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TRADE AND LABOR MARKETS: EVIDENCE FROM MATCHED EMPLOYER-EMPLOYEE DATA[‡]

Trade, Labor Market Frictions, and Residual Wage Inequality across Worker Groups[†]

By Pravin Krishna, Jennifer P. Poole, and Mine Zeynep Senses*

The relationship between international trade and wage inequality between workers has been studied extensively in the economics literature. Following the introduction of models examining the role of firm heterogeneity in international trade (Melitz 2003), an innovative theoretical literature has begun to analyze the labor market implications of trade openness in the context of heterogeneous firms, heterogeneous workers, and a variety of labor market frictions. With heterogeneous firms and heterogeneous workers in an industry, labor market equilibria and the labor adjustment process following trade liberalization depend critically on the mechanisms that match workers and firms. Furthermore, with labor market frictions, ex ante identical workers may earn different wages and experience differential wage changes following trade liberalization, enabling a rich study of trade and its relationship to within-group wage inequality.

A recent paper in this area, Helpman, Itskhoki, and Redding (2010a), henceforth HIR, examines the impact of trade on labor markets in a setting where firms are heterogeneous in their productivity and the labor allocation process is subject to search and matching frictions. Workers are ex ante identical but vary in terms of their match-specific ability level that is only realized (by both the worker and the firm) in the context of the particular worker-firm match. Thus, workers are heterogeneous ex post. The most productive firms export, screen workers more intensively, employ workers of higher match-specific ability, and pay higher wages relative to nonexporting firms. In this setting, an opening of the economy to trade changes within-group wage inequality among otherwise similar workers employed in heterogeneous firms. That is, trade impacts wage inequality unexplained by observable worker characteristics, or residual wage inequality. This is because liberalization both decreases the productivity threshold for exporters, and exporters screen to a higher ability threshold relative to domestic firms. A similar outcome occurs in Davidson, Matusz, and Shevchenko (2008), which extends the model in Yeaple (2005) to incorporate search and matching frictions. As in HIR, liberalization increases the wage gap between high productivity and low productivity firms, and increases the degree of positive assortative matching between high productivity workers and high productivity firms, changing the extent of within-group wage inequality.

Changes in wage inequality across otherwise similar workers following liberalization may also arise in other settings. For instance, in Amiti and Davis (forthcoming), wages paid by firms are increasing in the firm's profitability (through a "fair wage" mechanism), implying unequal wages for identical workers across heterogeneous firms. To the extent that trade changes the relative profitability of different firms in an industry, this also implies a corresponding

[‡]*Discussants:* Kerem Cosar, University of Chicago; Mine Zeynep Senses, Johns Hopkins University; Oleg Itskhoki, Princeton University; Marc-Andreas Muendler, University of California, San Diego.

* Krishna: Johns Hopkins University, 1717 Massachusetts Avenue, NW, Washington, DC 20036 (e-mail: pravin_krishna@jhu.edu); Poole: 437 Engineering 2, Department of Economics, University of California, Santa Cruz, Santa Cruz, CA 95064 (e-mail: jpoole@ucsc.edu); Senses: John Hopkins University, 1717 Massachusetts Avenue, NW, Washington, DC 20036 (e-mail: msenses@jhu.edu).

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increase in wage inequality for homogeneous workers employed in heterogeneous firms following liberalization. Similarly, exporters wishing to improve product quality for foreign markets could respond to a decline in protection by paying (higher) efficiency wages in order to induce increased effort from otherwise identical workers (Frías, Kaplan, and Verhoogen 2009; Davis and Harrigan 2011).

Importantly, regardless of the exact nature of the labor market frictions, theory suggests that trade can impact the variance of wages for otherwise similar workers (residual wage inequality). Moreover, as we highlight in this article, this effect could be nonuniform across different types of workers. For example, in Helpman, Itskhoki, and Redding (2010b), wage inequality rises with worker ability. In autarky, higher ability workers may be hired by a wider range of firms and, thus, face a wider possible support for wages compared to low ability workers. With liberalization, low ability workers continue to be employed by low productivity firms that do not export in the trade equilibrium and, thus, experience no change in the dispersion of wages. However, the increase in wages in exporters and the reallocation of workers between nonexporting firms and exporting firms after liberalization increases wage dispersion for high ability workers who can work for both exporters and firms serving only the domestic market.

Does trade liberalization in fact change residual wage inequality differently depending on the worker's ability level? Our analysis proceeds in two stages. We first consider whether liberalization impacts the wages of otherwise identical workers differently depending on the firm's exposure to global markets. Do high ability workers in exporting firms experience an increase in wages relative to high ability workers in domestic firms? If so, such differential wage changes across heterogeneous firms following liberalization have implications for changes in the dispersion of wages for identical workers. Therefore, we also examine whether liberalization is associated with a differential change in the variance of wages across workers within ex ante identical worker groups.

We explore these issues empirically using a detailed matched employer-employee dataset from Brazil for the years 1990 through 1998. The dataset traces individually identifiable workers across employers over Brazil's main trade liberalization episode and contains detailed information on worker characteristics such as age, gender, education, occupation, and tenure at the firm. This allows us to suitably account for the role of both observable and (time-invariant) unobservable worker, firm, and match characteristics in determining wages. We complement this worker-level information with firm-level data on exports from the Brazilian Customs Office, and industry-level information on trade protection levels to capture Brazil's main trade policy reforms.[1]

I. Relative Wages in Exporters

First, using available information on the characteristics of workers and of the firms in which they are employed, we consider the following wage equation:

$$\begin{aligned}(1)\quad \ln y_{ijt} = {} & \gamma_1 \, Protect_{kt} \times Exp_{jt} \\ & + \gamma_2 \, RER_t \times Exp_{jt} \\ & + \gamma_3 \, Exp_{jt} + M_{ij} + \delta_{tr} \\ & + \omega_{kt} + \varphi X_{it} + \beta Z_{jt} + \varepsilon_{ijt},\end{aligned}$$

where $\ln y_{ijt}$ denotes the logarithm of annual real wages in *reais* for worker i employed in firm j in year t, $Protect_{kt}$ reflects sector-level measures of protection,[2] Exp_{jt} is a dummy variable describing the export status of the firm, and RER_t denotes the real exchange rate, expressed in dollars per *real*.[3] The estimating equation includes time-varying worker characteristics (X_{it}), such as the worker's tenure at the firm, age, education, and occupation, and time-varying

[1] See Krishna, Poole, and Senses (2011) for a complete discussion of the data sources and Brazil's main trade policy reforms during this period.

[2] In our analysis, we concentrate on two trade protection measures: the effective rate of protection (ERP) and final goods tariffs. The ERP allows us to incorporate changes in tariffs on intermediate inputs together with changes in tariffs on final goods.

[3] The postliberalization period in Brazil coincided with a period of an appreciation of the *real*, making Brazilian goods less competitive in international markets, while making imported goods cheaper in *real* terms. Failing to incorporate such fluctuations in exchange rates into our analysis could bias the estimated effect of liberalization on wages.

TABLE 1— TRADE PROTECTION AND WORKER-LEVEL WAGES, BY WORKER GROUPS

	All workers	Less than primary school	Primary school grad	Middle school grad	High school grad	College grad or more
ERP						
Export × ERP	−0.045	0.013	−0.001	−0.024	−0.084	−0.265**
	(0.037)	(0.066)	(0.052)	(0.062)	(0.062)	(0.122)
Export	0.090	0.045	0.093	0.149*	−0.072	0.052
	(0.055)	(0.078)	(0.071)	(0.085)	(0.080)	(0.132)
Export × RER	−0.066	−0.038	−0.073	−0.127*	0.083	0.014
	(0.044)	(0.064)	(0.056)	(0.068)	(0.063)	(0.102)
Tariffs						
Export × Tariff	−0.110	0.065	−0.043	−0.043	−0.239*	−0.480**
	(0.070)	(0.124)	(0.090)	(0.115)	(0.125)	(0.234)
Export	0.110*	0.025	0.112	0.152	−0.017	0.101
	(0.062)	(0.085)	(0.079)	(0.095)	(0.092)	(0.158)
Export × RER	−0.077	−0.028	−0.083	−0.129*	0.055	−0.007
	(0.047)	(0.066)	(0.060)	(0.072)	(0.068)	(0.113)
Sector-year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region-year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Worker and firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Match fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	477,003	69,097	212,804	113,120	62,084	19,898

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

firm characteristics (Z_{jt}), such as employment, average worker tenure, and controls for the age, educational, and occupational composition of the firm. In addition, we also include region-specific year dummies (δ_{tr}) and sector-specific year dummies (ω_{kt}) in order to capture average trends in wages.[4] In each specification, robust standard errors are clustered at the industry-year level.

Most importantly, in order to allow for the nonrandom assignment of workers to firms—in particular, the fact that a worker's assignment to a firm may not be independent of the time-invariant match-specific productivity of the worker in that firm—our wage equation controls for worker-firm match fixed effects (or job-spell fixed effects), M_{ij}, denoting worker i's employment at a given firm j.[5] As discussed in detail in Krishna, Poole, and Senses (2011), the inclusion of match effects to address the problematic issue of the endogenous assignment of workers to firms is important for two reasons.

[4] Trade policy reforms in Brazil coincided with a number of other macroeconomic policy reforms. We include region-specific and sector-specific year dummies to account for the possibility that these reforms exhibit region-time or sector-time variation not fully captured by our other time-varying controls.

[5] A common practice in the literature on wage determination is the inclusion of observable worker and firm characteristics and worker and firm fixed effects in the wage specification (as in Abowd, Kramarz, and Margolis 1999). Unbiased estimation in this setting, however, requires an assumption of the "conditional exogenous mobility" of workers; that is, the assignment of workers to firms depends only on the included worker and firm characteristics, and firm and worker fixed effects. This is clearly at odds with a number of theoretical models of labor assignment, including HIR, which assumes that a worker's ability is specific to the firm in which the worker is employed. Including worker-firm match fixed effects (M_{ij}) in the specification accounts for any allocation of workers to firms based on time-invariant match-specific ability (as is the case in HIR). Thus, our estimation proceeds on the basis of weaker exogeneity assumptions and constitutes an improvement over most existing work in this area.

First, the implementation of statistical tests for endogenous worker mobility, proposed by Abowd, McKinney, and Schmutte (2010), on the Brazilian data decisively rejects the assumption of conditional exogenous worker mobility. Second, controlling for the nonrandom assignment of workers to firms via time-invariant match effects in studying the differential wage effects of trade reform on identical workers employed in exporting and nonexporting firms, suggests a strong bias in plant-level analyses. This is because, following trade liberalization, the firm-level average quality of matches differentially improves in exporting firms relative to nonexporting firms, as is documented in Krishna, Poole, and Senses (2011), who examine changes in the distribution of estimated matches in these firms over time.

To explore the differential impact of liberalization on identical workers, we estimate equation (1) separately for workers with different ability levels. We proxy for ability using the worker's educational attainment and consider workers according to five educational categorizations: less than primary school, primary school graduate, middle school graduate, high school graduate, and at least college graduate. The main coefficient of interest, γ_1, reflects the differential impact of a decline in protection on the wages for identical workers employed in exporting firms relative to firms serving only the domestic market. Table 1 reports coefficients from the estimation of equation (1), by the worker's educational attainment, where the trade protection measures are ERP and final goods tariffs, in the top and bottom panels, respectively.

As in Krishna, Poole, and Senses (2011), using detailed information on worker and firm characteristics to control for compositional effects and firm-worker match-specific effects to allow for the endogenous mobility of workers, we report an insignificant differential effect of trade openness on wages for the average worker at exporting firms relative to domestic firms. However, our analysis shows heterogeneous effects across educational categories. We find that the relative wages of workers with higher levels of education employed in exporting firms improve with liberalization compared to equally educated workers employed in firms serving only the domestic market. Specifically, following a decline in ERP, college-educated workers at exporting firms experience an increase in wages relative to college-educated workers at nonexporting firms. For workers with less than a college degree, we do not find a differential impact of liberalization on the wages of workers employed at exporters relative to nonexporters. These results are robust to using a more detailed educational categorization of workers.[6]

The evidence presented in Table 1 hints at greater residual wage inequality for high ability workers, roughly in line with the predictions of Helpman, Itskhoki, and Redding (2010b). Our findings are, however, also consistent with a range of other theories linking trade liberalization and labor markets. For instance, another explanation for these findings is that the fair-wage mechanism, whereby workers share a fraction of firm profits, may only be relevant in the case of highly educated workers even if it remains insignificant for workers with lower levels of education. Our findings may also be due to heterogeneous monitoring costs across different worker groups. Alternatively, the improvement in the quality of the labor force in exporting firms, documented in Verhoogen (2008) and Krishna, Poole, and Senses (2011) following a real exchange rate depreciation and liberalization, respectively, could result in positive productivity spillovers for more educated workers and, hence, improve their wage outcomes.

II. Dispersion of Wages

To explore the differential changes in the dispersion of wages for ex ante identical workers within an industry, as suggested by the theory, we compute the residual wage from equation (1) across all workers, as follows:

$$(2) \quad \hat{u}_{ijt} = \ln y_{ijt} - \hat{\phi} X_{it} - \hat{\delta}_{tr} - \hat{\omega}_{kt}.$$

In other words, we filter out of the individual's wage income the returns to observable worker characteristics and any average effect on wages within a region-year and sector-year. In our analysis, we focus on the dispersion of the residual wage within educational groupings (as proxies

[6] The detailed educational categories divide workers into nine groups: illiterate, primary school dropout, primary school graduate, middle school dropout, middle school graduate, high school dropout, high school graduate, college dropout, and at least college graduate.

TABLE 2—TRADE PROTECTION AND DISPERSION OF WAGES

		Tariffs	ERP
Primary school grad	0.026***	0.060	0.042
	(0.008)	(0.090)	(0.072)
Middle school grad	0.077***	0.103	0.122
	(0.008)	(0.096)	(0.078)
High school grad	0.094***	0.097	0.128*
	(0.009)	(0.093)	(0.076)
College grad	0.099***	0.343**	0.213*
	(0.014)	(0.140)	(0.114)
Protect		0.145	0.063
		(0.152)	(0.060)
Primary school grad × Protect		−0.047	−0.014
		(0.119)	(0.051)
Middle school grad × Protect		0.005	−0.022
		(0.122)	(0.055)
High school grad × Protect		−0.042	−0.078
		(0.131)	(0.065)
College grad × Protect		−0.635***	−0.341***
		(0.177)	(0.074)
Year and sector dummies	Yes	Yes	Yes
Education and RER interaction	No	Yes	Yes
R^2	0.459	0.498	0.495
Observations	540	540	540

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

for worker ability, as before). Specifically, to explore variations in the dispersion of residual wages across different types of workers and over time, we calculate for each industry-year the standard deviation of residual wages across workers within different educational categories. We denote this standard deviation as S_{ekt}, where e represents education levels, k represents the industry, and t represents the year.

We then estimate the following specification to investigate the differential residual wage inequality effects of trade on workers of different ability levels:

$$(3)\quad S_{ekt} = \sum_{e}^{E} \alpha_{1e}\, Educ_e + \alpha_2\, Protect_{kt} + \sum_{e}^{E} \alpha_{3e} Protect_{kt} \times Educ_e + \sum_{e}^{E} \alpha_{4e} RER_t \times Educ_e + \delta_t + \omega_k + \varepsilon_{ekt},$$

where $Educ_e$ is a dummy variable for each education category and E is equal to five in our main specification. As before, we use both tariffs and ERP to measure sector-level protection ($Protect_{kt}$) and also control for the effects of changes in the real exchange rate. We note that the coefficients α_{1e} measure the dispersion in the residual wage of workers in educational category e relative to the omitted category (the lowest educational category). Furthermore, the coefficients α_{3e} measure the changes in residual wage inequality following a decline in protection experienced by workers in educational category e relative to the omitted, lowest educational category.

Estimation results from specification (3) are presented in Table 2. The first column reports regression results without measures of trade protection. Recall, the HIR theory predicts that higher ability workers display higher wage dispersion. This is certainly true in our data—wage dispersion increases with the worker's education level, with the lowest residual wage dispersion

among workers with less than primary school and the highest dispersion among college graduates, a result that is also consistent with the findings of Lemieux (2006) for the United States.

In column 2, we use tariffs as our measure of trade protection, while in column 3 we measure trade protection using ERP. Again, recall that theory predicts an increase in residual wage inequality for high ability workers and no change in residual wage inequality for low ability workers following trade liberalization. Our results confirm this conjecture. The dispersion in residual wages for the highest educational category—college graduates—increases with trade liberalization, while the change in dispersion for all lower levels of education is insignificantly different from zero. Evaluating the coefficient at the mean dispersion in wages for college-educated workers across industry-years (0.61), a 10 percentage point decline in ERP increases dispersion by 0.034, or roughly 5 percent of the baseline. As before, the robustness checks we conducted using more detailed education categories confirm this result.[7]

III. Conclusions

Using a detailed matched employer-employee dataset, we study the effects of trade liberalization on wage dispersion in Brazil, while considering the fact that the assignment of workers to firms may be nonrandom and determined by the time-invariant productivity of workers specific to the firms with which they are matched. We find differential effects of trade reform on residual wage inequality across worker groups. In particular, high education workers experience greater increases in wage dispersion relative to low education workers following trade liberalization. We also show, following a decline in ERP, college educated workers at exporting firms experience an increase in wages relative to college educated workers at nonexporting firms. For workers with less than a college degree, we find no differential impact of liberalization on the wages of workers employed at exporters. As we discuss, this finding is broadly consistent with the theoretical predictions from models with labor market frictions and highlights the nuanced ways in which globalization may affect labor markets.

[7] Similar results are obtained when we examine within-group dispersion across five different occupational skill-intensity categories: unskilled blue collar, skilled blue collar, other white collar (such as workers in administrative or sales positions), technical, and professional and managerial workers. These results, which show a differential increase in wage inequality postliberalization for professional and managerial workers, are omitted to conserve space and are available upon request.

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