



Do Jobs In Export Industries Still Pay More? And Why?

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Executive Summary

Workers in export-intensive industries generally earn more. Industries with greater access to international markets invest heavily in technology and capital along the lines of U.S. comparative advantage. This increases the productivity of workers and contributes to higher earnings. Specifically, we find that:

- Exporting has a significant positive impact on earnings. We estimate that exports contribute an additional 18% to workers' earnings on average in the U.S. manufacturing sector. This export earnings premium is an employment-weighted average across the industries and occupation categories analyzed in this study.
- Our estimates likely understate the export earnings premium, because we do not count returns to education, even though export-intensive industries generally employ more highly educated workers.
- The export earnings premium for blue collar workers is approximately 20% greater than the export earnings premium for white collar workers.¹
- The export earnings premium varies by industry. It is highest in industries with high export shares, including machinery, computers, electrical equipment, and transportation equipment.
- Foreign tariffs reduce the export shares of U.S. manufacturing industries. As a result, they may reduce the earnings of workers by up to 12%, depending on the magnitude of the foreign tariffs that the industry faces. The impact of foreign tariffs on earnings is greatest for workers in the beverages and tobacco, food products, and apparel industries.

These findings are based on our analysis of the recent earnings of nearly 60,000 U.S. manufacturing workers. We estimate the earnings impact of several worker characteristics, including the export intensity of the worker's industry and the worker's education, age, location, and occupation.

¹ This ratio is calculated within each three-digit manufacturing industry. In these calculations, white collar is defined as all 2002 Census occupation codes for management, professional, and related occupations. The category blue collar is defined as all other occupation codes.

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1. Introduction

Workers in export-intensive industries generally earn more. There are several reasons for this. First, workers in industries with greater access to international markets benefit from the industries' investments in capital and technology along the lines of U.S. comparative advantage. These investments increase the value of labor inputs and therefore earnings.

Second, export-intensive industries employ a more highly educated workforce, and the higher earnings reflect the industry composition of the workforce. For this reason, part of the higher earnings should be attributed to the worker's educational attainment rather than to exporting.

Finally, the higher earnings reflect industry factors that increase the productivity of the workers whether they export or not, but which also increase the probability that the worker's industry will succeed in exporting. For example, if the U.S. industry produced an exceptionally high quality, relatively unique set of goods, then export success would coincide with higher earnings, even if export intensity did not increase the earnings. This third effect has been described as "success begets exporting."²

Since we are interested in measuring the *contribution of exporting to earnings*, we want to isolate and measure the first of these three effects. Using an econometric model of the earnings of individual manufacturing workers, we quantify the impact on earnings of lower barriers to international trade and the consequent expansion of U.S. manufacturing exports. In order to estimate the econometric model, we need to identify industry characteristics that explain why some U.S. industries are relatively export-intensive. We find that differences across industries in international freight costs and tariffs on imports from the United States are significant determinants of an industry's export intensity, and thus lower trade barriers are associated with significantly higher earnings.

² Bernard and Jensen (1999).

2. CPS Data Provide Detailed Information about Individual Workers

We analyze the weekly earnings of nearly 60,000 U.S. workers who participated in the Current Population Survey (CPS) between 2006 and 2008. The data source is the NBER's Merged Outgoing Rotation Group extracts from the CPS data files. The sample is limited to individuals employed in manufacturing industries (NAICS 311-339). Our earnings measure is usual weekly earnings, converted into constant 2008 dollars.

Our statistical analysis takes into account individual characteristics that affect a worker's earnings, including educational attainment, age, occupation, union, race, gender, and location. The measures of educational attainment are based on the highest degree completed (high school diploma or equivalent, associate degree, bachelor degree, or post-graduate degree). We aggregate occupations into three groups based on the occupation codes in the 2002 Census: management, professional, and related occupations; sales and office occupations; and all other occupations within the manufacturing industries. A worker is classified as *union* if he or she is a member of a union or is covered by a union contract. We also take into account the worker's state of residence and whether the worker lives in a metropolitan area.

We use the worker's three-digit industry designation to link the worker to industry-level trade flows, and we use the ratio of export sales to total sales to measure the export intensity of the worker's industry.³ We calculate each industry's export share and import penetration ratio from annual free along ship export values, landed duty paid import values, and the total shipment values from the Census Bureau.⁴ The six manufacturing industries with the highest export shares in 2007 were computers, electrical equipment, machinery, medical equipment and miscellaneous manufactures, leather products, and transportation equipment. The 2007 export shares of these six industries ranged from 26% to 41%.

³ The industry designations in the CPS worker-level data correspond to three-digit NAICS industries. It is not possible to further disaggregate the industries and still associate them with individual workers. We discuss this limitation in our *Looking Ahead* section.

⁴ The export share is the value of exports divided by the total value of shipments. The import penetration ratio is the value of imports divided by the sum of domestic shipments and imports.

Export-intensive industries are relatively technology-intensive and capital-intensive (Table 1).⁵ We use the ratio of R&D expenditure to the total value of shipments from the National Science Foundation and the Census Bureau as a measure of the technology intensity of each industry. We use the ratio of the value of private fixed capital to the size of the workforce from the Census Bureau as a measure of the capital intensity of each industry.

Table 1: Domestic Production-Related Industry Characteristics

Industry (NAICS code)	Export Share	R&D Ratio	Capital Ratio	Share of College Graduates
Leather (316)	41.3%	0.8%	210.8	20.1%
Machinery (333)	35.2%	2.8%	158.0	22.6%
Computers (334)	34.5%	12.6%	233.1	48.9%
Transportation Equipment (336)	27.5%	4.2%	135.9	28.6%
Medical Equipment <i>et al.</i> (339)	26.1%	4.3%	91.0	27.2%
Electrical Equipment (335)	25.9%	2.0%	125.5	25.2%
Textiles (313)	23.0%	0.8%	256.3	17.0%
Chemicals (325)	20.4%	7.7%	322.9	43.8%
Primary Metals (331)	17.3%	0.4%	297.5	14.6%
Apparel (315)	12.9%	0.8%	68.7	14.6%
Paper Products (322)	11.2%	0.9%	240.5	17.7%
Plastic and Rubber (326)	10.5%	1.0%	109.9	13.8%
Textile Mills (314)	9.2%	0.8%	276.0	10.2%
Fabricated Metals (332)	8.6%	0.5%	84.8	13.5%
Non-Metallic Minerals (327)	6.7%	0.4%	144.4	13.8%
Food Products (311)	6.6%	0.5%	125.9	12.6%
Printing (323)	6.1%	0.9%	87.8	17.7%
Petroleum and Coal (324)	5.1%	0.3%	1212.2	30.1%
Wood Products (321)	4.9%	0.4%	79.4	8.3%
Furniture (337)	4.1%	0.4%	41.0	9.6%
Beverages and Tobacco (312)	3.3%	0.4%	204.9	28.5%

Notes: The R&D ratio relates the industry's dollar value of private R&D expenditures to its total value of shipments in 2007. The capital ratio relates the industry's value of private fixed assets (in thousands of dollars) to industry employment.

⁵ The small leather products industry is an exception. It is capital-intensive but not technology-intensive.

Lower foreign tariff rates and lower international freight costs both increase an industry's export intensity. We use the ratio of the cost-in-freight value of imports to the customs value of imports from the U.S. International Trade Commission (ITC) as a measure of international freight costs. We use average tariffs rates from the ITC and the United Nations' *Tariff Profiles* report.

3. Education and Other Worker Attributes Explain Differences in Earnings

In order to quantify the contribution of exporting to a worker's earnings, it is important to adequately account for worker attributes that can explain much of the variation in earnings. Foremost among these is educational attainment. In our statistical analysis, we find that education – as well as other demographic characteristics like age, gender, and location – has a significant impact on earnings. For example, blue collar workers who have a college degree earn approximately 89% more than comparable blue collar workers who have a high school diploma but no post-secondary degrees.

Export-intensive industries tend to employ more highly educated workers that command higher earnings. However, if the worker would receive a similar return to education in non-exporting industries, then it would be inappropriate to count the worker's return to education as a contribution of exporting simply because the highly educated worker is employed in an export-intensive industry.

We resolve this issue in a conservative way that likely leads to an understatement of the export earnings premium. Our export earnings premium does not count returns to education. Technically, this is equivalent to assuming that the manufacturing workers would still be employed if they did not have a job in the export-intensive industry and that their alternative employment would still fully utilize their education. If that were not the case, then some of the returns to education should be counted in the export earnings premium.

4. Exporting Contributes Significantly to Workers' Earnings

The economic theory linking exporting to higher earnings is straightforward. Greater access to export markets will likely result in greater investments in technology and capital, both

of which increase the productivity of workers.⁶ If earnings are greater for more productive workers, then we expect higher earnings in export-intensive industries, even after we take into account the educational attainment and other attributes of the individual workers.

In order to quantify the contribution of exporting to earnings, we evaluate a *hypothetical* scenario in which we set each industry's export share equal to zero. We use the estimated parameters of a statistical model to simulate the zero-exports level of earnings. We then calculate how much higher actual earnings were relative to the zero-exports level of earnings. The percentage difference in these two measures of earnings is our export earnings premium. For example, for blue collar workers in the chemicals industry, the export earnings premium is 19.8%. The actual average weekly earnings of these workers is \$884. If the industry had no exports, rather than its actual export share of 20.4%, then we estimate that the average weekly earnings of these workers would be \$738. In this example, the export earnings premium is $(\$884 - \$738) / \$738 = 19.8\%$.

We estimate that exports increase earnings by 18% on average across the U.S. manufacturing industries and the two occupation categories. This summary statistic is an employment-weighted average of the export earnings premium that we calculated for each industry and occupation category. These calculations should be interpreted as estimates of the long-run impact of exporting on earnings. We expect these differences in earnings only after the industry's technology intensity and capital intensity has fully adjusted to international trade opportunities.

When we look within the three-digit manufacturing industries, we find that exports have a larger impact on blue collar earnings than on white collar earnings (Table 2 and Table 3). The export earnings premium for blue collar workers in each industry is approximately 20% greater than the export earnings premium for white collar workers.⁷

⁶ On the other hand, industries with large import penetration ratios are generally less technology-intensive and less capital-intensive.

⁷ We can summarize these industry-specific estimates by averaging across the industries in the U.S. manufacturing sector. The un-weighted average of the industry-specific export wage premium is 16.6% for blue collar workers and 13.3% for white collar workers. The employment-weighted average of the export earnings premium is 18.0% for blue collar workers and 19.3% for white collar workers.

Table 2: Portion of Current Earnings Attributed to Export Share, Blue Collar Workers by Industry

Industry (NAICS code)	Blue Collar Average Weekly Earnings Non-Export Portion	Blue Collar Average Weekly Earnings Export Portion	Export Earnings Premium
Food Products (311)	\$557	\$31	5.7%
Beverages and Tobacco (312)	\$747	\$20	2.7%
Textiles (313)	\$467	\$107	22.9%
Textile Mills (314)	\$515	\$41	8.0%
Apparel (315)	\$420	\$49	11.6%
Leather (316)	\$365	\$183	50.3%
Wood Products (321)	\$607	\$25	4.1%
Paper Products (322)	\$725	\$72	10.0%
Printing (323)	\$660	\$34	5.2%
Petroleum and Coal (324)	\$909	\$39	4.3%
Chemicals (325)	\$738	\$146	19.8%
Plastic and Rubber (326)	\$608	\$57	9.3%
Non-Metallic Minerals (327)	\$677	\$39	5.8%
Primary Metals (331)	\$669	\$109	16.3%
Fabricated Metals (332)	\$670	\$50	7.5%
Machinery (333)	\$542	\$216	39.9%
Computers (334)	\$572	\$222	38.8%
Electrical Equipment (335)	\$557	\$148	26.6%
Transportation Equipment (336)	\$635	\$182	28.7%
Furniture (337)	\$588	\$20	3.4%
Medical Equipment <i>et al.</i> (339)	\$515	\$138	26.8%

Note: The Technical Appendix provides the details of these calculations.

Table 3: Portion of Current Earnings Attributed to Export Share, White Collar Workers by Industry

Industry (NAICS code)	White Collar Average Weekly Earnings Non-Export Portion	White Collar Average Weekly Earnings Export Portion	Export Earnings Premium
Food Products (311)	\$1,216	\$57	4.7%
Beverages and Tobacco (312)	\$1,387	\$32	2.3%
Textiles (313)	\$1,036	\$193	18.6%
Textile Mills (314)	\$999	\$66	6.7%
Apparel (315)	\$1,070	\$103	9.6%
Leather (316)	\$878	\$344	39.1%
Wood Products (321)	\$1,075	\$37	3.4%
Paper Products (322)	\$1,302	\$107	8.2%
Printing (323)	\$1,034	\$45	4.3%
Petroleum and Coal (324)	\$1,482	\$53	3.6%
Chemicals (325)	\$1,280	\$206	16.1%
Plastic and Rubber (326)	\$1,226	\$95	7.7%
Non-Metallic Minerals (327)	\$1,296	\$62	4.8%
Primary Metals (331)	\$1,156	\$154	13.3%
Fabricated Metals (332)	\$1,218	\$76	6.2%
Machinery (333)	\$1,022	\$322	31.5%
Computers (334)	\$1,199	\$368	30.7%
Electrical Equipment (335)	\$1,092	\$234	21.4%
Transportation Equipment (336)	\$1,202	\$277	23.1%
Furniture (337)	\$1,081	\$31	2.9%
Medical Equipment <i>et al.</i> (339)	\$1,101	\$238	21.6%

Note: The Technical Appendix provides the details of these calculations.

The contribution of exporting to earnings is greater in industries with higher export shares. This is true for blue collar workers and for white collar workers. The six manufacturing industries with the largest export earnings premium are computers, electrical equipment, machinery, medical equipment and miscellaneous manufactures, leather products, and transportation equipment.

Finally, foreign tariffs reduce the export shares of U.S. manufacturing industries. As a result, they reduce the earnings of workers by up to 12%, depending on the magnitude of the

foreign tariffs that the industry faces (Table 4). The impact of foreign tariffs on earnings is greatest for workers in the beverages and tobacco, food products, and apparel industries.

Table 4: Impact of Foreign Tariffs on Earnings by Manufacturing Industry

Industry (NAICS code)	Blue Collar Workers	White Collar Workers
Food Products (311)	-8%	-7%
Beverages and Tobacco (312)	-12%	-10%
Textiles (313)	-4%	-3%
Textile Mills (314)	-4%	-3%
Apparel (315)	-7%	-6%
Leather (316)	-4%	-4%
Wood Products (321)	-1%	-1%
Paper Products (322)	-1%	-1%
Printing (323)	-1%	-1%
Petroleum and Coal (324)	-7%	-6%
Chemicals (325)	-3%	-2%
Plastic and Rubber (326)	-3%	-2%
Non-Metallic Minerals (327)	-2%	-2%
Primary Metals (331)	-2%	-2%
Fabricated Metals (332)	-2%	-2%
Machinery (333)	-2%	-1%
Computers (334)	-2%	-2%
Electrical Equipment (335)	-2%	-2%
Transportation Equipment (336)	-3%	-2%
Furniture (337)	-1%	-1%
Medical Equipment <i>et al.</i> (339)	-3%	-2%

5. Looking Ahead

One limitation of the CPS data is that they do not identify the worker's industry affiliation at a disaggregated level.⁸ Our measure of the worker's participation in export markets is at the three-digit industry level. The appropriateness of this measure depends on the scope of the product market of the worker's employer. For example, suppose that a worker makes a product that is not exported, but this product is within a broader three-digit industry that has a relatively high export intensity overall. In this case, we would have false positive indicators of

⁸ On the other hand, the CPS data provide detailed information on the workers' individual characteristics like education.

export intensity, because our measure of export intensity is at the industry level. On the other hand, there can be significant limitations to more disaggregated data. Workers who compete in an export-intensive market are likely to earn an export earnings premium if their products are competing in a globalized market, even if the output of their specific plant is not exported. In this case, plant-level data could generate false negative indicators of export intensity. For these reasons, we believe that it is important to consider both industry-level and plant-level evidence on the link between exporting and wages.

Finally, it would be interesting to disentangle how much of the impact of exporting on earnings comes through increased R&D intensity, increased capital intensity, and other channels. However, for technical reasons we cannot do this decomposition with the information available in this study.⁹ This could be a useful direction for further research.

⁹ It would require additional instrumental variables with specific stochastic properties, as we explain in the Technical Appendix.

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Technical Appendix

Model of Earnings Determination

In order to more precisely describe the technical assumptions underlying the econometric estimates, we present a mathematical model of earnings determination in equation (1). The model combines workers' characteristics, like education and age, with industry characteristics, like export share and capital intensity.

$$W_{i,j} = b_0 + b_1X_j + b_2M_j + b_3R_j + b_4K_j + b_5Z_{i,j} + \varepsilon_{i,j} \quad (1)$$

$W_{i,j}$ is the log of average weekly earnings for individual i in industry j . X_j is the ratio of exports to the total value of shipments in industry j , M_j is the industry's import penetration ratio, R_j is the industry's ratio of R&D expenditures to the total value of shipments (a proxy for the industry's technology intensity), K_j is the the industry's ratio of private fixed assets to the size of the workforce (a proxy for the industry's capital intensity), $Z_{i,j}$ is a set of individual attributes that are traditionally included in earnings models, and $\varepsilon_{i,j}$ is a random error. The b coefficients are constant parameters of the model.

Equations (2) and (3) represent the link between each industry's technology intensity and capital intensity and its export share and import penetration ratio.

$$R_j = g_0 + g_1X_j + g_2M_j + u_j \quad (2)$$

$$K_j = h_0 + h_1X_j + h_2M_j + v_j \quad (3)$$

The terms u_j and v_j are random variables that may be correlated with $\varepsilon_{i,j}$ in equation (1). The g and h coefficients are constant parameters of the model.

In these three equations, exports (X_j) affect earnings (W_j) in three ways. An increase in export intensity increases the industry's technology intensity ($g_1 > 0$), which in turn increases earnings ($b_3 > 0$). It increases the industry's capital intensity ($h_1 > 0$), which in turn increases earnings ($b_4 > 0$). In addition, it may also increase earnings through other channels, such as increased utilization of workers' unobserved skills ($b_1 > 0$).

Since R_j and K_j are endogenous variables, we can substitute equations (2) and (3) into (1) to derive a more reduced-form version of the earnings model.

$$W_{i,j} = \alpha + \beta X_j + \gamma M_j + \delta Z_{i,j} + e_{i,j} \quad (4)$$

where $\alpha = b_0 + b_3g_0 + b_4h_0$, $\beta = b_1 + b_3g_1 + b_4h_1$, $\gamma = b_2 + b_3g_2 + b_4h_2$, $\delta = b_5$, and $e_{i,j} = \varepsilon_{i,j} + b_3u_j + b_4v_j$.

We can estimate the parameters β and γ from equation (4). However, the OLS estimates of these parameters will be biased if the error terms are correlated with X_j or M_j . This will be the case if the industry's export share (or its import penetration ratio) is jointly determined with earnings, i.e., if X_j and M_j are also endogenous variables in the model. Equation (5) represents the determinants of X_j , as an illustration of potential bias.

$$X_j = c_0 + c_1T_j + c_2F_j + \omega_j \quad (5)$$

T_j is the average tariff rate on industry j 's products in U.S. export markets, F_j is the international freight costs for these products, and ω_j is an error term that represents unobserved factors that determine exports, including the shocks to the labor costs of U.S. producers in industry j that are represented by $\varepsilon_{i,j}$ in equation (1). The estimate of β in equation (4) will be downward biased if ω_j is negatively correlated with $\varepsilon_{i,j}$. This will be the case as long as increases in U.S. earnings in excess of increases in labor productivity reduce export competitiveness.

To deal with this issue, we use industry-specific measures of international freight costs and tariff rates as instruments for the industry's export share and import penetration ratio when we estimate the coefficients of equation (4). We *assume* that these barriers to trade have a significant impact on the trade ratios X_j and M_j but are not correlated with any shocks to U.S. earnings that are independent of international trade flows, i.e., $\varepsilon_{i,j}$ in equation (1). If this assumption is correct, then we can avoid or at least mitigate potential bias in our estimate of β by projecting the trade ratios on the measures of barriers to international trade.

Estimation Using Instrumental Variables

We estimated the coefficients in equation (4) using the instrumental variables that we described above. We estimate separate models for blue collar workers (Appendix Table 1) and for white collar workers (Appendix Table 2). Our estimates of β can be interpreted as the long-run impact of exports on earnings assuming that complementary investments in capital and R&D respond to exports as in equations (2) and (3).

We also estimated versions of equations (2) and (3) using the same instruments for the export share and import penetration ratio. We expect that the R&D ratio is increasing in the export ratio and decreasing in the import penetration ratio. Likewise, we expect that the capital ratio is increasing in the export ratio and decreasing in the import penetration ratio. We find that the instrumental variables estimates of g and h coefficients have the expected signs and are statistically significant.

Calculation of the Export Earnings Premium

Tables 2 and 3 report the export earnings premium for each of the industries and occupation categories. We use each industry's export share and the corresponding estimated coefficient on export share from Appendix Tables 1 and 2 to calculate what the industry average earnings would have been *but for* the exports. This is the export portion of the earnings reported in the Tables 2 and 3. The non-export portion is the difference between current earnings and the export portion of earnings. The export earnings premium is the ratio of the export portion to the non-export portions.

Estimation of the Impact of Foreign Tariffs on Export Shares

We also use the econometric model to calculate the impact of foreign tariffs on earnings. First, we estimated the coefficients in equation (5), which relates the export share to the average foreign tariff rates. Appendix Table 3 reports the coefficient estimates based on a cross-section of the 21 three-digit NAICS manufacturing industries. Second, we multiplied each industry's average foreign tariff rate by the estimate of the parameter c_1 to calculate the impact of the foreign tariffs on export shares in each industry. Appendix Table 4 reports these calculations. Finally, we multiplied the impact on the export share by the instrumental variable estimates of β

in Appendix Tables 1 and 2 to calculate the impact of the foreign tariffs on earnings. Table 4 reports these calculations.

Estimation Using Ordinary Least Squares

The instrumental variables estimation relies on a set of technical assumptions about the stochastic properties of the instrumental variables. Ordinary least squares (OLS) is an alternative estimation technique that is appropriate under a different set of technical assumptions. In order to evaluate the sensitivity of our estimates to our assumptions about the instrumental variables, we also calculate the export earnings premium based on an OLS estimate of the coefficient on export share (Appendix Tables 1 and 2). These OLS estimates, which are probably downward-biased, indicate that exports increased earnings by 12% on average across the U.S. manufacturing industries and the two occupation categories (Appendix Table 5).

OLS Estimation of a Partial Impact of Exporting on Earnings

We also estimate a partial impact of exporting on earnings, taking as given the industries' technology intensity and capital intensity. This partial impact does not include any positive contribution to earnings from the impact of exporting on the industry's technology intensity and capital intensity. It only includes the impact of exporting on earnings *conditional on* the industry's technology intensity and capital intensity. To estimate the partial impacts, we make the following alternative assumptions about the stochastic variables in the model: we assume that the R&D ratio, the capital ratio, the export share, and the import penetration ratio are all not correlated with $e_{i,j}$. Under these assumptions, we can estimate the model parameters in equation (1) using OLS.¹⁰

Arguably, the partial impact calculation is less appropriate than the full impact as a measure of the long-run effects of exporting. We expect that the partial impact will be substantially smaller than the full impact, since $b_1 < \beta$. We find that the coefficients from the partial impact model are smaller (Appendix Table 6). According to this partial impact model,

¹⁰ While it would be preferable to estimate these model parameters using an instrumental variables estimator, this would require additional instruments that are correlated with the R&D ratios and the capital ratios, are not correlated with $e_{i,j}$, and are independent of the trade barrier instruments. Currently, we do not have instrumental variables that fit these requirements.

exports increased earnings by 7% on average across the U.S. manufacturing industries and the two occupation categories (Appendix Table 7).

Technical Comparison to Studies with Alternative Methodologies

Bernard and Jensen (1999) and Bernard et al. (2007) use plant-level Census data to estimate an export wage premium. Their models include industry fixed effects, and they do not use instrumental variables. Bernard et al. (2007) report two alternative estimates of the export wage premium in 2002. First they estimate an export wage premium by comparing across plants in all manufacturing industries (i.e., without controlling for industry fixed effects), and they find that wages in exporting plants were on average 17% higher than wages in non-exporting plants. Then they estimate an export wage premium by comparing across plants *within* the same four-digit industry (i.e., controlling for industry fixed effects), and they find that wages in exporting plants were on average 6% higher.¹¹

Equation (6) represents the OLS model in Bernard et al. (2007).¹²

$$W_{i,p} = \mu_i + \theta \cdot \text{Indicator}(Exports_{i,p} > 0) + \epsilon_{i,p} \quad (6)$$

$W_{i,p}$ is the log of average wages in industry i in plant p . The parameter μ_i is the industry fixed effect, $Exports_{i,p}$ is the plant's exports, and $\epsilon_{i,p}$ is a random error term. If the error term $\epsilon_{i,p}$ is correlated with $Exports_{i,p}$, then the OLS estimate of θ will be biased.¹³ In principle, including industry fixed effects in the model specification could mitigate the bias, but it could also magnify it. $Exports_{i,p}$ and $\epsilon_{i,p}$ probably have both industry-wide and plant-specific components. The industry fixed effects partial-out the industry-wide components. If most of the bias comes from correlation of the plant-specific components, then the industry fixed effects would magnify the bias. An alternative way to address potential bias is to instrument for exports using variables that

¹¹ Bernard and Jensen (1999) also estimate the average change in wages within plants after they switch from non-exporting to exporting. These additional results provide only mixed evidence of an export wage premium.

¹² Specifically, it is the model reported in column (2) in Table 3 of Bernard et al. (1999).

¹³ To the extent that the error term is increasing in firm productivity, which increases the likelihood of exporting, the OLS estimate of θ will be upward-biased. To the extent that the error term reflects factors that increase earnings more than they increase labor productivity (and therefore reduce labor cost competitiveness and the likelihood of exporting), the OLS estimate of θ will be downward-biased.

are unlikely to affect U.S. manufacturing earnings except through trade flows; however, it would be difficult to find appropriate plant-level instruments to incorporate in the Bernard and Jensen framework. The instrumental variables in our study are industry-level barriers to international trade. The version of the Bernard and Jensen model that includes industry fixed effects is a within-industry estimator, and therefore it cannot utilize this inter-industry variation to estimate the relationship between exports and earnings.

Ebenstein et al. (2009) is a recent study that utilizes CPS data for the period 1982 to 2002.¹⁴ Their study estimates the impact of international trade and outsourcing on earnings and employment. The authors treat the industry-level export share, import penetration ratio, R&D ratio, and capital ratio as exogenous explanatory variables and they estimate the impact of these factors on earnings using OLS. As we discussed above, this could result in biases in the estimates, and it is for this reason that we use instrumental variables to estimate our model parameters. Ebenstein et al (2009) find mixed evidence of a positive impact of the export share on earnings.

¹⁴ In addition, Schank et al. (2007) and Munch et al. (2008) examined data that links individual workers with specific firms and trade flows, but their samples do not include U.S. manufacturing workers.

Table A-1: Econometric Model of Blue Collar Workers

Dependent Variable: Log of Usual Weekly Earnings for Blue Collar Workers

Explanatory Variables	Ordinary Least Squares Estimates	Instrumental Variables Estimates
Export Share	0.60752 (0.1157)	0.81058 (0.1790)
Import Share	-0.28326 (0.1048)	-0.37408 (0.1125)
Highest Education: High School Diploma	0.27723 (0.0106)	0.27232 (0.0109)
Highest Education: Associate Degree	0.37981 (0.0149)	0.37272 (0.0140)
Highest Education: Bachelor Degree	0.55658 (0.0320)	0.54970 (0.0297)
Highest Education: Post-Graduate Degree	0.69394 (0.0447)	0.68743 (0.0423)
Experience: Age	0.06406 (0.0023)	0.06399 (0.0023)
Experience: Age Squared	-0.00067 (0.0000)	-0.00067 (0.0000)
Sales and Office Support Occupations	0.12254 (0.0188)	0.12107 (0.0186)
Union Status	0.17977 (0.0162)	0.17745 (0.0155)
Gender: Male	0.29751 (0.0124)	0.29510 (0.0127)
Race: White	0.11106 (0.0086)	0.11165 (0.0085)
Lives in Metropolitan Area	0.05501 (0.0081)	0.05428 (0.0088)
State Fixed Effects	Included	Included

Notes: We report (in parentheses) standard errors that are corrected for potential industry-level clustering of the errors. The sample includes 43,113 individual CPS respondents.

Table A-2: Econometric Model of White Collar Workers

Dependent Variable: Log of Usual Weekly Earnings for White Collar Workers

Explanatory Variables	Ordinary Least Squares Estimates	Instrumental Variables Estimates
Export Share	0.39996 (0.1779)	0.68090 (0.2958)
Import Share	-0.15123 (0.0992)	-0.38287 (0.2438)
Highest Education: High School Diploma	0.40608 (0.0745)	0.40768 (0.0727)
Highest Education: Associate Degree	0.45982 (0.0722)	0.46108 (0.0708)
Highest Education: Bachelor Degree	0.76958 (0.0652)	0.76986 (0.0639)
Highest Education: Post-Graduate Degree	0.92096 (0.0628)	0.91969 (0.0617)
Experience: Age	0.07833 (0.0025)	0.07819 (0.0024)
Experience: Age Squared	-0.00078 (0.0000)	-0.00078 (0.0000)
Union Status	-0.04952 (0.0135)	-0.05451 (0.0164)
Gender: Male	0.23983 (0.0142)	0.23735 (0.0133)
Race: White	0.10071 (0.0121)	0.09856 (0.0129)
Lives in Metropolitan Area	0.10864 (0.0137)	0.10993 (0.0140)
State Fixed Effects	Included	Included

Notes: We report (in parentheses) standard errors that are corrected for potential industry-level clustering of the errors. The sample includes 16,662 individual CPS respondents.

Table A-3: Industry-Level Model of Export Shares

Dependent Variable	Export Share for Each Industry
Explanatory Factors	
International Freight Costs	-2.55226 (0.7750)
Average Tariff in Major U.S. Export Markets	-0.00687 (0.0041)
Constant	0.33873 (0.0540)

Notes: We report the standard errors in parentheses. The R^2 statistic for the regression is 0.4145.

Table A-4: Impact of Foreign Tariffs on Export Shares by Manufacturing Industry

Industry (NAICS code)	Reduction in Export Share Points Attributable to Foreign Tariffs
Food Products (311)	10
Beverages and Tobacco (312)	15
Textiles (313)	5
Textile Mills (314)	5
Apparel (315)	8
Leather (316)	5
Wood Products (321)	1
Paper Products (322)	1
Printing (323)	1
Petroleum and Coal (324)	9
Chemicals (325)	3
Plastic and Rubber (326)	3
Non-Metallic Minerals (327)	2
Primary Metals (331)	2
Fabricated Metals (332)	2
Machinery (333)	2
Computers (334)	3
Electrical Equipment (335)	3
Transportation Equipment (336)	4
Furniture (337)	1
Medical Equipment <i>et al.</i> (339)	3

Note: The Technical Appendix provides the details of these calculations.

Table A-5: Portion of Current Earnings Attributed to Exports, Based on OLS Estimates

Industry (NAICS code)	Blue Collar Export Earnings Premium	White Collar Export Earnings Premium
Food Products (311)	4.2 %	2.7 %
Beverages and Tobacco (312)	2.0 %	1.3 %
Textiles (313)	16.3 %	10.1 %
Textile Mills (314)	5.9 %	3.8 %
Apparel (315)	8.5 %	5.4 %
Leather (316)	33.5 %	19.8 %
Wood Products (321)	3.0 %	2.0 %
Paper Products (322)	7.3 %	4.7 %
Printing (323)	3.8 %	2.5 %
Petroleum and Coal (324)	3.2 %	2.1 %
Chemicals (325)	14.1 %	8.9 %
Plastic and Rubber (326)	6.8 %	4.4 %
Non-Metallic Minerals (327)	4.3 %	2.8 %
Primary Metals (331)	11.7 %	7.4 %
Fabricated Metals (332)	5.5 %	3.6 %
Machinery (333)	27.2 %	16.4 %
Computers (334)	26.5 %	16.0 %
Electrical Equipment (335)	18.7 %	11.5 %
Transportation Equipment (336)	20.1 %	12.4 %
Furniture (337)	2.6 %	1.7 %
Medical Equipment <i>et al.</i> (339)	18.8 %	11.6 %

Note: The Technical Appendix provides the details of these calculations.

Table A-6: Model of Impacts Conditional on R&D Intensity and Capital Intensity

Dependent Variable: Log of Weekly Earnings for Workers in Each Occupational Category

Explanatory Variables	Blue Collar OLS Estimates	White Collar OLS Estimates
Export Share	0.41452 (0.1130)	0.20388 (0.1308)
Import Share	-0.26539 (0.0883)	-0.17258 (0.0667)
R&D Intensity	0.77850 (0.2481)	0.85270 (0.2016)
Capital Intensity	0.23338 (0.0479)	0.13764 (0.0376)
Highest Education: High School Diploma	0.27333 (0.0107)	0.40170 (0.0736)
Highest Education: Associate Degree	0.37167 (0.0147)	0.45541 (0.0707)
Highest Education: Bachelor Degree	0.54381 (0.0281)	0.76101 (0.0653)
Highest Education: Post-Graduate Degree	0.67689 (0.0405)	0.90700 (0.0635)
Experience: Age	0.06372 (0.0023)	0.07762 (0.0025)
Experience: Age Squared	-0.00066 (0.0000)	-0.00077 (0.0000)
Sales and Office Support Occupations	0.11960 (0.0189)	
Union Status	0.17915 (0.0175)	-0.04552 (0.01218)
Gender: Male	0.29862 (0.0118)	0.24223 (0.0134)
Race: White	0.11361 (0.0086)	0.10823 (0.0120)
Lives in Metropolitan Area	0.05020 (0.0077)	0.10416 (0.0145)
State Fixed Effects	Included	Included

Notes: The robust standard errors are corrected for potential industry-level clustering of the errors. The sample size is 43,113 for blue collar workers and 16,662 for white collar workers.

Table A-7: OLS Estimates of the Partial Impact of Exports on Earnings, Taking as Given the Industry's R&D and Capital Intensity

Industry (NAICS code)	Blue Collar Export Earnings Premium	White Collar Export Earnings Premium
Food Products (311)	2.8 %	1.4 %
Beverages and Tobacco (312)	1.4 %	0.7 %
Textiles (313)	10.5 %	4.9 %
Textile Mills (314)	3.9 %	1.9 %
Apparel (315)	5.6 %	2.7 %
Leather (316)	20.7 %	9.2 %
Wood Products (321)	2.1 %	1.0 %
Paper Products (322)	4.9 %	2.3 %
Printing (323)	2.6 %	1.3 %
Petroleum and Coal (324)	2.2 %	1.0 %
Chemicals (325)	9.2 %	4.3 %
Plastic and Rubber (326)	4.6 %	2.2 %
Non-Metallic Minerals (327)	2.9 %	1.4 %
Primary Metals (331)	7.7 %	3.7 %
Fabricated Metals (332)	3.7 %	1.8 %
Machinery (333)	17.1 %	7.7 %
Computers (334)	16.7 %	7.6 %
Electrical Equipment (335)	12.0 %	5.6 %
Transportation Equipment (336)	12.9 %	5.9 %
Furniture (337)	1.7 %	0.8 %
Medical Equipment <i>et al.</i> (339)	12.1 %	5.6 %

Note: The Technical Appendix provides the details of these calculations.

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