Estimating the Impact of Trade and Offshoring on American Workers

Using the Current Population Surveys*

Avraham Ebenstein
Hebrew University of Jerusalem

Ann Harrison
World Bank, UC Berkeley and NBER

Margaret McMillan
Tufts University and NBER

Shannon Phillips
Boston College

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Abstract: We link industry-level data on trade and offshoring with individual-level worker data from the Current Population Surveys. We find that occupational exposure to globalization is associated with larger wage effects than industry exposure. This effect has been overlooked because it operates between rather than within sectors of the economy. We also find that globalization is associated with a reallocation of workers across sectors and occupations. We estimate wage losses of 2 to 4 percent among workers leaving manufacturing and 4 to 11 percent among workers who also switch occupations. These effects are most pronounced for workers who perform routine tasks.

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I. Introduction

Between 1983 and 2002, the United States economy experienced a boom in offshoring and a doubling of imports of manufactured goods from low-income countries. Over this same period, roughly 6 million jobs were lost in manufacturing and income inequality increased sharply. These parallel developments led some critics of globalization to conclude that "good" manufacturing jobs had been shipped overseas at the expense of the domestic labor force, putting downward pressure on wages of American workers. Concern over these developments motivated the US Congress to pass the American Jobs Creation Act of 2004. Yet the degree to which changes in the US labor market are related to international trade and offshoring is still the subject of a heated debate.

The standard approach to identifying effects of import competition on wages is to use variation in the prices (or quantities) of imported goods across industries over time. This approach has been used to measure the impact of globalization on industry wage differentials as well as to measure the effects of sector-specific import competition on wages and employment. For example, Feenstra and Hanson (1999) use a two-step procedure, first identifying the impact of outsourcing and high technology investments on productivity and prices and then tracing through the impact of induced productivity and price changes on production and non-production wages. Using data for the US manufacturing sector between 1979 and 1990, they find that the real wages of production workers were probably unaffected by offshoring activities, while the real wages of non-production workers increased by 1 to 2 percentage points.

However, recently scholars have suggested that wage pressure from developing countries is becoming increasingly important. Feenstra (2008) singles out expanded competition from China as having exerted pressure on US wages, and he is not alone in this view. A similar sentiment is captured by Freeman's (1995) provocative title for his *Journal of Economic Perspectives* article "Are Your Wages Set in Beijing?" Empirical evidence for this conjecture is lacking, however.

One of the contributions of this paper is to update previous results with more recent data. Using data between 1982 and 2002, we confirm the findings of previous studies: we find that longitudinal wage changes due to either changes in import competition or offshoring within the same industry range from zero to *positive* and significant, albeit small in magnitude. For example, a 10 percent increase in the number of workers employed by US firms in low-income countries had virtually no impact on wages across all skill groups. However, a 10 percent increase in offshoring to high-income countries is associated with a small increase in wages of less-skilled workers of between 0.1 and 0.2 percent. Likewise, the impact of an increase in import penetration is negligible and not statistically significant when we focus only on manufacturing workers.

However, we also find significant employment reallocation across sectors in response to import competition and offshoring. This finding is consistent with a number of studies, which show that the intensified competition brought about by trade liberalization has led to industry rationalization: the least productive firms exit the industry, and remaining firms shed excess labor.[1] The question left unanswered by these studies is what happens to the workers that are displaced. If most of the downward pressure from globalization on wages occurs in general equilibrium, then the downward pressure on wages resulting from workers leaving manufacturing and entering the service sector would be missed by looking only within manufacturing.

This is a key limitation of the existing literature. Using individual-level data we are able to examine the impact of globalization on wages both within the manufacturing sector and across sectors and occupations. We begin by identifying the within-*occupation* effect of trade on wages. If it is more costly for workers to change occupations than industries, then the wage impact of trade-related job switches could be significant at the occupation level while being negligible within manufacturing. We find a significant divergence between results for occupational exposure and

[1] See for example Pavcnik (2002), Paus et al. (2003), Ferreira and Rossi Junior (2003), Fernandes (2007), and Esclava et al. (2009).

results for industry exposure to globalization. These results are consistent with recent empirical work demonstrating the importance of occupational tenure and downplaying the importance of tenure within a particular industry for a worker's wages (Kambourov and Manovskii 2009).

The downward pressure on wages due to import competition and offshoring has been overlooked because it operates between rather than within sectors. Our results indicate that a ten percent increase in occupation-specific import competition is associated with a 2.9 percent decline in real wages for workers who perform routine tasks. While some occupations have experienced no increase in import competition (such as teachers), import competition in other occupations (such as shoe manufacturing) has increased by as much as 40 percentage points.[2] We also find substantial wage effects of offshoring: a ten percentage point increase in occupation-specific exposure to overseas employment in low wage countries is associated with a 0.73 percent decline in real wages for workers performing routine tasks. Our results suggest that domestic workers performing routine tasks have suffered from overseas competition, though the effect can only be observed by considering workers across sectors.

We then examine the mechanisms behind the contrast between the small *positive* wage effects of globalization within manufacturing and the relatively large *negative* wage effects we observe at the occupational level. Using a large panel of CPS workers who are matched across surveys, we show that workers who switch industries within manufacturing experience almost no decline in wages. However, when workers relocate to the service sector, they experience a significant wage loss, and the negative wage impact is particularly large among displaced workers who also switch occupations. We estimate wage losses of 2 to 4 percent among workers leaving manufacturing and an additional 4 to 11 percent wage loss among workers who also switch occupations.

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[2] See the supplementary online appendix tables for further information on imports by occupation.

The paper is organized as follows. Section II discusses the theoretical motivation for our framework. Section III describes our data and documents broad trends in trade, offshoring, wages and employment. Section IV presents our main empirical findings regarding the impact of offshoring and trade on domestic wages and employment within and between sectors. Section V concludes.

II. Conceptual Framework

A. Theoretical Framework

We discuss first the literature on trade and wages, and then turn to a discussion of offshoring and wages. Representative studies focusing on general equilibrium effects of trade on wages include Baldwin and Cain (1997), Baldwin and Hilton (1984), Krugman (2000), and Leamer (1994, 1998, 2000). Many of these studies begin with a simple illustration of the relationship between trade and factor prices using a specific formulation of the Stolper-Samuelson theorem with a two-good, two-factor, and two-country framework. For example, Leamer (1994) begins with a typical zero profit condition that can be written in vector form as $Aw = p$, where p is a vector of product prices, w is the vector of factor costs and A is the vector of input intensities. If skilled and unskilled labor are the only two factors and textiles (T) and machinery (M) are the only two goods, then Leamer reproduces the standard general equilibrium result using the Heckscher-Ohlin framework that wages and income inequality will depend on both technology (as represented by the A matrix) and product prices. If we assume that textiles are unskilled labor intensive and machines are skilled labor intensive, then the wages of unskilled workers will vary positively with p_T and negatively with p_M; this result is reversed for skilled workers.

However, the sign of the impact of offshoring on wages is ambiguous. As pointed out by Feenstra and Hanson (1996) and more recently by Grossman and Rossi-Hansberg (2008), offshoring can be productivity enhancing. As more tasks are offshored, input costs fall and offshoring has the same effect as a positive technology shock, which could raise wages if workers are able to share the gains from falling costs. Additionally, Grossman and Rossi-Hansberg (2008) show that the positive effect of productivity gains on wages can be overturned the terms of trade effect or the labor supply effect. The terms of trade and factor prices move in opposite directions; if the terms of trade improve because of a decrease in the relative price of the low-skilled intensive good, this puts downward pressure on low-skilled workers' wages. Finally, to the extent that an increase in offshoring acts like an increase in the labor supply of low-skilled workers, it will put downward pressure on domestic wages. While the popular press has focused on this last term, this framework makes clear that the net effect of offshoring could in fact be positive if the productivity gains from offshoring exceed the negative impact of labor supply effects.[3]

If we combine the standard Heckscher-Ohlin insights on wage determination with the more recent literature on offshoring and wages, a complex picture emerges. Wage changes of workers in occupations vary with relative product price changes, technology changes, and changes in the fraction of domestic employment which is offshored. In addition, the magnitude and the sign of these effects vary with the routine content or skill level of the worker.

An alternative way of approaching the anticipated effect of offshoring is the specific factor framework in which one factor of production cannot be reallocated across industries. In the specific factor framework, when trade is made easier through an exogenous shock (e.g. trade liberalization, technology), the sector of the economy engaged in producing the now-imported good will shrink. This is analogous to the offshoring context, where tasks that can be performed overseas more

[3] Grossman and Rossi-Hansberg (2008) differentiate workers by skill level, and assume that tasks of greater complexity are less likely to be performed by offshore workers. However, Autor et al. (2003) point out that highly skilled workers could in principle easily perform offshorable routine tasks, while unskilled workers could perform non-routine tasks. We remain agnostic on this point in the empirical work and test for the impact of offshoring on both routine and non-routine occupations.

cheaply are now the imported good. In this setting, workers performing routine tasks should be most vulnerable to offshore opportunities available in low wage countries, such as China or India.

An assumption common to all of these frameworks is that labor is completely mobile across sectors at no cost, and that as a result, wages will be equalized across sectors. We will explore this assumption in our empirical work. In particular, we will examine the impact of trade and offshoring on the movement of labor across sectors and occupations. We will then examine the consequences for wages of switching sectors or occupations or both. Since occupations are associated with the acquisition of specific skills or human capital, it is unlikely a priori that movement from one occupation to another is as costless as movement across industries; this intuition is supported by recent research by Kambourov and Manovskii (2009).

B. Empirical Framework

Our identification strategy is to regress log wages of worker *i* in industry *j* in period *t* (W_{ijt}) on lagged measures of exposure to offshoring and international trade (G_{it-1j}) using a panel from 1983 to 2002, first at the industry level and subsequently at the industry-occupation level. We use lagged measures of exposure to offshoring and trade for two reasons. First, since offshoring requires time to implement and wage adjustment is not instantaneous, it is unlikely that the causal effect of offshoring on wages will play out within a single calendar year. Second, within a given year, offshoring, trade exposure, and wages are likely to be affected by simultaneous shocks, which we sidestep by lagging right-hand-side variables by one year. We use four measures of exposure to offshoring and international trade (G_{jt-1}which we refer to as "globalization"): offshoring to low-income affiliate locations, offshoring to high-income affiliate locations, export shares, and import penetration. To allow for the possibility that offshoring to low-income locations might have different effects than offshoring to high-income locations, we include as separate regressors the log of employment in sector *j* by US based multinationals in low and high-income countries.

There are three additional challenges of identifying the causal effect of globalization on wages. First, the industries that are most likely to globalize may also be those with lower wages or greater volatility. We address this concern by including industry fixed effects (I_j) in our specification. Second, globalization and wages may be jointly affected by common time-varying shocks, such as the business cycle and exchange rate fluctuations. We control for these by including time fixed effects (d_t). Third, we control for time-varying shocks at the industry level that could be confounded with changes in globalization as follows. TFP_{jt-1} captures changes in productivity by industry and year that could affect demand for labor. Since total factor productivity is a function of wages, we estimate our equations with and without total factor productivity. Two arguably exogenous variables also meant to capture productivity changes are the price of investment goods and computer use rates. The price of investment goods captures in part the role of falling computer prices and the potential impact of labor-saving technology on labor market outcomes. We also control for computer use rates by industry and year to account for contemporaneous changes in an industry's wage rate based on the ability to substitute for labor with computers. To avoid possible biases due to output or demand shocks, which could be correlated with affiliate employment, we control for the real value of shipments in sector *j* at time *t*-1.[4] Finally, we control for individual characteristics including age, sex, race, experience, education, and location (Z_{ijt}):

$$(1a) W_{ijt} = \beta_0 Z_{ijt} + \beta_1 G_{jt-1} + \beta_2 TFP_{jt-1} + \beta_3 PINV_{jt-1} + \beta_4 REALSHIP_{jt-1} + \beta_5 COMP_{jt} + \beta_6 d_t + \beta_7 I_j + \varepsilon_{ijt}.$$

To take into account the relationship between wages and globalization at the occupation level, we create a measure of effective exposure of an occupation to offshoring or trade. This

[4] We also estimated all the specifications reported in this paper without including a control for sector level output and the results are not affected by inclusion of this variable. Results are available from the authors upon request.

variable was created from a merged dataset of BEA offshore employment data, trade data, and CPS monthly outgoing rotation group individual-level data, by industry and year. We calculate for each occupation its' exposure to trade using the distribution of workers employed in this occupation *across* industries in 1979. For each occupation *k* and industry *j*, we have: $\alpha_{kj} = \frac{L_{kj}}{L_k}$ where L_{kj} is the total number of workers in occupation *k* and industry *j*, and L_k is the total number of workers across all industries in occupation *k*. We then calculate occupation-specific import penetration in year *t* for occupation *k* as:

$$\sum_{j=1}^{J} \alpha_{kj} \cdot IMP_{jt},$$

where IMP_{jt} is the measure of import penetration for goods in industry *j* in year *t*. Occupation-specific measures of export shares and offshoring to low and high-income countries were also created in the same way.

This leads to a specification of the form:

$$(1b) W_{ijkt} = \beta_0 Z_{ijkt} + \beta_1 G_{kt-1} + \beta_2 TFP_{jt-1} + \beta_3 PINV_{jt-1} + \beta_4 REALSHIP_{jt-1} + \beta_5 COMP_{kt} + \beta_6 d_t + \beta_7 I_j + \beta_8 Occupation_k + \varepsilon_{ijkt}$$

where *k* indexes the worker's occupation, and workers within the same *k* occupation may be in different *j* industries.[5] Our *G* vector is now an occupation-specific measure for each worker, and we have added occupation fixed effects to absorb variation specific to time invariant features of occupations. Note that we also control for variation in computer use rates by occupation and year, which is meant to account for wage changes driven by the ability of some occupations to benefit from computer technology (Autor et al. 1998). We will estimate this specification for all occupations,

[5] For workers outside of manufacturing, the control variables for TFP, PIINV, and REALSHIP are not available and are therefore assumed constant.

separately by the degree of how routine the tasks are within a given occupation, and for samples of workers who stay within an industry, switch between industries, and specifically exit manufacturing.

III. Data Description, Trends, and Empirical Strategy

A. Data Description

Our sample of US workers is taken from the Current Population Survey Merged Outgoing Rotation Groups for 1983-2002, which provides data for over 3.4 million workers who are assigned a consistent classification of their industry and occupation.[6] Offshore activity in each industry is measured by the total employment of foreign affiliates among multinational US firms, separated into high and low-income locations, stored by the Bureau of Economic Analysis (BEA).[7] The BEA sample of multi-national firms accounted for 80 percent of total output in manufacturing in 1980, suggesting that the coverage is fairly extensive. Our data on import penetration and export shares are taken from Bernard at al. (2006), which we recalculated and updated through 2002. Since relative price series for imports and exports are incomplete, we generally substitute for prices by using the share of exports in production and import penetration at the four-digit SIC 1987 level. Results using prices instead of quantities are available in the appendix materials. As a control for productivity changes that could also affect labor demand as well as wages, we use the NBER's calculations of total factor productivity provided by Wayne Gray. This data source also provides us measures of the price of investment goods and the real price of shipments by industry and year, which we use to control for technology and industry level demand, respectively. We also match our workers to information on computer use rates by industry and occupation from CPS computer supplements

[6] Special thanks to David Autor for providing us with concordances that provided a consistent coding scheme of industries and occupations for the period. The CPS occupation and industry codes were reclassified in 2003 to correspond to the North American Industrial Classification System, which made it difficult to compare data before and after the change.

[7] We are unable to distinguish between arms-length trade between firms ("outsourcing") and trade in general. Note, however, the BEA sample includes all foreign firms where a US parent holds at least a 10% equity stake. This relatively low threshold implies that firms closely aligned will be included in our analysis. It is worth noting, however, that pure firm outsourcing where no equity stake is taken will be classified as trade and not offshoring.

conducted during our sample period (1984, 1989, 1993, 1997, 2000). Using the available surveys, we interpolate and extrapolate computer use rates for the entire window.[8] Summary statistics for the individual worker sample matched to our offshoring, trade, technology, and price data are available in Appendix Table 1.

We use Autor et al.'s (2003) distinction between routine and non-routine tasks to measure the "offshorability" of jobs. Autor et al. (2003) describe routine jobs as "tasks that can be expressed using procedural or 'rules-based' logic, that is, codified in a fully specified sequence of logical programming commands ("If-Then-Do" statements) that designate unambiguously what actions the machine will perform and in what sequence at each contingency to achieve the desired result." While Autor et al. (2003) use routine-ness to designate which jobs can be easily performed by computers, we would argue that routine jobs are also more readily codified, communicated, and consequently transferred overseas. Examples of these jobs include: attaching hands to faces of watches, sewing fasteners and decorative trimming to articles and, though not mentioned explicitly in their paper, include services tasks that we think of as offshorable such as answering telephones.

Following Autor et al. (2003), we aggregate their five different measures of the routine-ness of tasks into a single index for each occupation *k*. Two indicators measure how routine manual and cognitive tasks are (Routine Manual$_i$ and Routine Cognitive$_i$, ranging from 1 for not routine to 10 for fully routine). The index of routine-ness by worker education level, industry, and year is given by:

$$Routine_k = \frac{Routine\,Cognitive_k + Routine\,Manual_k}{Routine\,Cognitive_k + Routine\,Manual_k + DCP_k + EFH_k + Math_k}.$$

The index ranges from 0 to 1.[9] The input tasks include routine cognitive and routine manual, non-routine analytic, non-routine interactive, and non-routine manual. The last three terms refer to

[8] These data were also provided by David Autor and are used in Autor et al. (1998).

[9] See Autor et al. (2003) for a thorough description of these variables. Our calculation of routine is the sum of routine manual tasks (Finger Dexterity) and routine non-manual (Set Limits, Tolerances or Standards), as a share of those tasks

cognitive tasks that are higher order in their complexity, and presumably are associated with larger costs of performing outside of a firm's central location.

B. Trends in Offshoring, Trade, Employment, and Wages

In this section we outline broad trends in the data for employment, wages, and the relationship between wages and measures of globalization. In Figure 1, we compare the trends in employment and wages in the manufacturing sector alongside the same trends in the service sector between 1979 and 2002. We present these trends separately for workers performing routine and non-routine tasks. Total manufacturing employment (using the CPS employment numbers) fell from 22 to 17 million from 1979 to 2002, with rapid declines at the beginning of the 1980s and in the late 1990s. Within manufacturing, the labor force has become increasingly high-skilled with a large decline of roughly 6 million in the number of workers in routine occupations, and a modest increase of roughly 1 million in the number of workers performing non-routine occupations.

In contrast, demand for both types of workers continued to grow in the service sector, and many of the displaced routine manufacturing workers may have found employment in the service sector. These trends have important implications for the US wage distribution. As shown in the bottom of Figure 1, where we report the real hourly wage among CPS workers, manufacturing workers enjoyed a large wage premium during the entire period among both routine and non-routine workers. Insofar as manufacturing provided an opportunity to earn high relative wages – even for low-skill workers – its decline might also have played a role in increasing US income inequality during the period.[10] We turn now to an examination of how offshoring and trade may be related to these employment and wage trends within manufacturing and in the overall economy.

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and non-routine manual (Eye, Hand, Foot), non-routine analytic (General Educational Development, Mathematics), and non-routine interactive (Direction, Control and Planning) tasks. See also the data appendix.

[10] See Autor et al. (2008) for a review of these trends. It is worth noting that while the trends in Figure 1 are informative, they do not control for other factors that affect income, such as sex, age, and experience. We redid the trends in wages

Figure 2 shows domestic and foreign affiliate employment for US multinational firms, which account for a large share of the total US manufacturing employment reported in Figure 1. The figure shows that affiliate employment in low-income countries by US based multinationals nearly doubled over the entire period while affiliate employment in high-income countries remained roughly constant. The increase in developing country activity has been accompanied by a reduction in the US workforce for these parents from almost 12 million workers in 1982 to 7 million workers in 2002.

Figure 3 shows the increase in task trade has also been accompanied by an increase in conventional goods trade, with steep increases in US manufacturing imports during the sample period. The solid line in Figure 3 plots the ratio of imports to imports plus shipments over time and the dashed line plots the fraction that are coming from low-income countries. However, unlike offshoring, the trends in import penetration were already evident throughout the 1980s. Both imports from developed and developing countries increased steadily between 1982 and 2002, with the most dramatic increase occurring for developing countries.

In Figure 4 we plot the increase in both offshoring to low-income countries as well as import penetration by industry as a function of the share of routine jobs in that industry in 1983. The figure presents suggestive evidence that the ability to send tasks overseas via offshoring, or to purchase the final good with foreign labor via trade, may have placed differential pressure on some occupations. In the empirical results section, we will more rigorously test the hypothesis that occupations experienced the greatest external pressure on their wages from competition from low-income countries.

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by educational attainment, but instead using wage residuals. These wage residuals were computed using Lemieux's (2006) approach for each educational category separately. We also added industry dummies to control for inter-industry wage differentials. The wage residuals show similar trends, with falling wage premia for less educated workers and rising wage premia for more educated workers. Similar results are observed for wage premia when workers are stratified by routineness of occupation. Results are available from the authors upon request.

In Figure 5, we report important changes in the distribution of occupation wage residuals across the 476 occupations in the CPS. Each point in the figure represents the occupation-specific wage premium in 1983 and 2002. In order to compare the occupational wage residual changes by their potential exposure to offshoring, we stratify occupations by whether they are above the median occupation in terms of routine task content. The figure reflects that routine occupations were more likely to experience declines in wage premiums, possibly because these tasks can be performed overseas. Of 240 routine occupations, 187 experienced wage premium declines and only 53 had increases in their wage premium. In contrast, among 236 non-routine occupations, 134 experienced increases and only 102 experienced declines. While these patterns are suggestive of a potential role for globalization in declining wages in routine occupations, they do not account for technological changes (e.g. computers) that may have also contributed to this pattern as well. In our empirical results section, we will examine the role of globalization in declining wages of routine workers more rigorously with direct measures of technological change, such as computer use rates among workers in different industries and occupations.

In Table 1, we document the relationship between an industry's share of low skill or routine jobs in 1983 and the subsequent growth in offshoring and import activity. The dependent variables are the log difference between 1983 and 2002 in employment offshored to low-income countries (in columns (1) and (2)) or high-income countries (in columns (3) and (4)) and the change in import penetration (in columns (5) and (6)). We see in column (1) that an industry's share of routine jobs in 1983 is a significant predictor of the subsequent increase in employment offshored to low-income countries, explaining roughly 7 percent of the variation across industries as a single regressor. We estimate that industries with 1 percentage point more routine jobs in 1983 experienced a 5-6 percent increase in offshore employment to low-income countries by 2002. However, in column (3) there is no significant relationship with offshoring to high-income countries. Column (5) shows that the industry share of routine jobs in 1983 is also a significant predictor of the increase in import penetration. We find a 1.2-1.4 percentage point increase in import penetration measure among industries with 1 percentage point more routine jobs, suggesting that domestic firms in these industries have also faced greater import competition. In columns (2), (4), and (6), we include a range of additional predictors (which are described in greater detail in the next section), and continue to find similar effects for the industry share of routine jobs. The increase in import penetration over the sample period is also associated with increasing total factor productivity and falling real price of shipments.

In the remainder of the paper, we continue to make a distinction between high and low-income offshore locations, and to differentiate workers by the routine content of their jobs. The patterns of rising trade and offshoring to low-income countries in industries with workers whose jobs are characterized by a high routine content point to a decline in the demand for the labor of workers who perform these tasks in well-paying manufacturing industries. The domestic workers who perform these tasks in other sectors of the economy were also exposed to wage pressure from cheaper labor available abroad, which we will explore further below.

IV. Offshoring, Trade, and the Impact on Domestic Workers

A. Within and Between Sector Estimates of Offshoring on Wages

In Table 2, we estimate equations (1a) and (1b) to examine the link between individual level wages and our measures of globalization by sector and by occupation. We also analyze the changes in wages across the skill distribution by stratifying occupations by how routine they are. This allows us to examine whether tasks sent overseas are more likely to be routine and whether workers specializing in these tasks experience negative consequences from offshore competition. We first present all occupations pooled in column (1) and present separately our results stratified by the fraction of routine tasks for the occupation in columns (2) through (4). The categories include:

occupations where more than 2/3 of the tasks are routine; occupations where between 1/3 and 2/3 of tasks are routine; and occupations where less than a 1/3 of the tasks are routine.

In columns (1) through (4) of Table 2, the identification strategy is to use within-sector *j* shifts in exposure to offshoring, import penetration, and export activity to measure the effects on wages of workers in sector *j*. The results suggest a very limited role for offshoring or trade in changes in the American wage distribution. There is no statistically significant relationship between low-income-affiliate employment, lagged export share, or lagged import penetration and industry-level wages; indeed, the point estimates are close to zero. There is a positive and statistically significant relationship between high-income-affiliate employment and domestic wages, although the magnitude is not large: the point estimate suggests that a one percent increase in affiliate employment is associated with a 0.01 percent increase in wages, and this is found even for workers in the most routine occupations. Our results on within-sector wage impacts parallel those found in the prior literature, where trade has no substantial negative effect on workers.

However, as discussed in Section II, within-industry changes in wages and employment miss within-occupation effects of offshoring. In particular, there are wage losses or gains accruing to individuals who remain within the same occupation but shift from manufacturing to other sectors of the economy. The associated distributional implications are potentially important, given historically important wage premia paid to manufacturing (relative to service) workers in the United States. In addition to distributional consequences, there may also be efficiency consequences associated with the reallocation of labor from high to low wage sectors.[11] There is also a cumulative impact of import competition on workers who are easily able to relocate across sectors but cannot easily shift across occupational categories.

[11] See for example Katz and Summers (1989) and Krueger and Summers (1988).

In columns (5) through (8) of Table 2, we present results from specification (1b), namely within-occupation changes in wages. The effects of both offshoring and trade are larger in sign and generally significant at the five percent level, in contrast to the industry-level results reported in the first four columns. In the first row, the coefficients on low-income affiliate employment suggest that a one percent increase in employment abroad is associated with a 0.045 percent reduction in wages at home across all occupations. Among workers in the most routine occupations, we find that a one percent increase in low-income affiliate employment abroad is associated with a 0.073 percent decline in domestic wages, whereas workers in less routine occupations were largely unaffected by offshoring, with no coefficients significantly different from zero. We also find a positive effect of lagged high-income affiliate employment on wages. This is consistent with an interpretation that workers in low income locations perform the same tasks that low-skilled workers perform in the US and are therefore substitutes for workers in the US. In contrast, workers in high-income locations perform tasks that are complementary to workers in the US and so expansion of employment in high-income countries can benefit domestic workers. These results are robust to a range of specification choices, including whether we use prices of imported and exported goods instead of quantities, and our chosen set of control variables.[12]

Although these results are statistically significant and economically meaningful in magnitude, it is possible that there are even larger effects within sub-samples of the data, which we explore in Table 3. Krugman (2008) and Feenstra (2008) both write that the effects of international trade and offshoring may have increased recently relative to earlier decades. In Table 3, we split the results into earlier and later time periods. There is no significant association between employment in low-income

[12] Results are available in the appendix materials. The results indicate that workers with price decreases in their product market have suffered the largest wage declines, with this pattern most pronounced in routine occupations. Similar to our core results, however, this effect is only observed using occupational exposure measures of import price changes. Special thanks to Lawrence Edwards for generous use of his price series data on imports. Other specifications we have tested include removing measures of TFP and controlling for price changes in the service sector using a CPI/PPI index, both of which provide results similar to those presented in Table 2.

affiliates and domestic wages in the earlier periods (1983-1991, 1983-1996), whereas in the later periods (1992-2002, 1997-2002) they are negatively and significantly associated. In particular, in the years 1997-2002, there is a 10 percent increase in low-income affiliate locations associated with a one percent decrease in domestic wages. For the effects of international trade, the point estimates for occupation-specific import penetration are generally stable and statistically significant across time periods, with the coefficients ranging from -0.21 to -0.32. The point estimates are positive and significant for export share only in the later part of the sample period, indicating that wages were not significantly associated with export activity until the 1990s.

We also explore in Table 3 differences within different demographic sub-groups. Anecdotes in the popular press and elsewhere suggest that women, union workers, and older workers may have been disproportionately affected by international competition. If we restrict the sample to either women or union workers, there is no evidence that their wages were more negatively affected than the rest of the sample. In fact, the wages of unionized workers appear to have been relatively unaffected by either export activity or import competition. However, the wages of workers without higher education and older workers do appear to have been disproportionately affected by offshoring activities, as the point estimates are larger for these groups of workers.

Since the results point to much stronger effects of offshore activities on domestic wages in the later part of the sample period, we reproduce Table 2 for the 1997 through 2002 period in Table 4. The results confirm that, for the last five years of our sample, offshoring and international trade exerted much larger effects on occupation-specific wages than the earlier years. The results also confirm that over the most recent sample period, industry-level wage effects are negligible. In columns (1) through (4), all but two of the point estimates are statistically insignificant and the magnitudes are close to zero, indicating offshoring or trade does not significantly affect industry-level wage premia.

Columns (5) through (8) suggest that occupation-specific changes in offshoring and trade are associated with significant wage effects, particularly for workers who are in occupations with the most routine content. For these workers, a one percent increase in offshoring to low-income countries is associated with a 0.20 percent decrease in wages. For these same workers, however, increasing affiliate activity in high-income countries is associated with a 0.17 percent increase in wages. One explanation is that workers in high-income locations perform tasks that are complementary to workers in the US. A one percent increase in export shares is associated with a one percent increase in wages while a one percent increase in import penetration is associated with a -0.44 percent decline in wages. The effects of these globalization measures are generally small in magnitude and insignificant for individuals who work in the occupations with the least routine content.

B. Offshoring, Trade, and the Reallocation of Labor Across Sectors

In this section, we try to identify mechanisms for the striking differences between industry-level and occupation-level exposure to offshoring and trade. We begin by analyzing the relationship between offshoring and domestic manufacturing employment. We then examine the wage consequences of switching industries, sectors, and occupations using a large panel of CPS workers.

In Table 5, we present an analysis of employment trends in manufacturing in response to offshoring. Our unit of analysis is one's education × industry × year cell, where there are five education categories for workers, 68 manufacturing industries, and 20 years (1983-2002). In column (1), we present pooled results for all industries, and then in columns (2) through (4) split industries by the fraction of an industry's workforce performing routine tasks. Pooling all industries, the results in column (1) indicate that the effect of offshoring depends on whether affiliate employment is located in high or low-income countries. A one percent increase in employment in low-income countries reduces domestic employment by 0.023 percent while a one percent increase in employment in high-income countries increases domestic employment by 0.076 percent. Breaking the results down according to how routine the workforce is, we see that the negative effects of offshoring to low-income countries are largest for workers in highly-routine industries. The point estimate, at -0.05, is only statistically significant for the industries that employ the most routine workforces and suggests that a one percent increase in affiliate employment in low-income locations is associated with a 0.045 percent reduction in employment of workers in routine occupations. At the same time, the positive effects of offshoring to high wage countries are evident in the most-routine industries as well (along with industries with an intermediate degree of routine-ness), suggesting that offshore employment in high-income locations is complementary with employment at home. Trade does not significantly affect employment in industries with a preponderance of non-routine employment.

Our supplementary online appendix includes a rich set of robustness checks for these results. Among these are a set of results based on instrumental variables estimation where we instrument for trade and offshoring using the variables that capture changes over time in the cost of trade and offshoring. The instruments are: Internet access, telephone connections including cell phone usage, and the industry share of routine jobs. The results confirm the negative relationship between offshoring to low-income countries, import penetration and manufacturing employment.

While the coefficients on offshoring are small and suggest both substitution (in low-income countries) and complementarity (in high-income locations), the coefficients are large and negative (albeit not statistically significant at the 5 percent level) for both import penetration and export activity. For the pooled sample, a one percentage point increase in import penetration reduces US manufacturing employment by 0.61 percent. While it is not surprising that the coefficient on import competition is negative, the negative coefficient on sectoral export shares is less intuitive and deserves explanation. The negative coefficients may indicate that export growth was labor-saving for workers with less than a college degree, which is sensible if a significant degree of offshoring takes place through exports for further processing. Likewise, the negative and significant coefficient on total factor productivity suggests that productivity growth has been labor saving for most educational categories.[13] Productivity growth in manufacturing has been achieved in conjunction with falling employment.

The results in Table 5 suggest that productivity growth, export growth, and import competition have been associated with (sometimes significant) declines in domestic manufacturing employment and that the effects of offshoring have been smaller in magnitude and mixed in sign. These results are important insofar as they suggest a fluid labor market where changes in other factor prices and global competition lead to employment reallocation. Furthermore, these results provide an explanation for our finding in Table 2 that the within-industry wage effects of trade and offshoring are smaller than the within-occupation effects. If trade and offshoring lead some workers to shift sectors (in particular, to exit high-wage jobs in manufacturing), then it is possible that the wages of those who retain their jobs or find new jobs in the same industry are not significantly affected by offshoring, while those who stay within their occupation but shift sectors are negatively affected. We examine this conjecture in the next section.

C. Wage Implications of Switching Within and Between Sectors

In Table 6 we examine how (a) switching industries within manufacturing, (b) leaving manufacturing, or (c) leaving manufacturing and switching occupations entirely affects a worker's wages. Our sample is composed of manufacturing workers observed in CPS samples in consecutive years between 1983 and 2002. We regress the change in log wages between period t and t+1 for a given worker on an indicator for switching industry or occupation, including a rich set of controls

[13] Table 5 results are robust to excluding total factor productivity as a control variable.

for the worker's age, sex, education, race, union status in the first period, and industry in the first period.

In Panel A, we examine how switching industries *within* manufacturing affects wages relative to staying in the same industry. The table reflects almost no wage consequence of switching industries, provided the worker stays within manufacturing. In Panel B, we restrict the sample to workers who switched sectors, and examine whether leaving manufacturing has larger wage consequences than switching industries but staying in manufacturing. We estimate that wages decline by 3.1 percent when leaving manufacturing, with slightly larger wage losses for workers in occupations with the most routine content (3.6 percent) than for workers occupations with the least routine content (2.8 percent). This suggests the shedding of manufacturing jobs due to offshoring may negatively affect domestic workers, especially those performing occupations with a high degree of routine content. In Panel C, we restrict the sample to workers who exited manufacturing and examine whether switching occupations induced a greater wage decline than switching sectors; we find that switching occupations costs the worker an additional 5.9 percent of wages. Since our results in Tables 2 to 4 are within-occupation, they do not capture the wage consequences of trade-induced occupation switching (although this is a relatively small proportion of workers: 22,680 workers switch occupations compared to over 170,000 workers who switch industries). Nonetheless, insofar as switching occupations is costly to workers, it highlights an inelasticity to occupational choice that could leave workers vulnerable to shifting demand for labor due to offshoring and import penetration.

While these results are consistent with our findings in Table 2, they do not directly establish a link with offshoring and trade (i.e., the industry and occupation switches in Table 6 could be due to non-trade-related shocks). In Table 7 we directly examine whether exiting manufacturing magnifies the effect of trade and offshoring on wages. We re-run specification 1a, including an indicator for workers who left manufacturing and interacting this indicator with lagged measures of our globalization variables: import penetration, export share, and low- and high-income affiliate employment. Although sample sizes are small, we do find a negative and statistically significant effect of offshoring to low-income affiliates on wages among those workers who are classified as engaged in occupations with the most routine content. We estimate that, among this class, leaving manufacturing is associated with a 3.4 percent decline in wages between periods. However, if a worker leaves manufacturing, the *degree* of increased offshoring in the previous period is also associated with a decline in wages. Each percentage point increase in low-income country employment in the industry is associated with a further 1.6 percent decline in wages that is statistically significant at the 10% level. The results for imports and exports are not statistically significant, possibly owing to the smaller sample used here and the collinearity between trade and offshoring. This indicates that an important mechanism for our main results is the loss in wages from workers leaving manufacturing as a result of foreign competition.

As a final robustness check, we examine the sample of matched workers and whether year on year wage changes are related to offshoring and trade. The results in Table 8 should be compared to our core results, where we examine in columns (1) through (3) the wage impact of offshoring for workers within manufacturing, and in columns (4) through (6) among workers in all sectors. The exact same controls are used, but the left-hand side variable is year on year wage changes and the sample is restricted to only workers matched between periods. We also classify workers by whether the occupation has more or less than half routine task content.[14] The results are consistent with our findings in the overall sample: we observe mild wage effects when a worker's exposure to offshoring is measured within her industry, but significant negative impacts when offshoring is measured by occupational exposure. Increases in occupational exposure to low-income country employment is

[14] The change in worker classification was motivated by sample size considerations.

associated with a 1.8 percent decline in wages among routine workers, but almost no effect among non-routine workers. This result is statistically significant at the 5% level, indicating our core results are robust to focusing exclusively on workers observed two periods, using the individual's wage change between periods as our outcome variable.

These tables present evidence that workers can move fluidly between industries but that sectoral switches are costly, and particularly costly when they force a worker to switch occupations. Consistent with Kambourov and Manovskii (2008, 2009) who point to the large wage declines among workers who switch occupations, this evidence suggests an important role for occupation-specific human capital in a worker's wage profile. Kambourov and Manovskii (2008, 2009) also argue that forced occupation-switching may be an important cause of the increase in US wage inequality, as younger workers are missing out on the benefits to occupational tenure enjoyed by workers in previous decades. Insofar as this is partly driven by competition from overseas, this highlights another mechanism by which offshoring may be responsible for declining US wages and increasing wage inequality.

VI. Conclusion

This paper has moved beyond an analysis of trade and wages within the manufacturing sector to analyze the impact of trade and offshoring on wages across occupations and across sectors. We begin by showing that the effects of trade and offshoring on wages across industries within manufacturing are tiny in magnitude and sometimes positive. These results are in line with earlier work on trade and wages that focuses exclusively on the manufacturing sector. However, when we redefine the analysis at the occupation level, we find large and significant effects of import competition and offshoring activities on U.S. wages. These results are consistent with recent empirical work demonstrating the importance of occupational tenure and downplaying the importance of tenure within a particular industry for a worker's wages.

We then examine the mechanisms behind the contrast between the small *positive* wage effects of globalization within manufacturing and the relatively large *negative* wage effects we observe at the occupational level. We begin by showing that trade and offshoring are associated with a contraction in the manufacturing workforce. Then, using a large panel of CPS workers who are matched across surveys, we demonstrate that workers who switch industries within manufacturing experience almost no decline in wages. However, when workers relocate to the service sector, they experience a significant wage loss. The negative wage impact is particularly large among displaced workers who also switch occupations. We estimate wage losses of 2 to 4 percent among workers leaving manufacturing and an additional 4 to 11 percent wage loss among workers who also switch occupations. These effects are most pronounced for workers who perform routine tasks. This downward pressure on wages due to import competition and offshoring has been overlooked because it operates between and not within sectors.

This provides compelling evidence that the negative consequence of trade on workers is mediated through a reallocation of labor across sectors and into different occupations. While many models of trade posit that workers can move in a costless manner to new jobs in the face of pressure from foreign labor, we identify large and significant wage declines among workers forced to leave manufacturing, and the wage decline is particularly pronounced for those who are forced to switch occupations.

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Data Appendix:

A. Current Population Survey

We use the CPS Merged Outgoing Rotation Groups for years 1979 to 2002. Note that our analysis relies on the MORG copy prepared by the Center for Policy and Economic Research (CEPR). The CEPR MORG files are created from the National Bureau of Economic Research version of these data, and we rely on the processing performed by CEPR to produce consistent variables for wages, education, and other demographic characteristics of the MORG sample. Our sample includes wage/salary for workers ages 16 to 64 in current employment. Earnings weights, equal to the product of CPS sampling weights and hours worked in the prior week, are used in all calculations. Hourly wages are the logarithm of reported hourly earnings for those paid by the hour, and the logarithm of usual weekly earnings divided by usual weekly hours among salaried workers. Overtime, tips, and commissions are included in wages, and top-coded wages are computed by assuming a log-normal distribution for weekly earnings as described by Schmitt (2003). The calculated nominal hourly wage is converted to a real wage using the Consumer Price Index for 2006, and then trimmed to values between $1 and $100 per hour.

Source: Schmitt, John. 2003. "Creating a consistent hourly wage series from the Current Population Survey's Outgoing Rotation Group, 1979-2002." Available for download at http://www.ceprdata.org/cps/cps_documentation.php.

B. Bureau of Economic Analysis

Our data on offshoring is based on the most comprehensive available data and is based on firm-level surveys on US direct investment abroad, collected each year by the Bureau of Economic Analysis (BEA) of the US Department of Commerce. The BEA collects confidential data on the activities of US-based multinationals. Multinationals are defined a parent company, the US entity that made at least one direct investment in a foreign affiliate, defined as a foreign business enterprise. We use the data collected on majority-owned, non-bank foreign affiliates and non-bank US parents for the years from 1982 to 2002. The foreign affiliate survey forms that US multinationals are required to complete on an annual basis include detailed information on the number of employees hired abroad. In previous work we have cross-checked these data with national survey data from other countries and found the employment numbers to be remarkably similar. Using these data, we construct a panel of number of employees hired abroad by country by year.

C. Trade Data

Our data on import penetration were made available at the 4-digit ISIC level by Bernard et al. (2006). We also include a measure of the share of import penetration from low-wage countries, also computed by these authors.

D. Data on Occupational Characteristics (United States Department of Labor, supplied by David Autor)

Definitions of the Nature of Tasks, taken from Autor et al. (2003)

Task Name	Task Description
DCP: Direction, Control, and Planning of Activities	Measures nonroutine cognitive tasks, intended to capture interactive, communication, and managerial skills. This variable captures the extent to which the occupation involves direction, control, and planning of activities. It takes on high values for occupations requiring interpersonal and managerial tasks.
GED-MATH	Measures quantitative or analytical reasoning skills.
STS: Set limits, Tolerances or Standards	Measures routine cognitive tasks. Measures adaptability to work requiring the setting of limits, tolerances or standards.
FINGDEX: Finger Dexterity	Measures routine manual activity. FINGDEX is an abbreviation for finger dexterity.
EYEHAND	Measures non-routine manual task requirements. EYEHAND is an abbreviation for eye, hand, foot coordination.
Notes: Our measure of routine-ness is defined as the sum of the cognitive and manual routine measures divided by all the measures. Routine = (sts + fingdex)/(sts + fingdex + math + dcp + eyehand)	

E. Price of Investment, Total Factor Productivity, and the Real Price of Shipments

The price of investment, which varies by industry and year, is taken from the NBER's productivity database. Total factor productivity is computed by the NBER for all years through 1996, and was updated through 2002 using data provided to the authors by Wayne Gray. The real price of shipments is taken from this database as well.

F. Bureau of Labor Statistics Imports and Export Prices

Our data on prices of imports and exports are recorded by the Bureau of Labor Statistics using the Standard Industrial Trade Classification scheme and are weighted by purchases of goods within each industry. These are converted to the 3-digit SIC coding scheme, and then made compatible with the CPS industrial codes using code provided by David Autor. These concordances between SIC coding and CPS coding are available in the online appendix to Autor et al. (1998).

G. Panel Data Set of Current Population Survey Workers

We construct a panel data set from the CPS Merged Outgoing Rotation Groups by matching individuals surveyed in two consecutive years between 1983 and 2002. Each month, one quarter of survey respondents are asked questions about their job including wage, occupation and industry. One year later, half of these individuals are again asked these same job-related questions. We use Madrian and Lefgren's (2000) matching algorithm to first match an individual based on their household identifier, household number and individual line number. Based on this naive match criteria, a high non-matching rate results, as survey respondents who move out of a housing unit are replaced in the sample by those who move in and given the same unique identifiers, as well as non-response, mortality and migration. A naive match is then dropped if it does not match on sex, race or age criterion. Based on these criteria, the match rate is 50%, with 871,917 individuals matched, or 1,743,834 observations out of a possible 3,481,692 observations.

H. Imputing Computer Use Rates to CPS Workers

We calculate average industry and occupation computer use rates from the October 1984, 1989, 1993, 1997, and August 2000 CPS Internet and Computer Use Supplement files. The use rate within an industry or occupation is the fraction of respondents who report using a computer or the internet at work. We impute computer use rates for the remaining years by linearizing the percent change within an occupation or industry between available years. We use the linear trend from 1984-1989 to impute computer use rates for 1982-1983, setting a lower bound of 0%. We use the linear trend from 1997-2000 to impute computer use rates for 2001-2002, setting an upper bound of 100%.

I. Creating Price Indices by Industry

We create a set of price indices at the industry level using data from the Bureau of Labor Statistics (BLS) and the US Department of Agriculture (USDA). For most industries, a match is made to the industry-specific BLS Producer Price Index (PPI) data. For the four agricultural industries, we use an industry-specific Producer Price Index from the USDA. For 46 industries, a consistent PPI is not available across time; we instead use a product-specific Consumer Price Index from the BLS. For an additional 46 industries (mainly in the service sector), no consistent PPI or CPI is available for our entire time period; we instead use the economy-wide PPI from the BLS. For eleven of the industries, coverage begins in 1985; we freeze prior years to the 1985 level. The series are simple averages across monthly values, and are not seasonally adjusted.

We also create a series of import and export prices from BLS data. These data are downloaded at the 1, 2, and 3-digit SITC level. We then use the concordance between SITC and SIC codes received from Robert Feenstra and used in Feenstra et al. (2002) to create price series data at the SIC level. These data are then matched to our CPS industry coding scheme using a concordance created by the authors mapping each 3-digit SIC code into a corresponding CPS industry code. We then construct export and import price indices at the 1, 2 and 3-digit CPS industry codes.

A supplemental import price data series was also provided at the NAICS level generously by Robert Lawrence. We use a concordance between NAICS and SIC codes to create a series of import prices at the SIC level, which are then mapped to our CPS industry classification scheme. For many-to-one matches between the SIC code and CPS industry codes, we use the SIC code with non-missing import prices.

These data are used in our supplementary online materials and summary statistics for these variables are available upon request.

J. Summary Statistics

In Appendix Table 1, we present summary statistics for our sample of individual CPS workers, and their assigned values for offshoring, trade, and technology measures. We present summary statistics for the entire sample (1983-2002), the 1983 sample, and the 2002 sample of workers. In Panel A, we report over 3.4 million workers in the data, with a noticeable decline in the fraction of workers who are employed in the manufacturing sector during the sample period. The workforce has become better educated, a slightly higher fraction of females, and real wages have risen. Hourly wages are higher in manufacturing than services, but this difference declined from $2.49 in 1983 to $1.78 in 2002. In Panel B, we report our offshoring and trade measures, which reflect a marked increase in all offshoring and activity between 1983 and 2002. Though all measures of offshoring and trade increased during the period, offshoring to low income countries and import penetration nearly doubled. Offshoring to high-income countries and exports increased more modestly, which may be due to the increased access during the period to markets in low income countries such as China and India. In Panel C, we report these offshoring and trade measures but we use our occupational-exposure measures instead, which capture the essential intuition behind our empirical results in Tables 2-4: that offshoring and trade may have affected workers not in the "tradable" manufacturing sector, but rather may have importantly affected workers in services as well. In Panel D, we report the summary statistics for our technology variables. These variables are meant to account for differential technical change across industries that may have affected relative demand for labor. For example, we report large increases in computer use rates, which may have also affected the wages earned by workers depending on their ability to benefit from the technology (Autor et al. 1998).

Table 1: OLS Estimates of Change in Offshoring and Import Penetration Given Industry Skill Composition in 1983

	Dependent Variable: Log Difference in Employment Offshored (1983-2002)				Dependent Variable: Import Penetration Difference (1983-2002)	
	Low Income Countries		High Income Countries			
	(1)	(2)	(3)	(4)	(5)	(6)
Industry Share of Routine Jobs in 1983	5.132**	5.926**	-0.980	-0.246	1.217***	1.337***
	(2.40)	(2.57)	(2.03)	(2.27)	(0.34)	(0.33)
Difference in log of price of investment between 1983 and 2002		-0.056		-0.043		-0.018
		(0.51)		(0.45)		(0.07)
Difference in total factor productivity level between 1983 and 2002		0.395		-0.364*		0.102***
		(0.24)		(0.22)		(0.03)
Difference in log of real price of shipments between 1983 and 2002		-0.175		0.210		-0.052**
		(0.19)		(0.17)		(0.02)
Difference in computer use rates between 1983 and 2002		0.434		-0.227		0.023
		(0.67)		(0.59)		(0.09)
Number of observations	66	59	66	59	66	61
R-squared	0.07	0.14	0.004	0.07	0.17	0.37

Source : Affiliate (or offshore) employment data are taken from the Bureau of Economic Analysis annual survey of US firms with multinational affiliates for 1983-2002. Low income countries are defined according to the World Bank income categories. Employment data are taken from all workers in the Current Population Surveys Merged Outgoing Rotation Groups for the same period. Import penetration and export share are taken from Bernard et al. (2006). Investment good prices, total factor productivity measures, and the real price of shipments are taken from the NBER productivity database. Computer use rates are taken from October CPS supplements during the sample period. Details for each of the data sources are available in the data appendix.

Note: Robust standard errors reported in parentheses below coefficient estimates.

Table 2: OLS Estimates of Wage Determinants using Occupational versus Industry Offshoring Exposure, 1983-2002

Dependent Variable: Log Wage

	Offshoring Measured by Industry-Specific Exposure, Manufacturing Only				Offshoring Measured by Occupation-Specific Exposure, All Sectors			
Variable	All Occupations	Most Routine	Intermediate Routine	Least Routine	All Occupations	Most Routine	Intermediate Routine	Least Routine
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged log of low income affiliate employment	0.001	0.002	0.001	0.003	-0.045**	-0.073***	0.010	0.062
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.02)	(0.03)	(0.07)
Lagged log of high income affiliate employment	0.014**	0.010*	0.010	0.023**	0.039**	0.053***	0.007	-0.035
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.07)
Lagged import penetration using 1979 weights	0.07	0.11	0.019	-0.056	-0.290***	-0.289***	-0.944	1.024
	(0.08)	(0.08)	(0.08)	(0.10)	(0.09)	(0.10)	(0.59)	(0.65)
Lagged export share using 1979 weights	0.04	-0.01	0.012	0.077	0.234	0.636***	0.278	-0.845**
	(0.06)	(0.07)	(0.06)	(0.05)	(0.16)	(0.19)	(0.19)	(0.39)
Number of observations	586,499	337,295	159,538	89,666	3,068,095	1,109,836	1,156,207	802,052
R-squared	0.46	0.39	0.41	0.38	0.50	0.42	0.54	0.40

Source : See Table 1.

Note : Robust standard errors reported in parentheses below coefficient estimates. The classification of occupations into routine categories is determined by the proportion of tasks which are routine in each occupation, with low being occupations with more than 2/3, intermediate being between 1/3 and 2/3, and high being occupations with less than 1/3 of tasks designated routine. Controls are included for lagged log price of investment, lagged total factor productivity, and lagged log real price of shipments among manufacturing workers. Wage specifications control for a worker's gender, age, race, experience, whether in a union, and include industry, year, education and state fixed effects. The occupation-specific exposure regressions also include 2-digit occupation fixed effects. Controls for lagged computer use rates are imputed by the worker's industry (columns 1-4) and by occupation (columns 5-8).

Table 3: OLS Estimates of Wage Determinants Overall, By Occupational Exposure of a Group to Trade and Offshoring

Dependent Variable: Log Wage

Specification	Lagged Log of Low Income Affiliate Emp	Lagged Log of High Income Affiliate Emp	Lagged Import Penetration	Lagged Export Share	Obser-vations	R-Squared
	(1)	(2)	(3)	(4)	(5)	(6)
1983-1991	0.004 (0.02)	-0.006 (0.02)	-0.213*** (0.08)	0.051 (0.2)	1,390,331	0.52
1992-2002	-0.061*** (0.02)	0.049*** (0.02)	-0.323** (0.13)	0.489** (0.19)	1,677,764	0.49
1983-1996	-0.014 (0.02)	0.010 (0.02)	-0.259*** (0.08)	0.171 (0.16)	2,181,111	0.51
1997-2002	-0.111*** (0.03)	0.098*** (0.03)	-0.312** (0.14)	0.485** (0.21)	886,984	0.48
Female	-0.054** (0.02)	0.049** (0.02)	-0.167 (0.12)	0.340* (0.19)	1,491,459	0.49
Union	0.004 (0.02)	-0.011 (0.02)	-0.074 (0.12)	-0.095 (0.16)	549,056	0.37
High School or Less	-0.046** (0.02)	0.037** (0.02)	-0.203** (0.08)	0.188 (0.18)	1,475,120	0.44
College or More	-0.030* (0.02)	0.028* (0.02)	-0.136 (0.18)	0.108 (0.14)	1,592,975	0.44
Over 40	-0.061*** (0.02)	0.053*** (0.02)	-0.201*** (0.08)	0.093 (0.14)	1,262,929	0.48
Over 50	-0.067*** (0.02)	0.054*** (0.02)	-0.287*** (0.08)	0.087 (0.14)	550,042	0.48

Source : See Table 1.

Note : Each row represents a separate regression. The independent variables are listed in the column headings, and the subsample of interest is listed in the row heading. Robust standard errors are clustered at the industry level and reported in parentheses below coefficient estimates. Wage specifications control for a worker's gender, age, race, experience, whether in a union, imputed computer use rate by occupation and include year, education, state, industry, and two-digit occupation fixed effects.

Table 4: OLS Estimates of Wage Determinants using Occupational versus Industry Offshoring Exposure, 1997-2002

Dependent Variable: Log Wage

	Offshoring Measured by Industry-Specific Exposure, Manufacturing Only				Offshoring Measured by Occupation-Specific Exposure, All Sectors			
Variable	All Occupations	Most Routine	Intermediate Routine	Least Routine	All Occupations	Most Routine	Intermediate Routine	Least Routine
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged log of low income affiliate employment	-0.008	-0.007	-0.019*	0.007	-0.111***	-0.200***	0.141***	0.323*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.03)	(0.05)	(0.19)
Lagged log of high income affiliate employment	-0.009	-0.016	-0.01	0.004	0.098***	0.171***	-0.134***	-0.293*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.03)	(0.05)	(0.16)
Lagged import penetration using 1979 weights	0.152	0.222*	-0.03	0.027	-0.312**	-0.441***	-0.100	1.620
	(0.1)	(0.12)	(0.15)	(0.21)	(0.14)	(0.12)	(0.75)	(1.83)
Lagged export share using 1979 weights	0.016	-0.102*	0.09	0.074	0.485**	1.006***	0.326	-0.791
	(0.06)	(0.06)	(0.07)	(0.1)	(0.21)	(0.20)	(0.33)	(0.96)
Number of observations	132,104	71,985	36,982	23,137	886,984	291,894	337,059	258,031
R-squared	0.44	0.35	0.40	0.34	0.48	0.39	0.51	0.37

Source : See Table 1.

Note : Robust standard errors reported in parentheses below coefficient estimates. The classification of occupations into routine categories is determined by the proportion of tasks which are routine in each occupation, with low being occupations with more than 2/3, intermediate being between 1/3 and 2/3, and high being occupations with less than 1/3rd of tasks designated routine. Controls are included for lagged log price of investment, lagged total factor productivity, and lagged log real price of shipments among manufacturing workers. Wage specifications control for a worker's gender, age, race, experience, whether in a union, and include industry, year, education and state fixed effects. The occupation-specific exposure regressions also include 2-digit occupation fixed effects. Controls for lagged computer use rates are imputed by the worker's industry (columns 1-4) and by occupation (columns 5-8).

Table 5: OLS Estimates of Employment Determinants in Manufacturing, 1983-2002

Dependent Variable: Log U.S. Manufacturing Sector Employment

Variable	All	Most Routine	Intermediate Routine	Least Routine
	(1)	(2)	(3)	(4)
Lagged log of low income affiliate employment	-0.023**	-0.045**	0.005	-0.050
	(0.01)	(0.02)	(0.02)	(0.04)
Lagged log of high income affiliate employment	0.076**	0.155**	0.201***	0.034
	(0.03)	(0.06)	(0.05)	(0.13)
Lagged import penetration using 1979 weights	-0.605*	-0.226	-0.064	0.254
	(0.32)	(0.61)	(0.35)	(1.55)
Lagged export share using 1979 weights	-0.276	-0.466	0.181	0.046
	(0.27)	(0.67)	(0.33)	(1.27)
Lagged log of price of investment using 1979 weights	-0.075	0.344	0.106	-0.854
	(0.17)	(0.25)	(0.26)	(0.73)
Lagged total factor productivity level using 1979 weights	-0.167**	-0.042	-0.191**	0.527
	(0.07)	(0.14)	(0.08)	(0.68)
Lagged log of real price of shipments using 1979 weights	0.150**	0.152	0.067	0.257
	(0.06)	(0.11)	(0.07)	(0.25)
Lagged computer use rates by industry	-0.035	0.043	-0.113	-0.805
	(0.144)	(0.259)	(0.200)	(0.482)
Number of observations	6,399	1,662	4,248	489
R-squared	0.86	0.78	0.55	0.65

Source : See Table 1.

Note : Robust standard errors reported in parentheses below coefficient estimates. All models include year and industry fixed effects. Low-income affiliate employment is defined according to the World Bank income categories. The sample size corresponds to 5 education groupings X 21 years X 67 industries, less missing values. The results shown in columns 2-4 are (2) industry and year combinations where more than 2/3 of the tasks are routine, (3) cells where between 1/3 and 2/3 of tasks are routine, and (4) cells with than a 1/3 of the tasks are routine.

Table 6: Wage Changes Among Manufacturing Workers Observed 2 Periods Who Switch Industry, 1983-2002

Dependent Variable: Log Wage Change Between Periods

	All Occupations	Most Routine	Intermediate Routine	Least Routine
	(1)	(2)	(3)	(4)
Panel A: Sample of Workers who Stay in Manufacturing both Periods				
Switched Industry Classification (1=yes)	-0.003	0.0001	-0.002	-0.015*
	(0.003)	(0.003)	(0.005)	(0.008)
Observations	147,865	83,026	41,827	23,012
Panel B: Sample of Workers who Switch Industry Classification between Periods				
Left Manufacturing (1=yes)	-0.031***	-0.036***	-0.025***	-0.028***
	(0.004)	(0.006)	(0.006)	(0.010)
Observations	170,545	93,689	49,015	27,841
Panel C: Sample of Workers who Leave Manufacturing between Periods				
Switched Occupation (1=yes)	-0.059***	-0.044***	-0.042***	-0.106***
	(0.010)	(0.011)	(0.013)	(0.021)
Observations	22,680	10,663	7,188	4,829

Source : Sample is composed of CPS MORG workers observed in two consecutive samples and employed in manufacturing in the first period.

Note : Robust standard errors reported in parentheses below coefficient estimates. Standard errors are clustered by occupation. All models include year, state and education level fixed effects. Other demographic controls are age, sex, non-white, and union status in the first period. Industries and occupations are defined by 3-digit census classifications. Classification of routine is based on first period occupation. The classification of occupations into routine categories is determined by the proportion of tasks which are routine in each occupation, with low being occupations with more than 2/3, intermediate being between 1/3 and 2/3, and high being occupations with less than 1/3 of tasks designated routine. See appendix for details on how workers are matched across samples.

Table 7: Wage Changes Among All Workers Observed 2 Periods and the Impact of Leaving Manufacturing, 1983-2002

Dependent Variable: Log Wage Change Between Periods

Variable	All Occupations	Most Routine	Intermediate Routine	Least Routine
	(1)	(2)	(3)	(4)
Left Manufacturing (1=yes)	-0.034*** (0.003)	-0.034*** (0.005)	-0.033*** (0.005)	-0.029*** (0.008)
Lagged log of low income affiliate employment change X Left Manufacturing	-0.010 (0.006)	-0.016* (0.009)	-0.004 (0.018)	0.0002 (0.021)
Lagged log of high income affiliate employment change X Left Manufacturing	0.045*** (0.016)	0.038 (0.026)	0.076** (0.031)	0.0260 (0.054)
Lagged import penetration change X Left Manufacturing	0.093 (0.243)	0.124 (0.335)	0.092 (0.250)	-0.083 (0.564)
Lagged export share change X Left Manufacturing	-0.014 (0.118)	-0.189 (0.141)	0.123 (0.153)	0.102 (0.278)
Number of observations	162,270	90,989	45,527	25,754

Source : Sample is composed of CPS MORG workers observed in two consecutive samples and employed in manufacturing in the first period.

Note : Robust standard errors reported in parentheses below coefficient estimates. The classification of occupations into routine categories is determined by the proportion of tasks which are routine in each occupation, with low being occupations with more than 2/3, intermediate being between 1/3 and 2/3, and high being occupations with less than 1/3 of tasks designated routine. The regressions are run with the same controls as in Table 2. This includes controls for the worker's age, race, experience, union status, and sex. Fixed effects are included at the industry, year, and state levels. We also control for lagged log price of investment, lagged total factor productivity, lagged log real price of shipments, and computer use rates in the worker's industry.

Table 8: Wage Changes Among All Workers Observed 2 Periods by Industry- and Occupation-Specific Exposure to Offshoring, 1983-2002

Dependent Variable: Log Wage Change Between Periods

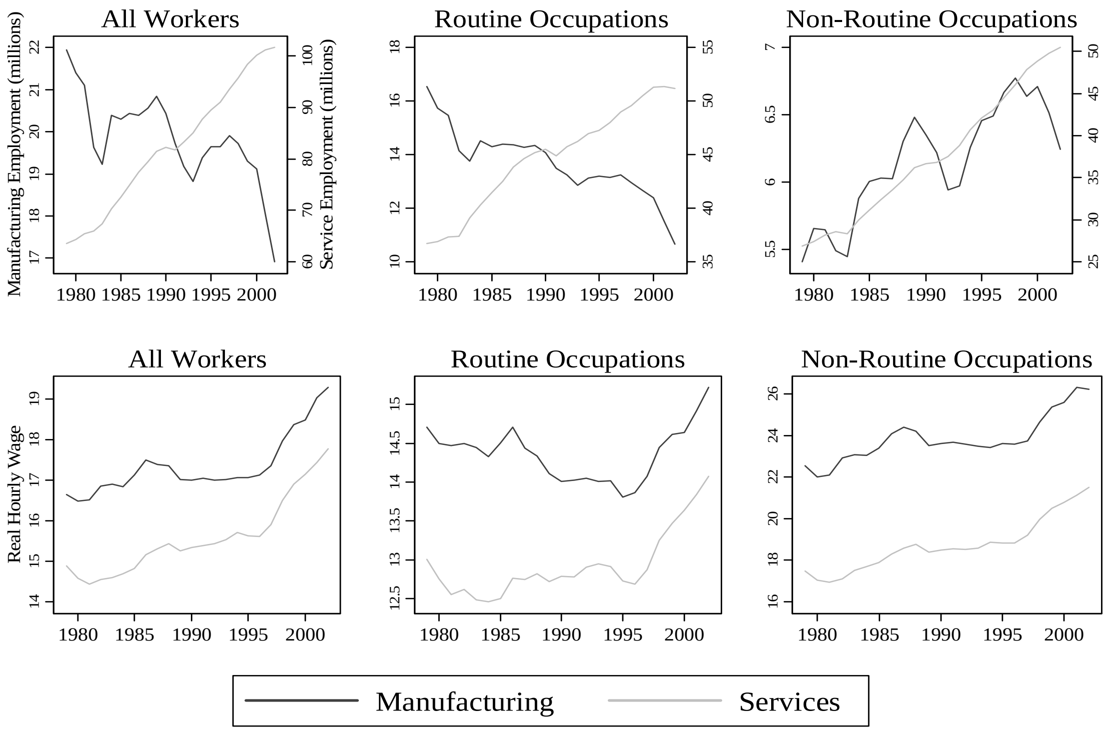
Variable	Offshoring Measured by Industry-Specific Exposure, Manufacturing Only			Offshoring Measured by Occupation-Specific Exposure, All Sectors		
	All	Routine	Non-Routine	All	Routine	Non-Routine
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged log of low income affiliate employment	-0.002	-0.003	-0.003	-0.015**	-0.018**	0.020
	(0.001)	(0.002)	(0.004)	(0.006)	(0.008)	(0.025)
Lagged log of high income affiliate employment	0.005*	0.009**	-0.004	0.013**	0.016**	-0.014
	(0.003)	(0.004)	(0.007)	(0.005)	(0.007)	(0.022)
Lagged import penetration using 1979 weights	0.023	0.033	0.010	-0.033	-0.006	-0.660**
	(0.016)	(0.025)	(0.043)	(0.040)	(0.045)	(0.256)
Lagged export share using 1979 weights	-0.042**	-0.058	-0.013	0.091*	0.049	0.415***
	(0.020)	(0.039)	(0.052)	(0.051)	(0.063)	(0.129)
Number of observations	162,285	110,265	52,020	797,124	447,299	349,825

Source : Sample is composed of CPS MORG workers observed in two consecutive samples and employed in manufacturing in the first period.

Note : Robust standard errors reported in parentheses below coefficient estimates. The classification of occupations into routine categories is determined by the proportion of tasks which are routine in each occupation, with routine being occupations with more than half. The regressions are run with the same controls as in Table 2. This includes controls for the worker's age, race, experience, union status, and sex. Fixed effects are included at the industry, year, and state levels in columns (1-3) and fixed effects for industry, occupation, year, and state in columns (4-6). Industry-specific regressions (columns 1-3) also control for lagged log price of investment, lagged total factor productivity, and lagged log real price of shipments. Controls for computer use rates are imputed by the worker's industry (columns 1-4) and by occupation (columns 4-6).

Figure 1

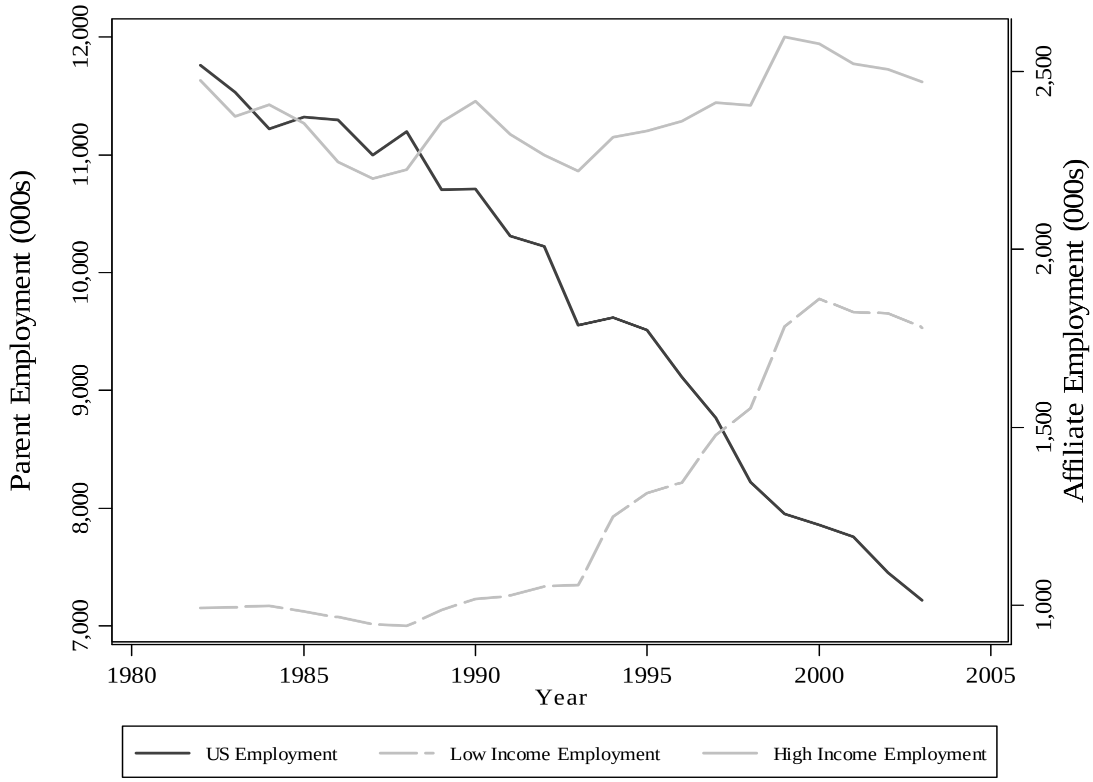
Trends in Employment and Wages in the Manufacturing and Service Sectors



Notes : Employment and wage calculations are based on the Current Population Survey Merged Outgoing Rotation Groups (MORG). Sample includes all part-time and full-time workers. Wages are in 2005 dollars. Definition of routine workers is based on occupational task content. Details are available in the data appendix.

Figure 2

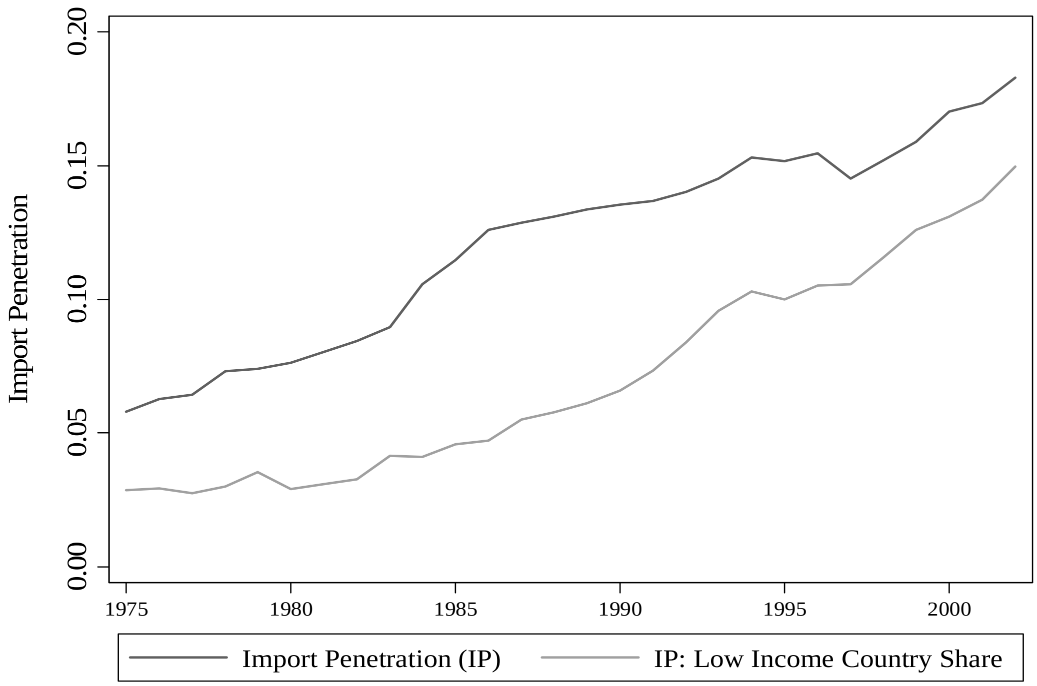
Trends in Domestic and Affiliate Employment among Multinational Firms



Notes : Author's calculations based on the most comprehensive available data and is based on firm-level surveys on US direct investment abroad, collected each year by the Bureau of Economic Analysis (BEA) of the US Department of Commerce. Using these data, we compute number of employees hired abroad by country and year, and then aggregate employment by Low (High) Income country according to World Bank income classifications.

Figure 3

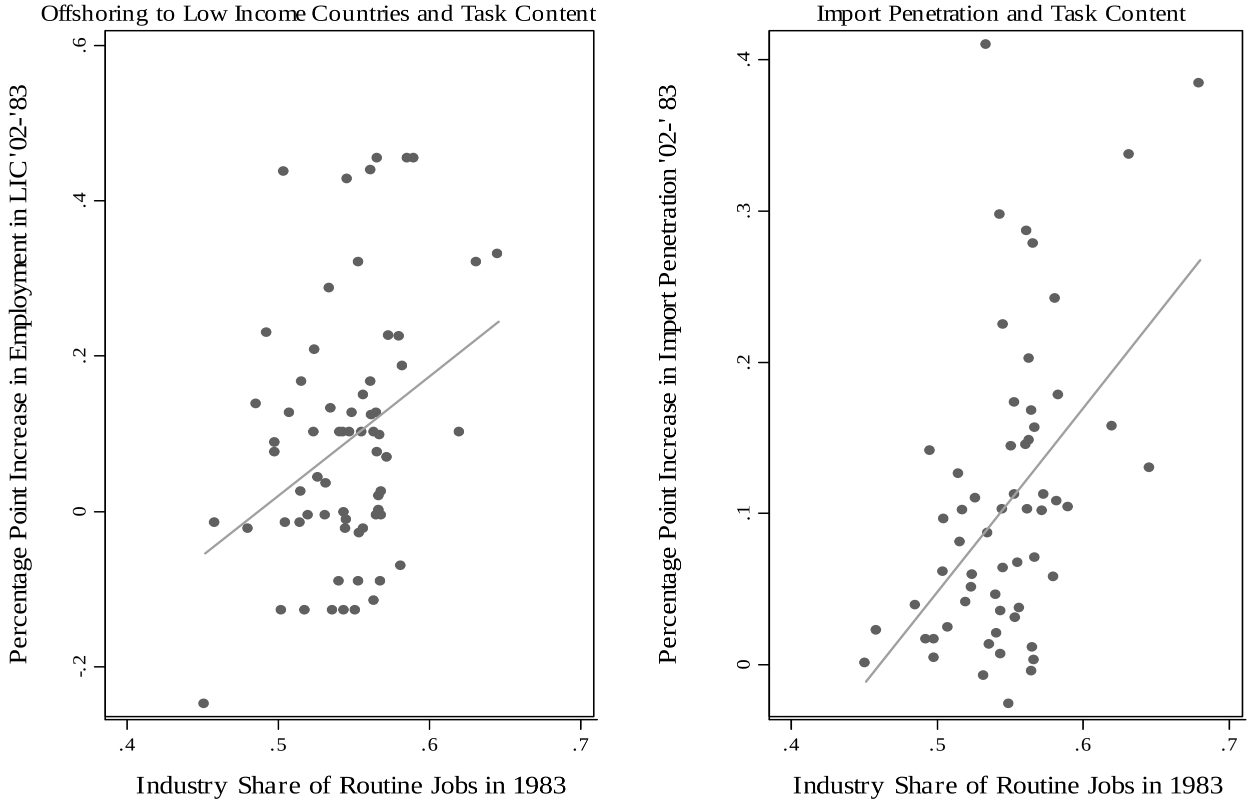
Trends in Import Penetration by Source



Notes : Import penetration trends by source are taken from Bernard et al. (2006), and are calculated as a share of the total product market. The industry level data are aggregated to annual averages using industry employment weights taken from the CPS MORG.

Figure 4

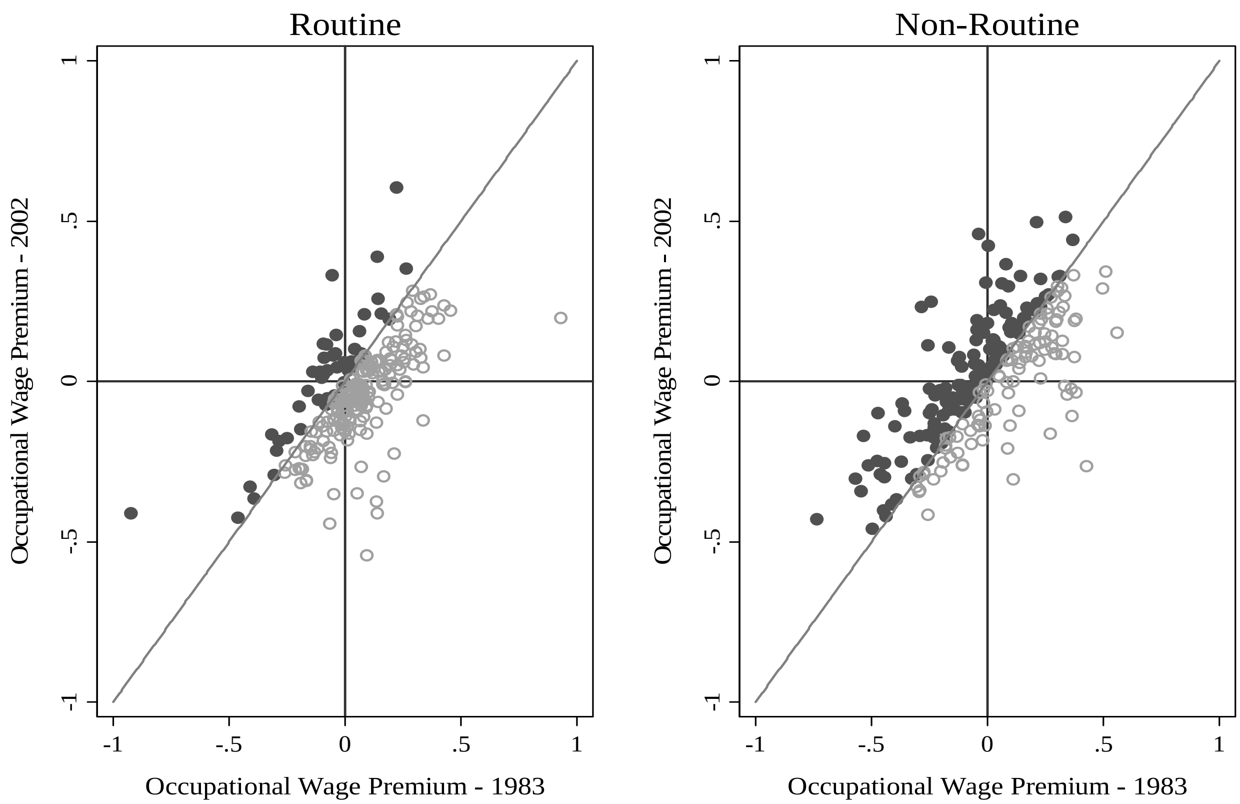
Patterns in Offshoring to Low Income Countries and Import Penetration by Industry



Notes : Change in low wage employment is defined as the change between 1983 and 2002 in the share of employees hired by US based multinationals in low income countries using World Bank classification. Import penetration is taken from Bernard et al. (2006). Industry share of routine jobs is computed from information about individual job characterics using Department of Labor definitions. See data appendix for details.

Figure 5

Occupational Wage Premiums in 1983 and 2002 among Routine and Non-Routine Occupations



Notes : Wage premium are calculated by a standard Mincerian regression of the log wage on education, experience, age, sex, race, year fixed efffects and state fixed effects among all workers in the CPS MORG between 1983 and 2002. Each point in the plot is a separate occupation identified in the CPS (N=474). The occupations are considered routine if the share of tasks that is routine is greater than the median occupation. Occupations with higher wage premiums in 2002 than in 1983 are shaded in.

Appendix Table 1

Summary Statistics of Current Population Survey Merged Outgoing Rotation Group Workers, Means and (Standard Deviations), 1983-2002

	Overall Sample				**1983**				**2002**			
	All	Manufact-uring	Services	Agriculture	All	Manufact-uring	Services	Agriculture	All	Manufact-uring	Services	Agriculture
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Demographic and Wage Information												
Number of Observations	3,481,692	647,105	2,770,662	63,925	176,454	38,071	134,239	4,144	185,798	26,229	156,319	3,250
Age	37.3	38.8	37.0	34.2	36.2	38.1	35.8	32.4	39.2	41.2	38.9	36.0
	(12.1)	(11.4)	(12.2)	(12.8)	(12.6)	(12.2)	(12.6)	(13.1)	(12.1)	(11.0)	(12.3)	(12.9)
Female	0.48	0.32	0.52	0.27	0.46	0.32	0.50	0.27	0.49	0.30	0.52	0.27
	(0.50)	(0.47)	(0.50)	(0.44)	(0.50)	(0.47)	(0.50)	(0.45)	(0.50)	(0.46)	(0.50)	(0.45)
Years of Education	13.2	12.7	13.3	12.0	12.9	12.4	13.0	11.8	13.4	13.0	13.5	12.3
	(2.3)	(2.1)	(2.3)	(2.2)	(2.3)	(2.1)	(2.3)	(2.2)	(2.3)	(2.1)	(2.3)	(2.1)
Real Hourly Wage ($2006)	16.28	17.86	16.02	10.34	15.00	17.04	14.55	9.52	18.44	20.06	18.28	12.20
	(10.83)	(10.68)	(10.87)	(6.98)	(9.47)	(9.62)	(9.38)	(6.34)	(12.70)	(12.20)	(12.81)	(7.87)
Panel B: Offshoring and Trade Data												
Low Income Affiliate	44,560	44,560	.	.	35,054	35,054		.	68,868	68,868		.
Employment	(64,514)	(64,514)	.	.	(44,962)	(44,962)		.	(94,642)	(94,642)		.
High Income Affiliate	90,740	90,740	.	.	85,826	85,826		.	101,637	101,637		.
Employment	(102,991)	(102,991)	.	.	(99,695)	(99,695)		.	(114,111)	(114,111)		.
Import Penetration	0.13	0.13	.	.	0.09	0.09		.	0.16	0.16		.
	(0.10)	(0.10)	.	.	(0.07)	(0.07)		.	(0.12)	(0.12)		.
Export Share	0.11	0.11	.	.	0.08	0.08		.	0.14	0.14		.
	(0.09)	(0.09)	.	.	(0.07)	(0.07)		.	(0.11)	(0.11)		.
Panel C: Offshoring and Trade Data, Occupational Exposure Measure												
Low Income Affiliate	7,269	21,168	4,150	1,785	5,301	14,532	2,813	1,073	9,668	32,440	5,986	2,970
Employment	(14,166)	(24,569)	(7,429)	(4,522)	(9,335)	(14,932)	(4,490)	(2,882)	(17,559)	(31,679)	(9,781)	(6,550)
High Income Affiliate	13,268	38,507	7,608	3,081	13,097	35,600	7,046	2,386	12,669	42,105	7,909	4,065
Employment	(22,270)	(35,341)	(12,122)	(7,686)	(21,828)	(33,269)	(11,274)	(6,986)	(21,675)	(37,442)	(12,324)	(9,008)
Import Penetration	0.02	0.07	0.01	0.01	0.02	0.05	0.01	0.00	0.03	0.09	0.02	0.01
	(0.04)	(0.06)	(0.02)	(0.01)	(0.03)	(0.04)	(0.01)	(0.01)	(0.04)	(0.07)	(0.03)	(0.02)
Export Share	0.02	0.06	0.01	0.01	0.02	0.04	0.01	0.00	0.03	0.08	0.02	0.01
	(0.03)	(0.05)	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)	(0.01)	(0.04)	(0.06)	(0.03)	(0.02)
Panel D: Technology Measures												
Real Price of Investment	1.05	1.05	.	.	0.94	0.94	.	.	1.00	1.00	.	.
	(0.18)	(0.18)	.	.	(0.05)	(0.05)	.	.	(0.33)	(0.33)	.	.
Total Factor Productivity	1.04	1.04	.	.	0.95	0.95	.	.	1.10	1.10	.	.
	(0.18)	(0.18)	.	.	(0.05)	(0.05)	.	.	(0.33)	(0.33)	.	.
Real Price of Shipments	24,334	24,350	.	.	13,704	13,709	.	.	38,841	38,874	.	.
	(44,437)	(44,454)	.	.	(16,427)	(16,431)	.	.	(77,503)	(77,535)	.	.
Computer Use Rate	0.42	0.37	0.44	0.16	0.23	0.22	0.24	0.07	0.60	0.55	0.62	0.26
	(0.31)	(0.30)	(0.31)	(0.24)	(0.22)	(0.23)	(0.22)	(0.14)	(0.35)	(0.33)	(0.35)	(0.32)

Source : Sample consists of Current Population Surveys Merged Outgoing Rotation Group Workers for 1983-2002. Affiliate (or offshore) employment data are taken from the Bureau of Economic Analysis annual survey of US firms with multinational affiliates for the same period. Low income countries are defined according to the World Bank income categories. Import penetration and export share are taken from Bernard et al. (2006). Computer use rates are taken from October CPS supplements during the sample period. Investment good prices and total factor productivity measures, and the real price of shipments are taken from the NBER productivity database.

APPENDIX MATERIALS - NOT FOR PUBLICATION

Supplementary Online Appendix Materials - NOT FOR PUBLICATION

In this section, we present materials that supplement our results in the main text, but were not included due to space considerations. We first examine the data and robustness associated with our results on manufacturing displayed in Table 5. We then present a robustness check on our results for wages where we replace our measures of quantities of imports and exports with prices. We conclude with a thorough breakdown of imports by occupation, to provide insight into the patterns underlying our regression results in the paper.

A. Employment Determinants in Manufacturing

In Table A1, we present summary statistics for the analysis underlying Table 5, where we investigate the relationship between offshoring, trade, and employment in manufacturing. The data are organized by education X year X industry cells and our outcome is the log of total manufacturing employment, as measured by the sum of the sample weights of the CPS workers in the cell. In each cell, we also record affiliate employment to low income countries, affiliate employment to high income countries, and import and export penetration. We also report the summary statistics for measured total factor productivity, the price of investment, and the real value of shipments in each cell.

In Table A2, we demonstrate that the results presented in Table 5 are robust to a range of alternative specifications. Columns (2) and (3) report the results of the first specification when only imports or exports are controlled for. In column (3), the negative association between export orientation and employment becomes statistically significant, which could be indicative of collinearity between export and import shares. The point estimate , at -0.57, suggests that a 1 percentage point increase in export shares is associated with nearly a .6 percentage point decline in employment, suggesting that export growth is labor-saving. The results are even stronger in column (4), where we eliminate the control for total factor productivity—which is likely to be associated with changes in trade orientation. Similarly, the negative association between import shares and employment become significant and negative in column (6) when we omit the control for export shares, consistent with possibility collinearity between exports and imports at the industry level. The results in columns (3), (4), (6) and (7) suggest a strong and significant negative association between trade shares and employment if either export shares or import penetration are included independently. In columns (8) through (11) we remove trade shares to ensure that the relationship between offshoring and employment is robust to these alternative specifications. We also explore the robustness of the results to using import and export prices as measures of trade in goods instead of trade shares. Finally, in the last two columns we explore the robustness of the results to the inclusion of lags of the dependent variable.

In Table A3, we account for the fact that trade and offshoring are simultaneously determined with employment. Note that this is not as much of a concern with our wage regressions since wages are at the individual level. To take into account the possibility that simultaneity bias may be driving the results in Table 5, we instrument for trade and offshoring using the variables suggested by Grossman and Rossi-Hansberg that capture changes over time in the cost of offshoring. These variables include: internet access, telephone (including cell phones) access and education. In addition, we use the industry share of routine jobs.

The results in the first row of Table A3 confirm the results already presented in Table 5 of the paper: both offshoring and trade are increasing in the share of routine jobs by industry. The effects are statistically significant at the 1 percent level and quantitatively large. Internet access is positively associated with offshoring to both high and low wage countries and appears to have little effect on trade. Education levels in low wage countries is a significant predictor of offshoring to both high and low wage countries and is also positively associated with import penetration indicating that import penetration is driven by countries with relatively higher degrees of educational attainment. Education in low wage countries is negatively correlated with export share, a possible indication that U.S. based multinationals prefer to send exports for further processing to lower wage countries where workers are less educated. Finally, education in high wages countries is negatively associated with offshoring to low wage countries and positively correlated with import penetration. In each case, the F-statistic exceeds 10 indicating that the instruments are indeed strong predictors of our trade and offshoring variables.

Second stage results are reported in column (5). The sign on offshoring to low wage countries remains negative and statistically significant, which is consistent with the results in Table 5. However, the magnitude of the coefficient increases significantly. The coefficient on offshoring to high wage countries retains its sign but is no longer significant. As in Table 5, the signs on total factor productivity and important penetration are negative and significant at the 1 percent level.

Consequently, we also report both IV and GMM results, using both lags of right-hand side variables as instruments and a number of appropriate excluded instruments for the endogenous regressors. If we allow for separate effects of foreign capital, employment, and trade flows from low and high income destinations, we have already six endogenous variables (in addition to import penetration at the sector level) that we need to instrument. For capital abroad, we use the following instruments: capital controls, distance, a dummy for the use of a common language, C02 emissions in metric tons per capita, the percentage of child labor, fixed line and mobile phone subscribers per 1000 people, internet users per 1000 people, and number of telephone main lines per 1000 people. The last three measures capture the ease with which parents are able to communicate with their affiliates and should be positively correlated with investment abroad. Emissions and child labor are also likely to adversely affect foreign investment, as firms now care increasingly about corporate responsibility. A dirty environment is increasingly regarded as a potential liability, in addition to the problems incurred in trying to manufacture high quality goods in a dirty environment.

For intra-firm trade, as instruments we use air transport (in million tons per kilometer), aircraft departures, and trade agreements. These all are correlated with bilateral trade but should be excluded from the estimating equation. Finally, candidate instruments for employment in high and low income locations include the total labor force in each affiliate location, the percentage of the labor force engaged in manufacturing, the percentage of national income spent on education, the local unemployment rate, and the number of PCs per 1000 people. The measures we use determine both the supply of labor available as well as the quality of that labor, yet should only affect U.S. labor market outcomes through their impact on the choice of employment in affiliate locations.

B. Imports and Exports using Prices instead of Quantities

In Table 2 in the paper, we examine the impact of import penetration and the quantity of exports on worker's wages. It is worth examining the impact of prices of imported or exported goods on workers wages, since most traditional models of trade presume that changing relative prices are the catalyst for wage effects. In Table A4, we replace our quantity measures for imports and exports with price series data for each. Our data on the prices of imports were generously provided by Robert Lawrence, which catalogue prices within manufacturing by 4-digit NAICS industry codes. We used a concordance to translate this into prices for each CPS industry. Our data on export prices are taken from the Bureau of Labor Statistics export price series data. The results are qualitatively similar to the results in the paper: while we see little or no wage effects within manufacturing, occupational exposure to import price declines has affected workers across sectors. In particular, we find that a 1 unit increase in the price index for imports raises a worker's real wage by .031 percent. We find no significant effect of our export price series on wages. For the wage impact of offshoring, our results are similar in sign and magnitude to those presented in the paper. This suggests that our core results are robust to our use of quantities for imports and exports. Since our data on quantity of imports and exports is more comprehensive than the price data we have for this period, we proceed in our other results with our quantity measures.

C. Imports and Trends in Wage Premiums by Occupation

In Table A5, the most affected workers were shoe machine operators, for whom occupation-specific import penetration increased from 37.2 percent in 1983 to 77.4 percent in 2002. For these workers, the coefficient on import penetration in column (5) of Table 3, which is -.27, implies that their real wages fell by nearly 11 percent as a result of competition from trade. The contrasting experiences of workers in textiles and apparel related sectors compared to many service sector employees such as teachers helps to explain why some parts of the U.S. economy have been deeply affected by globalization while others have not. On average, occupation-specific import and export shares only increased from an average of 2 to 4 percent during the 1983 through 2002 period, in large part because of the importance of services and the lack of global competition in service occupations. Consequently, the average effect of an increase from .02 to .04 for occupation-specific import competition is quite small, equal to .02 x .27, which is a fall in real wages of half a percent. However, what Table A5 makes clear is that some groups of occupations experienced significant wage declines as a consequence of rising (occupation-specific) import competition. Since occupation-specific import penetration is correlated with offshore employment in low wage countries, this provides insight into the occupations most affected by offshoring as well.

Table A1: Summary Statistics on Industry-Year Cells

Variables	Number of Observations	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)
Log US Manufacturing Sector Employment	6,675	10.09	1.48	4.63	13.34
Log of low income affiliate employment	6,615	9.52	1.39	4.97	12.80
Log of high income affiliate employment	6,635	10.47	1.06	6.07	13.14
Log of price of investment using 1979 weights	6,437	4.68	0.13	3.60	4.86
Total factor productivity level using 1979 weights	6,583	1.01	0.32	0	5.31
Export share using 1979 weights	6,583	0.11	0.09	0	0.58
Import penetration using 1979 weights	6,583	0.13	0.13	0	0.83
Log of real price of shipments using 1979 weights	6,437	8.94	1.13	5.70	13.14
Education level	6,675	2.97	1.40	1	5

Source : Affiliate (or offshore) employment data are taken from the Bureau of Economic Analysis annual survey of US firms with multinational affiliates for 1983-2002. Low income countries are defined according to the World Bank income categories. Employment data are taken from all workers in the Current Population Surveys Merged Outgoing Rotation Groups for the same period. Import penetration and export share are taken from Bernard et al. (2006). Investment good prices, total factor productivity measures, and the real price of shipments are taken from the NBER productivity database.

Table A2: Robustness Checks of Estimates of Employment Determinants, 1983-2002

Dependent Variable: Log US Manufacturing Sector Employment

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Lagged Log US Manufacturing												0.348***	0.348***
Sector Employment												(0.07)	(0.07)
Lagged log of low income	-0.022**	-0.024**	-0.027**	-0.029**	-0.022**	-0.022**	-0.027**	-0.029**	-0.030**	-0.027**	-0.021***	-0.0270*	-0.0270*
affiliate employment[1]	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.011)	(0.007)	(0.016)	(0.016)
Lagged log of high income	0.076**	0.084***	0.087***	0.097***	0.083***	0.075**	0.087***	0.092***	0.091***	0.088**	0.024	0.100***	0.100***
affiliate employment[1]	(0.03)	(0.03)	(0.032)	(0.031)	(0.03)	(0.031)	(0.032)	(0.033)	(0.034)	(0.036)	(0.089)	(0.031)	(0.031)
Lagged log of price of	-0.071	0.061	-0.039	0.102	0.105	-0.073	-0.039	-0.023	-0.009	-0.055	-0.008	0.370*	0.370*
investment using 1979 weights	(0.17)	(0.159)	(0.188)	(0.182)	(0.096)	(0.172)	(0.188)	(0.206)	(0.207)	(0.187)	(0.219)	(0.221)	(0.221)
Lagged total factor productivity	-0.164**		-0.172**		-0.005	-0.170**	-0.172**	-0.195**	-0.189**	-0.141*	0.009	0.046	0.046
level using 1979 weights	(0.069)		(0.072)		(0.026)	(0.069)	(0.072)	(0.075)	(0.073)	(0.08)	(0.088)	(0.074)	(0.074)
Lagged export share using 1979	-0.279	-0.336	-0.567**	-0.648**	-0.365		-0.567**						
weights	(0.27)	(0.267)	(0.249)	(0.247)	(0.269)		(0.249)						
Lagged import penetration	-0.597*	-0.639*			-0.592	-0.747***							
using 1979 weights	(0.323)	(0.347)			(0.363)	(0.275)							
Lagged log of real price of	0.149**	0.051	0.148**	0.045		0.155**	0.148**	0.163**	0.157**	0.125*	0.034	-0.064	-0.064
shipments using 1979 weights	(0.064)	(0.042)	(0.072)	(0.049)		(0.063)	(0.072)	(0.076)	(0.075)	(0.07)	(0.088)	(0.068)	(0.068)
Log price of exports									-0.017	0.148	-0.168		
									(0.156)	(0.141)	(0.285)		
Log price of imports									-0.043	-0.001	0.548**		
									(0.134)	(0.148)	(0.254)		
Prices at 1-digit level									Y	N	N		
Prices at 2-digit level									N	Y	N		
Prices at 3-digit level									N	N	Y		
Industry-Specific Time Trend													-0.013***
													(0.003)
Number of observations	6,427	6,427	6,427	6,427	6,427	6,427	6,427	6,427	6,382	5,284	1,596	1,173	1,173
R-squared	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	.	.

Source : See Table A1.

Note : Robust standard errors reported in parentheses below coefficient estimates. All employment specifications include industry and year fixed effects. Low-income affiliate employment is defined according to the World Bank income categories. Regressions in columns 12 and and 13 are Arellano-Bond dynamic panel data regressions include current rather than lagged offshoring to low and high income countries.

Table A3: Instrumental Variable Estimates of Employment Determinants Overall, 1983-2002

Variable	First Stage				Second Stage
	Lagged log of low income affiliate employment	Lagged log of high income affiliate employment	Import Share Using 1979 Weights	Export Share Using 1979 Weights	Log U.S. Manufacturing Sector Employment
	(1)	(2)	(3)	(4)	(5)
Industry Share of Routine Jobs	0.68***	1.31***	0.23***	0.37***	
	(0.27)	(0.21)	(0.040	(0.04)	
Internet High	0.003***	0.001***	-0.00002	.0.00007***	
	(0.0001)	(0.00009)	(0.00002)	(0.00002)	
Fixed line and mobile phone subscribers (per 1,000 people)	0.0003***	-0.0003***	0.00009***	0.00002	
	(0.0001)	(0.0001)	(0.00001)	(0.00002)	
Education Low	0.03***	0.009***	0.003***	-0.002***	
	(0.01)	(0.003)	(0.0009)	(0.0009)	
Education High	-0.02***	-0.02	.0.002***	-0.004	
	(0.005)	(0.004)	(0.001)	(0.0008)	
Lagged log of low income affiliate employment					-0.05**
					(0.26)
Lagged log of high income affiliate employment					0.02
					(0.71)
Lagged log of price of investment using 1979 weights	-0.53***	-0.15***	0.31***	0.08***	0.96
	(0.09)	-0.07	.(0.01)	(0.01)	(0.92)
Lagged total factor productivity level using 1979 weights	0.296***	0.03	0.19***	0.06***	-0.18***
	(0.05)	(0.04)	(0.008)	(0.004)	(0.07)
Lagged export share using 1979 weights					-0.82
					(2.86)
Lagged import penetration using 1979 weights					-0.42***
					(0.15)
Lagged log of real price of shipments using 1979 weights	-0.23***	-0.06***	-0.18***	0.08***	0.14***
	(0.03)	(.020)	(0.004)	(0.01)	(0.04)
F statistic	18.96	17.31	12.09	19.20	
Sargan Chi-sq (1) P-Value					0.19
Number of observations	1,756	1,756	1,756	1,756	1,756

Source : See Table A1.

Note : Robust standard errors reported in parentheses below coefficient estimates. All specifications include year, education, industry and location fixed effects.

Table A4: Robustness of OLS Estimates of Wage Determinants to using Import Prices instead of Quantities, using Occupational versus Industry Offshoring Exposure, 1983-2002

Dependent Variable: Log Wage

	Offshoring Measured by Industry-Specific Exposure, Manufacturing Only				Offshoring Measured by Occupation-Specific Exposure, All Sectors			
Variable	All Occupations	Most Routine	Intermediate Routine	Least Routine	All Occupations	Most Routine	Intermediate Routine	Least Routine
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged log of low income affiliate employment	-0.0106*	-0.0156***	-0.004	0.007	-0.0575***	-0.0633***	0.015	0.0705*
	(0.006)	(0.006)	(0.007)	(0.011)	(0.019)	(0.016)	(0.050)	(0.042)
Lagged log of high income affiliate employment	0.014	0.013	0.012	0.006	0.031	0.0529**	0.030	-0.094
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.06)	(0.08)
Lagged import prices	0.01	0.001	-0.005	0.0384*	0.01	0.0331***	0.01	0.0254**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Lagged export prices	0.09	0.05	0.05	0.101*	0.002	-0.001	-0.004	0.006
	(0.06)	(0.09)	(0.06)	(0.05)	(0.00)	(0.00)	(0.00)	(0.01)
Number of observations	204,364	113,108	58,699	32,557	1,470,051	597,699	521,986	350,366
R-squared	0.44	0.34	0.38	0.35	0.50	0.40	0.54	0.41

Source : See Table 1.

Note : Robust standard errors reported in parentheses below coefficient estimates. These regressions are the same as Table 2 in the paper, with import and export price series data replacing the quantity measures used in our core specifications. Prices on imports are taken from data provided to the authors by Robert Lawrence at the 4-digit NAICS level, and converted to our consistent industry classification for the CPS MORG. Export price data is taken from the Bureau of Labor Statistics. Details are available in the data appendix. Sample sizes differ from Table 2 due to more limited price series data on imports and exports than on quantities.

Table A5: Import Penetration in 1983 and 2002, for 40 Occupations with Highest Import Penetration in 2002

	Occupational Exposure to Import Penetration		Share of Total Workforce		Share of each Occupation in Manufacturing	
Occupation	**1983**	**2002**	**1983**	**2002**	**1983**	**2002**
Shoe machine operators	0.372	0.774	0.09%	0.01%	100%	100%
Shoe repairers	0.182	0.379	0.02%	0.01%	23%	16%
Textile sewing machine operators	0.135	0.304	0.86%	0.26%	93%	94%
Textile cutting machine operators	0.092	0.245	0.00%	0.01%	100%	100%
Electrical and electronic equipment assemblers	0.090	0.219	0.27%	0.18%	96%	96%
Solderers and brazers	0.095	0.217	0.04%	0.01%	92%	86%
Miscellaneous textile machine operators	0.077	0.209	0.08%	0.02%	89%	82%
Knitting, looping, taping, and weaving machine operators	0.046	0.207	0.05%	0.02%	97%	100%
Production testers	0.072	0.205	0.06%	0.04%	75%	73%
Numerical control machine operators	0.107	0.204	0.00%	0.03%	100%	83%
Assemblers	0.099	0.204	1.01%	0.86%	87%	81%
Tool and die maker apprentices	0.102	0.203	0.01%	0.00%	100%	100%
Precision assemblers, metal	0.084	0.201	0.01%	0.02%	83%	87%
Miscellaneous precision woodworkers	0.061	0.195	0.00%	0.00%	100%	100%
Cementing and gluing machine operators	0.089	0.194	0.05%	0.02%	88%	83%
Hand molding, casting, and forming occupations	0.103	0.188	0.02%	0.01%	87%	100%
Lathe and turning machine set-up operators	0.105	0.188	0.03%	0.01%	100%	100%
Folding machine operators	0.068	0.188	0.03%	0.01%	90%	100%
Patternmakers, lay-out workers, and cutters	0.091	0.188	0.03%	0.01%	71%	63%
Tool and die makers	0.096	0.188	0.15%	0.08%	94%	96%
Milling and planing machine operators	0.092	0.184	0.02%	0.00%	96%	76%
Drilling and boring machine operators	0.094	0.183	0.04%	0.01%	96%	100%
Mechanical engineering technicians	0.085	0.183	0.02%	0.01%	79%	70%
Lathe and turning machine operators	0.097	0.180	0.09%	0.02%	93%	97%
Miscellaneous woodworking machine operators	0.082	0.177	0.03%	0.02%	82%	70%
Patternmakers and model makers, wood	0.095	0.177	0.00%	0.00%	100%	100%
Cabinet makers and bench carpenters	0.074	0.177	0.03%	0.05%	95%	61%
Production inspectors, checkers, and examiners	0.080	0.174	0.71%	0.36%	79%	64%
Production samplers and weighers	0.067	0.172	0.01%	0.00%	54%	100%
Nailing and tacking machine operators	0.062	0.169	0.01%	0.00%	100%	100%
Misc metal, plastic, stone, and glass working machine oper.	0.096	0.168	0.05%	0.02%	89%	100%
Wood lathe, routing, and planing machine operators	0.086	0.167	0.01%	0.01%	95%	100%
Precision grinders, filers, and tool sharpeners	0.096	0.167	0.02%	0.01%	81%	57%
Shaping and joining machine operators	0.091	0.164	0.01%	0.00%	100%	100%
Grinding, abrading, buffing, and polishing machine oper.	0.090	0.164	0.17%	0.07%	88%	82%
Metal plating machine operators	0.074	0.164	0.04%	0.02%	85%	87%
Adjusters and calibrators	0.081	0.160	0.01%	0.00%	53%	35%
Agricultural	0.093	0.160	0.01%	0.00%	46%	58%
Miscellaneous machine operators, n.e.c.	0.078	0.157	0.95%	0.79%	90%	87%
Industrial	0.070	0.157	0.23%	0.19%	68%	45%

Source: Sample consists of Current Population Surveys Merged Outgoing Rotation Group Workers for 1983-2002. Import penetration data are taken from Bernard et al. (2006).