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The Determinants of Outsourcing from the U. S.: Evidence from Domestic Manufacturing Industries 1972-2002.

Maxim Belenkiy

Abstract

The issue of outsourcing as a form of foreign direct investment (FDI) has been widely discussed in the recent past. In this essay, I analyze what determines the outsourcing activity by looking at U. S. manufacturing industries between 1972 and 2002. I concentrate on correlation between the measure of outsourcing and wages, bargaining coverage contracts, transportation costs, and private gross fixed investment in information technology. My analysis finds differences in the effects of wages on outsourcing activity depending on the type of industry (in other words the industry producing durable goods versus non-durable goods). The main regression model finds that wages and union coverage cannot fully explain the colossal increase in outsourcing activity in the last three decades. Rather, the likely main sources of the U. S. outsourcing are foreign productivity growth and technological changes that allow more international specialization in the intermediate production stages of the final good.

“The global deployment of work has its critics, but it holds huge opportunities for rich and poor countries alike” – Ben Edwards (*The Economist* - Nov. 13-19,2004 pg.1)

Introduction

The election year of 2004 sparked a new wave of debate on globalization. However, the process of globalization, or, more precisely, international trade that exploits comparative advantage, was already discussed back in the 19th century by David Ricardo, in an age when people traded grain to remote countries. More recently high-tech methods allow corporations to transfer various projects efficiently through computer networks. These networks make it easier for many corporations to offshore or outsource their production to countries with cheaper labor. So, what is outsourcing, and does the government really need to protect America against it? Would our economy be better of

with competitive free markets or a closed economy? The majority of economists favor the former.

In Webster's dictionary outsourcing is defined as: "the practice of subcontracting manufacturing work to outside and especially foreign or nonunion companies". A recent "Survey of Outsourcing" in *The Economist* provides a proper definition of outsourcing: "Handing work the companies used to perform in-house to outside firms".(2004, p. 4). In his recent speech in Congress, G Mankiw said that "if services can be sourced more cheaply overseas than at home, it is to America's advantage to seize that opportunity". (*The Economist* 2004). This quote would raise the eyebrows of ordinary American workers, as it seems that even the government underplays the danger of losing white-collar jobs in which Americans have had a comparative advantage.

Yet many economists consider such a danger a myth. They consider globalization and its derivative outsourcing as advantage for developed and developing countries alike. In his speech on globalization Alan Greenspan noted: "During the past half-century, barriers to trade and to financial flows have generally come down, resulting in a significant broadening of world markets. Standards of living rise because the depreciation and other cash flows of industries employing older, increasingly obsolescent, technologies are marshaled, along with new savings, to finance the production of capital assets that almost always embody cutting-edge technologies" (Greenspan, Lecture, First Annual Stavros S. Niarchos Lecture, 2001). One of the popular claims about outsourcing is that it will cause the U. S. to lose a net 3.3 million jobs by 2015. However, on closer scrutiny it becomes clear that this loss amounts to only 0.71 % of all cyclic job losses in America (Ansberry, 2003). Other economists show that the gains of trade outweigh the

costs, even when job dislocations are factored into account. “The Survey of Outsourcing” reckons that, due to outsourcing, there is a net gain in jobs, a finding that was also emphasized in a recent Global Insight study.

This intense debate calls for a deeper look at the question of what determines outsourcing. To do so I perform a statistical analysis of the U. S. manufacturing industries that suffered the biggest job losses in recent decades as these are the industries that are highly labor and capital intensive and thus more susceptible to outsourcing trends (Lipsey,1994).

Background

Manufacturing has been a troubled sector for the past several decades. In particular manufacturing has seen a decline in work-force as more and more labor intensive intermediate goods of production are being imported from countries that can produce those goods more cheaply. In short, U. S. manufacturing firms outsource intermediate stages of production by importing intermediate parts. In theory outsourcing activity is a kind of vertical foreign direct investment for the U. S. firm that splits the manufacturing of the final good across different countries. It is doing so by substituting foreign imported parts for U. S. made intermediate parts. (Blonigen, 2001). The use of foreign suppliers allows for a reduction in the complexity and in the average cost of producing a final good, without sacrificing proximity to the initial market and overall productivity.

What does such a strategy mean for U. S. manufacturing? The statistics from Michigan, once the nation’s capital of manufacturing, suggest some answers. Between

1970 and 2003 manufacturing employment declined from a 33% share to a 16% share of the job market. The decline of manufacturing jobs was absolute and not just relative: from 1994 to 2003 approximately 7000 manufacturing jobs disappeared (in the Michigan Capital Area). Only 21% of those job losses were tied to international trade¹. The bar graph below (Fig. 1) shows the overall trend of employment patterns in the U. S. for 1970 and 2003.

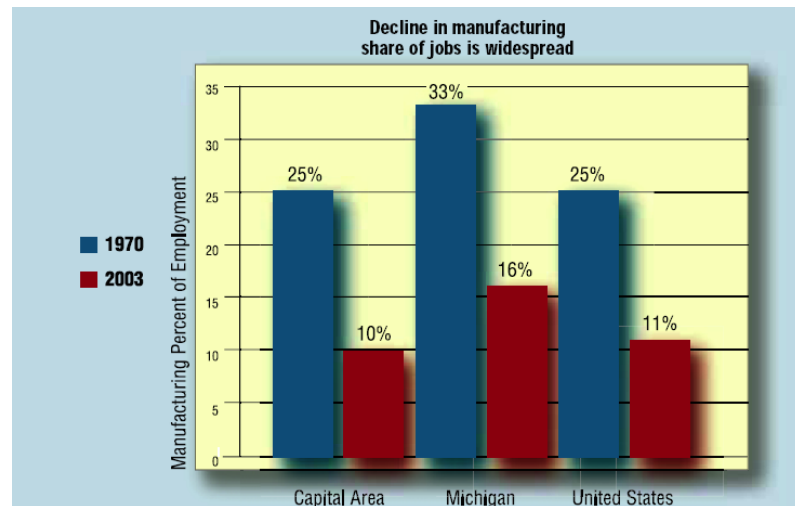


Figure 1

Source: Capital Area Manufacturing 1970 and 2003

Yet the increase in high-technology capital investment in the manufacturing industry brought some positive signs as well: Worker productivity in local automobile plants increased from 14 vehicles per worker in 1970 to 48 vehicles per worker in 2002, an increase of 243%. Globalization and outsourcing brought some mixed trends in employment patterns in manufacturing industries. The Department of Labor Statistics reports that advances in technology are increasing costs of production and that, to remain competitive, manufacturers must emphasize education and training more than they have in the recent past. This report shows that, in the manufacturing industry, openness to

trade forces firms to seek to increase the skill levels of their employees, hence increasing productivity over time.

So how much harm does outsourcing really cause in manufacturing? Various studies suggest that it is not very much. Domestic manufacturing investment grew in the 1990s and the U. S. was the largest recipient of foreign investment (Navaretti & Venables, 2004). In the past two years, manufacturing investment by U. S. manufactures in China and Mexico was only 3% of \$140 billion in investment by U. S. manufactures.

To explain the pattern of outsourcing activity empirically is the main goal of this research paper. Specifically I will concentrate on finding a partial correlation between shares of outsourcing and wages, in order to observe how much the increase in wages increase the decision to outsource. Furthermore I will explore how outsourcing decisions are affected by union bargaining agreements as share of expenses. The vast improvement and development of transportation logistics also deserves attention as it reduces transportation costs, making it cheaper to outsource intermediate goods of production. In order to answer the question—*If investment in high-technology capital increases productivity, does it also increase, the share of outsourcing?*—I will look at the investments in IT technology to answer this question.

To perform a detailed study on U. S. Manufacturing Industries it is necessary to disaggregate manufacturing into sub-industries according to SIC and NAICS classifications. This will give 20 sub-industries spanning the whole of U. S. manufacturing activity. I can then examine each industry in five-year increments from 1972-2002 in order to obtain the desired trends.

An Empirical Model

A DESCRIPTION OF THE MODEL

The principal method of this paper is to examine how characteristics of the U. S. manufacturing industries (SIC 20-39)² affect outsourcing of intermediate parts of production.

Consider the following multivariate model:

$$(BIMAT)_{it} = \beta_0 + \beta_1(Real_Wages)_{it} + \beta_2(Union_Cov)_{it} + \beta_3(Trans_Cost)_{it} + \beta_4(GPF_IT)_{it} + \varepsilon_{it} \quad (1)$$

where i is the code for 2-digit SIC industry, t is a year, β represents the coefficients of independent variables, BIMAT is a dependent variable representing the outsourcing indicator, and ε is an error term that captures all other factors not explained by determinants included in the model. This is essentially a log-log model, as it helps to predict the effects of percentage changes of independent variables on share of dependent variable (outsourcing indicator)³. The model estimates the elasticity of the explanatory variable on the share of outsourcing while holding constant all other explanatory variables⁴.

A DESCRIPTION OF DEPENDENT AND EXPLANATORY VARIABLES.

The Dependent Variable: Share of Outsourcing. It has been noted that, “because outsourcing involves more than just a purchase of a particular type of good or service, it has been difficult to measure the growth of international outsourcing” (Grossman, Helpman, 2002, p. 2). Despite this potential, in order to stay empirical I will use the traditional approach of measuring outsourcing—examining the share of intermediate goods imported by the manufacturing industries (SIC 20-39) from outside the United

States to produce a unit of a final good. Feenstara and Hanson's (1999) method of constructing the measure of outsourcing share by 2-SIC industry across years is particularly useful for my purpose.

The following formula allows us to obtain this measure:

$$\sum_i \frac{\text{input purchases of good } j \text{ by industry } i}{\text{imports of good } j / \text{consumption of good } j} (2)$$

This formula represents a method to obtain the share of intermediate inputs used by the firms in a given industry. As the above formula is the key for calculating the measure of outsourcing, it merits a detailed interpretation. The denominator in the last term of the formula is consumption. However, in this case it is equivalent to the demand of the good j by industry i . Demand is equal to the shipments minus the exports plus the imports of the good j . This way of calculating the demand allows for the measurement of imported good j purchased or demanded by the industry as an intermediate good for production. The numerator of the last term represents the quantity of good j that was imported. This value, when divided by demand provides an import ratio of good j used by industry i as an intermediate input for production of one unit of the final good. In short to calculate the outsourcing indicator for every industry I take a particular good j —in this case a potential good used for manufacturing by 2-SIC industry—and multiply it by the import ratio. I do this for every good used by industry i , and then add all of them to obtain their sum, which represents the total demand for all intermediate goods.

HYPOTHESIS AND RELATIONSHIPS OF DEPENDENT AND INDEPENDENT VARIABLES.

Wages across industries. This explanatory variable appears as “Wage_{it}” in equation (1). The primary motivation for outsourcing activity is reducing labor costs and splitting the intermediate stages of production between firms with narrow specialization. The effect of globalization increased the demand for higher skills and better training in the U. S. manufacturing sector. Higher skill level increases the bargaining power of workers, and therefore puts upward pressure on wages. Therefore, an initial hypothesis is that *a higher wage level will increase the share of outsourcing, as the opportunity to import intermediate goods reduces employment and wages formerly used for production of those intermediate inputs*

Union bargaining contracts. This explanatory variable appears as “Union_Cov_{it}” in equation (1). Basic macro-theory hints at the reason that this variable is important in the study. Unions affect the bargaining power of workers, and thus the wages. This then increases labor costs for firms, and encourages them to seek cheaper labor sources. The analysis of union bargaining agreements is especially important in the manufacturing sector, which is comparatively more unionized than other sectors. As reported for the year 2002 by the Bureau of Labor Statistics, 14.6% of those employed in manufacturing were members of a union and therefore covered by a bargaining agreement. This percentage is second only to that in the construction industry. Thus, a second hypothesis is that *the stronger the union presence in a given industry, the more likely a firm in that industry will seek outsourcing as a cost-reduction measure.*

Transportation accounts and costs of delivering a unit of a final good. This explanatory variable appears in (1) as “Transport_Cost_{it}”, and captures the transportation costs incurred by a firm as a share of its total intermediate expenditures. The highly improved transportation networks that rely on logistics systems tend to reduce the costs of international transportation. Sub-contracting companies deliver goods more quickly and reliably than the manufacturers themselves, thereby creating potential savings and making outsourcing more attractive. This leads to the hypothesis that *reduced international transportation costs increase the share of outsourcing.*

Gross Private Fixed Investment in Information technology. This explanatory variable appears in (1) as “GPF_IT_{it}”. One of the major factors in increasing the level of productivity among workers in the manufacturing sector is undoubtedly the emergence of new technologies, especially information technologies, including basic computers, robots, communication equipment and many others. In recent decades the marginal costs of producing IT have dropped significantly enough that owners of manufacturing firms have been keen to invest in it in order to reduce costs of production by substituting machines for workers. It is therefore conceivable that the share of outsourcing would increase with the amount of investment in IT—especially in communication, where cheaper IT technologies have reduced production costs. A fourth hypothesis, therefore, is that *increasing the share of IT technology increases the share of outsourcing.*

Preliminary Results

In this section I present descriptive statistics for each variable and explain some key points of interest related to these statistics. Also present will be the line graphs⁵ of

changes in share of outsourcing across years for three sample industries. Some peculiarities that merit discussion arise. Together with sample trends will appear the line graph of overall movement in the share of outsourcing in the manufacturing industry from 1972-2002, showing the bi-variate scatter plots of share of outsourcing and of each of the explanatory variables. Finally, the matrix of correlation for dependent and independent variables helps in estimating preliminary relationships and the preliminary economic significance of the data.

DESCRIPTIVE STATISTICS

Before undertaking the regression analysis, it is important to learn all the statistical aspects of the dependent and independent variables of interest.

Table 1 - Summary of Descriptive Statistics (Dependent Variable = BIMAT)					
	BIMAT	WAGES	Um_COV	Transport_Cost	GPF_IT
Mean	0.080	9.070	0.245	0.025	0.150
Median	0.078	8.909	0.231	0.013	0.084
Maximum	0.228	14.633	0.579	0.147	0.803
Minimum	0.006	5.159	0.059	0.002	-0.088
Std. Dev.	0.047	2.059	0.124	0.027	0.149
Skewness	0.663	0.298	0.558	1.949	1.808
Observations	160	160	160	160	160

Table 1 reports summary statistics of the dependent and independent variables. Although the mean and the median for BIMAT are close to each other, the skewing is rather high, indicating a lack of symmetry in the data of spread of the dependent variable. This skewing could be attributed to the large number of outlier companies that rely much more heavily on outsourcing. It might therefore be necessary to control for such outliers in the regression analysis.⁶ The remaining determinants listed in Ttable 1 show an asymmetrical distribution similar to that shown in BIMAT. Wage determinant has the

least skewing among all other determinants. This could be attributed to the movement of real wages across years. Overall real wages did not increase significantly over the past several decades. Table 1 also presents standard deviations for every variable. In almost every case the variance barely exceeds 1-2% suggesting a low probability of auto-correlation of the explanatory variables⁷.

THE BEHAVIOR OF THE SHARE OF OUTSOURCING ON INDIVIDUAL SECTORS

In order to trace outsourcing trends across years, two representative industries from the manufacturing sectors were chosen. As mentioned previously, the data set on BIMAT suggests the presence of outliers that rely more heavily than other firms on outsourcing. The manufacturing sector is divided according to the production of durable and non-durable goods. I pick SIC 20, and SIC 37 as two representative industries producing durable and non-durable goods, respectively. Figure 2 presents side-by-side graphs of BIMAT for SIC 20 and SIC 37 for purposes of comparison.

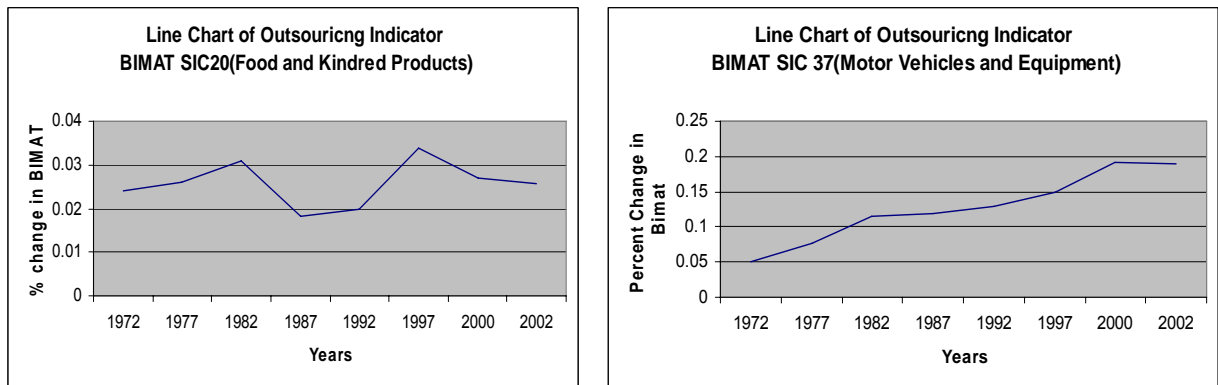


Figure 2 – Line Charts of BIMAT

Figure 2⁸ graphically shows the change in share of outsourcing across years for SIC 20 and SIC 37. There is a visible difference in the shape of these two graphs: SIC 20, which represents food and kindred products, shows no clear trend as the line graph goes up and down throughout the years, whereas SIC 37 shows a steady, almost linear increase in the share of outsourcing. Part of this difference may be attributed to the fact, that between 1972-2002 the automobile industry, in order to produce its end product, steadily imported a greater share of intermediate goods than did the food industry. Even though there are some industries producing non-durable goods that have seen a steady increase in outsourcing activity (e.g., SIC 31 had an increase from 6% in 1972 to 27% in 1997), the data still show that, compared with non-durable goods industries, durable goods industries had considerably greater outsourcing activity throughout 1972-2002. These data suggest the plausibility of controlling for the type of industry when measuring outsourcing.

BIVARIATE RELATIONSHIPS AND MATRIX OF CORRELATION

To show the individual relationships between the measure of share of outsourcing and each explanatory variable, scatter plots reveal certain trends. The scatter plot in Figure 3 represents a relationship between the outsourcing indicator and lagged unionization variable. The small variance of the independent variable produces a more efficient estimate of the beta coefficient, and also helps us determine how “tight” the data is concentrated around the estimated regression line.

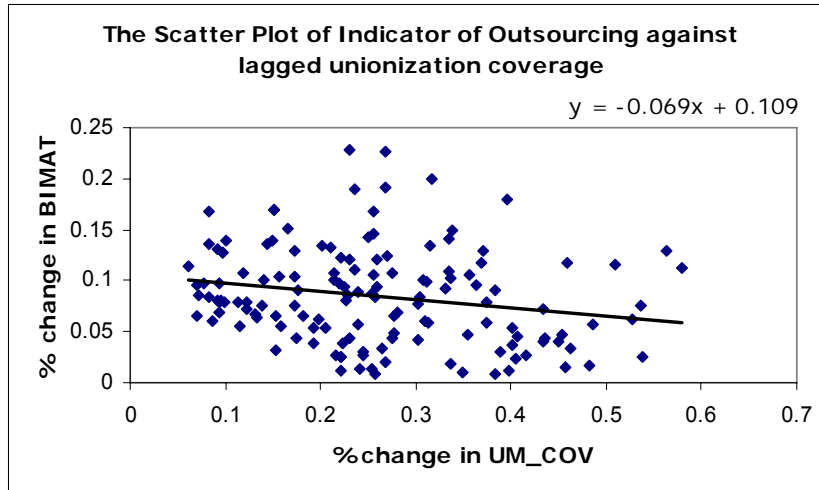


Figure 3

An important observations about the scatter plot in Figure 3 merit attention.. Contrary to the earlier hypothesis, there is a negative relationship between percent change in unionization coverage and percent change in share of outsourcing.

Table 2 shows the Matrix of Correlation between the variables in the model. The correlation coefficients help us predict the relationships as well as the strength of the relationships between variables.

Table 2 - Matrix of Correlations					
	BIMAT	RWH	UM_COVERAGE	TRANSPORATIONCOSTS	CAPITAL
BIMAT	1.000	-0.230	-0.224	-0.174	0.171
RWH	-0.230	1.000	0.325	0.052	0.288
UM_COVERAGE	-0.224	0.325	1.000	0.553	-0.428
TRANSPORATIONCOSTS	-0.174	0.052	0.553	1.000	-0.423
CAPITAL	0.171	0.288	-0.428	-0.423	1.000

Note that none of the correlation coefficients of BIMAT and independent variables are equal to zero. That is, each independent variable has a linear relationship to BIMAT (outsourcing indicator). Also none of the correlation coefficients between

independent variables is equal to 1, indicating that there is no perfect multicollinearity. The first column in Table 2 reports the correlation coefficients of BIMAT and its determinants. The coefficients for Transportation Costs and Capital predict the trends between BIMAT and each variable, a result in accordance with my early predictions. The correlation coefficient of BIMAT and Transportation Costs is negative, allowing for the prediction that a decrease in the cost of international transportation will result in an increase in the share of outsourcing. Similarly, with an increasing share of IT investment, the share of outsourcing is predicted to rise. However, the results for the trends in real wages and union coverage seem to contradict the earlier hypothesis.

PRELIMINARY ECONOMIC SIGNIFICANCE OF DATA

The preliminary economic significance of the data is illustrated in the following table..

Year	BIMAT	RWH	UM_COV	TRANS_COSTS	GPF_IT
1972	0.05	9.195	0.364	0.058	0.052
2002	0.096	9.335	0.151	0.004	0.33
Δchange	0.046	0.14	-0.213	-0.054	0.278
% change	92%	1.50%	-58.52%	-93.10%	534.60%

Table 3 reports the mean changes in respective variables from 1972 and 2002. One of the goals of my research was to find the economic significance of changes between BIMAT and its determinants. A dramatic increase in outsourcing activity over the past two decades—from a mere 0.05% to 0.096%, a change of 92%—brings up the question, *To what factors can such a change be attributed?* More precisely, to what extent does the change in the determinants account for such an increase in outsourcing activity?

Two peculiar features of Table 3 are also worthy of note. Column 3 reports the change in real wages from 1972 to 2002. Real wages are the cost of labor to an employer adjusted for inflation. One would expect that the rise in real wage would increase the outsourcing activity. The real wages, however, increased very little over the past several decades (an increase of only 1.5%). To what extent does this small change help explain such a big change in the outsourcing of manufacturing?

Labor unions are one of the strongest buffers between producers and workers in the manufacturing sector. Union bargaining agreements dropped a precipitous 58%. The hypothesis was that an increase in union strength would increase the outsourcing share, as firms would try to reduce additional costs of covering bargaining agreements. This leaves the question, of how such a big drop in the share of union coverage affects outsourcing?

Columns (5) and (6) in Table 3 report the change in transportation costs and in investments in Information Technology, respectively. The tremendous decline in international logistics expenditures would seem to make outsourcing activities more attractive as the costs of transporting are minimized. The increase in IT investments indicates that expanding the technological infrastructure reduces the risks to production by allowing a firm to manage outsourcing projects from a remote location. The regression analysis allows us to assess how much of the change in outsourcing share is in fact explained by these determinants.

Regression Analysis of the Model

A regression analysis allows us to empirically verify the hypothesized effects of independent variables on outsourcing and to check the robustness of the results. As noted

previously there is some evidence that some industries producing durable good are more heavily involved in outsourcing more than non-durable producers. To confirm this assertion I use a dummy variable, IS_DURABLE, which is equal to 1 if the industries produce durable goods and 0 otherwise.⁹ I then construct an interactive term with each of the determinants to determine whether the resulting coefficient indeed suggests a differences in wages between these two groups that would affect outsourcing. I estimate the model using the following methods in turn: OLS pooled data (1), GLS panel (2) and TOBIT ¹⁰(3) estimations. To avoid bias due to omitted variables I include dummy variables for the time trend and for the industry effects in the estimation equation for OLS pooled data regression. To interpret the results, I will present a table comparing the actual and the predicted changes in BIMAT due to wages, union coverage, capital investment in information technology, and transportation costs for every SIC industry. In order to determine the robustness of the estimates, I cross-check the independent and dependent variables by constructing a BIMAT_LAG variable that allows a determination of whether outsourcing affects wages and union coverage.

TOBIT ESTIMATION OF PANEL DATA

The use of TOBIT allows an estimation of the model in which the dependent variable is bounded in value. In my base specification the dependent variable BIMAT is bounded between [0,1]. If the dependent variable is bounded, then the coefficient of the independent variable would depend on the value of the dependent variable, indicating that the OLS estimation is biased. Let's consider the estimated equation of estimation

$$(1): \widehat{BIMAT}_i = -0.326 + 0.0003 * isdrwh_lag + \text{allotherterms} + \varepsilon_i .$$

If $0 < \text{BIMAT} < 1$ then $\varepsilon_i > 0.326 - 0.0003 * \text{isdwh_lag}$, where BIMAT is just greater than zero (lower bound). Note that the error term is negatively correlated with *isdwh_lag*, making the coefficient downward-biased, and the OLS assumption is violated (i.e. $\text{corr}(\varepsilon|X) \neq 0$). I therefore estimate the model using the TOBIT method, which uses estimation based on maximum likelihood with a bounded dependent variable.

Variables	Coefficient	Standard Errors	z-statistic	Pr> z
<i>rwh_lag</i>	-0.004	0.001	-2.68	0.007
<i>isdwh_lag</i> *	0.005	0.0007	7	0
<i>um_lag</i>	-0.119	0.038	-3.12	0.002
<i>trans_lag</i>	0.416	0.127	3.29	0.001
<i>cap_lag</i>	0.011	0.03	0.37	0.711
Wald Chi2	139.72			
Log Likelihood	300.07			
n	140			

Notes: dependent variable is BIMAT. Random effects of error term has Gaussian distribution and $\text{corr}(\varepsilon, X) = 0$ (assumed). (*) indicates the coefficient is significant at 5 percent level

The coefficients of estimations in Table 4 improve upon estimation (1), correcting the downward bias in the OLS estimation. Moreover, out of five independent variables, only *cap_lag* remains statistically not significant. Bounding the interval of variation of BIMAT provides a significant improvement over estimations (1) and (2), in which only two variables were statistically significant. Note that the value for real wages has a negative sign, which persists in all estimations, but only in (3) is it statistically significant. That is, real wages are an important determinant of outsourcing. Most important is the coefficient of the second regressor, *isdwh_lag*. The magnitude of the coefficient is exactly the same as in estimation (2). That is, when comparing durable and non-durable production industries, there is strong evidence that, in the former, the share of outsourcing increases

more consistently in response to increases in real wages (as measured against the overall pool of wages).

As in estimations (1) and (2) the coefficient of union coverage is statistically significant and negative. In the case of the TOBIT estimation, a 1% increase in the share of union coverage decreases the share of outsourcing by 11.9%. Estimation (2) gives similar results.

The coefficient representing transportation costs is statistically significant and has nearly the same magnitude as in estimation (1). However, in estimation (2) transportation costs are overestimated, perhaps indicating an excessive upward bias in estimation (1). The coefficient of capital investment remains non-significant but persistently positive. The low value of the coefficient most likely arises from an error in measurement rather than the downward bias that I tried to correct using the TOBIT model.

REJECTED VARIABLES.

Trans_lag, representing transportation costs, was statistically significant in estimation (1), but the coefficient was over-estimated. In estimation (2) and (3) this coefficient drops but still remains positive, indicating that a rise in transportation costs increases the share of outsourcing, again opposite to my earlier predictions. Because the coefficient is not statistically significant, I do not consider it an important determinant of outsourcing.

The same applies to investments in information technology. Even though the coefficient of cap_lag is positive, indicating that an increase in IT investments results in

an increase in outsourcing, the effect is not statistically significant and suggests an error in the measure of IT investments. As with transportation costs, I do not consider IT investments an important determinant of outsourcing¹¹.

ADMISSIBLE VARIABLES

The last two estimations helped to strengthen the hypothesis that the relationship between real wages and BIMAT varies with the type of industry. The interaction term `isdrwh_lag` yields strong statistically significant coefficients in estimations (2) and (3). Union coverage, albeit with negative coefficients, remains significant in all (3) specifications. I therefore conclude that changes in real wages and in union coverage are important determinants of outsourcing, and thus I can proceed with interpretation of the results in terms of their impact on the share of outsourcing.

INTERPRETATION OF RESULTS

As already noted in a previous section, the share of outsourcing increased more than 90% over the past three decades (1972-2002). As the primary goal of this research is to find what determines the outsourcing, after performing the regression analysis I selected changes in real wages and in union coverage as important determinants of outsourcing. I now ask the questions, *How much change in BIMAT is explained by changes, over time, in real wages and in share of union coverage, and what is the economic significance of such change?*

A reverse causality estimation helps in finding answers to these questions by allowing us to check the robustness of the primary results. For this analysis I create a new independent variable BIMAT_LAG and regress first on RWH and then on UM¹².

Table 5 -OLS Estimation for Panel Data Set with Fixed Effects(4)				
Variables	Coefficient	Standard Errors	t-statistic	Pr> z
bimat_lag	2.562	2.687	0.95	0.342
Intercept	8.851	0.2237	39.57	0
F-statistic	0.91			
R ²	0.054			
n	140			

Notes: dependent variable is rwh1982; Included are variables (not shown) of industry and time fixed effects.

Table 5. OLS Estimation for Panel Data Set with Fixed Effects(4)

The reverse causality estimation in Table 5 shows that the share of outsourcing in the last period increases with the industry wage, although the effect is not statistically significant. This insignificance can be partly explained by the large standard error of the BIMAT coefficient, which arises from low variance of data on BIMAT. Yet the coefficient is useful in predicting that an increase in outsourcing increases wages in the U. S. A similar result was obtained by Feenstra and Hanson (1999).

I now turn to the effects of union coverage on outsourcing.

Table 6 -OLS Estimation for Panel Data Set with Fixed Effects (5)				
Variables	Coefficient	Standard Errors	t-statistic	Pr> z
bimat_lag	-0.6474*	0.233	-2.78	0.006
Intercept	0.278	0.019	14.41	0
F-statistic	7.75			
R	0.039			
n	140			

Notes: dependent variable is UM; Included are variables (not shown) of industry and time fixed effects. (*) indicates the coefficient is significant at 5 percent level

In estimation (5) the coefficient of `bimat_lag`, in contrast to that in estimation (4), is statistically significant and thus can be interpreted with a higher degree of confidence. The sign of this coefficient is negative, indicating that an increase in outsourcing activity reduces the share of workers covered by bargaining agreements. Essentially this means that, over time, union strength in the manufacturing industries has lessened.¹³

The reverse causality estimations support the hypothesis that real wages and union coverage are important determinants of outsourcing. But what is the economic significance of that conclusion?

To answer that question, I first show the marginal effects predicted by the model. That is, I calculate the β change in BIMAT associated with one unit change in real wages and in union coverage. When estimating wages, I observed the difference in overall effects of real wages on BIMAT compared with the effects when wages interact with a dummy variable that indicates whether the industry produces durable or non-durable goods. The interaction term produced positive coefficients in both specifications (2) and (3) that were statistically significant. The positive sign of this coefficient indicates a predicted trend of an increase in outsourcing activity when real wages increase. I therefore use the coefficient of the interaction term to calculate marginal effects. A 10% increase in real wages is estimated to increase outsourcing share by $0.005 * (.10 * 8.8) = 0.0044$ or 0.44%. Ten percent increase in share of workers covered under bargaining agreements is estimated to decrease outsourcing share by $-119 * (.10) = -0.0119$ or 1.19%.¹⁴

To determine the economic effects of how much change in the share of outsourcing is explained by changes in real wages and in union coverage, I would use the following formula:

$$WageEffect = (\hat{\beta}_{reg_type}^{wage}) * \Delta wage , (3)$$

where the estimated coefficient for real wages would come from GLS (2) and TOBIT estimations (3)¹⁵. The last term of the equation is $\Delta Wage$. As I am looking at the whole span of years under observation (1972-2002), I use the change in mean values of real wages for 1972 and 2002. The values of this change are in Table 3 (row 4). I use a similar formula for change in union coverage. Analyzing marginal effects means that only the explanatory power of the model is considered, whereas analyzing economic effects means examining the model's predictions of how real wages and union coverage impact outsourcing.

Years	$\Delta BIMAT$	$\Delta Wage$ Effect	$\Delta Union$ Effect	
1972-2002	0.046	0.0007	0.023	GLS
1972-2002	0.046	0.0007	0.025	TOBIT

In Table 7 I present the estimated economic effects using GLS – estimation (2) and TOBIT – estimation (3). Both estimations show almost the same values for the economic impact of real wages and union coverage on outsourcing activity. The change in real wages explains only a tiny proportion of the increase in outsourcing activity. Put another way, the model's predictions do not allow us to conclude that an increase in real wages is a primary cause of outsourcing, and this is even more true in predicting the effects in the non-durable industries.

The effect of union coverage seems to be stronger than that of wage. The model predicts that a change over time in the share of workers' union affiliation explains only 2.3% of the increase in outsourcing activity in the case of GLS estimation and only 2.5% in the case of TOBIT estimation. Even though this change is greater than in the case of wages, it is still not great enough to explain the 92% increase overall in outsourcing over the time span. Moreover as the reverse causality estimates show, outsourcing reduces the strength of labor unions over time.

POSSIBLE EXPLANATIONS FOR the INCREASE IN OUTSOURCING

While many opponents of outsourcing argue that it destroys domestic jobs and decreases wages through manufacturers' access to cheaper goods overall, Table 7 shows the opposite picture in respect to wages. Moreover, various studies provide figures showing that in the recent past firms that outsourced the stages of production actually ended up hiring *more* U. S. workers compared with firms that outsource less (Haveman, Shatz, 2004). Another important consideration is that many opponents of outsourcing misjudge the real cause of the decline in jobs and the decrease in wages in the manufacturing sector. There is evidence to suggest that this decline is mostly attributable to an increase in the productivity of workers and to the widespread replacement of workers by highly productive machinery.¹⁶ While it is true that manufacturing jobs are being lost, the loss is not primarily due to outsourcing activity.

As Haveman and Shatz (2004) note the primary motive in firms that outsource are the savings in both direct and indirect costs, the increase in productivity, and the minimization of risk. My study is concerned with the first motive—direct costs. Direct

costs are those associated with labor costs—wages and benefits of employees, including union bargaining agreements, health insurance and so forth as well as the cost at all intermediate steps of production (bill payments for imported parts, transportation expenses, etc.). My base specification includes only real wages and the share of union agreements. While my hypothesis was that these two determinants have the biggest impact on share of outsourcing, my estimations did not show that. The estimations in the model used here do not support the view of opponents of outsourcing who blame increased outsourcing activity on high wages paid to U. S. workers, which, in order to sustain, requires a protectionist stance in trade policy.

As “The Survey of Outsourcing” (*The Economist*) reckons, one of the drivers of the increased outsourcing is the opportunity for manufacturers to split the production process into a number of small sub-divisions, each with its own narrow specialization. This strategy is similar to that used by Henry Ford in this first factory. However, in today’s manufacturing world, the sub-divisions are remotely located in various countries where labor costs are low, while the parent company can still reap the benefits of its domestic location (i.e. closeness to customers, resources, etc). Even when the final product is assembled by domestic workers, it becomes more productive to import the intermediate parts of production, to outsource the production of intermediate parts to countries like China, Mexico and other low-wage countries. While some firms move their production completely out of the U. S., the model used here does not consider the implications of such a decision. Still, we can conclude that it is not only an increase in wages, but the pressures for higher profits through greater productivity that perhaps increase outsourcing activity over time.

Despite that conclusion, the empirical results showing a statistical significance in the fact that an increase in the share of bargaining agreements decreases outsourcing activity is puzzling, as we might intuit just the opposite. It is widely believed that unions can be a great obstacle to firms in their drive to increase productivity, by reducing domestic workforce or, in some cases, by partially exiting particular markets altogether (as is the case with GM plants in Germany, where 10,000 people—nearly a third of GM workforce—are slated to be cut) (*The Economist*,2004). Because unions increase labor costs, firms will often try to avoid them by turning to outsourcing activity. This can mean displacing workers that produce various intermediate parts or the final goods, or it can mean importing intermediate goods, assuming it is cheaper to do so. Why, then, do we see just opposite effect?

I first note that a statistically significant result for the coefficient of the union coverage was obtained when industry effects and time trend dummy variables were added to my model. The time trend variable allows me to capture the decision of a manufacturing firm to outsource across time.. The possible explanation for the negative relationship between union coverage and outsourcing might be due to the increasing costs of unions bargaining for higher protection and compensation for workers in the event that they are displaced by the decision to outsource. If the costs associated with compensating workers for the decision to outsource is higher than the savings from the outsourcing project, then the firm might well choose not to pursue such a project. Such a decision might then lead to a decrease in the firm's competitiveness with rivals due to the higher costs of producing the final good. By avoiding outsourcing project a firm faces higher labor costs by staying in unionized environment. Various regulations imposed by unions

might pursue a firm to continue incurring such costs even if cost saving alternative exists because following such alternative would require breaking the union contracts that can result in cost greater than benefits. However the reverse causality estimation in Table 6 shows that the benefit of outsourcing as a way of disintegrating intermediate stages of production and dispersing the labor force seems to outweigh the potentially higher labor costs incurred through collective bargaining agreements in case of the US manufacturing industries in my study. The data also show the decline in union strength over time.

Conclusion

While the issues of globalization and outsourcing are attracting attention as our global economy becomes more integrated, the debate about losing jobs due to outsourcing is being waged with little data on the relationship between job losses and outsourcing. My hope is that this study contributes some of the missing data to these debates. In examining trends in outsourcing in the U. S. manufacturing industry, one of the biggest losers of labor-intensive jobs that moved overseas (especially to China) from 1972-2002, I am interested in what factors are the greatest determinants in the decision to outsource. The simple linear model used in this study allows me to estimate the relationship between shares of outsourcing and the various determinants. The results show that there are differences between durable and non-durable goods industries in the impact that real wages have on outsourcing. These results can serve as the basis for further analysis of outsourcing and associated factors.

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Appendix

Index of variables used in tables with relevant data sources:

- **BIMAT** – broad measure of outsourcing measured as described in section 3.2 [Sources: Input-Output Tables – BEA; Import Ratios – Linda Goldberg’s data set, NYU FED]
- **WAGES** - real wage measured by dividing nominal wage by CPI [Sources: Industry-Specific Occupational Employment and Wage Estimates Annual Survey – BLS; CPI index tables – BLS]
- **UM_COV** – measures share of union bargaining coverage [Source: “Union by sector” - Barry T. Hirsch and David A. Macpherson, Trinity University]
- **TRANSPORT_COST** – measures international transportation costs as share of intermediate expenditures by a firm [Source: Input-Output Tables – BEA]
- **GPF_IT** – measures capital invested in information technology [Source: “Distribution of New Structures and Equipment by Using Industries” – BEA]

Tables:

Below are tables with estimation results of the base specification – equation (1)

Table 1 – Estimation using OLS

OLS Estimation for Pooled Data Set with Industry and Time Fixed Effects(1)				
Variables	Coefficient	Standard Errors	t-statistic	Pr> t
rwh_lag	-0.0005	0.034	-0.15	0.879
isdrwh_lag	0.0003	0.005	0.07	0.946
um_lag	-0.158*	0.06	-2.61	0.01
trans_lag	0.483*	0.18	2.68	0.008
cap_lag	-0.0001	0.3	-0.01	0.995
F_statistic	32.18			
R	0.7875			
n	140			

Table 2 – Estimation using GLS

GLS Estimation for Panel Data Set with Random Effects (2)				
Variables	Coefficient	Standard Errors	z-statistic	Pr> z
rwh_lag	-0.003	0.002	-1.63	0.103
isdrwh_lag	0.005*	0.001	3.51	0
um_lag	-0.109*	0.05	-2.16	0.031
trans_lag	0.289	0.157	1.83	0.067
cap_lag	0.028	0.036	0.78	0.434
Wald Chi2	29.81			
R ²	0.3			
n	140			

¹ The estimates were obtained from data of Bureau of Labor Statistic with co-operation of Bureau of Labor Market Information and Special Initiatives of Michigan Labor Department and Growth.

² For this project I use the standard industry classification of 1987.

³ It measures the share of imported intermediate goods of total demand of intermediate goods for producing a unit of a final good.

⁴ The detailed description for each variable would be given in the next sub-section.

⁵ For the purpose of this research I assume linear relationship between outsourcing indicator and its determinants.

⁶ Section 5 would explain what I control for

⁷ I refer to one of classical OLS assumptions $\text{var}(\epsilon|X)=\text{const}$

⁸ BIMAT on the graph denotes broad measure of outsourcing.

⁹ Durable goods production is done by industries SIC 24,25 and 32-39; Non-durable goods production is done by industries SIC 20-23, 26-31

¹⁰ I only thoroughly discuss TOBIT estimation as it yields most relevant results. Resulting tables for all regressions can be found in Appendix; The variables in tables are lagged one period for trend-specific observations.

¹¹ In some literature IT investments considered significant when looked at how it impacts wages when wages are the dependent variable. See R. Feenstra, G. Hanson (1999), C. Morrison (1997). That is in reality it is important to consider IT investments in conjunction with outsourcing. Our project came short of finding the relevant data that can produce statistically significant results. Similar situation applies to transportation costs. It's reduction over time (see "Survey of Outsourcing"(The Economist)) should significantly increase outsourcing activity.

¹² RWH = real wages with a base year 1982; UM=share of workers covered by bargaining agreement

¹³ In 1973, 24% of the labor force was unionized and that proportion had fallen to 14 percent in 1997 (Alejandra Cox Edwards,2000)

¹⁴ I used the following formula (β -wage effect)*(10 percent increase in real wages /union coverage) in the last period. The coefficients for `isdrwh_lag` and `um_lag` were taken from estimation (3). For marginal effect of real wages in durable production industries mean of `isdrwh_lag` was taken.

¹⁵ I do not use OLS estimation (1) since it produces biased coefficients as outlined in sub-section on regression analysis

¹⁶ Source: Boston Globe, on-line edition -

http://www.boston.com/business/articles/2004/05/06/manufacturing_jobs_lost_at_steady_pace/