Two Tales on the Returns to Education: The Impact of Trade on Wages

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ABSTRACT

This paper uses microdata from the Current Population Survey combined with data from the U.S. International Trade Commission and Bureau of Economic Analysis to evaluate the impacts of international trade (imports penetration and exports intensiveness) on wages with a special focus on the returns to education. Consistent with the literature, our empirical analysis provides evidence that the wage rates of similarly skilled workers differ across net-exporting, net-importing and nontradable industries. Our results add to the literature by showing that the wage gap usually found across importing and exporting industries vanishes for highly-skilled workers (workers with college degree and beyond) when we control for the cross-effect between international trade and education, but the wage gap due to international trade still persists for low-skilled workers. This finding supports the view that education serves as an equalizer and counterbalances the adverse impact from imports-penetration on wages of highly-skilled workers.

Keywords: Trade, Returns to Education, Wage Differential

JEL Code: F1 – Trade; J3 – Wages, Compensation, and Labor Costs

I Introduction

Theoretical and empirical studies show that international trade impacts the labor market and affects intra and interindustry employment and relative wages of heterogeneous labor (e.g. Davis and Harrigan, 2007; Muendler, 2007; Taylor, 2002; Katz and Summers, 1989). International trade has been also blamed for contributing to increased interindustry wage inequality (e.g. Acosta and Gasparini, 2007; Busse and Spielmann, 2006; Mitra and Trindade, 2005; Leamer, 1998). For the United States in particular, empirical analyses show that international trade explains a significant fraction of the interindustry wage differential (Katz and Summers, 1989; Gaston and Trefler, 1994) and that the relative wage of unskilled workers have fallen over the last decades as a consequence of the reduction in prices of unskilled labor-intensive goods and a shift in relative demand away from unskilled labor due to the increasing penetration in the U.S. domestic market of unskilled labor-intensive goods (Katz and Summers, 1989; Bhagwati, 1998; Collins, 1998; Berman et al., 1998). One notable finding from the long list of research on the impact of international trade on domestic wage is that export-oriented establishments (or business units) out-perform import-oriented establishments (or business units) (Bernard and Jensen, 1999) and the workers in export-oriented establishment out-earn those in import-oriented establishments.

However, the empirical literature on trade is still scratching the surface when it comes to explain if the wage differential observed across net-exporting and net-importing industries is actually a case in which similarly skilled workers are better paid when working for net-exporting firms compared to net-importing firms, or a case in which the wage differential is due to workplace productivity-differentials and workforce-skill differentials (Schank, Schnabel, and Wagner, 2007; Bernard and Jensen, 1995). This is still an open question because the majority of the empirical studies examining the impacts of international trade on wages fall short of accounting for important individual-specific characteristics such as gender, race, marital status, and market experience, among others, which may over or underestimate the effects of trade on wages and put out of sight important features regarding the relationship among international trade, wages and the returns to skill accumulation (Schank *et al*., 2007; Bernard and Jensen, 1995).

This paper contributes to the literature by examining the impacts of international trade on wages and on the returns to education using individual data, which allows investigating these relationships in much more depth. More specifically, this study uses microdata from the Current Population Survey (CPS) combined with data from the U.S. International Trade Commission (USITC) and from the Bureau of Economic Analysis (BEA) to evaluate the degree in which trade affects wages. This study tests if workers employed in tradable sectors earn differentiated wage rates compared to similarly skilled workers employed in nontradable sectors and examine if the returns to human capital accumulation differ across tradable (net-importing and net-exporting sectors) and nontradable industries.

Our results show that the impact of international trade on wages vanishes for highly-skilled workers (workers with college degree and beyond), but not for low-skilled workers. This finding supports the view that education serves as an equalizer and counterbalances the adverse impact from imports-penetration on wages of highly-skilled workers. Our results also suggest that some theories found in the trade literature needs to move away from the simplistic idea that all workers employed in importing industries are affected the same way by trade intensiveness.

The rest of the paper is organized as follows: Section 2 briefly discusses the literature on the impacts of international trade on wages. It also discusses the main empirical findings in the field. Section 3 presents the dataset and the methodology. Section 4 reports the results and discusses the empirical findings, and Section 5 summarizes the paper's findings.

II Literature Review

There is near consensus in the literature that the relative price of different types of labor is changing over time. In particular, it has been shown that the wage rates of unskilled workers relative to the wage rates of skilled workers have declined significantly and that this phenomenon is very strong in industrialized countries (e.g. Katz and Summers, 1989; Katz and Murphy, 1992; Leamer and Levinsohn, 1995; Jones and Engerman, 1996; Collins, 1998; Leamer, 1998; Taylor, 2002). For the U.S. in particular, studies demonstrate that the relative wage rate of less-skilled workers has declined over the last two decades[1] (e.g. Bernard and Jensen, 2000; Collins, 1998; Bhagwati, 1998; Jones and Engerman, 1996; Katz and Summers, 1989; Katz and Murphy, 1992).

Katz and Summers (1989) show that international trade seems to contribute to raise the wage gap of skilled and less-skilled workers in the U.S. because workers in the exporting sectors are more capable of taking out part of firms' rents. Leamer (1998) shows that, during the 1970s, both the prices of unskilled labor-intensive goods and the wages of unskilled workers decreased significantly.[2] However, he also finds that this result does not hold during the 1980s. Bernard and Jensen (2000) find that foreign trade seems to have no effect on relative wage of unskilled workers across states in the United States between the 1970s and 1990s.[3] Moreover, studies that use plant level data find strong evidence that exporting industries pay a significant wage

[1] "Prices of less-skilled-labor-intensive goods have fallen and caused the real wages of such labor to fall, in turn." (Bhagwati, 1998:54)

[2] This is in general taken as evidence that the Stolper-Samuelson theorem holds during the 1970s.

[3] Bernard and Jensen (2000) find that changes in the industry-mix (e.g. manufacturing employment share) strongly affected relative wages across regions in the United States between the 1970s and 1990s.

premium. This result is found in several studies and is robust for developed and developing countries [for detail and a synopsis of studies see Schank *et al.,*2007 and Bernard and Jensen, 1995].

Even though these findings are usually accepted by labor and trade researchers, the debates on the factors that explain them are subject of an inconclusive debate. Two major branches in the literature provide the theoretical foundations for explaining the impacts of trade on wage differentials: the neoclassical international trade theory and the *efficiency* wages theory.

The Stolper-Samuelson (SS) theorem – one of the significant implications of the neoclassical trade theory – provides a compelling argument regarding the effects of trade on relative wage. According to this proposition, if the relative price of a good falls, then the relative price of the factor of production intensively used to produce that good will also decrease. Therefore, using the SS theorem, one can easily jump to the conclusion that international trade, which has contributed to reduce the price of unskilled-labor-intensive goods in industrialized countries, is the major determinant of the decline in relative wages of unskilled workers and the increase in wage inequality in the United States.

The efficiency wage theory, on the other hand, is based on the idea that productivity and workers' commitment to work (workers' effort) are positively related to wage levels. Therefore, wage cuts may decrease productivity and, consequently, increase average labor costs and reduce profitability. This theory also assumes that skilled workers are more capable of taking part of the firm's rents, so industries intensive in skilled workers would pay higher wage rates. Therefore, the *efficient wage* level for similarly productive workers might also differ among industries (Davis and Harrigan, 2007; Melitz, 2003; Akerlof and Yellen, 1986; Shapiro and Stiglitz, 1984). Under this context, international trade affects the efficient wage level by impacting the generation and distribution of rents (Melitz, 2003; Davis and Harrigan, 2007). More precisely, Melitz (2003) shows that only the more efficient firms will benefit from trade "in the form of gains in market share and profit" (p. 1719). Because firm's efficiency is highly correlated with wages, only those workers employed in the highly-efficient firms will benefit from trade.

Leamer and Thornberg (2000) evaluate the empirical ground of these propositions and find that the wage-effort relationship has behaved differently over time in the United States. Their empirical analysis shows that between 1960 and 1970 the wage-effort curve was characterized by higher wages associated with every level of effort, while between 1970 and 1980 "the wage-effort curve twisted, with the better contracts getting better and the worst contracts getting worse." They also find that this change is associated with "price decline of labor-intensive tradable" goods. Finally, since the 1980s it seems to be the case that more effort has been required "for the same wage level" (Leamer and Thornberg, 2000:79).

Overall, international trade is considered to be a source of rising wage differentials across educational attainment cohorts due to the increasing the demand for skilled workers in developed countries (Katz and Murphy, 1992 among many others). The rising wage differentials in developed countries also have occurred as a consequence of the exposure of unskilled workers employed in labor intensive industries to foreign competition with cheaper labor costs.

There has been little research to investigate the link between international trade and the returns to education (Taylor, 2002). Despite this lack, a conceptual understanding of the link is not difficult. To the extent that labor market skills are directly related to, and usually acquired by education, international trade affects the returns to education. As the relative demand for less skilled and lower educated workers declines in industrialized countries, so does the returns to education at lower levels.

III Data and Methodology

This article focuses on individual characteristics to examine how they affect wages across exporting and importing industries. The best way to handle this situation is to use a matched employee-employer data set. However, to the knowledge of the authors, no matched employee-employer data sets are available to investigate the role of individual characteristics on the impact of international trade on wages. To resolve this difficulty, we combine several data sets to match individual characteristics, including the industry to which they belong, and the volume of exports, imports, and GDP for those industries. For individual characteristics, we use micro data from the 2006 Current Population Survey (CPS). The CPS dataset uses the Industry Classification Codes (ICC) and provides detailed information on (248) industries. We use Gross Domestic Product (GDP) data from the Bureau of Economic Analysis (BEA). The BEA provides the GDP data by Input-Output (IO) industry codes and a list of IO codes matching the North American Industry Classification System (NAICS) codes, which allows generating GDP data by 2002 NAICS codes.[4] We also use the 2006 U.S. imports and exports data from the United States International Trade Commission (USITC), which provides data on 456 industries in 6-digit level NAICS codes.[5] The U.S. Census Bureau provides the code equivalence between the ICC and the NAICS codes, which allows combining the three data sets listed above.[6] However, this procedure requires aggregating data for many industries in the 6-digit NAICS code. The final data set used in this study is comprised of 264 industries. From these 264 industries, 89 are tradable

[4] The BEA list matches the IO codes with the 1997 NAICS codes. First, we generated the GDP data by 1997 NAICS codes and then matched the 1997 NAICS codes with the 2002 NAICS codes.

[5] 2006 data is the most recent data available for matching CPS, GDP and trade data. Details for NAICS are available at http://www.census.gov/epcd/www/naics.html.

[6] Details about the equivalence between the 2002 Census Industry Classification and 2002 NAICS Codes are available at http://www.bls.gov/cps/cenind.pdf.

industries [61 net-importing (imports > exports) and 28 net-exporting (imports < exports) industries] and 175 are nontradable industries.

Table 1 reports selected descriptive statistics for the top five net-exporting and net-importing industries. It shows that the hourly average wage in the top five exporting-intensive industries is about 20 percent greater than the average wage in the top five importing-intensive industries. More precisely, the average hourly wage in the top five intensive exporting sectors is, on average, about $22.2, compared to $18.6 in the top five intensive-importing sectors. However, this wage gap reduces considerably and almost disappears if one calculates the average wage rates for all net-exporting and net-importing industries.

Table 1. Trade Intensiveness and Wages, U.S. 2006

ICC Code	Industry	$\tau = \frac{(Exports - imports)}{GDP}$	Hourly Wage ($)
Top 5 Net-Exporting Industries			
3580	Aircraft and parts manufacturing	0.50	27.05
2970	Ordnance	0.38	19.33
170	Crop Production	0.14	12.94
2170	Resin, synthetic rubber and fibers, and filaments manufacturing	0.13	21.16
390	Metal ore mining	0.12	30.42
	Average - Top five net-exporting industries	**0.25**	**22.18**
	All Net Exporting Industries	*0.07*	*21.34*
Top 5 Net-Importing Industries			
1770	Footwear manufacturing	-9.76	27.20
1670	Knitting mills	-3.51	10.40
1680	Cut and sew apparel manufacturing	-3.51	13.50
280	Fishing, hunting, and trapping	-1.64	13.93
370	Oil and gas extraction	-1.04	28.05
	Average - Top five net-importing industries	**-3.89**	**18.62**
	All Net Importing Industries	*-0.56*	*21.27*

Source: Author's calculation using data from the Current Population Survey, U.S. International Trade Commission, and Bureau of Economic Analysis.

Table 2 shows that net-importing and net-exporting industries employ about the same proportion of workers with associate degree, bachelor's degree, and master's degree, which suggests that tradable (importing and exporting) industries have no significant differentials in terms of the educational attainment of their workforce. However, there are noticeable differentials in the proportions of workers with high levels of education in tradable industries compared to nontradable industries, with the latter employing a much larger proportion of highly-skilled workers (bachelor's degree and graduate degree). Table 2 also shows that there are significant differentials in the proportions of unskilled workers (high school or less than high school) employed in net exporting, net importing, and nontradable industries

Table 2: Educational Attainment and Average Hourly Wage in Tradable and Nontradable Industries, U.S., 2006

Variable	**Net-Importing**	**Net-Exporting**	**Nontradable**
	Percentage of workforce with: Average wages reported between parentheses		
Year of Schooling	12.9	12.6	13.8
Less than High School Degree	12.2% ($11.8)	17.4% ($10.9)	7.8% ($12.2)
High School Degree	56.2% ($18.1)	51.9% ($18.3)	47.8% ($17.0)
Associate Degree	9.2% ($21.9)	8.2% ($23.9)	10.8% ($20.3)
Bachelor's Degree	16.8% ($32.3)	16.4% ($32.8)	21.7% ($27.2)
Graduate Degree	5.6% ($41.6)	6.0% ($43.3)	11.9% ($37.0)

Source: Author's calculation using data from the Current Population Survey, U.S. International Trade Commission, and Bureau of Economic Analysis.

Table 2 also shows small or no difference in average wages between net-importing and net-exporting industries across all education categories, except for associate degree and graduate degree. A natural question arises at this point: what does explain the earnings advantage of workers employed in the top five net-exporting industries (as reported in Table 1) compared to workers employed in the top five net-importing industries when there are small differences in hourly wages across education categories, and workers in net-exporting sectors are not necessarily better educated than the workers in net-importing industries?

To better understand how individual's characteristics influence the wage gap identified above, we estimate a standard wage equation that includes educational attainment, industry trade-intensiveness, and other covariates as explanatory variables. The following standard wage equation is estimated:

(1) $\ln(wage) = X\beta + \phi T + \varepsilon$

where β and ϕ are vectors of parameters, wage is a N x 1 vector of hourly wages, X is a N x K matrix of covariates describing the characteristics of the individuals (e. g. educational attainment, market experience, marital status, and race), T is a N x M matrix of variables that measures the intensity[7] of international trade in the industry in which the individual is employed, and ε is a vector of disturbances.

Ordinary Least Square (OLS) estimates of Equation 1 are plagued with sample selection bias because wages of those who are not working are not observed. Precisely, the sample in Equation 1 is selected according to the condition $\varepsilon > -(X\beta + \phi T)$. As a consequence, the expected value of the error term is not zero and the use of OLS generates inconsistent estimates. We treat this problem using the Heckman two-stage procedure, which translates sample selection into a problem of an omitted variable. Specifically, we generate the so-called Inverse Mill's Ratio (λ) by estimating an ancillary Probit model[8] and then include λ into Equation 1 as an explanatory variable. This procedure controls for sample selectivity, but makes the error term heteroskedastic. We deal with heteroskedasticity by using the Heckman consistent and efficient covariance matrix. Table 3 reports the list of variables used in this study and the section below presents and discusses the results.

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[7] We measure the intensity of trade using three alternative variables: $\tau_i = \frac{(Exports_i - imports_i)}{GDP_i}$, $\tau_{mi} = \frac{Imports_i}{GDP_i}$, and $\tau_{xi} = \frac{Exports_i}{GDP_i}$, where i indexes the industry in which the individual is employed.

[8] We follow Elmslie and Tebaldi (2007) and estimated a Probit model (not reported) in which the dependent variable assumes value 1 if a person's hourly wage is observable and 0 otherwise. The set of explanatory variables includes education, work experience and its square, number of own children in family under 6, non-wage income, industry dummies, and state dummies. See Greene (2002) for detail regarding the Heckman two-step procedure.

Table 3: List of Variables used in the Regression Analysis

Variable	Definition
Wage	Hourly wage = Annual salary earnings / Total number hours worked per year ("hours usually worked at main job" times "weeks worked during the year")
High School Degree	1 if a worker has a High school degree, 0 otherwise
Associate Degree	1 if a worker has Associate degree, 0 otherwise
Bachelor's Degree	1 if a worker has a Bachelor's degree, 0 otherwise
Master's Degree	1 if a worker has a graduate degree (MA and beyond), 0 otherwise
Market Experience	Age – years of schooling – 6
Dependent	Number of own children in household under 6
Black	1 if African American, 0 otherwise
Other nonwhite	1 if nonwhite except black, 0 otherwise
Married	1 if married, 0 otherwise
Metropolitan	1 if a worker resides in a metropolitan area, 0 otherwise
τ	$\tau = \frac{(Exports - Imports)}{GDP}$
τ_x	$Exports/GDP$
τ_m	$Imports/GDP$
Nontradable	1 if industry's exports and imports are both zero, 0 otherwise.
Occupation fixed effect	Dummy variables for 9 major occupation categories*
Industry fixed effect	Dummy variables for 13 major industry categories**
State fixed effect	Dummy variables for all states in the United States

*1. Management, business, and financial occupations; 2. Professional and related occupations; 3. Service occupations; 4. Sales and related occupations; 5. Office and administrative support occupations; 6. Farming, fishing, and forestry occupations; 7. Construction and extraction occupations; 8. Installation, maintenance, and repair occupations; 9. Production occupations, Transportation and material, and moving occupations.
** 1. Agriculture, forestry, fishing, and hunting; 2. Mining; 3. Construction; 4. Manufacturing; 5. Wholesale and retail trade; 6. Transportation and utilities; 7. Information; 8. Financial activities; 9. Professional and business services; 10. Educational and health services; 11. Leisure and hospitality; 12. Other services; 13. Public administration.

IV Empirical Results

To circumvent gender-related issues that usually plague wage regressions our sample includes only men.[9] We also exclude the elderly (65 years old or older) and persons who are 24 years old or younger from the dataset. The sample used in this study consists of 44,746 male individuals. Log of hourly wages are observable for 40,636 individuals, while 4,110 observations are censored due to the fact that wages are not observable. We use the two-step

[9] The results discussed in the paper also hold when we pool both men and women and run regressions with a gender dummy variable. Upon request the authors will gladly send the tables with results of the pooled regressions.

Heckman procedure with consistent and efficient covariance matrix to produce the estimates reported in Table 4.

All regressions include controls for educational attainment (high school, associate, bachelor's and graduate degrees), market experience, marital status, race, metropolitan area, industry fixed effects, occupation fixed effects, and state fixed effects. Overall, the results on this set of *standard variables* are in accordance with the theory and the empirical literature, so no discussion regarding these variables is added to the paper. Only the parameters related to international trade are examined below. It is also worth emphasizing that the coefficients on the sample selectivity variable (λ) are statistically significant in all regressions, which implies that the control for sample selection plays an important role in the reliability of the estimates. We also check the robustness of the results by specifying the trade-related variables in two alternative ways: First, we consider a *standard specification* by using $\tau_i = \frac{(Exports_i - imports_i)}{GDP_i}$[10] as the relevant measure of trade intensiveness (regressions 1 and 2 of Table 4). We also consider an *alternative specification* by using both the imports share $\left(\tau_{mi} = \frac{Imports_i}{GDP_i}\right)$ and the exports share $\left(\tau_{xi} = \frac{Exports_i}{GDP_i}\right)$ as two separate variables (regressions 3 and 4 of Table 4). For the sake of simplicity, we first focus on the results of our *standard specification* and then we compare the findings from our standard specification with those of the alternative model.

[10] Where GDP is the gross domestic product and *i* indexes the industry. By construction, τ is zero for all nontradable industries.

Table 4 – Heckman Two-Step Regression Analysis, Men

The dependent variable is the natural logarithm of hourly wage Continues

Explanatory Variables	(1)	(2)	(3)	(4)
High School degree	0.284	0.282	0.283	0.280
	[24.13]***	[23.84]***	[24.02]***	[22.76]***
Associate degree	0.402	0.398	0.400	0.395
	[25.59]***	[25.18]***	[25.41]***	[24.02]***
Bachelor's degree	0.552	0.549	0.550	0.544
	[36.49]***	[36.11]***	[36.26]***	[34.66]***
Graduate degree	0.787	0.783	0.784	0.778
	[43.21]***	[42.89]***	[42.96]***	[41.38]***
Market experience	0.025	0.025	0.025	0.025
	[17.83]***	[17.83]***	[17.75]***	[17.74]***
Market experience^2/100	-0.046	-0.046	-0.046	-0.046
	[15.66]***	[15.65]***	[15.65]***	[15.62]***
African American	-0.125	-0.125	-0.125	-0.126
	[10.48]***	[10.51]***	[10.51]***	[10.54]***
Other nonwhite races	-0.053	-0.053	-0.055	-0.055
	[4.33]***	[4.34]***	[4.44]***	[4.46]***
Married	0.161	0.161	0.161	0.161
	[22.00]***	[22.01]***	[21.98]***	[21.99]***
Metropolitan	0.115	0.115	0.114	0.114
	[13.14]***	[13.13]***	[13.01]***	[12.98]***
Fulltime	0.118	0.118	0.118	0.118
	[13.11]***	[13.10]***	[13.12]***	[13.11]***
τ	0.050	0.100		
	[3.90]***	[3.54]***		
Nontradable	-0.003	-0.004	0.017	0.014
	[0.07]	[0.10]	[0.43]	[0.35]
τ * High school degree		-0.031		
		[0.90]		
τ * Associate degree		-0.117		
		[1.90]*		
τ * Bachelor's degree		-0.088		
		[2.23]**		
τ * Graduate degree		-0.099		
		[2.19]**		
τ_x			0.194	0.198
			[4.55]***	[1.80]*
τ_m			-0.050	-0.098
			[3.91]***	[3.41]***
τ_x * High School degree				-0.017
				[0.15]
τ_x * Associate degree				-0.076
				[0.48]

Table 4 – Heckman Two-Step Regression Analysis, Men

The dependent variable is the natural logarithm of hourly wage Continuation

Explanatory Variables	(1)	(2)	(3)	(4)
τ_x * Bachelor's degree				-0.006
				[0.05]
τ_x * Graduate degree				-0.016
				[0.11]
τ_m * High school degree				0.032
				[0.93]
τ_m * Associate degree				0.115
				[1.83]*
τ_m * Bachelor's degree				0.080
				[1.98]**
τ_m * Graduate degree				0.091
				[1.98]**
Constant	.287	1.289	1.260	1.266
	[16.98]***	[17.01]***	[16.54]***	[16.58]***
λ (Inverse Mill's Ratio)	0.651	0.648	0.664	0.663
	[5.11]***	[5.09]***	[5.22]***	[5.21]***
State fixed effect	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Occupation fixed effects	Yes	Yes	Yes	Yes
Observations	44,746	44,746	44,746	44,746

Absolute value of z statistics in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

4.1 *Standard Specification*

Does international trade impact wages? Consistent with the literature, our estimates show that trade has a sizeable and significant impact on average wages. Controlling for skills, industry fixed effects, occupation fixed effects, and other covariates, regression 1 of Table 4 provides evidence that there is a positive wage premium for similarly skilled workers employed in net-exporting industries compared to workers employed in net-importing and nontradable industries. And the wage premium is increasing with the trade intensiveness variable (τ).The estimates suggest that an increase of 1 point in τ is associated with an increase of 5 percent on average wage. Using the point estimates we calculate the wage gap for similarly skilled individuals working in the top five net-exporting industries compared to individuals working in the top five net-importing industries and find a wage differential of about 23 percent in favor of workers employed in net-exporting industries.[11] These results imply that the wage gap across importing and exporting industries increase as the industries become more dissimilar in terms of trade orientation. They are also consistent with expectations from the neoclassical trade theory and with the empirical record (e.g. Schank, Schnabel, and Wagner, 2007; Bernard and Jensen, 2004, 2000 and 1995).

Controlling for industry fixed effects, occupation fixed effects, and other covariates we find that coefficient on *nontradable* industries is insignificant. This result is robust to model specification and holds in all regressions reported in Table 4.[12] It suggests that the intercept of the relationship between the trade intensiveness variable (τ) and wages is the same for both the tradable and nontradable industries.

Does trade impact the returns to human capital accumulation? Table 5 reports only the interaction terms between educational attainment and τ, and suggests that trade has differentiated impacts on the returns to human capital accumulation. The coefficients on the cross terms for associate degree, bachelor's degree, and graduate degrees are negative and statistically

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[11] The wage-gap can be calculated as follows:

$$E[\ln(w)|(\tau = \tau_{x5} = 0.253, Z)] - \mathrm{E}[\ln(w)|(\tau = \tau_{m5} = -3.89,\ Z) = 0.2071$$

where Z is a vector of a worker's characteristics and τ_{x5} and τ_{m5} denote the average trade share of the top five exporting and top five importing industries, respectively. Then we need to apply the Halvorsen and Palmquist (1980) adjustment-formula to obtain the wage gap in percentage terms. Precisely, the percentage change in wages is given by:

$$\%\Delta wage = 100 * [\exp(\beta_i) - 1]$$

where β is the coefficient (or combination of coefficients) of interest.

[12] We excluded "nontradable" dummy variable in a set of regressions not reported in the paper and the results did not change. It was kept in the paper for completeness.

significant while the coefficient on high school degree is statistically insignificant.[13] These results are somewhat surprising and imply that trade intensiveness and educational attainment are correlated, but higher education counterbalances the impacts (negative or positive) of trade on average wages of skilled workers, while low-skilled workers are still subject to wage differentials depending on the trade orientation of the industry in which they are employed.

Table 5 – Interaction Terms (From Regression 2 of Table 4)

Variable	**Coefficient**
τ	0.100
	[3.54]***
τ * High school degree	-0.031
	[0.90]
τ * Associate degree	-0.117
	[1.90]*
τ * Bachelor's degree	-0.088
	[2.23]**
τ * Graduate degree	-0.099
	[2.19]**

Source: Author's calculation.
*** p<0.01, ** p<0.05, * p<0.1. z statistics are reported between parentheses;

This finding is supported by the fact that at the 5 percent level of significance, the impact of international trade on wages vanishes for highly skilled workers (those who hold an associate degree or higher degree as their terminal degrees). As an example, consider the hypothesis:

$$H_{0|BA=1} = \beta_\tau + \beta_{\tau*BA} = 0$$

where β_τ is the coefficient on τ and $\beta_{\tau*BA}$ is the coefficient on the interaction term between trade-intensiveness (τ) and bachelor's degree. According to the estimates reported in Table 5, the null hypothesis above cannot be rejected at the 1 (or 5) percent level of significance.[14] Identical results are obtained for associate degree and graduate degree. These results suggest that

[13] The omitted category is "less than high school." Coefficients on the interaction terms between trade-intensiveness (τ) and bachelor's degree and graduate degree are statistically significant at the 5 percent level, while the interaction term for associate degree is significant at the 10 percent level.

[14] The null hypothesis is not rejected in either one-sided or two-sided tests.

similarly[15] highly-skilled workers employed in tradable (net exporting and net importing industries) or nontradable industries earn about the same, which implies that higher education works as a wage *equalizer* across tradable and nontradable industries. This result also implies that highly-skilled workers are able to shield themselves from any potential harmful effect from international trade on their wages, even if they are employed in net-importers or nontradable industries.

It is important to notice that our results imply that low-skilled workers are subject to wage differentials due to the trade orientation of industry in which they are employed. In particular, consider the hypothesis:

$$H_{0|HS=1} = \beta_{\tau} + \beta_{\tau*HS} = 0$$

where β_{τ} is the coefficient on τ and $\beta_{\tau*HS}$ is the coefficient on the interaction term between trade-intensiveness (τ) and high school degree. This null hypothesis is rejected at the 1 (or 5) percent level of significance. The result for workers with high school degree combined with significant positive estimates on the trade-orientation variable (τ) suggests that low-skilled workers are exposed to the effects of international trade and those who are employed in net-importing industries earn less than similarly low-skilled workers employed in net-exporting industries.

Overall, our results provide evidence that college and graduate education is an important source of highly-valued skills that are not easily replaced by foreign competition, and highly-educated workers are in better position to protect themselves from the impacts of international trade.

[15] In terms of individuals characteristics such as market experience, race, marital status, place of residence, and occupation.

4.2 Model specification and Robustness

Regressions 3 and 4 of Table 4 are estimated using a different set of trade-related variables to check the robustness of the results. These regressions are estimated using both the imports share (τ_m) and the exports share (τ_x) as two separate variables. This alternative way to measure the trade flows allows examining, for instance, the impacts of imports penetration on average wages holding exports-intensiveness constant. This method might also control for misspecification and biases generated by using only the trade share (τ) variable.

Overall, the results produced using this alternative specification are comparable to those obtained previously and corroborate our previous analysis. Regression 3 of Table 4 shows that controlling for other covariates and holding imports-penetration (exports-intensiveness) constant, the wage rate increases (decreases) as the industry becomes relatively more exports-intensive (imports-intensive). It is worth noticing that the point estimates suggest that wages are more sensitive to exports-intensiveness than to imports penetration. More precisely, regression 3 of Table 4 implies that an increase of 1 point in τ_x (exports-intensiveness) is associated with an increase of about 21 percent on average wage. In addition, an increase of 1 point in τ_m (imports-penetration) is associated with a decrease of 5 percent on average wage.

With regards to the returns to education, we find mixed results. Table 6 summarizes only the coefficients on imports penetration, exports intensiveness and their interactions with educational attainments and shows that all coefficients on the interaction terms between τ_x and educational attainment are not significant. This result suggests that controlling for imports penetration and other covariates, the returns to education is not affected when an industry redirects its business towards international markets. In other words, industries will not pay any additional wage premium to their workers based on educational attainment when they increase their exports relative to output.

Table 6 – Interaction Terms (Regression 4 of Table 4)

Variables	Coefficients
τ_x	0.198
	[1.80]*
τ_m	-0.098
	[3.41]***
τ_x* High School degree	-0.017
	[0.15]
τ_x* Associate degree	-0.076
	[0.48]
τ_x* Bachelor's degree	-0.006
	[0.05]
τ_x* Graduate degree	-0.016
	[0.11]
τ_m* High school degree	0.032
	[0.93]
τ_m* Associate degree	0.115
	[1.83]*
τ_m* Bachelor's degree	0.08
	[1.98]**
τ_m* Graduate degree	0.091
	[1.98]**

Source: Author's calculation.
*** p<0.01, ** p<0.05, * p<0.1. z statistics are reported between parentheses;

Table 6 also shows that the coefficients on τ_m*associate degree, τ_m*bachelor's degree, and τ_m*graduate degree are positive and statistically significant, which suggests that that an increase in imports penetration will also cause both an increase in the returns to education of highly-skilled workers and an increase in the wage gap between low-skilled and highly-skilled workers employed in these industries. In addition, the estimates also imply that the increased returns to education offset the wage differentials caused by an increase in imports penetration. Consider the following hypothesis:

$$H_{0|BA=1} = \beta_{\tau m} + \beta_{\tau m*BA} = 0$$

where $\beta_{\tau m}$ is the coefficient on τ_m and $\beta_{\tau m*BA}$ is the coefficient on the interaction term between imports-penetration (τ_m) and bachelor's degree. This null hypothesis cannot be rejected at the 1 (or 5) percent level of significance. Similar results are obtained for the interaction terms between imports-penetration and associate degree and graduate degrees. These tests, therefore, corroborate the results discussed previously and imply that highly skilled workers will not experience a decrease in their wage rate as the industry in which they work increase its exposition to imports. In other words, high-skilled workers are in a better position to protect themselves from the impacts of international trade.

However, the estimates reported in Table 6 (and equation 4 of Table 4) do imply that workers employed in industries that are able to increase their exports shares will earn a wage premium compared to workers who are employed in industries that are unable to compete in international markets.

We also tested several alternative specifications not reported in the paper, including interaction terms for market experience and the trade shares, regional dummies, and a continuous measure of educational attainment (years of education). These variables turned out to be statistically insignificant and/or their addition to the model did not change the results presented above.

V Conclusion

This article contributes to the literature by using microdata to investigate how international trade impacts wages and the returns to education in the United States. The empirical estimates provide robust evidence that international trade affects wages and that the wage premium is increasing with trade intensiveness (τ). Overall, controlling for skills and other personal attributes we find that the average wage rates of workers employed in net-exporting industries are higher than that of workers employed in net-importing industries or tradable industries. However, our results show that education serves as an equalizer and counterbalances the adverse impact from imports-penetration on wages of highly-skilled workers. In other words, highly-skilled workers are able to shield themselves from any potential harmful effects from international trade on their wages, even if they are employed in industries that are traditionally net-importers or nontradable. However, low-skilled workers are subject to wage differentials due to the trade orientation of industry in which they are employed.

The results together support policies aimed at reinforcing the importance of educational attainment beyond high school as a major strategy to stay competitive in global markets and reduce inter-industry wage inequality. Although there are still uncertainties on the channels through which education affects wages of workers who are working in environments where they are directly exposed to foreign competition, the findings of this paper show that workers with higher education (or highly-skilled workers) are able to endure the competition posed by international trade.

VI References

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