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Outsourcing and your Collar's Color

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Abstract

In order to assess the effects of increased outsourcing on the relative demand for skilled and unskilled labor, it is crucial to understand whether outsourcing is a complement or a substitute for each kind of labor. Using the traditionally employed log-log framework, Amiti and Wei (2006) find that outsourcing of goods and labor are complements. Using the same methodology but differentiating between skilled and unskilled labor, one would conclude that outsourcing acts as a complement to unskilled labor but as a substitute for skilled labor. This paper proposes an improved methodology which uses estimated prices for outsourcing instead of other proxies (such as its intensity) and a complete factor cost-share system of equations to find the completely opposite result, that is, outsourcing is a substitute for unskilled labor and a complement for skilled labor. This result is consistent with the findings of the literature on outsourcing and the wage gap.

Keywords: outsourcing, labor demand.
JEL classification: F11, F14, F20, J31.

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1 Introduction

Between 1978-1999 we observe two possibly related phenomena. First, for each industry, there was a large decline in the number of unskilled workers needed to produce one unit of output. Second, there was an increase in the level of outsourcing, both of goods and of services. Some authors have tried to relate the changes in the level of outsourcing to the decrease in the labor input per unit output. In particular, they study the elasticity of substitution between outsourcing and labor and hypothesize that if labor and outsourcing are substitutes, a decrease in the price of outsourcing would imply that workers in the US are more exposed to competition from foreign labor. Another argument also found in the literature, is that it might be still possible that outsourcing increases overall industry sales, so that more labor is demanded.

This paper replicates and improves on previous methodology used to investigate the elasticity of substitution between outsourcing and labor, and finds results that are opposite to what previous studies have shown. The starting point is recent work by Amiti and Wei (2006), where the authors advance the claim that outsourcing of goods and labor are complements. Applying the same methodology, but distinguishing between skilled and unskilled labor, our conclusion is that outsourcing and unskilled workers are complements, while outsourcing and skilled labor are substitutes. This would seem to contradict previous research relating outsourcing and the wage gap, which typically investigates the idea that more outsourcing substitutes for unskilled labor and might thereby contribute to the wage gap. However, on applying our improved methodology we find that total outsourcing and unskilled labor are actually substitutes, and outsourcing and skilled labor are complements, which reconciles with the literature on outsourcing and the wage gap.

As examined elsewhere, Canals (2006), outsourcing has been understood in many different ways. We use Feenstra (1998)'s definition of outsourcing. Thus, outsourcing is understood as those imported intermediate inputs (both goods and services) necessary to produce a final good or service. We do control for domestic intermediate inputs using imported intermediate inputs, as Hummels et al. (2001) do.[1] Moreover, in the preliminary analysis of the data, we decompose outsourcing into outsourcing of goods and of services. Defining the outsourcing of goods (services) as those imported intermediate goods (services) necessary to produce the final good

[1] Domestic intermediate inputs are intermediate goods and services purchased inside the country.

or service[2].

Since outsourcing has been suggested as one of the factors affecting labor demand, we start by carefully analyzing the behavior of outsourcing, as well as the evolution of the number of skilled workers and unskilled workers. We find that the outsourcing share, as well as the outsourcing of goods and services shares have been increasing since 1973. Further, we observe that the behavior of outsourcing of services share is slightly different, in that it has been growing more rapidly in the more recent period than during the seventies and part of the eighties. This might explain some of the worries generated by the "new" type of outsourcing. Nevertheless, in level terms, the outsourcing of services share is still smaller than the outsourcing of goods share. Our next step is to compute the quantity of unskilled and skilled workers needed per unit of output at the industry level, where we find that the number of unskilled workers per unit of output has been going down in all industries, while the number of skilled workers has gone up or down depending on the industry analyzed.

In order to estimate the effect that total outsourcing has on the labor demand, we then start by following the Amiti and Wei (2006) log-log framework, commonly used in empirical work.[3] The idea behind the approach is that each industry minimizes a cost function, which takes, as arguments, factor prices, and output. Amiti and Wei (2006) consider four types of factors of production: labor, capital, and two types of outsourcing. Using the first order condition for choice of labor units employed, applying Shephard's lemma, and then taking time differences we obtain an expression for the percentage change in the labor demand as a function of the percentage change of wage, the percentage change of factor prices (for instance: price of capital, and price of outsourcing), and the percentage change of output. An increase in the wage decreases the quantity of labor demanded, and an increase in the level of output increases its demand. Finally, the effect on labor demand of an increase in some other factor price, such as the price of outsourcing, depends on the degree of substitutability between labor and outsourcing.

Our paper has some novelties worth mentioning here. First, previous research uses the value (or intensity) of outsourcing as a proxy for the price for outsourcing. There is a problem with this, in that the relationship between the price of outsourcing

[2]We actually construct three measures of outsourcing share, total outsourcing share,outsourcing of goods share, and outsourcing of services share.

[3]See Hamermesh (1993) as the main reference, Hanson et al. (2005) for an example using firm level data, and Amiti and Wei (2005) for another example using industry level data.

and intensity might itself be changing over time, due to a change in the type of outsourcing. We address this by being able to compute the price of outsourcing following the approach used in Canals (2006). We would ideally like to compute two prices, one for outsourcing of goods, and another for outsourcing of services, as previous research using values.intensities does. However, this is not possible since prices of several services are very difficult to obtain. Hence, we can only construct the price of total outsourcing, a necessary tradeoff in our attempt to control for the interrelatedness of outsourcing price and intensity. A second improvement is the fact that we have richer information regarding the number of skilled and unskilled workers used in each industry at each point in time. Hence, instead of using total labor we are able to exploit data on both unskilled and skilled labor. Finally, we use a more flexible form for the cost function than the one has been used before, in particular, we make use of a translog cost function. A silent feature of this is that when minimizing the translog cost function, we obtain a system of cost-share equations, with one equation for each production factor. Earlier research would only take the cost-share corresponding to labor and disregard the cost-shares of other factors. Not solving simultaneously for all the cost-shares plausibly biases the typical single equations estimated in these studies.

Applying this new methodology with the aforementioned improvements suggests that between 1978 and 1999, outsourcing and unskilled workers are substitutes. Our estimate of the partial elasticity of substitution equals 0.618. Outsourcing and skilled labor are found complements with a partial elasticity of substitution equal to -1.142. Previous studies that, as we suggest, might not have addressed simultaneity and other issued, have had results that are the exact opposite. Outsourcing and unskilled workers were found to be complements, and outsourcing and skilled workers were found to be substitutes.

The reminder of this paper is organized as follows. Section 2 describes the data set used in the empirical exercise. Then, in section 3 a preliminary analysis of total outsourcing and labor is taken up. A replication and extension of the Amiti and Wei (2006) approach is performed in section 4, together with an analysis of the problems of such a methodology. Section 5 presents the new methodology applied. 6 concludes.

2 Data Set

We use several sources to construct all the variables needed, ending up with a total of 27 industries over the period 1973-1999 (18 manufactures, and 9 services), see table 1. We do not have data for the 26 years, but for 16 of the 26 years.[4] In the following section we use all 16 available years to show the evolution of outsourcing and labor. However, in the replication and extension of the methods that relate outsourcing with labor demand, our data will start in year 1978, since we have some restrictions in obtaining real output for all industries before that time. See Canals (2006) for a more detailed explanation for the construction of the data set.

It is also important to briefly describe the data set used by Amiti and Wei (2006), since we compare our results to theirs. They have a total of 96 manufacturing industries, and they have data for the 1992-2000 period. These manufacturing industries do outsource from both manufacturing as well as services, where services are: telecommunications, insurance, finance, business services, and computing and information. As you can see there are two major differences in the data sets. First of all, while they only consider manufacturing industries, where these industries can outsource from other manufacturing as well as services, we also have services that can also outsource from manufacturing as well as services. Secondly, our data sets starts in 1973, while they only have data for the 90's decade.[5] Thus, we can observe if there has been large changes in outsourcing behavior over the last three decades.

3 Evolution of Outsourcing and Labor

Since outsourcing has been suggested as one of the factors affecting labor demand, we start by presenting the evolution of outsourcing over time. Later, we show how the number of unskilled and skilled workers per unit of output has varied in the 1978-1999 period.

Following Feenstra and Hanson (1996) we define outsourcing share for each industry i at time t (os^s_{it}) as the share of imported intermediate inputs over total non-energy intermediate inputs:

[4]The years where we do have data for all variables are: 1973, 1974, 1975, 1976, 1978, 1979, 1980, 1981, 1983, 1984, 1985, 1986, 1996, 1997, 1998, and 1999.

[5]Notice that for the preliminary analysis we use data going back to 1973, but for the more extended analysis we start in 1978.

$$os^s_{it} = \sum_j \left[\frac{input\ purchases\ of\ intermediate\ input\ j\ by\ industry\ i,\ at\ time\ t}{total\ non\text{-}energy\ intermediate\ inputs\ used\ by\ industry\ i,\ at\ time\ t} \right] * \left[\frac{imports\ of\ good\ or\ service\ j,\ at\ time\ t}{production_j + imports_j - exports_j\ at\ time\ t} \right] \quad (1)$$

Moreover, we apply Hummels et al. (2001)'s method [6] to control for the fact that some domestic intermediate inputs might be using imported intermediate inputs. The first square bracket is computed using Input-Output tables from 1973 until 1999 constructed by Bureau of Economic Analysis (BEA). The second square bracket is calculated using trade data from the BEA, as well.

We can define the *outsourcing of services share* by industry i at time t (oss_{it}) and the *outsourcing of goods share* (osm_{it}) in a similar fashion. In particular, the outsourcing of services (goods) share by industry i at time t is the share of imported intermediate services (goods) over total non-energy intermediate inputs.

Table 2 shows changes in the outsourcing share (os^s_{it}) by industry over time, where rows stand for industry and columns for time, except for the last two columns where the annual growth rate is computed for the 1973-1986 and 1986-1999 periods, respectively. First, we observe that the outsourcing share does increase in most of the industries over the period analyzed. The largest outsourcing industries are: lumber and wood products, machinery except electrical (includes computers), electrical machinery, motor vehicles, textile and apparel, and leather products and footwear. In general, services use less outsourcing than average. Moreover we observe that among the largest outsourcers, the annual growth rate for outsourcing has slowed down in the last time period (86-99 versus 73-86) for motor vehicles, 1.9% vs. 3.4%, and apparel and textiles, 2.3% vs. 4.1%. While it has increased for lumber and wood products, and has stayed the same for machinery, both electrical and non-electrical.

The change in the outsourcing of goods and of services shares by industry are in Tables 3 and 4, respectively. The behavior of the outsourcing of goods share is similar to the total outsourcing share. Again, big outsourcers of goods are: lumber and wood products, electrical and non-electrical machinery, motor vehicles, textile and apparel, and leather products and footwear. However, that is not true for the outsourcing of services share. First, we notice that the outsourcing of services share in levels is a lot smaller than the outsourcing of goods share in every industry. For

[6] They use it to compute what they name Vertical Specialization

instance, computing a weighted average of the outsourcing of goods and services shares in 1999, we observe that it is 8.35% for *osm* vs. 0.87% for *oss*, see table 5. Still, the most striking feature for the outsourcing of services share is that the annual growth rate for the last period is a lot larger than for the first period for most of the industries. This difference is not so evident in the total outsourcing share or the outsourcing of goods share.

Finally, following Canals (2006) we construct an average measure of the outsourcing share for the total US economy per year. We average the outsourcing share(of goods/of services) measure using as weights the value added of each industry. We observe that in 1973 this average measure of the outsourcing share is 5.19%, it is 6.52% in 1986, and 9.22% in 1999, see first column in table 5. Thus, between 1973 and 1986 the annual average growth rate of the outsourcing share was 1.77%, while between 1986 and 1999 it was 2.70%, see last two rows. Similarly for the outsourcing of services and of goods share, see column 2 and 3. In 1973 the outsourcing of services share was 0.38%, it increased to 0.50% in 1986, and it was 0.87% in 1999. It was 4.81%, 6.02%, and 8.35% for the outsourcing of goods share in 1973, 1986, and 1999, respectively.

The most interesting feature of this decomposition is that it allows us to study the different trend of the outsourcing of goods share and of services share over time. The annual average growth rate of the outsourcing of services share increases a lot in the last years in comparison to the first years studied. We have that between 1973 and 1986 the annual growth rate in the outsourcing of goods share is 1.73%, and it is 2.5% in the 1986-1999 period, while the outsourcing of services share jumps from a 2.07% to a 4.42% annual increase. That could be a possible explanation of why people started getting worried about outsourcing of services by the end of the nineties, even though, the level of the outsourcing of services share was still a lot lower than the goods one, it accelerated.

We want to compare our results with ongoing research on the outsourcing topic. In particular, we consider Amiti and Wei (2006)'s recent research on offshoring and its effects on productivity and employment. They compute a similar measure for the outsourcing of services share and the outsourcing of goods share for the 1992-2000 period. The two differences are that we control for the indirect usage of imported intermediates, and we do include both, outsourcing by manufacturing and services sectors, instead of only including manufacturing industries. When looking at the

outsourcing of goods share, they obtain that osm^s equals 15.55% by 1999, while we find it equals 8.35%. However, if we compute the same measure using only manufacturing industries we get 16.97%, which is very close to the 15.55% they obtain. In general, we obtain very similar results to the ones they obtain for the outsourcing of goods share when only considering manufacturing industries. Nevertheless, it is not true for the outsourcing of services share, where our results differ quite a lot from their results. For instance, they find that in 1999 the outsourcing of services share by manufacturing industries equals 0.29%, while when we compute it is 0.93%. One possible explanation might be that we do use a more comprehensive set of services.[7] Though, this explanation cannot explain such big discrepancy because the smaller service set they use accounts for most of the services outsourced. Even more shocking, is that our results are very similar to the ones Amiti and Wei (2006) obtained in an earlier version of this paper, where they did consider, as we did, both manufacturing and services. Particularly, they claimed that by 1999 oss^s was 0.75%. When using all sectors, we get that the average oss^s by 1999 equals 0.87%. Hence, in this case the disparity between 0.75% and 0.87% could be explained by the smaller set of services they use. Due to this big change in both versions of their paper, we do believe our computation for the outsourcing of services share is more accurate than the one that appeared in their latest version of the paper.

We end up this section by showing the evolution of unskilled and skilled workers by industry. In particular, we start by constructing the ratio between the number of unskilled workers to Real Output for each industry i at time t, (u_{it}). We observe that u_{it} goes down for all industries.[8] As an example, see Figure (1) where we graph the evolution of u over time for the sector "Machinery except electrical." Once we have u_{it} for each industry at each point in time, we compute the growth rate of it for the 78-99 period, see first column in table 6. We observe that the Growth rate for the unskilled measure is always negative, as expected, since we already said that u_{it} decreases over time for all industries. We can go a step further and compute the weighted average growth rate, where value added is used as weight, and observe that it equals -27.42%. This decrease in the quantity of unskilled workers per unit of output could be attributable to the change in the quantity of outsourcing among other things, like skilled bias technological changes, immigration, change in education, etc. Analogously, we examine how the ratio of skilled workers over Real

[7] They only use telecommunications, insurance, finance, business services, and computing and information as service sectors

[8] Except for Business and Professional Services

Output, (s_{it}), evolves over time. s_{it} behaves in a different way, since it goes up for around half of the industries and down for the other half. Particularly, the weighted average of the s_{it} growth rate between 1978 and 1999 equals -6.92%, see table 6. Again, a possible explanation driving this ratio up or down could be technological changes, outsourcing, or immigration, among others. A deeper analysis is necessary in order to conclude the causes of such a change in both, u_{it} and s_{it}.

4 Replication and Extension of a Previous Approach

4.1 Theory

We follow Amiti and Wei (2006) and Amiti and Wei (2005) model and estimating framework, where they claim that the conditional labor demand can be estimated in differences, using Hanson et al. (2005) approach.[9] The idea is that each industry i at time t has a cost function, which is a function of factor prices, and output, that wants to minimize:

$$C_{it} = C_{it}(p_{it}^{oss}, p_{it}^{osm}, \omega_{it}, r_{it}, Y_{it}) \tag{2}$$

where p_{it}^{oss} and p_{it}^{osm} stand for price of outsourcing of services and of goods for industry i at time t, respectively; ω_{it} is price of labor; r_{it} is price of capital; and Y_{it} is quantity of output.

Hence, minimizing the above expression, applying Shepard's lemma, and taking logs, we obtain the following expression for labor demand:

$$\ln l_{it} = \alpha + \gamma_1 \ln p_{it}^{oss} + \gamma_2 \ln p_{it}^{osm} + \gamma_3 \ln \omega_{it} + \gamma_4 \ln r_{it} + \gamma_5 \ln Y_{it} \tag{3}$$

where l_{it} stands for number of employees in industry i at time t.

The problem in this specification is that α is a measure of industry-year technology. However, as we do not have a good proxy for it, a solution would be to exploit the panel dimension, and take differences. Then, we should add industry-dummies to control for the industry dimension of the technology. Thus, the final specification

[9] All these approaches are based on Hamermesh (1993).

runned by Amiti and Wei (2006) is:

$$\Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss^s_{it} + \gamma_2 \Delta osm^s_{it} + \gamma_3 \Delta \ln \omega_{it} + \gamma_4 \Delta \ln r_{it} + \gamma_5 \Delta \ln Y_{it} + \delta_t D_t + \delta_i D_i + \epsilon_{it} \quad (4)$$

where Δ indicates time differences; D_t and D_i are time and industry dummies, respectively. Before continuing, notice that, equation (4) does not include price of outsourcing of services and of goods (p^{oss}_{it},p^{osm}_{it}), but intensity of outsourcing of services and goods (oss^s_{it} and osm^s_{it}). They argue that these are valid inverse proxies for its prices, since: "[...] 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."[10] Moreover, in this specification we are assuming that wage is exogenous to the industry.

The interpretation of the coefficients in equation (4) is as follows: γ_1, γ_2, and γ_4 are constant-output cross-price elasticities. In particular, if $\gamma_1 < 0$, it means that labor and outsourcing of services are substitutes. In other words, workers in the US are exposed to competition from foreign labor. On the other hand, if $\gamma_1 > 0$, labor and outsourcing of services are complements, meaning that a decrease in the price of outsourcing of services (equivalent to an increase in oss^s) would imply an increase in the demand of US labor.[11] Analogously for γ_2. For γ_4 the interpretation of the sign goes the other way around, since for capital we use its price and not the inverse proxy as for the other two cases. Moreover, we should find $\gamma_3 < 0$, since an increase in price of labor should decrease its demand; and $\gamma_5 > 0$, since if output goes up, labor demand should go up, as well.

4.2 Results

The results for running equation (4) for the 27 industries and the 1978-1999 time period are in Table 7, column 1. Notice first, that we add some extra independent variables to the specification in (4). In particular, we include lags for all regressors. Thus, for instance, allowing for the possibility that the effect of outsourcing on labor demand does take some time to happen. The inclusion of these lags is also done in Amiti and Wei Papers, so we should obtain comparable results. We obtain, on one hand, that outsourcing of services has no significant effect on industries employment.

[10] Remember that we use outsourcing, offshoring, or international outsourcing indistinctively.

[11] This may indicate that outsourcing of services increase overall industry sales, and thus more labor is demanded.

That is also true in Amiti and Wei (2006) when running the same equation for 96 manufacturing industries.[12] On the other hand, there is a positive and significant effect of outsourcing of goods onto labor demand, $\gamma_2 > 0$. Thus, again, this coincides with the results obtained in Amiti and Wei (2006). As already pointed out, this means that outsourcing of goods and labor demand in US are complements. In particular, we obtain that the coefficient associated with outsourcing of goods equals 1.1. Amiti and Wei (2006) obtain that the coefficients on outsourcing of goods and its lag oscillate between 0.3 and 1.7, depending on the specification used.[13,14]

Before continuing with the analysis, we should mention that Amiti and Wei (2006) claim that the coefficient γ means more than the constant-output own price demand or cross-price demand elasticity. They say outsourcing can affect labor demand through three different ways, and all them are summarized in γ. These three effects are, a substitution effect, the same way we defined it; a scale effect where an increase in outsourcing can increase the competitiveness and efficiency of an industry, and thus an increase in their demand of output would imply an increase in labor demand; and a productivity improvement, where a change in outsourcing could decrease the labor demand. However, the justification for giving so much meaning to γ is not strongly justified. Hence, we will continue with the interpretation of γ as only giving information regarding the complementarity or substitutability between production factors.

4.3 Extension

One of the advantages of our data is that it allows us to make a more detailed analysis distinguishing between skilled (s) and unskilled (u) workers, since we have disaggregated information on employees and wages ($l^u, l^s, \omega^u, \omega^s$).[15] Thus, we can re-run the previous equation for unskilled and skilled workers separately, see table

[12] Remember that the time period is also different. While we do have years from 78 until 99, they have 92-00

[13] Redoing the regression only for manufacturing industries, as Amiti and Wei, we obtain that the coefficient for the change in outsourcing of goods equals 2.06. Again, similar to their results. However, we cannot trust a lot our result only for manufacturing industries because of the small number of observations.

[14] Notice that our variables *oss* and *osm* are already in percentages. Thus, in order to compare our results with Amiti and Wei (2006)'s we should multiply their results by a hundred.

[15] We define unskilled as those workers with a high school degree or less, and skilled as those workers with some years of college or more

7 column two and three, respectively:

$$\Delta \ln l_{it}^{f} = \gamma_0 + \gamma_1 \Delta oss_{it}^{s} + \gamma_2 \Delta osm_{it}^{s} + \gamma_3 \Delta \ln \omega_{it}^{u} + \gamma_{3'} \Delta \ln \omega_{it}^{s} + \gamma_4 \Delta \ln Y_{it} + \\ + \delta_t D_t + \delta_i D_i + \epsilon_{it} \qquad \text{for } f = u, s \qquad (5)$$

It is striking that while the results for unskilled workers are very similar to the ones obtained using total number of employees pulled together, this is not true for skilled workers. Particularly, for unskilled workers we obtain that "price" for outsourcing of services does not affect unskilled employment (not significant); and "price" for outsourcing of goods affects it positively, such that outsourcing of goods and unskilled workers are complements.[16] In particular, we obtain that the coefficient for outsourcing of goods equals 1.3 versus the 1.1 obtained before with total employment. For skilled workers outsourcing of services is not significant, as before; nonetheless, lag outsourcing of goods is significant and has a big negative effect on the skilled employment, -3.2, thus they are substitutes. Hence, it seems that in this case US skilled workers are affected by the competition brought by foreign labor. Moreover, it is surprising that wages of skilled and unskilled workers are not significant on the unskilled employment regression.[17]

Finally, if we compare the results for skilled and usnkilled employment with the literature that relates outsourcing with the wage gap,[18] it seems that the results obtained in both types of analysis contradict each other. Feenstra and Hanson (1999), and Canals (2006) conclude that the change in the level of outsourcing has provoked an increase in the wage gap. Thus, it seems outsourcing is "shipping away" unskilled jobs relatively to skilled ones. However, the above results seem to be saying just the opposite, since the outsourcing coefficient for the unskilled workers regression is positive, and it is large and negative for skilled workers regression. On top of that, it is also shocking that is outsourcing of goods and not of services the force driving down skilled employment, since lately most examples given by newspaper articles talk about how call centers, software developers, and engineers in India are having a big impact in skilled US jobs.

[16] Remember that Amiti and Wei (2006) do not have price of outsourcing but use value (intensity) of outsourcing as an inverse proxy for it. We are using the same proxy.

[17] We re-run the same equation for unskilled and skilled labor but using price of output instead of quantity, as Amiti and Wei did. We do not show these results because they are very similar to the ones showed in this section.

[18] Where the Wage gap is the ratio between skilled wages over unskilled wages

4.4 Problems behind Previous Approach

The first problem we encounter is related to the fact of using industry data instead of firm-level data. In particular, with firm-level data we can obtain the skilled and unskilled wages paid in countries where the firm is outsourcing from. That is not true if the data is at the industry-level.

Being more precise, let's start by presenting the data set and approach used by Hanson et al. (2005), since Amiti and Wei (2006)' estimations are based on it. They have data on the operations of U.S. parent companies and their foreign affiliates. Thus, the approach they use is:

$$\Delta \ln l_{pit} = \alpha_{it} + \beta_j \Delta \ln \omega_{pit} + \beta_s \Delta \ln \omega^s_{pit} + \beta_u \Delta \ln \omega^u_{pit} + ... \tag{6}$$

where l_{pit} is the demand for US labor by parent p in industry i at time t; ω_{pit} is the price of labor facing the US parent in industry i at time t at home; ω^s_{pit} is the cost of skilled labor facing parent p's affiliates in industry i at time t abroad; and ω^u_{pit} is the cost of unskilled labor facing parent p's affiliates in industry i at time t abroad;

However, when using industry data, skilled and unskilled wages information from countries we are outsourcing from is not available. Thus, Amiti and Wei (2006) affirm that using price of outsourcing of goods and of services is a valid way to solve for the problem. In doing so, they are assuming there is some kind of constant relationship between the skilled and unskilled workers used in the two types of outsourcing. Then, on top of that, they add another assumption, since they do not have the price of outsourcing of goods and of services, either. Instead, and as already explained, they use the value of outsourcing of goods and of services as an inverse proxy. However, since the composition of outsourcing varies over time, a change in the value of outsourcing may not capture the change in its price, thus the proxy is not good. In other words, the price elasticity change depending on the composition of outsourcing. We compute the price of outsourcing, avoiding the usage of this inverse proxy. Nevertheless, the previous problem regarding the constant relationship between types of workers and outsourcing is still not solved.

The second problem is related with the fact of estimating the labor demand equation by itself. In other words, when each industry minimizes its cost function we obtain a full system of equations, one for each production function, where certain characteristics must hold. Moreover, with the approximation of the cost function

used, they are not allowing for any type of flexibility in the elasticity terms. Thus, we could improve our results approximating the cost function with a more general and flexible form like the translog, plus estimating the whole system at the same time.

5 New Approaches

5.1 Using Price of Outsourcing

As aforementioned, using the value of outsourcing as an inverse proxy for price of outourcing is a problem. The reason given is that finding these prices is a hard task, nevertheless we are able to compute them. Even though we would like to have two prices, one for outsourcing of goods, and another one for outouring of services, this is not going to be possible because prices of services are difficult to obtain, plus they are not very reliable. However, what can be constructed is the price of total outsourcing (goods plus services) for each industry at each point in time, p_{it}^{os}. We compute it combining the Input Output tables together with the US Import Price Index Series (IIP) for a category of goods reported by the Bureau of Labor Statistics (BLS). In particular, we construct a price index for each industry, then, using the imported intermediate input coefficients (b_{ij}^{m}), we input to each industry the price of imported intermediate inputs (outsourcing) that is associated with the quantity of imported intermediate inputs that is using from all industries. We should *highlight* that we construct two alternative price index for the sectors belonging to services. In the first alternative, we assume that the price index for all services equals the average of manufactures price index, since we do not have particular information for services prices. One could argue, that the intermediate input price for services goes down too slowly when assuming the average manufacturing price to construct the price index for services. In order to correct for this, we construct the second alternative, where the price for computer manufacturing affects certain types of services, and so on top of the average price of manufactures we include its tendency in some of the services prices. Thus, we end up with two alternative prices of outsourcing.[19]

We want to compare the results using the proxy outsourcing share with the ones using the price of outsourcing constructed. In order to do that, first, we must re-estimate equation 4 with the outsourcing share instead of using the outsourcing

[19] See the appendix in Canals (2006) for a more detailed explanation of the data set.

services share and the outsourcing goods share, since, as already mentioned, we cannot construct the two prices separately. The results for total outsourcing are given in table 8. In the first column the dependent variable is the percentage change in the total number of employees, and we find that the change in the level of outsourcing has a positive and significant effect of 1.1, comparable to the 1.1 for outsourcing of goods that was obtained when using both outsourcing of goods and of services. Thus, they are complements. The second column shows the results for unskilled workers, where the effect of outsourcing equals 1.2, the same as when outsourcing is disaggregated, factors are complements, again. Finally, the third column shows that the change in the level of outsourcing in the previous period has a negative effect on the skilled employment equal to -3.0, analogous to -3.1 in the disaggregated case. Thus, skilled labor and outsourcing are substitutes. As before, the results of the effect of outsourcing on the labor demand are not very stable once we split the labor demand in unskilled and skilled workers. However, this is not true when we use price of total outsourcing (first alternative) instead of its value, see table 9. Particularly, when the dependent variable is the percentage change of total employment or of unskilled employment the lag of the price of outsourcing has a negative effect on the labor demand, see column 1 and 2. In other words, total labor (unskilled labor) and total outsourcing are complements, as before.[20] Nonetheless, when the dependent variable is the percentage change of skilled employment, we observe that the change in outsourcing price does not have any significant effect in the change of skilled employment, very different than the substitutability we had before. Hence, when using price of total outsourcing instead of value we do not observe the strange behavior in the skilled workers regression. Still the results seem to contradict the literature that relates outsourcing with the wage gap. Moreover, we do still find that wages for skilled and unskilled workers do not have any significant effect on labor demand for unskilled, which still surprises us. As before, the effect of output is positive and significant, and the coefficient for capital price is not significant.

We should re-run the regressions using the second alternative for the price of outsourcing. Remember that, this alternative price considers the fact that the price of services should not go down as slowly as the one given by the average price of manufactures. The results are robust, see table 10.

[20]Notice now that a positive coefficient implies substitutes, and a negative one means complements. The reason is that we do not use the value of outsourcing anymore but its price.

5.2 Translog Cost Function

The second problem we point out is due to the fact of estimating the labor demand equation by itself. Notice that from the cost minimization we obtain as many equations as production factors, with some constraints among them. This is what must be usedin order to estimate the substitution and complementarity among inputs. On top of that, they are not using a very flexible cost function approximation. We solve for all this using a translog cost approximation plus estimating the whole system of equations with the appropriate constraints.

In particular, following Canals (2006) let's consider an economy with a number of industries (i) and 5 production factors (f) unskilled labor (u), skilled labor (s), domestic intermediate inputs (d), imported intermediate inputs (os), and capital (k);[21] where the cost function for each industry, after assuming homogeneity and homotheticity of a constant degree, is approximated using a second-order Taylor polynomial:

$$lnC_{it} = \alpha_{0i} + \sum_f \alpha_{fi} \cdot ln\omega_{fit} + \frac{1}{2} \sum_f \sum_{f'} \gamma_{ff'} \cdot ln\omega_{fit} \cdot ln\omega_{f'it} +$$
$$+ t \cdot \sum_f \beta_{fi} \cdot ln\omega_{fit} + \alpha_{ti} \cdot t + \frac{1}{2} \cdot \pi_{ti} \cdot t^2 + \alpha_{y_i} \cdot lny_{it} + \eta_{ty_i} \cdot t \cdot lny_{it} \qquad (7)$$

where ω_{fit} are factor prices, in the previous approach these where ω, r and p^{os}; and t stands for time and represents technological changes affecting the cost function over time.

If we logarithmically differentiate (7) with respect to factor prices and employ Shep-

[21] As stated before, we understand imported intermediate inputs as outsourcing.

ard's lemma we get the following system of cost-share equations:

$$\begin{aligned}
\theta_{uit} &= \alpha_{ui} + \beta_{ui} \cdot t + \sum_{f'} \gamma_{f'u} \cdot ln\omega_{f'it} \\
\theta_{sit} &= \alpha_{si} + \beta_{si} \cdot t + \sum_{f'} \gamma_{f's} \cdot ln\omega_{f'it} \\
\theta_{dit} &= \alpha_{di} + \beta_{di} \cdot t + \sum_{f'} \gamma_{f'd} \cdot ln\omega_{f'it} \\
\theta_{osit} &= \alpha_{osi} + \beta_{osi} \cdot t + \sum_{f'} \gamma_{f'm} \cdot ln\omega_{f'it} \\
\theta_{kit} &= \alpha_{ki} + \beta_{ki} \cdot t + \sum_{f'} \gamma_{f'k} \cdot ln\omega_{f'it}
\end{aligned} \tag{8}$$

where θ_{fit} is the cost-share of factor f in industry i at time t. Notice that, for the cost function to be well-behaved we must assume certain restrictions: homogeneity of degree one with factor prices, sum of cost-share equal to one, symmetry restrictions in the cross elasticities.

Following Canals (2006) we add a time trend in each cost-share equation to account for biased technological changes affecting the share usage of each input. Since the above system of equations is linearly dependent, we first drop one of the equations, and secondly, we run the system using the iterated Zellner'seemingly unrelated procedure adding the cross-equation symmetry constraints. From the results, we can compute what is known as the Allen elasticities of substitution ($\sigma_{ff'}$). These are partial elasticities of substitution, since they measure the substitutability between inputs, holding output and other input prices constant. The equations to obtain them are:

$$\begin{aligned}
\sigma_{ff'} &= \frac{\gamma_{ff'} + \theta_f \cdot \theta_{f'}}{\theta_f \cdot \theta_{f'}} \\
\sigma_{ff} &= \frac{\gamma_{ff} + \theta_f^2 - \theta_f}{\theta_f^2}
\end{aligned} \tag{9}$$

These elasticities will change at every point in time, since they depend on the factor's cost share. Following previous research we compute them at a central point, in particular, 1986, and we take as cost-share a weighted average of the 27 industries' cost share, see table 11. We are interested in the degree of substitution between outsourcing and labor, distinguishing between skilled and unskilled workers. A positive number indicates that the factors are **substitutes**, and a negative number means factor **complementarity**. We find that $\sigma_{um} = 0.618$, thus, unskilled labor and

outsourcing are substitutes. This contradicts the complementarity we found before with the Amiti and Wei (2006)'s approach. Moreover, $\sigma_{sm} = -1.142$, indicating outsourcing and skilled labor are complements. Again, this contradicts the result in the previous approach. However, the results are, finally, in line with the literature relating outsourcing and the wage gap.

There is a strong assumption in this approach due to the data availability, that is, we are assuming the parameters $\gamma_{ff'}$ $\forall f, f'$ equal across industries. However, we do relax a little bit this assumption and allow for two different sets of γs depending on the labor intensitivity of the sectors. Thus, we divide the sectors into two subgroups, those capital intensive and those more labor intensive. The results are in table 12, still outsourcing and unskilled labor are substitutes, while outsourcing and skilled labor are complements. However, the degree of substitution and complementarity are smaller in the labor intensive sectors. We do the same distinguishing γ's between manufactures and services, and find stable results.

Finally, we redo all the Allen elasticities of substitution with price of outsourcing and price of domestic intermediate inputs compute in the second alternative way. The results are robust, see tables 13 and 14.

5.3 Still a Problem with the New Approach

Computing the price of outsourcing as above disregards costs that might be affecting as well the decision of outsourcing more or less. In particular, improvements in property rights, or law enforcement in a country, might, as well, increase the likelihood of outsourcing from that country, and thus increase the quantity of total outsourcing.[22] Notice that, even though the quantity of outsourcing might have increased, it is still possible that the price for skilled, and unskilled labor, and capital is the same as before in the new country. Thus, the price of outsourcing as we compute it, is the same as we were paying before. However, better property rights might be allowing us to outsource more because there will be less imitators in the country where we are outsourcing. So, although using p^o gives more stable results than using value of outsourcing, still the new approach is not free of criticism, since it should consider these costs as well.

Moreover, skilled and unskilled workers usage varies over time in outsourcing of

[22] See Bartel et al. (2005)

goods and outsourcing of services. Hence, the effect of these onto unskilled and skilled labor demand might be varying over time. However, as Amiti and Wei (2006) before, we are assuming this effect being constant over time.

6 Conclusions

The outsourcing of goods and of services share has been growing since the seventies. Moreover, the outsourcing of services share has been raising more rapidly in the last decade. We also observe that the quantity of unskilled workers needed to produce one unit of good has been going down for most of the industries. These facts might lead to think there is a relationship between outsourcing and the labor demanded in the US to produce the same amount of output.

In order to prove if this causality exists we estimate the effects of outsourcing (of goods and of services together) on employment demand in the US for the 1978-1999 period using Amiti and Wei (2006) and Amiti and Wei (2005) estimation procedure. We observe that using such an approach, unskilled workers and outsourcing are complements, and skilled workers and outsourcing are substitutes. This contradicts previous research on outsourcing and its effects in the wage gap. Correcting for price of outsourcing, and improving the general methodology leads to a complete change in the results. In particular, we obtain the exact opposite, that is, unskilled workers and outsourcing are substitutes, while outsourcing and skilled workers are complements.

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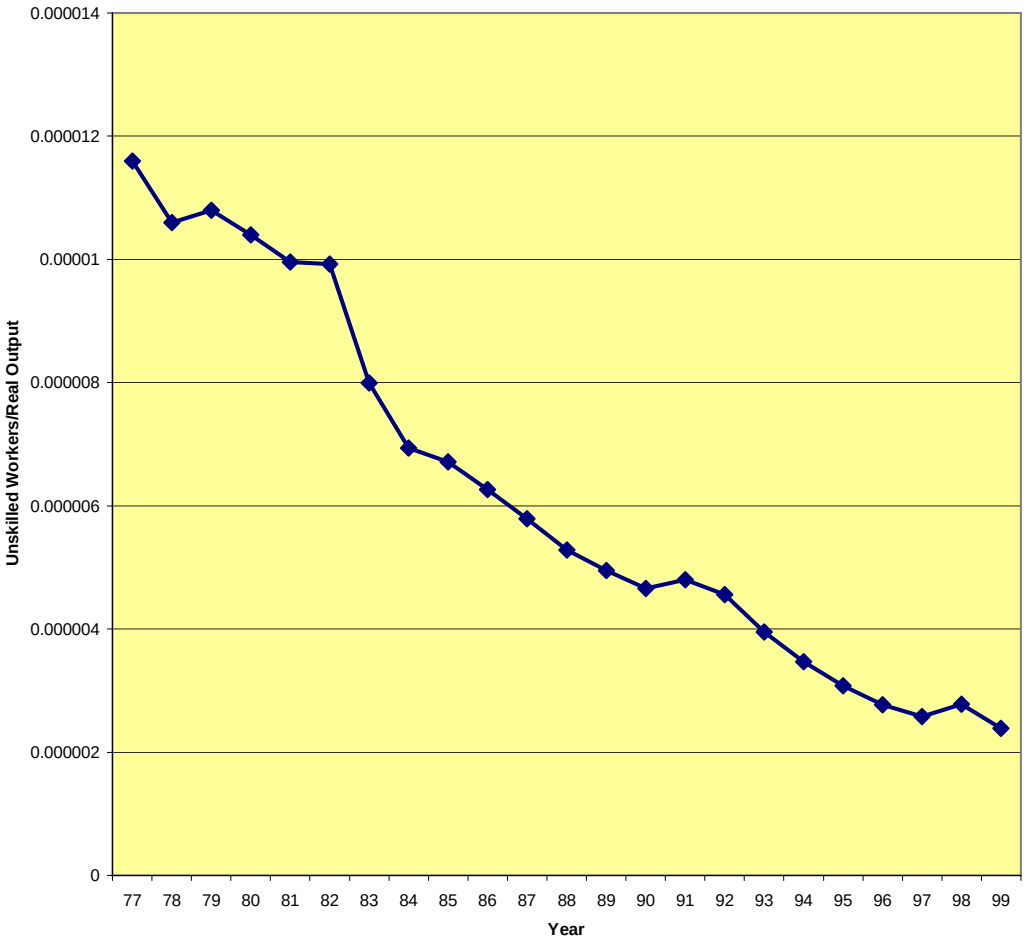

Figure 1: Ratio Unskilled Workers - Real Output for "Machinery except Electrical"

Table 1: Final Sectors

1 Construction
2 Lumber and Wood products
3 Furniture and Fixtures
4 Stone, Clay and Glass products
5 Primary Metals
6 Fabricated Metals
7 Machinery except electrical
8 Electrical Machinery, equipment and supplies
9 Motor vehicles and other transportation equipment
10 Misc.Manufacturing industries
11 Food and Kindred products
12 Tobacco products
13 Textile Mill products
14 Apparel and other finished textile products
15 Paper and allied products
16 Printing, Publishing and allied industries
17 Chemicals and allied products
18 Rubber and misc. plastic products
19 Leather and leather products and footwear
20 Transportation, Utilities and Sanitary Services
21 Communications
22 Wholesale and Retail Trade
23 Finance, Insurance and Real Estate
24 Business Services and professional services
25 Personal Services
26 Entertainment and Recreation
27 Health, Educational and Social Services

Table 2: Evolution of the Outsourcing Share by Industry - Part 1

Industry	73	80	86	96	99	AGR 73-86	AGR 86-99
Agriculture, Foresty and Fishery	4.33%	6.58%	7.10%	11.12%	11.44%	3.879%	3.741%
Mining	5.15%	8.57%	8.27%	15.46%	14.50%	3.700%	4.418%
Construction	7.32%	8.23%	9.14%	12.98%	13.47%	1.726%	3.030%
Lumber and Wood products	14.10%	13.10%	13.72%	18.40%	18.68%	-0.208%	2.401%
Furniture and Fixtures	9.52%	10.21%	11.25%	15.30%	15.85%	1.292%	2.674%
Stone, Clay and Glass products	6.14%	7.54%	8.56%	11.68%	12.45%	2.584%	2.926%
Primary Metals	11.91%	13.17%	12.93%	16.84%	17.50%	0.638%	2.355%
Fabricated Metals	10.26%	12.63%	13.17%	17.28%	18.23%	1.943%	2.533%
Machinery except electrical	9.60%	12.62%	15.38%	22.04%	22.50%	3.693%	2.973%
Electrical Machinery, equipment and supplies	9.46%	12.49%	13.86%	20.49%	21.34%	2.984%	3.373%
Motor vehicles and other transportation equipment	11.34%	16.22%	18.78%	22.31%	23.92%	3.957%	1.877%
Misc. Manufacturing indutries	8.97%	10.53%	11.22%	16.28%	16.83%	1.732%	3.168%
Food and Kindred products	5.20%	6.86%	7.05%	10.86%	11.45%	2.376%	3.798%
Tobacco products	3.85%	6.32%	5.71%	8.16%	7.72%	3.083%	2.344%
Textile Mill products	7.27%	9.04%	12.59%	15.99%	16.91%	4.313%	2.293%
Apparel and other finished textile products	9.36%	11.46%	15.77%	21.33%	21.15%	4.092%	2.286%
Paper and allied products	9.91%	11.02%	11.23%	15.04%	15.31%	0.969%	2.414%
Printing, Publishing and allied industries	7.43%	9.14%	9.02%	12.05%	11.39%	1.499%	1.811%
Chemicals and allied products	6.25%	10.85%	10.79%	14.84%	14.70%	4.289%	2.404%
Rubber and misc. plastic products	6.85%	9.01%	10.39%	15.32%	15.33%	3.264%	3.033%
Leather and leather products	10.92%	12.99%	17.56%	28.56%	29.12%	3.720%	3.967%

Evolution of the Outsourcing Share by Industry - Part 2

Industry	73	80	86	96	99	AGR 73-86	AGR 86-99
Transportation, Utilities and Sanitary Services	4.74%	9.40%	6.80%	11.22%	11.04%	2.820%	3.796%
Communications	4.16%	5.89%	5.77%	6.98%	6.62%	2.553%	1.058%
Wholesale and Retail Trade	3.47%	4.27%	3.88%	6.75%	6.71%	0.866%	4.301%
Finance, Insurance and Real Estate	1.68%	2.16%	1.98%	3.38%	3.05%	1.268%	3.379%
Business Services and professional services	3.33%	4.43%	4.41%	8.47%	8.10%	2.186%	4.790%
Automobile and Repair Services	10.47%	10.68%	12.58%	16.16%	15.98%	1.421%	1.855%
Personal Services	4.97%	6.75%	7.24%	8.01%	7.46%	2.931%	0.231%
Entertainment and Recreation	2.25%	3.66%	3.52%	4.35%	4.25%	3.492%	1.466%
Health, Educational and Social Services, and Membership Organizations	3.45%	5.49%	5.08%	7.52%	8.33%	3.011%	3.882%
Average	7.122%	9.043%	9.825%	13.838%	14.044%	2.536%	2.819%

Source BEA: Annual Input-Output Tables
Total Outsourcing: value of imported intermediate inputs as a share of total intermediate inputs.
AGR := Average Growth Rate

Table 3: Evolution of the Outsourcing of Goods Share by Industry - Part 1

Industry	73	80	86	96	99	AGR 73-86	AGR 86-99
Agriculture, Foresty and Fishery	4.05%	6.16%	6.63%	10.22%	10.56%	3.863%	3.647%
Mining	4.86%	8.12%	7.86%	14.85%	13.81%	3.762%	4.425%
Construction	6.83%	7.76%	8.53%	12.13%	12.68%	1.728%	3.098%
Lumber and Wood products	13.72%	12.68%	13.23%	17.44%	17.74%	-0.284%	2.284%
Furniture and Fixtures	9.09%	9.75%	10.73%	14.23%	14.86%	1.278%	2.539%
Stone, Clay and Glass products	5.51%	6.89%	7.98%	10.56%	11.36%	2.888%	2.757%
Primary Metals	11.43%	12.56%	12.36%	15.66%	16.31%	0.603%	2.159%
Fabricated Metals	9.85%	12.15%	12.69%	16.28%	17.30%	1.969%	2.412%
Machinery except electrical	9.23%	12.17%	14.89%	21.03%	21.56%	3.741%	2.890%
Electrical Machinery, equipment and supplies	9.11%	12.05%	13.35%	19.54%	20.45%	2.980%	3.333%
Motor vehicles and other transportation equipment	10.97%	15.85%	18.39%	21.41%	23.09%	4.055%	1.763%
Misc. Manufacturing indutries	8.56%	10.05%	10.64%	15.14%	15.77%	1.683%	3.073%
Food and Kindred products	4.87%	6.44%	6.55%	9.91%	10.43%	2.305%	3.642%
Tobacco products	3.63%	6.08%	5.42%	7.25%	6.90%	3.131%	1.880%
Textile Mill products	6.93%	8.56%	12.09%	15.15%	16.08%	4.377%	2.218%
Apparel and other finished textile products	9.02%	11.03%	15.28%	20.50%	20.33%	4.135%	2.220%
Paper and allied products	9.41%	10.43%	10.65%	14.06%	14.37%	0.957%	2.328%
Printing, Publishing and allied industries	6.99%	8.71%	8.50%	11.11%	10.49%	1.511%	1.629%
Chemicals and allied products	5.84%	10.33%	10.30%	13.86%	13.69%	4.458%	2.214%
Rubber and misc. plastic products	6.41%	8.54%	9.91%	14.40%	14.42%	3.399%	2.928%
Leather and leather products	10.57%	12.62%	17.13%	27.74%	28.32%	3.787%	3.942%

Evolution of the Outsourcing of Goods Share by Industry - Part 2

Industry	73	80	86	96	99	AGR 73-86	AGR 86-99
Transportation, Utilities and Sanitary Services	3.95%	8.43%	6.14%	9.35%	9.36%	3.453%	3.295%
Communications	3.92%	5.51%	5.38%	6.32%	5.98%	2.457%	0.822%
Wholesale and Retail Trade	3.07%	3.78%	3.37%	5.80%	5.77%	0.721%	4.227%
Finance, Insurance and Real Estate	1.46%	1.79%	1.51%	2.65%	2.40%	0.243%	3.617%
Business Services and professional services	2.99%	4.11%	3.99%	7.66%	7.25%	2.236%	4.703%
Automobile and Repair Services	10.07%	10.03%	11.82%	15.25%	15.14%	1.243%	1.923%
Personal Services	4.66%	6.15%	6.74%	7.22%	6.67%	2.883%	-0.075%
Entertainment and Recreation	1.98%	3.24%	3.09%	3.57%	3.49%	3.496%	0.942%
Health, Educational and Social Services, and Membership Organizations	3.12%	5.07%	4.67%	6.72%	7.57%	3.145%	3.782%
Average	6.74%	8.57%	9.33%	12.90%	13.14%	2.540%	2.687%

Source BEA: Annual Input-Output Tables
Total Outsourcing: value of imported intermediate inputs as a share of total intermediate inputs.
AGR := Average Growth Rate

Table 4: Evolution of the Outsourcing of Services Share by Industry - Part 1

Industry	73	80	86	96	99	AGR 73-86	AGR 86-99
Agriculture, Foresty and Fishery	0.28%	0.42%	0.47%	0.90%	0.88%	4.106%	4.970%
Mining	0.29%	0.45%	0.40%	0.62%	0.69%	2.579%	4.272%
Construction	0.49%	0.47%	0.61%	0.85%	0.79%	1.695%	2.008%
Lumber and Wood products	0.38%	0.43%	0.50%	0.96%	0.94%	2.162%	5.056%
Furniture and Fixtures	0.43%	0.46%	0.52%	1.06%	0.99%	1.588%	5.065%
Stone, Clay and Glass products	0.63%	0.65%	0.58%	1.12%	1.09%	-0.665%	4.968%
Primary Metals	0.48%	0.61%	0.58%	1.17%	1.19%	1.441%	5.750%
Fabricated Metals	0.41%	0.47%	0.48%	1.00%	0.94%	1.289%	5.208%
Machinery except electrical	0.36%	0.45%	0.49%	1.01%	0.95%	2.399%	5.159%
Electrical Machinery, equipment and supplies	0.34%	0.45%	0.51%	0.96%	0.89%	3.095%	4.352%
Motor vehicles and other transportation equipment	0.37%	0.37%	0.39%	0.90%	0.83%	0.389%	6.020%
Misc. Manufacturing indutries	0.41%	0.48%	0.58%	1.13%	1.06%	2.699%	4.731%
Food and Kindred products	0.32%	0.42%	0.50%	0.94%	1.02%	3.380%	5.621%
Tobacco products	0.22%	0.24%	0.29%	0.91%	0.82%	2.236%	8.216%
Textile Mill products	0.34%	0.48%	0.50%	0.84%	0.83%	2.911%	3.937%
Apparel and other finished textile products	0.34%	0.43%	0.49%	0.83%	0.83%	2.858%	4.123%
Paper and allied products	0.49%	0.58%	0.58%	0.98%	0.94%	1.192%	3.864%
Printing, Publishing and allied industries	0.44%	0.43%	0.52%	0.94%	0.90%	1.308%	4.337%
Chemicals and allied products	0.41%	0.52%	0.50%	0.98%	1.01%	1.438%	5.622%
Rubber and misc. plastic products	0.43%	0.47%	0.49%	0.92%	0.91%	0.950%	4.933%
Leather and leather products	0.35%	0.36%	0.43%	0.82%	0.80%	1.448%	4.911%

Evolution of the Outsourcing of Services Share by Industry - Part 2

Industry	73	80	86	96	99	AGR 73-86	AGR 86-99
Transportation, Utilities and Sanitary Services	0.79%	0.98%	0.66%	1.87%	1.68%	-1.346%	7.438%
Communications	0.24%	0.38%	0.39%	0.66%	0.64%	4.003%	3.764%
Wholesale and Retail Trade	0.40%	0.49%	0.51%	0.95%	0.94%	1.901%	4.768%
Finance, Insurance and Real Estate	0.22%	0.37%	0.47%	0.72%	0.65%	6.140%	2.562%
Business Services and professional services	0.34%	0.32%	0.42%	0.82%	0.85%	1.724%	5.582%
Automobile and Repair Services	0.41%	0.65%	0.76%	0.91%	0.84%	4.967%	0.717%
Personal Services	0.31%	0.61%	0.50%	0.78%	0.78%	3.620%	3.536%
Entertainment and Recreation	0.27%	0.42%	0.43%	0.78%	0.76%	3.469%	4.540%
Health, Educational and Social Services, and Membership Organizations	0.33%	0.42%	0.41%	0.79%	0.76%	1.625%	4.958%
Average	0.38%	0.48%	0.50%	0.94%	0.91%	2.22%	4.700%

Source BEA: Annual Input-Output Tables
Total Outsourcing: value of imported intermediate inputs as a share of total intermediate inputs.
AGR := Average Growth Rate

Table 5: Evolution of the Outsourcing Share

	os^s	osm^s	oss^s
1973	5.19%	4.81%	0.38%
1974	5.97%	5.60%	0.37%
1975	5.86%	5.38%	0.48%
1976	5.96%	5.45%	0.51%
1978	6.63%	6.18%	0.45%
1979	6.86%	6.40%	0.47%
1980	6.78%	6.30%	0.48%
1981	6.79%	6.19%	0.60%
1983	6.67%	6.14%	0.53%
1984	6.82%	6.37%	0.44%
1985	6.47%	6.01%	0.46%
1986	6.52%	6.02%	0.50%
1996	9.27%	8.35%	0.92%
1997	9.44%	8.50%	0.94%
1998	9.36%	8.36%	1.00%
1999	9.22%	8.35%	0.87%
Annual Growth Rate	Total	of Goods	of Services
73-86	1.77%	1.73%	2.07%
86-99	2.70%	2.55%	4.42%

Source BEA: Annual Input-Output Tables
Total Outsourcing: value of imported intermediate inputs as a share of total intermediate inputs.
Outsourcing of Goods: value of imported intermediate goods as a share of total intermediate inputs.
Outsourcing of Services: value of imported intermediate services as a share of total intermediate inputs.

Table 6: Growth Rate for the 1978-1999 period of u_{it} and s_{it}

Industry	Growth Rate u_{it}	Growth Rate s_{it}
Construction	-3.76%	55.94%
Lumber and Wood products	-39.49%	41.70%
Furniture and Fixtures	-38.10%	52.01%
Stone, Clay and Glass products	-43.68%	-1.94%
Primary Metals	-50.92%	4.74%
Fabricated Metals	-34.88%	6.68%
Machinery except electrical	-77.45%	-59.18%
Electrical Machinery, equipment and supplies	-76.77%	-36.06%
Motor vehicles and other transportation equipment	-62.35%	3.13%
Misc. Manufacturing indutries	-53.07%	10.11%
Food and Kindred products	-38.61%	-16.23%
Tobacco products	-57.44%	39.13%
Textile Mill products	-52.00%	16.73%
Apparel and other finished textile products	-58.87%	-13.19%
Paper and allied products	-45.37%	-7.10%
Printing, Publishing and allied industries	-43.36%	-1.21%
Chemicals and allied products	-60.51%	-18.97%
Rubber and misc. plastic products	-56.02%	-24.59%
Leather and leather products	-53.73%	9.74%
Transportation, Utilities and Sanitary Services	-69.05%	-32.09%
Communications	-82.49%	-51.31%
Wholesale and Retail Trade	-45.31%	3.41%
Finance, Insurance and Real Estate	-32.84%	0.76%
Business Services and professional services	74.11%	-45.21%
Personal Services	-59.27%	88.62%
Entertainment and Recreation	-58.85%	31.19%
Health, Educational and Social Services, and Membership Organizations	-46.25%	-5.95%
Weighted Average	-27.42%	-6.92%

u_{it}: Ratio of the number of unskilled workers over the Real Output for each industry i at time t
s_{it}: Ratio of the number of skilled workers over the Real Output for each industry i at time t

Table 7: Regression using outsourcing of services and of goods (oss, osm)

Dep. Var. $\Delta \ln$	Employment	Unskilled Employment	Skilled Employment
Indep. Var.	(1)	(2)	(3)
Δoss^s	2.061	-.790	19.791
	(5.891)	(9.677)	(15.647)
Δoss^s_{-1}	-2.415	-.728	-2.701
	(7.233)	(11.851)	(19.162)
Δosm^s	1.117	1.283	.804
	(.472)**	(.779)*	(1.260)
Δosm^s_{-1}	-.185	1.061	-3.241
	(.477)	(.780)	(1.262)**
$\Delta \ln r$	-.021	-.040	-.031
	(.022)	(.035)	(.057)
$\Delta \ln r_{-1}$	.039	-.003	.099
	(.022)*	(.037)	(.060)*
$\Delta \ln \omega$	-.539		
	(.097)***		
$\Delta \ln \omega_{-1}$	.004		
	(.100)		
$\Delta \ln \omega^u$		.033	-.875
		(.080)	(.129)***
$\Delta \ln \omega^u_{-1}$		-.021	.060
		(.091)	(.148)
$\Delta \ln \omega^s$		.077	-.431
		(.075)	(.121)***
$\Delta \ln \omega^s_{-1}$		-.093	.647
		(.077)	(.125)***
$\Delta \ln Y$	.836	.904	.684
	(.047)***	(.078)***	(.126)***
$\Delta \ln Y_{-1}$	.033	-.028	.245
	(.048)	(.080)	(.129)*
Time dummies	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*
N	216	216	216
R^2	.794	.622	.51

Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels of significance.

Table 8: Regression using total outsourcing (os)

Dep. Var. $\Delta \ln$	Employment	Unskilled Employment	Skilled Employment
Indep. Var.	(1)	(2)	(3)
Δos^s	1.112	1.285	.766
	(.469)**	(.774)*	(1.258)
Δos^s_{-1}	-.175	1.051	-3.119
	(.473)	(.774)	(1.257)**
$\Delta \ln r$	-.021	-.040	-.035
	(.021)	(.035)	(.057)
$\Delta \ln r_{-1}$	.040	-.003	.099
	(.022)*	(.037)	(.059)*
$\Delta \ln \omega$	-.538		
	(.097)***		
$\Delta \ln \omega_{-1}$	.004		
	(.100)		
$\Delta \ln \omega^u$		.034	-.880
		(.079)	(.129)***
$\Delta \ln \omega^u_{-1}$		-.019	.049
		(.091)	(.147)
$\Delta \ln \omega^s$		.076	-.427
		(.074)	(.120)***
$\Delta \ln \omega^s_{-1}$		-.093	.646
		(.077)	(.124)***
$\Delta \ln Y$	.835	.907	.659
	(.046)***	(.077)***	(.124)***
$\Delta \ln Y_{-1}$	.034	-.026	.241
	(.048)	(.078)	(.127)*
Time dummies	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*
N	216	216	216
R^2	.794	.622	.505

Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels of significance.

Table 9: Regression using price of outsourcing (p^o) (First Alternative)

Dep. Var. $\Delta \ln$	Employment	Unskilled Employment	Skilled Employment
Indep. Var.	(1)	(2)	(3)
$\Delta \ln p^o$	-.008	-.031	.033
	(.051)	(.084)	(.139)
$\Delta \ln p^o_{-1}$	-.186	-.170	-.077
	(.070)***	(.115)[1]	(.191)
$\Delta \ln r$	-.023	-.032	-.059
	(.021)	(.034)	(.057)
$\Delta \ln r_{-1}$	.032	-.010	.090
	(.022)	(.036)	(.060)
$\Delta \ln \omega$	-.528		
	(.096)***		
$\Delta \ln \omega_{-1}$	.013		
	(.100)		
$\Delta \ln \omega^u$		.034	-.881
		(.080)	(.132)***
$\Delta \ln \omega^u_{-1}$		-.011	.033
		(.091)	(.151)
$\Delta \ln \omega^s$		.065	-.415
		(.075)	(.124)***
$\Delta \ln \omega^s_{-1}$		-.081	.650
		(.076)	(.127)***
$\Delta \ln Y$	.821	.898	.649
	(.047)***	(.077)***	(.128)***
$\Delta \ln Y_{-1}$	.043	-.012	.233
	(.047)	(.078)	(.130)*
Time dummies	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*
N	216	216	216
R^2	.796	.62	.483

Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels of significance.

[1] The coefficient corresponding to past price of outsourcing is significant at the 14% level.

Table 10: Regression using price of outsourcing (p^o) (Second Alternative)

Dep. Var. $\Delta \ln$	Employment	Unskilled Employment	Skilled Employment
Indep. Var.	(1)	(2)	(3)
$\Delta \ln p^o$	-.016	-.035	.026
	(.048)	(.078)	(.130)
$\Delta \ln p^o_{-1}$	-.153	-.166	-.035
	(.070)**	(.114)[1]	(.190)
$\Delta \ln r$	-.022	-.030	-.060
	(.021)	(.034)	(.057)
$\Delta \ln r_{-1}$	.032	-.010	.090
	(.022)	(.036)	(.060)
$\Delta \ln \omega$	-.520		
	(.097)***		
$\Delta \ln \omega_{-1}$	.011		
	(.100)		
$\Delta \ln \omega^u$		.035	-.880
		(.080)	(.132)***
$\Delta \ln \omega^u_{-1}$		-.011	.031
		(.091)	(.151)
$\Delta \ln \omega^s$		.066	-.412
		(.075)	(.124)***
$\Delta \ln \omega^s_{-1}$		-.081	.651
		(.076)	(.127)***
$\Delta \ln Y$	.820	.894	.653
	(.047)***	(.077)***	(.128)***
$\Delta \ln Y_{-1}$	-.015	.230	
	(.048)	(.079)	(.130)*
Time dummies	*Yes*	*Yes*	*Yes*
Industry dummies	*Yes*	*Yes*	*Yes*
N	216	216	216
R^2	.793	.62	.483

Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels of significance.

[1] The coefficient corresponding to past price of outsourcing is significant at the 15% level.

Table 11: Allen/Partial Elasticities of Substitution (First Alternative)

	u	s	d	os	k
u	-4.075	-1.047	1.544	0.618	-0.106
s		-2.558	1.044	-1.142	0.553
d			-1.159	1.882	0.670
os				-34.252	0.226
k					-2.223

u stands for unskilled, s for skilled, d for domestic intermediates, os for imported intermediates (outsourcing), and k for capital.

These are the Allen Elasticities of Substitution. The upper and lower part of the matrix presented are equal. These elasticities are estimated elasticities, since they vary across years and industries. Thus, we compute them for 1986 (middle year) and for a weighted cost-share, where more weight is given to the industries with higher gross output.
A positive number indicates the factors are **substitutes**, and a negative number means factor **complementarity**

Table 12: Allen/Partial Elasticities of Substitution for K and L intensive (First Alternative)

K - intensive	u	s	d	os	k
u	-4.13	-0.53	1.36	1.27	-0.14
s		-2.93	0.92	-1.94	0.92
d			-0.95	1.76	0.37
os				-26.85	-0.21
k					-1.70

L - intensive	u	s	d	os	k
u	-4.00	-1.50	1.68	0.10	-0.01
s		-2.16	1.10	-0.51	0.30
d			-1.32	2.50	0.87
os				-49.30	0.39
k					-2.59

u stands for unskilled, s for skilled, d for domestic intermediates, os for imported intermediates (outsourcing), and k for capital.

These are the Allen Elasticities of Substitution. The upper and lower part of the matrix presented are equal. These elasticities are estimated elasticities, since they vary across years and industries. Thus, we compute them for 1986 (middle year) and for a weighted cost-share, where more weight is given to the industries with higher gross output.
A positive number indicates the factors are **substitutes**, and a negative number means factor **complementarity**

Table 13: Allen/Partial Elasticities of Substitution (Second Alternative)

	u	s	d	os	k
u	-4.044	-1.048	1.538	0.511	-0.116
s		-2.631	1.071	-1.072	0.521
d			-1.170	1.893	0.689
os				-34.063	0.230
k					-2.248

u stands for unskilled, s for skilled, d for domestic intermediates, os for imported intermediates (outsourcing), and k for capital.

These are the Allen Elasticities of Substitution. The upper and lower part of the matrix presented are equal. These elasticities are estimated elasticities, since they vary across years and industries. Thus, we compute them for 1986 (middle year) and for a weighted cost-share, where more weight is given to the industries with higher gross output.
A positive number indicates the factors are **substitutes**, and a negative number means factor **complementarity**

Table 14: Allen/Partial Elasticities of Substitution for K and L intensive (Second Alternative)

K - intensive	u	s	d	os	k
u	-4.016	-0.515	1.328	0.991	-0.133
s		-3.078	0.982	-1.841	0.865
d			-0.971	1.860	0.410
os				-27.428	-0.253
k					-1.742

L - intensive	u	s	d	os	k
u	-4.031	-1.531	1.688	0.161	-0.029
s		-2.156	1.102	-0.492	0.289
d			-1.326	2.557	0.870
os				-50.233	0.396
k					-2.596

u stands for unskilled, s for skilled, d for domestic intermediates, os for imported intermediates (outsourcing), and k for capital.

These are the Allen Elasticities of Substitution. The upper and lower part of the matrix presented are equal. These elasticities are estimated elasticities, since they vary across years and industries. Thus, we compute them for 1986 (middle year) and for a weighted cost-share, where more weight is given to the industries with higher gross output.
A positive number indicates the factors are **substitutes**, and a negative number means factor **complementarity**