (2.4%); telecommunications (1.3%); insurance (0.5%); and the lowest share is computing and information (0.4%).

The second square bracketed term 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 intensity of business services is equal to 0.12*0.022=0.3

[5] 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 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 intensties. In contrast, the BLS I/O tables use the same classification throughout the sample period.

percent. We aggregate across the five service inputs to get the average service offshoring intensity for each industry, oss_i. An analogous measure is constructed for material offshoring, denoted by osm_i.

Table 1 presents averages of offshoring intensities of materials and services, weighted by industry output. The average share of imported service inputs in 2000 is only 0.3 percent whereas the average share of imported material inputs 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 materials.

The breakdown of the two components of the offshoring intensity ratio for each service category is provided for 1992 and 2000 in Table 2. The first column shows the average intensity of each service category (the first term in equation (3.1)), and the last column gives the average import intensity of each service category (the second term in equation (3.1)). 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 2000, in the "household audio and video equipment" industry business services only accounted for 2 percent of total inputs whereas in the "greeting cards" industry it was 45 percent. From the last column, we see that the import share of all service category, 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 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 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: (i) BLS I/O categories comprising 96 manufacturing industries; and (ii) 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 ASM, and the same methodology wherever possible. See Table A1 in the Appendix for details of the data sources. All the summary statistics are provided in Table 3.

3.1. Endogeneity

Which industries engage in more offshoring may not be random, and hence could lead to biased estimates. If the industries that self select into offshoring do not change over time, then the industry effects should take account of this. However, if there is some time-varying effect, then the bias might persist. In order to address this potential problem, we follow Amiti and Wei (2006) and re-estimate the equations using instruments for service offshoring and material offshoring. An instrumental variables approach can also mitigate potential bias from measurement error. A good instrument is one that would only affect productivity through its effect on offshoring.

New technologies that have led to an increase in service offshoring can be related to the level of internet development in foreign countries, which can be measured by the number of internet hosts or internet users in the countries that supply the largest share of imported services to the United States. Of course, there are also other technological changes that affect service offshoring, such as changes in digital telephone technology. It turns out that all of these measures are highly correlated so could not all be included in one estimation, and when included in separate estimations they produced similar results. Thus the number of internet hosts can be thought of as a proxy for technology changes more generally.

Industries that rely heavily on service inputs are more likely to respond to technology changes that reduce the cost of service offshoring. To capture this idea, we interact the number of internet hosts in each country c at time t, (IH_{ct}) with total services as a share of output at the beginning of the sample for each industry in the first stage regression, thus

$$\Delta oss_{it} = f\left(\sum_{c} \gamma_c * \left(\Delta \ln IH_{c,t} * \frac{services_{i,1992}}{output_{i,1992}}\right)\right),$$

which provides us with c instruments that vary by industry and time. Although the offshoring measure is not by country, firms respond to technological changes in different countries when making their importing decisions. The $\gamma_c^{\prime}s$ will be estimated in the first stage regression of the two-stage least squares estimation. We would expect that industries would respond to technological developments in different ways as each country differs in its technology and the type of services they provide.

The number of internet users are from the International Telecommunication Union (2003) Yearbook. To determine which countries' internet developments to include we turn to the BEA bilateral services trade statistics to identify the countries that the U.S. imports the largest shares of its services. For the year 2000, these countries are United Kingdom (21%), Canada (10%), Japan (7%), and Germany (7%). We also include the number of internet hosts in India. Even though the U.S. share of service imports from India are only 1.5% as reported by the BEA, Indian statistical sources show this number to be much higher.[6]

For material offshoring, we also follow Amiti and Wei (2006) and use the average freight and insurance rate, FI_{it}, on U.S. imports, averaged across all partner countries, from import data at the fob and cif basis provided by the U.S. Census Bureau. Then for each industry, i, this is weighted by the share of input j used in industry i, using weights from the I/O tables, a_{ij} at the beginning of the sample (1992).

$$\Delta \ln FI_{i,t} = \Delta \ln \left(\sum_j a_{ij,1992} * FI_{j,t} \right)$$

[6] See Wedding, 2005.

4. Results

We estimate equations (2.4) and (2.5) at the industry level for the period 1992 to 2000. All variables are entered in log first differences, except offshoring which is the change in offshoring intensity. 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 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 96 industries.[7] In Table 4, we present results from estimating the conditional employment equation, and allowing for scale effects, with one and two 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 columns 2 and 3, which allow for scale effects in the one period differenced variables.

Robustness checks for potential endogeneity, using instrumental variables estimation and GMM as in the productivity specification, are presented in Table 5. None of these specifications show a negative significant effect from offshoring on employment. In fact, two stage least squares estimation in columns 1 and 2 show a positive effect from service offshoring; and all of the specifications in Table 5 show a significant positive employment effect from material offshoring. This finding is consistent with Hanson, Mataloni and Slaughter (2003),

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

which finds that expansion in the scale of activities by foreign affiliates appears to raise demand for labor in U.S. parents.[8]

4.0.1. More Disaggregated Effects

It is possible that any negative effects from offshoring could be washed within broadly defined industry classifications. To explore this possibility, we re-estimate equation (2.4) and (2.5) 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 96 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 6 using the more disaggregated industry classifications, and this effect persists with two period differences in columns 4, 5, and 6. Service offshoring has a significant negative effect in all specification in Table 6, 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, with and without controlling for output. However, the material offshoring effect has now become insignificant.

Robustness checks for potential endogeneity are presented in Table 7. The instruments fail some of the overidentification tests. It could be that the industry effects are sufficient to address endogeneity in the employment equations. With instrumental variables, service offshoring is negative in all specifications, but it is not significant in all specifications. The coefficients on material offshoring are positive in all specification but insignificant in Table

[8] Harrison and McMillan (2005) report correlations between US multinational employment at home and abroad. Their preliminary findings also suggest a positive correlation between jobs at home and abroad.

6.

Using estimates from Table 6, with scale effects, the effect from service offshoring on employment is equal to 0.3. Since service offshoring grew by 0.1 percentage point over the sample period, this implies a loss of 3 percent employment. However, weighted by employment shares this number falls to 0.4 of a percent.

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 more aggregate industry level of 96 industries indicating that there is sufficient growth in demand in other industries within these broadly defined classifications to offset any negative effects.

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, 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.

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Table 1. Offshoring Intensity: 1992-2000

	Share of Imported Material Inputs - OSM		Share of Imported Service Inputs - OSS	
Year	%	%Δ	%	%Δ
1992	11.72	0.00	0.18	0.00
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

Table 2. Offshoring of Services, by Type: 1992-2000

Services	Share of Service Inputs (%)				Import of Services (%)
	Mean	Std Dev	Min	Max	
(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*.

Table 3 Summary Statistics

Variable	Obs	Mean	Std. Dev.	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(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(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
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: 1) htech is defined as (high-tech capital services / total capital services).

Table 4. Offshoring and Employment

Dependent variable : $\Delta\ln(\text{employment})_t$						
	One period difference			Two period difference		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta oss_{i,t}$	0.015	-0.123	-0.129	0.058	-0.209	-0.232
	(0.106)	(0.131)	(0.134)	(0.120)	(0.168)	(0.173)
$\Delta oss_{i,t-1}$	-0.035	0.079	0.055	-0.050	0.154	0.142
	(0.077)	(0.094)	(0.090)	(0.125)	(0.133)	(0.131)
$\Delta osm_{i,t}$	0.002	0.003	0.003*	0.000	0.002	0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
$\Delta osm_{i,t-1}$	0.001	0.001	0.001	0.001	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
$\Delta\ln(\text{wage})_{i,t}$	-0.498***	-0.327***	-0.325***	-0.575***	-0.409**	-0.398**
	(0.092)	(0.109)	(0.109)	(0.145)	(0.161)	(0.161)
$\Delta\ln(\text{wage})_{i,t-1}$	0.071	0.161*	0.163*			
	(0.077)	(0.093)	(0.093)			
$\Delta\ln(\text{real output})_{i,t}$	0.489***			0.485***		
	(0.060)			(0.071)		
$\Delta\ln(\text{real output})_{i,t-1}$	0.066					
	(0.042)					
$\Delta\ln(\text{price})_{i,t}$		0.060			0.110**	
		(0.042)			(0.054)	
$\Delta\ln(\text{price})_{i,t-1}$		0.089				
		(0.056)				
$\Delta(\text{htech})_{i,t}$	-0.002	-0.004	-0.004	0.000	-0.004	-0.005
(*ex post rental prices*)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta(\text{htech})_{i,t-1}$	-0.004	-0.003	-0.004	-0.004*	-0.003	-0.003
(*ex post rental prices*)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
$\Delta(\text{impshare})_{i,t}$	0.000	-0.002***	-0.002***	0.001	-0.002**	-0.002**
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta(\text{impshare})_{i,t-1}$	0.000	-0.000	-0.000	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
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	F(1,93)=0.00	F(1,93)=0.05	F(1,93)=0.13
	p-value=0.89	*p-value*=0.82	*p-value*=0.69	*p-value*=0.96	*p-value*=0.82	*p-value*=0.72
$\Delta osm_{i,t} + \Delta osm_{i,t-1} = 0$	F(1,93)= 1.98	F(1,93)= 2.87	F(1,93)= 2.47	F(1,93)=0.51	F(1,93)=0.26	F(1,93)=0.14
	p-value=0.16	*p-value*=0.09	*p-value*=0.12	*p-value*=0.48	*p-value*=0.61	*p-value*=0.71
$\Delta(\text{htech})_{i,t}+\Delta(\text{htech})_{i,t-1}=0$	F(1,93)= 1.57	F(1,93)= 1.73	F(1,93)= 2.50	F(1,93)=0.97	F(1,93)=1.74	F(1,93)=2.30
(*ex post rental prices*)	*p-value*=0.21	*p-value*=0.19	*p-value*=0.12	*p-value*=0.33	*p-value*=0.19	*p-value*=0.13
$\Delta(\text{impshare})_{i,t}$ +	F(1,93)= 0.71	F(1,93)= 8.17	F(1,93)= 8.02	F(1,93)=0.09	F(1,93)=13.5	F(1,93)=13.1
$\Delta(\text{impshare})_{i,t-1} = 0$	*p-value*=0.40	*p-value*=0.01	*p-value*=0.01	*p-value*=0.77	*p-value*=0.00	*p-value*=0.00
Observations	626	626	626	620	620	620
R-squared	0.63	0.44	0.44	0.74	0.60	0.60

Notes: 1) Robust standard errors in parentheses; * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent; 2) Import shares for metal coating and engraving (I/O code 36) are missing; 3) All columns have year and industry fixed effects.

Table 5. Offshoring and Employment: Instrumental Variables

Dependent variable : Δln(employment)$_t$						
	IV		GMM		GMM	
Instruments	Internet hosts*service intensity				Exogenous Instrument	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta oss_{i,t}$	0.236*	0.110	-0.040	-0.123	0.050	-0.065
	(0.139)	(0.207)	(0.094)	(0.121)	(0.110)	(0.125)
$\Delta oss_{i,t-1}$	0.339	0.621**	-0.104	0.024	0.000	0.142
	(0.217)	(0.282)	(0.072)	(0.086)	(0.075)	(0.093)
$\Delta osm_{i,t}$	0.009	0.007	0.003**	0.005***	0.003**	0.005***
	(0.006)	(0.008)	(0.002)	(0.001)	(0.002)	(0.001)
$\Delta osm_{i,t-1}$	0.010*	0.017***	0.001	0.001	0.001	0.002*
	(0.005)	(0.006)	(0.001)	(0.001)	(0.001)	(0.001)
Δln(wage)$_{i,t}$	-0.459***	-0.284***	-0.425***	-0.28***	-0.43***	-0.26***
	(0.081)	(0.098)	(0.084)	(0.108)	(0.082)	(0.104)
Δln(wage)$_{i,t-1}$	0.131*	0.264***	0.128	0.185*	0.119	0.174
	(0.077)	(0.095)	(0.095)	(0.110)	(0.093)	(0.109)
Δln(real output)$_{i,t}$	0.478***		0.509***		0.519***	
	(0.047)		(0.054)		(0.053)	
Δln(real output)$_{i,t-1}$	0.056		0.046		0. 056	
	(0.038)		(0. 062)		(0. 059)	
Δln(price)$_{i,t}$		0.107		-0.002		0.02
		(0.099)		(0.053)		(0.051)
Δln(price)$_{i,t-1}$		0.246***		0.066		0.095*
		(0.095)		(0.063)		(0.058)
Δ(htech)$_{i,t}$	-0.002	-0.003	0.000	-0.002	0.000	-0.003
(*ex post rental prices*)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
Δ(htech)$_{i,t-1}$	-0.005**	-0.004	-0.001	-0.001	-0.002	-0.002
(*ex post rental prices*)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Δ(impshare)$_{i,t}$	-0.000	-0.003**	0.000	-0.002***	0.000	-0.002***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Δ(impshare)$_{i,t-1}$	-0.000	-0.001*	0.001	0.000	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Δln(employment)$_{i,t-1}$			0.063	0.152**	0.044	0.128*
			(0.051)	(0.066)	(0.049)	(0.066)
Joint significance tests						
$\Delta oss_{i,t} + \Delta oss_{i,t-1} = 0$	$\chi^2(1)$= 3.57	$\chi^2(1)$= 3.22	$\chi^2(1)$= 1.18	$\chi^2(1)$= 0.34	$\chi^2(1)$= 0.10	$\chi^2(1)$= 0.18
	p-value=0.06	*p-value*=0.07	*p-value*=0.28	*p-value*=0.56	*p-value*=0.75	*p-value*=0.67
$\Delta osm_{i,t} + \Delta osm_{i,t-1} = 0$	$\chi^2(1)$= 3.41	$\chi^2(1)$= 3.65	$\chi^2(1)$= 2.74	$\chi^2(1)$= 8.8	$\chi^2(1)$= 3.23	$\chi^2(1)$= 8.63
	p-value=0.06	*p-value*=0.06	*p-value*=0.10	*p-value*=0.00	*p-value*=0.07	*p-value*=0.00
H_0 : no 2nd order autocorrelation			z = -0.35	z = -0.21	z = -0.63	z = -0.27
			p-value=0.72	*p-value*=0.83	*p-value*=0.53	*p-value*=0.79
	Hansen J statistic		Sargan test			
	4.75	5.66	$\chi^2(20)$=29.8	$\chi^2(20)$= 32.3	$\chi^2(29)$= 34.8	$\chi^2(20)$= 45.93
	$\chi^2(4)$= 0.31	$\chi^2(4)$= 0.23	*p-value*=0.07	*p-value*=0.01	*p-value*=0.21	*p-value*=0.02
Observations	626	626	529	529	529	529

Note: 1) All columns include year and industry fixed effects 2)Robust standard errors in parentheses; * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent. 3) 3) Shea R^2: $\Delta oss_{i,t}$ (0.35), $\Delta oss_{i,t-1}$(0.13), $\Delta osm_{i,t}$ (0.03), $\Delta osm_{i,t-1}$ (0.03).

Table 6. Employment and Offshoring:
More disaggregated Manufacturing Industries (450 industries- SIC)

Dependent variable : $\Delta\ln(\text{employment})_t$						
	One period difference			Two period difference		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta oss_{i,t}$	-0.069	-0.253**	-0.278**	-0.192*	-0.263*	-0.297**
	(0.084)	(0.119)	(0.111)	(0.097)	(0.146)	(0.141)
$\Delta oss_{i,t-1}$	-0.175*	-0.007	-0.047	-0.303	-0.157	-0.166
	(0.105)	(0.114)	(0.106)	(0.191)	(0.152)	(0.153)
$\Delta osm_{i,t}$	0.002	0.000	0.000	0.001	-0.000	-0.000
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
$\Delta osm_{i,t-1}$	0.001	-0.001	-0.001	-0.002	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
$\Delta\ln(\text{wage})_{i,t}$	-0.646***	-0.531***	-0.527***	-0.544***	-0.510***	-0.506***
	(0.083)	(0.090)	(0.090)	(0.075)	(0.083)	(0.083)
$\Delta\ln(\text{wage})_{i,t-1}$	0.039	0.075**	0.077**			
	(0.039)	(0.033)	(0.034)			
$\Delta\ln(\text{real output})_{i,t}$	0.523***			0.425***		
	(0.029)			(0.034)		
$\Delta\ln(\text{real output})_{i,t-1}$	0.050***					
	(0.017)					
$\Delta\ln(\text{price})_{i,t}$		0.113**			0.097	
		(0.045)			(0.073)	
$\Delta\ln(\text{price})_{i,t-1}$		0.072				
		(0.063)				
$\Delta(\text{htech})_{i,t}$	-0.003	-0.006*	-0.006**	-0.008**	-0.011***	-0.011***
(*ex post rental prices*)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
$\Delta(\text{htech})_{i,t-1}$	-0.006**	-0.007**	-0.007**	-0.011***	-0.009**	-0.009**
(*ex post rental prices*)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
$\Delta(\text{impshare})_{i,t}$	-0.000	-0.001***	-0.001***	-0.000***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta(\text{impshare})_{i,t-1}$	0.000	-0.000	-0.000	-0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Joint significance tests						
$\Delta oss_{i,t} + \Delta oss_{i,t-1} = 0$	F(1,93)=2.37 *p-value*=0.12	F(1,93)=1.52 *p-value*=0.22	F(1,93)=2.82 *p-value*=0.10	F(1,93)=4.15 *p-value*=0.04	F(1,93)=2.83 *p-value*=0.10	F(1,93)=3.71 *p-value*=0.06
$\Delta osm_{i,t} + \Delta osm_{i,t-1} = 0$	F(1,93)=1.43 *p-value*=0.23	F(1,93)=0.02 *p-value*=0.88	F(1,93)=0.14 *p-value*=0.70	F(1,93)=0.15 *p-value*=0.70	F(1,93)=0.39 *p-value*=0.53	F(1,93)=0.59 *p-value*=0.44
$\Delta(\text{htech})_{i,t}+\Delta(\text{htech})_{i,t-1}=0$ (*ex post rental prices*)	F(1,93)=3.36 *p-value*=0.07	F(1,93)=5.37 *p-value*=0.02	F(1,93)=5.87 *p-value*=0.10	F(1,93)=9.85 *p-value*=0.00	F(1,93)=9.17 *p-value*=0.00	F(1,93)=9.34 *p-value*=0.00
$\Delta(\text{impshare})_{i,t} + \Delta(\text{impshare})_{i,t-1} = 0$	F(1,93)=0.22 *p-value*=0.64	F(1,93)=28.0 *p-value*=0.00	F(1,93)=28.8 *p-value*=0.00	F(1,93)=20.6 *p-value*=0.00	F(1,93)=24.7 *p-value*= 0.00	F(1,93)=25.2 *p-value*=0.00
Observations	3,018	3,018	3,018	2,581	2,581	2,581
R-squared	0.55	0.33	0.33	0.55	0.48	0.48

Notes: 1) Robust standard errors in parentheses; * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent; 2) There are 13 SICs with missing import data, and several SICs that have missing employment data for various years; 3) All columns have year and industry fixed effects.

Table 7. Employment and Offshoring:
More Disaggregated Industries and Instrumental Variables (SIC)

Dependent variable : $\Delta\ln(\text{employment})_t$						
	IV		GMM		GMM	
Instruments	Internet hosts*service intensity				Exogenous Instrument	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta oss_{i,t}$	-0.111	-0.270	-0.224	-0.392*	-0.112	-0.276
	(0.193)	(0.236)	(0.147)	(0.179)	(0.153)	(0.190)
$\Delta oss_{i,t-1}$	-0.099	0.181	-0.341***	-0.159	-0.216*	-0.0003
	(0.207)	(0.260)	(0.121)	(0.149)	(0.124)	(0.154)
$\Delta osm_{i,t}$	0.004	0.001	0.003	0.002	0.003	0.002
	(0.005)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)
$\Delta osm_{i,t-1}$	0.003	0.005	0.001	0.0003	0.001	0.001
	(0.004)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{wage})_{i,t}$	-0.647***	-0.532***	0.662***	-0.557***	0.661***	0.554***
	(0.064)	(0.067)	(0.073)	(0.08)	(0.073)	(0.08)
$\Delta\ln(\text{wage})_{i,t-1}$	0.039	0.077	0.018	0.042	0.013	0.039
	(0.041)	(0.048)	(0.06)	(0.065)	(0.060)	(0.065)
$\Delta\ln(\text{real output})_{i,t}$	0.524***		0.517***		0.518***	
	(0.025)		(0.034)		(0.034)	
$\Delta\ln(\text{real output})_{i,t-1}$	0.049***		0.052		0.056*	
	(0.017)		(0.032)		(0.032)	
$\Delta\ln(\text{price})_{i,t}$		0.116***		0.136**		0.152***
		(0.043)		(0.053)		(0.052)
$\Delta\ln(\text{price})_{i,t-1}$		0.108*		0.095		0.112
		(0.057)		(0.090)		(0.087)
$\Delta(\text{htech})_{i,t}$	-0.003*	-0.006***	-0.002	-0.005*	-0.004*	-0.006**
(*ex post rental prices*)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
$\Delta(\text{htech})_{i,t-1}$	-0.006***	-0.007***	-0.004	-0.004	-0.006**	-0.005
(*ex post rental prices*)	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
$\Delta(\text{impshare})_{i,t}$	-0.000	-0.001***	-0.0002**	-0.0009***	-0.0002**	-0.0009***
	(0.000)	(0.000)	(0.00001)	(0.0001)	(0.0001)	(0.0001)
$\Delta(\text{impshare})_{i,t-1}$	-0.000	-0.000	-0.0002**	-0.0002**	-0.0002**	-0.0002**
	(0.000)	(0.000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\Delta\ln(\text{employment})_{i,t-1}$			-0.334	-0.002	-0.041	-0.004
			(0.037)	(0.003)	(0.037)	(0.033)
Joint significance tests						
$\Delta oss_{i,t} + \Delta oss_{i,t-1} = 0$	$\chi^2(1)$= 0.38	$\chi^2(1)$= 0.04	$\chi^2(1)$= 5.9	$\chi^2(1)$= 3.88	$\chi^2(1)$= 1.75	$\chi^2(1)$= 0.80
	p-value=0.54	*p-value*=0.83	*p-value*=0.01	*p-value*=0.05	*p-value*=0.18	*p-value*=0.37
$\Delta osm_{i,t} + \Delta osm_{i,t-1} = 0$	$\chi^2(1)$= 0.64	$\chi^2(1)$= 0.39	$\chi^2(1)$= 1.65	$\chi^2(1)$= 0.74	$\chi^2(1)$=2.21	$\chi^2(1)$= 1.06
	p-value=0.42	*p-value*=0.53	*p-value*=0.2	*p-value*=0.39	*p-value*=0.14	*p-value*=0.30
H_0 : no 2nd order autocorrelation			z = -0.57	z = -0.89	z = -0.89	z =0.26
			p-value=0.57	*p-value*=0.37	*p-value*=0.37	*p-value*=0.79
	Hansen J statistic		Sargan test			
	10.68	6.57	$\chi^2(20)$=29.35	$\chi^2(20)$= 32.55	$\chi^2(29)$=45.56	$\chi^2(29)$= 64.6
	$\chi^2(4)$= 0.03	$\chi^2(4)$= 0.16	*p-value*=0.08	*p-value*=0.04	*p-value*=0.03	*p-value*=0.00
Observations	3018	3018	2581	2581	2581	2581

Note: 1) All columns include year and industry fixed effects, 2)Robust standard errors in parentheses; * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent; 3) Shea R^2: $\Delta oss_{i,t}$ (0.33), $\Delta oss_{i,t-1}$(0.17), $\Delta osm_{i,t}$ (0.03), $\Delta osm_{i,t-1}$ (0.04).

Appendix: Data Sources

Variable	Code	Years available	Source
Input/output tables	BLS	1992 to 2000	BLS
Trade (Manufacturing)	HS10 digit	1992 to 2001	Feenstra
Trade (Services)	Balance of Payments	1992 to 2001	IMF
Output (Manufacturing)	SIC 4 digit	1992 to 2001	BEA
Output (Services)	SIC 3 digit	1992 to 2001	BEA
Employment	SIC 4 digit	1992 to 2001	ASM
Payroll	SIC 4 digit	1992 to 2001	ASM
Materials	SIC 4 digit	1992 to 2001	ASM