Outsourcing and US Manufacturing Employment

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Abstract

In an increasingly protectionist trade environment, there is public concern in the USA that services outsourcing is contributing to declining employment. Addressing this concern, this paper analyzes the impact of outsourcing on the relative demand for skilled worker in US manufacturing industries between 1998 and 2004. Greater outsourcing of communications and business services slightly reduces skilled labor demand and the outsourcing of other services increases labor demand, although nonproduction labor demand is generally inelastic to changes in outsourcing intensity. Part of the reason for this is the fact that tradable services are only small shares of the industries' total inputs.

Keywords: outsourcing, trade in services, Mode 1, employment, manufacturing

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1. Introduction

Since the 1980s the term "outsourcing" has been used to describe a variety of economic activities, from the sourcing of intermediate material inputs from outside a firm to foreign direct investment by domestic firms in foreign countries. The economic implications of these activities have been well researched in the literature and have covered terms of trade effects, welfare, industrial structure, labor market effects, and growth. However, the last decade or so has seen globalization – together with rapid advances in technology – expand the set of activities that can be labeled "outsourcing" to include trade in services. With the services sector comprising two-thirds of GDP in many industrialized economies, this has greatly enhanced potential labor market impacts.

The need for a clear discussion on outsourcing has become especially important in recent years in the wake of claims that tens of thousands of American jobs are being moved overseas because of firms outsourcing their back office operations and other lower wage services to countries like India and China. Mankiw and Swagel (2006) point out that the rising concern in 2004 over the impact of US outsourcing on the labor markets was driven in large part by the economic slowdown of 2000 and 2001. Despite high productivity growth rates, real hourly wages grew by less than a percent between 1999 and 2003. Within the context of this sluggish growth, public discourse on job losses treated outsourcing as a major contributor to the weak job market.

Fueling the public interest and anxiety about outsourcing, the popular media provided estimates from a variety of private sector consulting groups which cogently depicted the threat of job losses through outsourcing. The estimates on the number of jobs lost range from Forrester Research's apocalyptic value of 3.3 million jobs to be lost by 2015 (McCarthy, 2002) to other less well-cited estimates such as Deloitte Research's two million jobs by 2008 (Gentle, 2003).

These concerns have had repercussions in US policy as well. Drezner (2004) points out that during economic downturns – such as the type experienced in the new millennium and in the ongoing global financial crisis – public hostility towards trade increases. Even even though the benefits of trade are enjoyed by the aggregate economy, the costs of trade are concentrated in a subset of occupational groups and industries. The constituents of this subset then have incentive to form interest groups in favor of political action to form trade barriers. To support this, Drezner (2004) names several pieces of legislation introduced to the floor in the US Senate in 2004 which would have made it more difficult for US firms to import services. Drezner (2004) also notes that between 2002 and 2004, more than 20 state legislatures introduced bills designed to render illicit several forms of outsourcing. By increasing the barriers to Mode 1 service trade, such legislation is operationally equivalent to non-tariff barriers.

There is thus a need for empirical work examining the impact on employment of outsourcing in the USA, especially under the shadow of rising protection of the services sector. Much of the commentary on services outsourcing is similar to the points made about materials offshoring in manufacturing industries in the 1980s. As such, services outsourcing in the manufacturing sector in the late nineties is a good starting point for research in this topic. This research will thus examine of how changes in outsourcing have affected employment of skilled workers in US manufacturing industries, with outsourcing being specifically defined as the trading of services described as Mode 1 services under the General Agreement of Trade in Services[2].

Section 2 of this paper will review the literature by first revisiting the definition of outsourcing, and then briefly describing previous empirical analyses of outsourcing. Section 3 describes the model, estimation results, and some comments on further work. Section 4 provides some concluding remarks.

2. Impact of Outsourcing

Unlike Mode 1 services trade in the Indian context, outsourcing from the USA has been the focus of a large body of empirical literature. However, the best place to begin reviewing this empirical work is not with the services, but rather with materials offshoring from the early 1980s, which is similar to the current services outsourcing phenomenon. The fragmentation of production processes gave rise to a booming trade in intermediate inputs[3]. A review of the literature shows the development of many methodological tools used in the analysis of the labor market effects of offshoring. The studies discussed here examine the impact of the trade in material intermediate inputs and services outsourcing on employment, wages, and productivity. Reviewing the services outsourcing literature that has evolved out of the offshoring work can demonstrate how the techniques developed in the material intermediate inputs trade literature can be adapted for examining services.

The first study to be reviewed is Feenstra and Hanson (1996). The paper examines the impact of the trade in material intermediate outsourcing on the relative demand for skilled labor, by focusing on the US labor market in the period 1972-1992. The paper finds that for the 1970s, material offshoring was insignificant as a determinant of the increase in the nonproduction wage share. In contrast to the 1970s, materials offshoring was significant in explaining part of the increase in the nonproduction wage share for the 1980s.

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[2] Defined in General Agreement of Trade in Services (GATS) Articles I.2 (a) and XXVIII (b) as the "the production, distribution, marketing, sale, and delivery of a service by a service supplier from the territory of one Member to the territory of any other Member" (GATS, 2007).

[3] This is synonymous with the terms vertical specialization and slicing up the value chain, which describe the breaking of a single production process into separable production processes that can occur in physically distinct stages, where the products of the fragmented production processes are intermediate inputs used to produce the final good.

While the results of this paper are interesting in that they offer a partial explanation of the increase in nonproduction wages in the USA, the two most important contributions of this paper are in its methodology. The first is in the justification of the variables they chose to use. The nonproduction wage share was regressed on control variables which included the change in materials imports and the import share of consumption. Based on Baldwin and Hilton (1984) and Leamer (1995), the estimates reported by Feenstra and Hanson (1996) are reduced form relationships between offshoring and the unit input requirement for skilled labor[4]. In a general equilibrium framework, when firms source intermediate inputs from overseas, they reduce the range of activities that domestic industries can perform, and thereby reduce the industry unit demand for intensively used factors of production, skilled labor in this case. Without this explanation, there is little theoretical justification for using import quantities to measure the impact on skilled labor demand.

The second major contribution of this paper to intermediate inputs trade literature is in the way that the impact of the trade was measured. Quantifying the impact of imported intermediate on an economy for the purposes of an empirical study is a difficult, yet necessary prerequisite. Feenstra and Hanson (1996) describes a method for constructing two variables which together provide a measure of how much, and how important, the material intermediate input imports are for an industry. The first variable measures the share of a given input in the total input usage for an industry. The second variable measures the share of the imports of the input of the total available to the entire economy. The assumption is that industries that use more of a particular input receive a greater share of the imports.

This measure was useful enough that it was used again in Feenstra and Hanson (1999) to empirically examine the relative influence of trade versus technology on changes in wages in the USA focusing on the manufacturing sector between 1972 and 1990. The paper finds that use of computers explained 35 percent of the increase in the wages of non-production workers (a proxy for skilled workers), while imported intermediate inputs explained only 15 percent of the wage increase, for the given time period. Complementing this analysis of wages, Feenstra and Hanson (2002) show that imports of materials intermediate inputs is associated with increases in the wage share of skilled workers in total costs – as a proxy for skilled labor demand – in the USA, Japan, Hong Kong, and Mexico, with materials intermediate inputs imports explaining the higher demand and wages of higher skilled workers.

Although this study by Feenstra and Hanson focuses on the manufacturing sector, the techniques for measuring imports of intermediate inputs that the authors use can be adapted for examining services outsourcing, as seen in Amiti and Wei (2009). Amiti and Wei (2009) examines the effects of services outsourcing on productivity and employment in the United States in the 1992-2000 period, after constructing a control variable referred to as the

[4] The unit input requirement is the quantity of labor required to produce a unit of output.

outsourcing intensity of services, OSS_i. The formula for the variable can be seen below, through equations 1 to 3.

$$\alpha_{ji} = \frac{\text{purchases of service j by i}}{\text{total nonenergy inputs used by i}} \quad \text{EQ. 1}$$

$$\beta_j = \frac{\text{import of service j}}{\text{production}_j + \text{imports}_j - \text{exports}_j} \quad \text{EQ. 2}$$

$$OSS_i = \sum_j [\alpha_{ji} * \beta_j] \quad \text{EQ. 3}$$

From EQ. 1, the amount of intermediate input *j* used in industry *i*, as a share of total industry inputs is determined. The IMF Balance of Payments database is used to construct the second term – β_j – in EQ. 2, which is the economy-wide import share of intermediate service input *j*. In EQ. 3, the product of these two terms is taken to determine the share of service inputs *j* used by *i* are imported. By summing across all five service intermediate inputs, a measure of the intensity of outsourcing in a given industry, OSS_i, is calculated and used as a control variable in the regression analysis.

Amiti and Wei (2009) finds that outsourcing has a positive effect on productivity, accounting for a greater change in labor productivity than material offshoring in the same period. Egger and Egger (2006) find a similar strong connection between outsourcing and productivity growth for the European Union. Houseman (2007), however, qualifies these conclusions on productivity by pointing out that the rise in manufacturing productivity in the USA, driven by the trade in intermediate inputs, has been mirrored by declines in employment and wages. The study argues that impacts of outsourcing and materials intermediate input imports may be overstated in the productivity measures. Productivity statistics, while able to capture the impact of the intermediate inputs imports on industry cost savings, are not able to able to accurately determine their impact on US labor productivity due to the input-use changes that occur with greater materials or services intermediate inputs imports.

Amiti and Wei (2009) also finds that outsourcing has a small negative effect on employment when industries are highly disaggregated. When a more aggregate industry level is considered this small negative effect disappears, implying that even though there may be a loss of employment in certain sectors due to outsourcing, the newly unemployed find employment in other sectors. These conclusions hold true for the United Kingdom as well, where the authors use similar techniques to examine the effect of service outsourcing and material offshoring on employment in the UK (Amiti and Wei, 2005).

Canals (2007) continues the empirical analyses by focusing on the wage difference between US skilled and unskilled labor between 1980 and 1999. This study considered the trade in both materials and services intermediate inputs, quantified as a structurally determined

variable in a manner similar to Feenstra and Hanson (1996, 1999) and Amiti and Wei (2005, 2009), and builds on two other earlier works: Feenstra and Hanson (1999) and Haskel and Slaughter (2002).

Canals' (2007) methodology begins by building on Feenstra and Hanson (1999), which used a partial equilibrium model to explain part of the wage difference in manufacturing as arising from technological changes and materials intermediate inputs imports. To overcome the limitations of the PE approach, Canals (2007) adapts the work of Haskel and Slaughter (2002) , to develop a general equilibrium framework that incorporates intermediate inputs imports biased technological change, biased technological changes (changes due to labor and capital), and total biased technological change (changes from all factors). In addition to the methodology, another important innovation of this paper over its predecessors in the literature is its application of the methodology to both services and manufacturing industries. Previous studies limited their scope to just manufacturing, while Canals (2007) is more comprehensive, examining changes in the wage gap over both types of industries. The study finds that intermediate inputs imports were responsible for 28 to 36 percent of the observed change in the wage difference, versus factor biased technological change which was responsible for 15 to 19 percent of the change.

To summarize, Feenstra and Hanson (1996) suggests that materials intermediate inputs imports has positive effects on the wage share of skilled workers. Then, focusing more on services outsourcing, but using similar measurement techniques, Amiti and Wei (2005, 2009) finds that the claim that outsourcing dramatically reduces job growth is heavily exaggerated, refuting the estimates of McCarthy (2002). Finally, examining both the manufacturing and services industries through a general equilibrium estimation framework, Canals (2007) finds that the trade in intermediate inputs explains up to 36 percent of the changes in the skilled-unskilled wage gap for the period 1980 to 1999 in the USA.

The empirical literature thus supports the idea that increases in imported intermediate inputs – both services and manufacturing inputs – has historically been beneficial for higher skilled workers, increasing their demand and wages, relative to those of less-skilled workers. This literature does not analyze the impact of increases in just services outsourcing on the labor market for more recent years, a timeframe which has seen rapid increases in services imports as well large changes in labor market and wider economy. The strength of these studies' conclusions to the contemporary context thus remains untested.

3. Empirical Analysis

As noted earlier, there is a great deal of concern in the USA that increases in services outsourcing will lead to decreases in employment domestically. I use panel data on 86 US manufacturing industries for the 1998 to 2004 period to examine how changes in the relative demand for skilled labor – as represented by the nonproduction labor cost shares of an industry – can be explained by changes in outsourcing, with outsourcing being Mode 1 services trade.

This is done by regressing the nonproduction labor cost shares on several structural variables including variables measuring outsourcing.

While Feenstra and Hanson (1996, 2002) and Amiti and Wei (2005, 2009) have done similar but complementary empirical analyses, this research differs from those studies in three important ways. First, the study by Feenstra and Hanson is on materials offshoring for the 1980s. I will focus on services outsourcing specifically. Second, the studies by Amiti and Wei focus on services trade, but consider a time period (the 1990s) when the services trade was just coming into its own, and the policy environment in which trade in services currently takes place was still immature. There was a major structural change – the signing of the GATS – in the middle of the time period they consider. I will examine relative demand shifts for different labor types in a more recent timeframe – the 1998 to 2004 period – when the GATS commitments of the mid-nineties are already in place and I do not need to consider the ramifications of any major policy shock. Also, Amiti and Wei (2005, 2009) consider an outsourcing intensity that is aggregated over the services traded. I consider outsourcing intensity indices for five different services – communications, insurance, financial services, computer and information services, and other business services.

3.1 Model and Estimating Framework

Following Feenstra and Hanson (2004), the econometric model that this analysis uses is derived from a short-run cost function for US manufacturing industries. The short run approach implies that industry output and capital stock are fixed, and enter the estimation equation as structural variables. For this task, the translog cost function of Diewert (1974) is chosen as the functional form for costs, as seen in equation 4, with restrictions to ensure linear homogeneity in factor prices in equations 5 and 6. In time t, the cost function of an industry X, C_{Xt}, is determined by wage w_{it} for R labor types and a series of cost-shifting structural variables: O outputs Y_{Xmt} and capital K_{Xt}.

$$\ln C_{Xt} = \alpha_0 + \sum_{i=1}^{R} \alpha_i \ln w_{it} + \sum_{m=1}^{O} \beta_m \ln Y_{Xmt} + \beta_K \ln K_{Xt} + \frac{1}{2}\sum_{n=1}^{O}\sum_{m=1}^{O} \partial_{mn} \ln Y_{Xmt} \ln Y_{Xnt}$$
$$+ \frac{1}{2}\sum_{m=1}^{O} \partial_{mK} \ln Y_{Xmt} \ln K_{Xt} + \frac{1}{2}\sum_{i=1}^{R}\sum_{j=1}^{R} \gamma_{ij} \ln w_{it} \ln w_{jt} + \sum_{i=1}^{R}\sum_{m=1}^{O} \eta_{im} \ln w_{it} \ln Y_{Xmt}$$
$$+ \sum_{i=1}^{R} \eta_{iK} \ln w_{it} \ln K_{Xt} \qquad \text{Eq. 4}$$

$$\sum_{i=1}^{R} \alpha_i = 1 \qquad \text{Eq. 5}$$

$$\sum_{i=1}^{R} \gamma_{ij} = \sum_{j=1}^{R} \gamma_{ij} = 0 \qquad \text{Eq. 6}$$

This specification can be further simplified by assuming that each industry produces only one output. I examine the hypothesis that the outsourcing intensities of S services (OS_{sXt}) interact with the wages of workers to influence the variable costs of the industry. So, an additional term is added to the right hand side of equation 4, to account for services outsourcing intensities: $\sum_{s=1}^{S}\sum_{i=1}^{R}\eta_{iS}\ln w_{it}\ln OS_{sXt}$.

Then by taking the derivative of the cost function with respect to the natural log of the wage w_i, expressions for the wage share of labor type i, Θ_{Xit}, are obtained. From Feenstra and Hanson (2004) and Berman et al (1994), we know that cross industry variation in wages provides less useful information when pooling data across industries. The intuition behind this is the idea that wages for a particular type of worker in a particular industry are based on quality characteristics specific to the workers in that industry. Following this reasoning, it is possible to drop the wage terms from the right hand side to obtain equation 7.

$$\Theta_{Xit}=\alpha_i+\eta_i\ln Y_{Xt}+\eta_K\ln K_{Xt}+\sum_{s=1}^{S}\eta_{is}OS_{sXt} \qquad \text{Eq. 7}$$

The outsourcing variable, OS_{sXt} is be constructed following Feenstra and Hanson (1996, 2004), and Amiti and Wei (2005, 2009), through equations 8 to 10. The amount of intermediate service input S used in industry X, as a share of total industry inputs, can be determined from equation 8. Equation 9 provides the economy-wide import share of intermediate service input S. In equation 10, the product of α_{sXt} and β_{st} is taken to determine what share of service inputs S used by X are imported, assuming that industries that use more of an input will receive a higher percentage of the imported inputs. An intensity of outsourcing for a service S, OS_{sXt} in industry X is thus determined:

$$\alpha_{sXt}=\frac{\text{purchases of input S by X}}{\text{total\_non}-\text{energy\_inputs\_used\_by\_X}} \qquad \text{Eq. 8}$$

$$\beta_{st}=\frac{\text{import of input S}}{\text{shipments}_S+\text{imports}_S-\text{exports}_S} \qquad \text{Eq. 9}$$

$$OS_{sXt}=\alpha_{sXt}*\beta_{st} \qquad \text{Eq. 10}$$

A first-differencing approach is then used to wash out time-constant heterogeneity within each panel and an industry dummy variable (IND_X) is added after differencing to capture qualitative differences between industries. A time trend variable, t, is also added. The final equation – equation 11 – is then obtained.

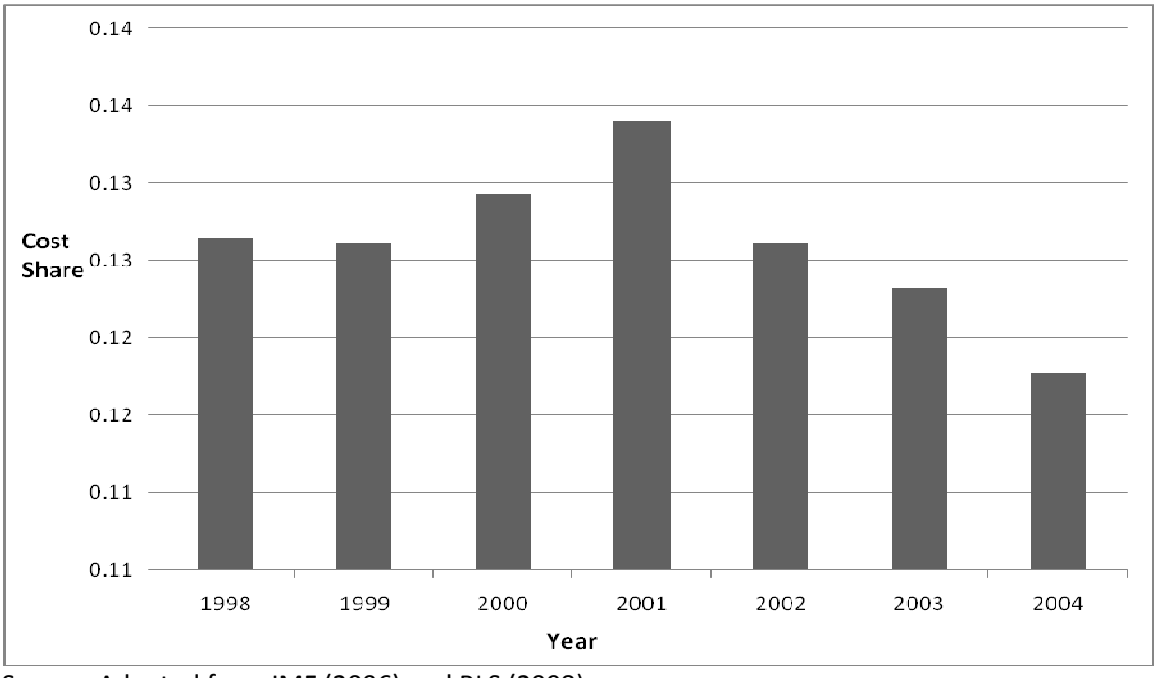
$$\Delta\Theta_{Xit} = \eta_i \Delta \ln Y_{Xt} + \eta_{iK} \Delta \ln K_{Xt} + \sum_{s=1}^{S} \eta_{is} \Delta OS_{sXt} + \lambda_X IND_X + \tau t_t + \nu_t \qquad \text{Eq. 11}$$

We can now estimate the impact of services outsourcing in the US manufacturing industries. The null hypothesis is thus that increases in services outsourcing do not reduce the relative demand for nonproduction workers in the 86 industries of the manufacturing sector.

3.2 Data

The data come from a variety of different sources. 86 US manufacturing industries at the four-digit NAICS level of aggregation for the period 1998 to 2004 are considered. The Annual Survey of Manufacturers (ASM) provides the total costs value of output, the value of capital, and industry wage bills.

Figure 1 shows how the variable cost share of workers in the overall manufacturing sector has changed on a year to year basis from 1998 to 2004. Although the cost shares rose briefly in 2000-2001, the cost shares have been on the decline, falling by 6.92 percent between 1998 and 2004. The demand for nonproduction workers – as measured by their wage bill as a share of industry costs – has thus been falling.



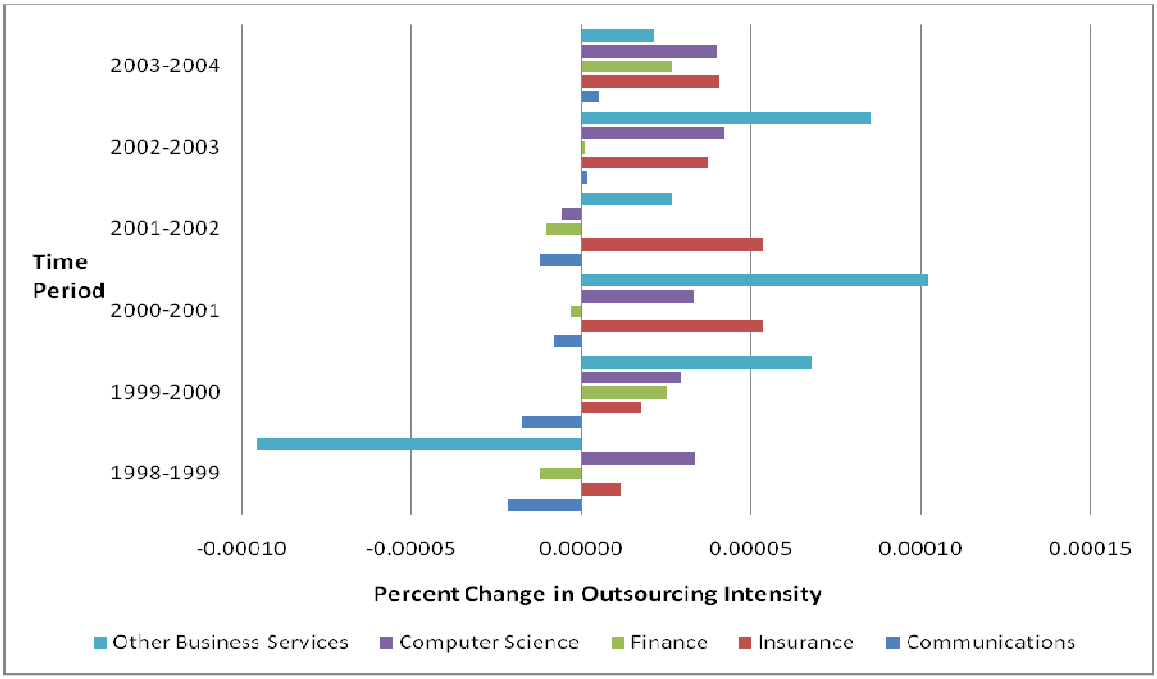
Source: Adapted from IMF (2006) and BLS (2008)
Figure 1 Nonproduction Workers' Wages as Shares of Variable Costs in Manufacturing Industries (1998-2004)

The services trade data used to calculate the outsourcing intensities are from the IMF's Balance of Payment Statistics (2006). The IMF data is particularly suited for calculating the service outsourcing intensity since service categories it has data for can be neatly classified as

Mode 1 or non-Mode 1 based on guidelines provided in the Manual on Statistics for International Trade in Services. Five services were considered: Communications, Finance, Insurance, Computer and Information, and Other Business Services. The intermediate input use data are obtained from the input-output tables produced by the Bureau of Labor Statistics (2008). These I-O tables are based on the benchmark I-O tables produced by the Bureau of Economic Analysis.

The outsourcing intensities in Table 1 show that imported service inputs make up a very small share of the manufacturing sector's total costs. The average values range from 0.00008 for Communication to 0.0016 for Other Business Services. These mean that Mode 1 imported Communications services are on average 0.008 percent of the manufacturing sector's variable cost, while imported Other Business Services are 0.16 percent of the cost.

It can be seen from Figure 2 that with the exception of Communications and Finance, the outsourcing intensities of the other Mode 1 services have increased in almost every period. On average, in the period 1998-2004, every service, with the exception of Communications, saw increases in their outsourcing intensities. Imported Communications services as a share of the manufacturing industries' intermediate inputs declined overall in the time period considered

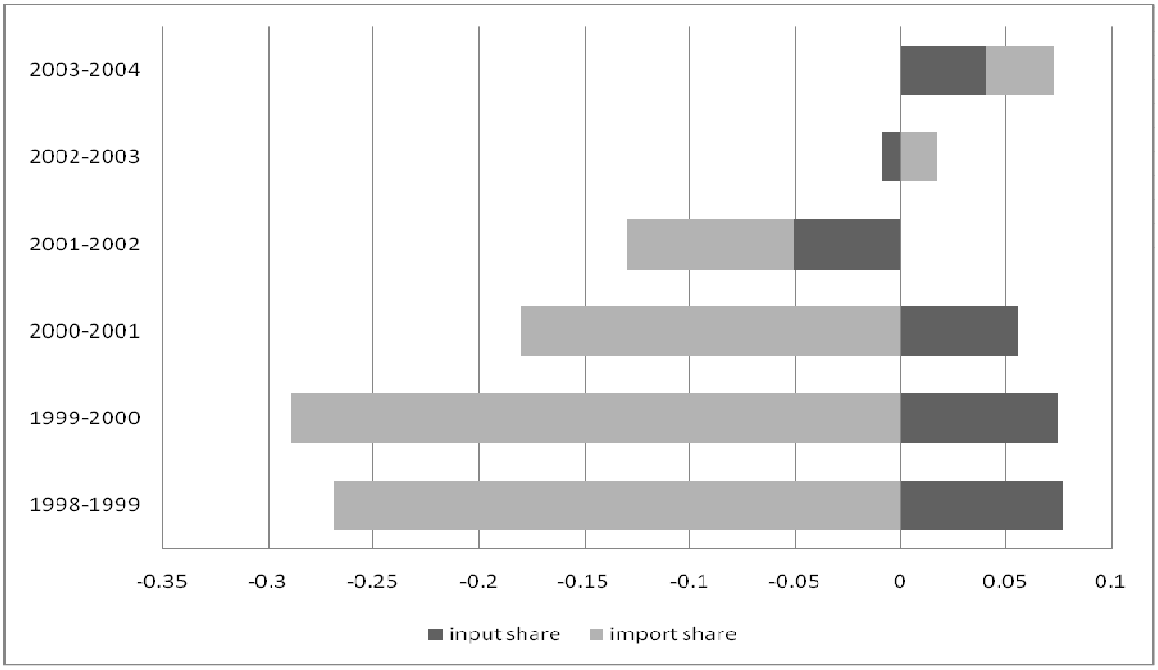


Source: Adapted from IMF (2006) and BLS (2008)
Figure 2 Percent Changes in Outsourcing Intensities in US Manufacturing Industries (1998-2004)

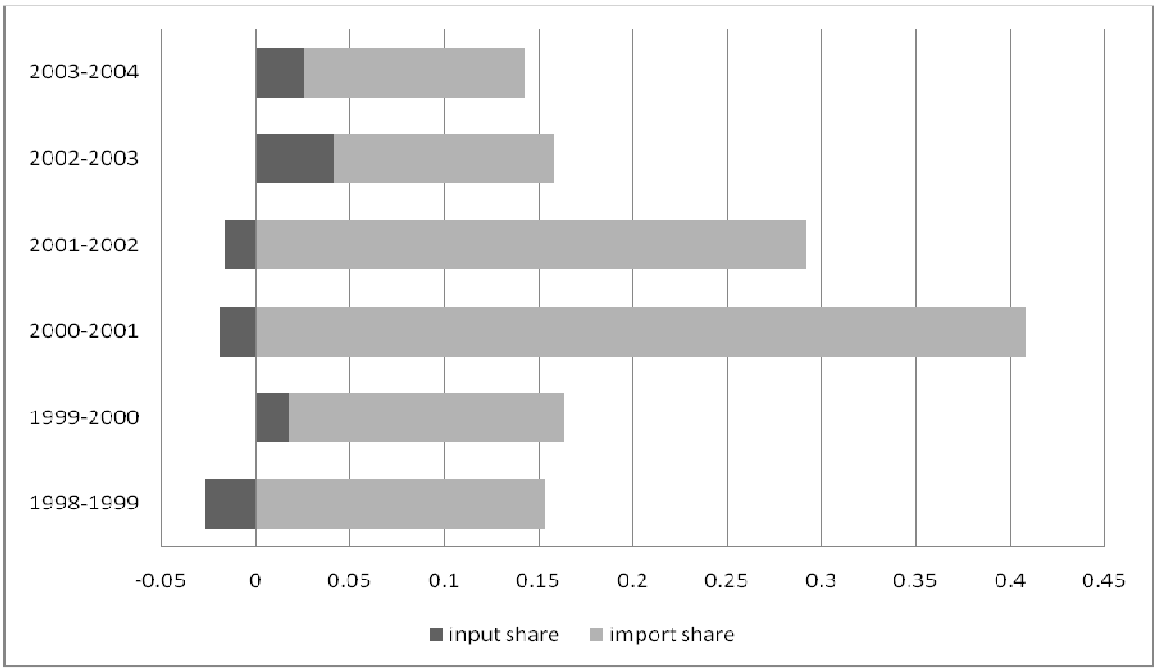
Log decomposition of the change in outsourcing intensity (OS) of Communications services into the contributions from changes in α (input shares) and changes in β (import shares) in Figure 3, it can be seen that the decline in the outsourcing intensity of Communications is mostly due to negative contributions of falling import shares of

Communications between 1998 and 2002. However, the import shares' contributions are positive after 2002, resulting in increases in the OS of Communications. This is consistent with the declines in nonproduction workers' wage shares after 2002, observed in Figure 1.

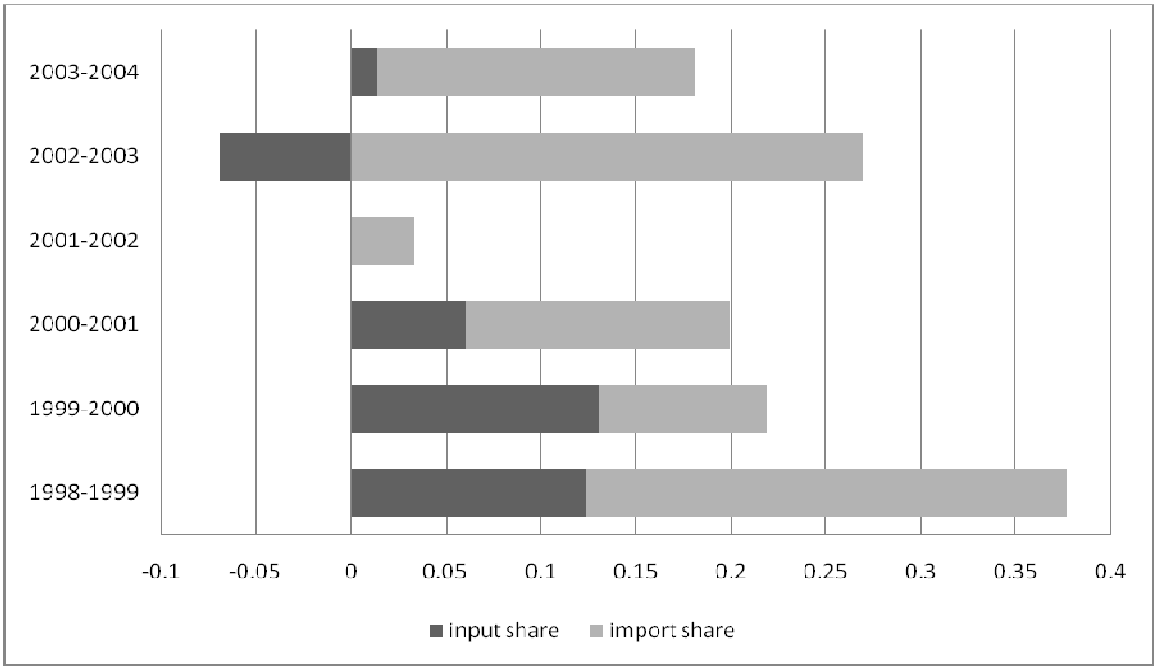
Decompositions for Insurance, and Computer and Information services show that the increases in OS for those services have been driven – almost completely in some cases – by increases in the import shares of services (Figures 4 and 5). The import shares contributions to the changes in the outsourcing intensity of Computer and Information can be seen to be positive and high in most years. Changes in input shares also play important roles in the changes in the outsourcing intensity Finance and Other Business Services – positively in the former and negatively in the latter (Figures 6 and 7). Changes in the services imports are thus found to contribute more to changes in outsourcing intensity than changes in input use by manufacturing industries.



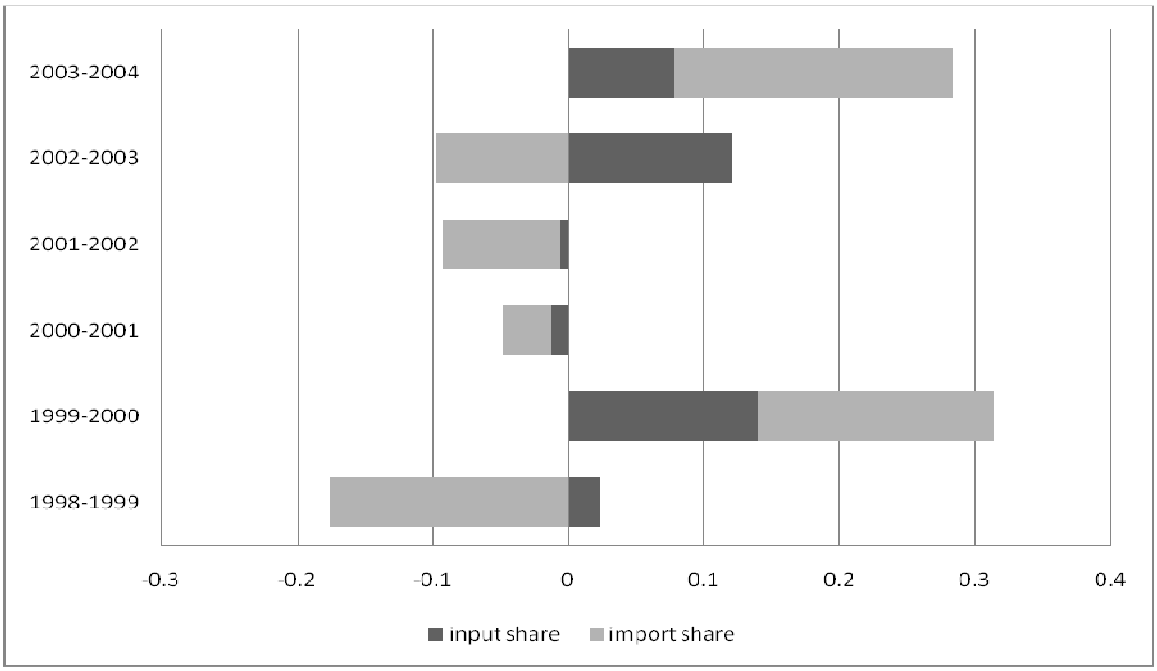
Source: Adapted from IMF (2006) and BLS (2008)
Figure 3 LN Decomposition of Change in OS of Communications Services (1998-2004)



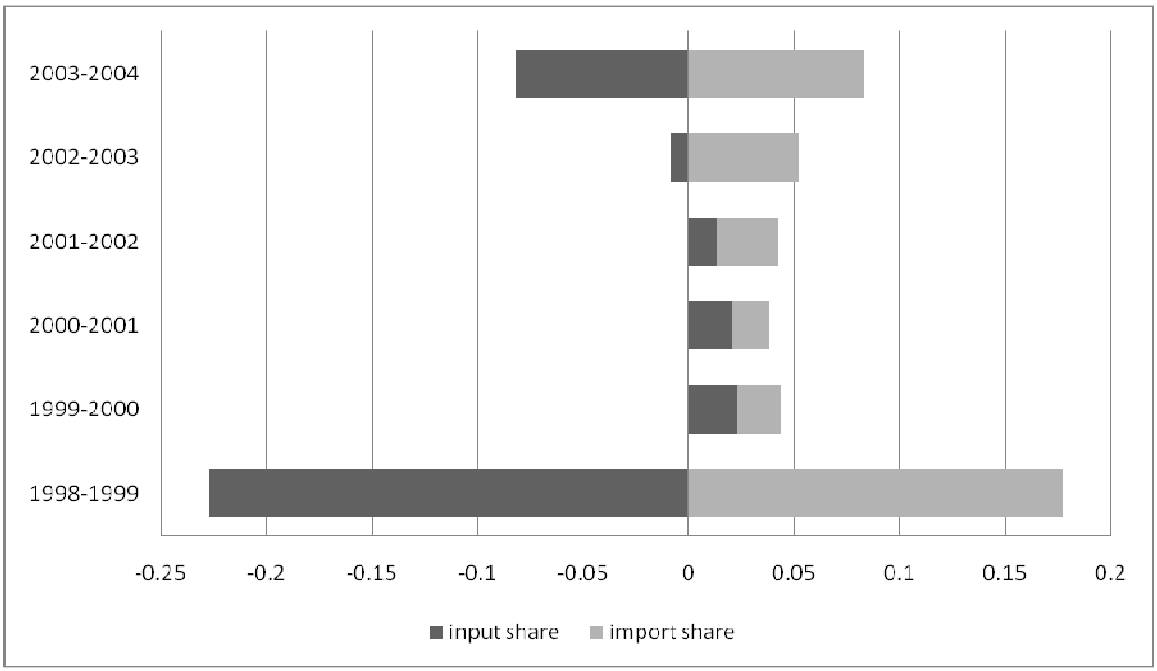
Source: Adapted from IMF (2006) and BLS (2008)
Figure 4 LN Decomposition of Change OS of Insurance Services (1998-2004)



Source: Adapted from IMF (2006) and BLS (2008)
Figure 5 LN Decomposition of Change in OS of Computer and Information Services (1998-2004)



Source: Adapted from IMF (2006) and BLS (2008)
Figure 6 LN Decomposition of Change in OS of Financial Services (1998-2004)



Source: Adapted from IMF (2006) and BLS (2008)
Figure 7 LN Decomposition of Change in OS of Other Business Services (1998-2004)

3.3 Estimation Results

Equation 11 is estimated with the outsourcing intensities for the five Mode 1 services' outsourcing intensities as separate explanatory variables at two levels of data aggregation. The

dependent variable is the change in nonproduction workers' wages as a share of industry variable costs.

The first set of estimations were conducted with the data aggregated to the four-digit NAICS level, while the second set of estimations were obtained with the data aggregated up to the three-digit NAICS level. Estimations at two different levels of aggregation will allow us to examine not just changes in employment by industry, but changes in intra-industry employment[5]. For example, even if there are declines in employment at the four-digit level, are the newly unemployed workers remaining within the three-digit industrial grouping, or moving out of the industry altogether.

The results for the four-digit NAICS level estimations can be seen in column I of Table 2. It can be seen from the significant and negative estimate for the change in capital (ΔlnK), that as manufacturing industries' capacities expand, the nonproduction workers' share of variable costs fall by 0.03 percent. This can be interpreted as being indicative of the presence of labor-augmenting technical change. For example, the increased use of computers or management enhancing technology could fall under an increase in capital, and reduce the employment of nonproduction workers by allowing fewer workers to do the same amount of work. Alternatively, the negative estimate for capital could also be indicative of scale effects. For example, there could be no change in the number of plant managers or IT specialists if plant size increases.

The parameter estimates on the changes in the outsourcing intensities of Communications (ΔOScom) and Other Business Services (ΔOSobs) are negative and significant at the 90 percent confidence level. The apparent implication is that increases in Mode 1 imports of these services decrease the share of workers' wages in manufacturing industries' costs. This would be true of Other Business Services, whose Mode 1 imports have expanded, on average, between 1998 and 2004, and which has a negative estimate (-56.61) of its structural variable. However, the outsourcing intensity of Communications has declined on average between 1998 and 2004, even though Figure 2 showed positive changes in Communications outsourcing after 2002. The negative estimate (-53.68) on this variable thus means that since Communications intensities fell, falling Communications outsourcing has increased the relative demand for nonproduction workers in manufacturing.

The positive and significant estimate for ΔOSfin indicates that increased imports of Mode 1 Financial Services have increased the nonproduction workers' share of the variable costs of manufacturing. The remaining Mode1 service imports are not significant in explaining changes in employment in the manufacturing sector.

[5] Following De Hoyos and Sarafidis (2006), Pesaran's CD test is used and cross-sectional dependence is detected. To correct for these issues, Feasible Generalized Least Squares (FGLS) were used, which also addressed within panel heteroskedasticity that was detected. There was no first order autocorrelation either.

Column II of Table 2 shows the estimates obtained when the data is aggregated at the three-digit NAICS level. The story can be seen to change somewhat at this higher level of aggregation. Estimates of the changes in capital stock are no longer significant. The magnitude and significance of the estimates on the changes in Communications outsourcing both increase, meaning that declines in Communications outsourcing intensity have led to even greater increases in relative demand for nonproduction workers in manufacturing.

The negative estimate for Other Business Services has gotten much smaller, reflecting the idea that when considering clusters of industries (going from the four-digit NAICS level to three-digit level), increases in the outsourcing intensity of Other Business Services lead to much smaller declines in the demand for nonproduction workers. This can be interpreted as representing workers that are laid off by one four-digit industry, but that are able to find employment within the same three-digit industrial group, that is in other four-digit industries that produce products similar to those produced by the worker's original employer and require similarly skilled employees.

At the three-digit NAICS level, the parameter estimates for the changes in outsourcing intensities of Computer and Information (ΔOScsc), and Insurance (ΔOSins) services are both positive and significant, with the ΔOScsc having an especially large coefficient. The increases in the outsourcing intensities of these two types of services between 1998 and 2004 thus increase nonproduction workers' wages as a share of manufacturing industries' costs.

It can thus be seen that with the exception of Other Business Services, the outsourcing of all services has provided positive pressures on the relative demand for nonproduction workers. Given the large and significant estimates on the outsourcing variables, the results raise an important question: are the estimates able to explain why the nonproduction workers' wages' share of the manufacturing industries' costs fall by 0.009 between 1998 and 2004, representative of the 6.92 percent decline illustrated in Figure 5-1? To answer this, the parameter estimates must be considered together with the actual change in the outsourcing intensities between 1998 and 2004.

Following Feenstra and Hanson (1996), it was possible to calculate how much of the change in nonproduction workers' cost share is attributable to a change in the outsourcing intensity of a service with a significant estimate, by taking the product of the estimate and the change in the intensity over the period. For example, the change in the outsourcing intensity of Other Business Services in the time period considered has a value of 0.0002, while the four-digit NAICS aggregation estimate for that variable is negative 56. The product is negative 0.011753. So, the 0.0002 increase in the outsourcing intensity of that service reduced the nonproduction labor's wage share in total industry costs by 0.0118.

Following this methodology, it is found that for the four-digit NAICS aggregation, the significant parameter estimates of the outsourcing intensity variables are able to explain a 0.0004 decline in the nonproduction labor demand, which is about 44 percent of the observed 0.009 wage share decline. At the three-digit NAICS level, the estimates explain an increase of 0.044 in the demand for nonproduction, implying that there are other factors at work, which overwhelm the positive impact of outsourcing.

An alternative perspective on the responsiveness of the demand for nonproduction labor in the US manufacturing industries to changes in the outsourcing intensities of the various services can be obtained by examining the outsourcing intensity elasticities of nonproduction labor demand. To determine these elasticities, a non-differenced version of equation 11 is estimated to obtain parameter estimates, which are then used to calculate elasticities for each of the five services types (Table 3), evaluated at the average values of the nonproduction labor cost share, and outsourcing intensities. Since they are determined from an output constant cost function, these elasticities provide insight into how the compensated demand for the nonproduction labor input changes with respect to intensities in outsourcing.

Based on the magnitudes of the elasticities, it can be seen that nonproduction labor demand is fairly inelastic to changes in the outsourcing intensity of services. Increases in Communications and Other Business Services would have negative impacts on the nonproduction labor demand, while the increases in outsourcing intensity of the remaining services would increase demand. For example, the average outsourcing intensity of Communications was found to be 0.000081 for the period 1998-2004. If this extremely small intensity had increased by one percent, it would have reduced the compensated demand for nonproduction labor by 0.004 percent. In contrast, if the outsourcing intensity of Finance of 0.000089 had been higher by a percent, then the compensated output constant demand for nonproduction labor in US manufacturing would have increased by 0.019 percent.

So, while the outsourcing of some services may be statistically significant in explaining changes in labor demand, the outsourcing intensity of services would have to increase by about a hundred percent or so to make more than a percent change in demand for nonproduction labor demand, and hence manufacturing sector employment.

The impacts of changes in outsourcing intensities thus appear very small, and were foreshadowed by Table 1. The intensities shown in that table are small, implying that imported service imports are very small shares of the manufacturing sector's inputs. Given these very small input shares, the large estimates on the change in outsourcing intensities found in Table 2, translate into very small changes in relative demand for skilled labor.

3.4. Further Work

Services outsourcing has not been an important determinant of nonproduction labor demand for the manufacturing sector. Although the explanatory variables for the outsourcing intensities of various services were significant when considering manufacturing industries at various levels of aggregation (three-digit and four-digit NAICS levels), the Mode 1 trade in these services was not useful in explaining changes in the labor demand in the industries considered. This is due to the fact that Mode 1 services constituted only a very small percentage of the intermediate inputs used in manufacturing industries. One may have expected to find different results if industries that used a much higher share of services – imported and domestic – were considered, such as software development, telecommunications, or other service industries. Unfortunately, data are not available to accommodate this estimation.

While providing insight into the effects of outsourcing on employment in manufacturing industries, the analysis was constrained by the limitations of the data. These limitations would specifically be the shortness of the time series and the absence of better imported input data

for the industries under consideration. Data that consider a more disaggregated labor classification would be more suited to examining the impact of outsourcing on specific labor groups. Based on the ASM data used in this paper, workers are classified as being either production or nonproduction. The reality is that even within these broad groups, there are some labor types that are more sensitive to changes in outsourcing than others. Omitted variable bias might thus be present, and can be addressed by adding variables for imports of materials intermediate inputs and by considering a long run cost function.

As Blinder (2006) suggests, labor engaged in activities that do not require personal interaction, that are impersonal, and that can be carried out electronically is more likely to be affected by outsourcing. Workers that might be affected negatively would include database processors and back-office workers. At the same time, if workers are employed in production processes further up in a value chain – such as in management or sales– that uses the Mode 1 service imports as intermediate inputs, then those workers may benefit from outsourcing. At the aggregate level that this analysis was done, it is impossible to pick up on these subtleties, since managers and back office workers would be aggregated together in the same category – nonproduction workers. Future iterations of this research will seek to address this shortcoming by using more disaggregated labor data.

4. Conclusion

I analyze panel data from 86 US manufacturing industries from 1998 to 2004 to determine the impact of Mode 1 trade in five distinct services on the relative demand for skilled workers. It was found that in the US manufacturing industries, outsourcing has not had a large labor market impact. Declines in the outsourcing of Communications services were found to increase the demand for skilled labor in manufacturing, while increases in the outsourcing of Other Business Services were found to reduce the demand for that kind of labor. Increase in the outsourcing of Finance services improves labor demand when considering industries at the four-digit NAICS level, while Insurance, and Computer and Information services increases improve labor demand when considering industries at the three-digit level.

However, the changes to the relative demand for nonproduction workers that can be attributed to services outsourcing are very small, and are unable to explain the bulk of the decline in nonproduction labor demand in manufacturing industries observed in the period 1998-2004. This is because the five tradable services are very small percentages of the manufacturing sector's total inputs. Unlike the imported materials intermediate inputs in the 1980s, imported services intermediate inputs have not been important in manufacturing production, and the relatively modest increases in outsourcing observed in the recent past have not affected labor demand much. At least in the context of skilled workers in manufacturing industries, the concern that outsourcing is contributing to declining employment may be somewhat misplaced.

An examination of industries that typically use more service intermediate inputs – such as the telecommunications and information technology industries – may yield different conclusions. In addition to examining sectors that are use more services inputs, further work with more disaggregated labor data is necessary to accurately capture the impact of outsourcing on the US labor market.

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Table 1 Average Service Outsourcing Intensities for the US Manufacturing Sector by Service Type (1998-2004)

	Communications	Insurance	Finance	Computer Science	Other Business services
1998	0.000120	0.000087	0.000081	0.000076	0.001578
1999	0.000099	0.000099	0.000069	0.000109	0.001482
2000	0.000081	0.000116	0.000094	0.000138	0.001550
2001	0.000073	0.000170	0.000091	0.000172	0.001652
2002	0.000061	0.000224	0.000081	0.000166	0.001678
2003	0.000063	0.000261	0.000082	0.000208	0.001764
2004	0.000068	0.000302	0.000109	0.000248	0.001785
Average	0.000081	0.000180	0.000086	0.000160	0.001641

Source: Adapted from IMF (2006) and BLS (2008)

Table 2 Estimation Results with Dependant Variable the Change in Nonproduction Workers' Wages Cost Share (1998-2004) [6]

Independent Variable	Estimate (z)	Estimate (z)
	Four-Digit NAICS	Three-Digit NAICS
	I	II
ΔlnY	0.018	0.019
	(0.57)	(1.22)
ΔlnK	-0.027*	-0.001
	(-1.78)	(-1.44)
ΔOScom	-53.684*	-168.293***
	(-1.78)	(-7.12)
ΔOSins	71.274	65.071**
	(1.61)	(2.40)
ΔOSfin	305.469*	3.603
	(1.78)	(0.62)
ΔOScsc	23.467	130.423***
	(0.45)	(3.71)
ΔOSobs	-56.613**	-6.833*
	(-2.08)	(-1.72)

* P<0.1, ** P<0.05, ***P<0.01

Source: Author's Results

Note: com= Communications, ins=Insurance, fin=Finance, csc=Computer and information, obs=Other Business Services

[6] Estimates for industry dummy and time trend variables not significant at 90 percent CI, and are not reported

Table 3 Outsourcing Intensity Elasticities of Nonproduction Labor Demand in US Manufacturing

Service Type	Elasticity
Communications	-0.004
Insurance	0.002
Finance	0.019
Computer and Information	0.019
Other Business Services	-0.007

Source: Author's Results