Unequal Effects of Trade on Workers with Different Abilities*

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Abstract

In recent research, we have proposed a new framework for examining the determinants of income inequality, which emphasizes firm and worker heterogeneity and selection into export markets. In this paper, we use our framework to examine how wage inequality and unemployment vary across workers with different abilities. Both in the closed and open economy, the unemployment rate is decreasing in worker ability, whereas both the average wage and wage inequality are increasing in worker ability. Upon opening the economy to trade, however, intermediate-ability workers experience reductions in average wages and increases in unemployment rates relative to both lower and higher ability workers.

Keywords: wage inequality, unemployment, worker heterogeneity, firm heterogeneity
JEL classification: F12, F16, E24

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1 Introduction

The relationship between wage inequality and international trade is one of the most intensely-debated issues in economics. In recent research in Helpman, Itskhoki and Redding (2009; henceforth HIR), we have proposed a new framework for examining the determinants of income inequality, which emphasizes heterogeneity across both workers and firms, labor market frictions and selection into export markets. One of the framework's central results is that the opening of a closed economy to trade increases wage inequality and unemployment within industries, because it reallocates resources towards more productive firms that pay higher wages and are more selective in their hiring policies.

In this paper, we use the HIR framework to examine how wage inequality and unemployment vary across heterogeneous workers. Both in autarky and in a trade equilibrium, we show that the unemployment rate is decreasing in worker ability, whereas both the average wage and wage inequality are increasing in worker ability. While opening the closed economy to trade raises the unemployment rate for all worker abilities, workers with intermediate abilities experience the largest increases in the unemployment rate. Similarly, the opening of the closed economy to trade has a non-monotonic effect on average wages. While the lowest-ability workers face the same wage distribution conditional on ability in the open and closed economies, average wages conditional on being employed *decrease* for workers of intermediate abilities and *increase* for workers with high levels of ability. The reason for these adverse effects of trade on intermediate-ability workers is that firms entering export markets become more selective in their recruitment practices and stop hiring these workers.

Although worker ability typically cannot be directly measured, our analysis yields empirical predictions for observables, because worker ability is directly linked in the model to quantiles of the wage distribution. The model implies that wage inequality increases across quantiles of the wage distribution and takes the form of residual wage inequality in the sense that it is unexplained by observed worker characteristics. These features of the model are consistent with empirical findings of greater residual wage inequality for higher-wage workers (e.g. Lemieux 2006, Autor, Katz and Kearney 2008). Additionally, the model implies that average wages and unemployment rates are negatively correlated across quantiles of the wage distribution, which is in line with the empirical findings of Juhn, Murphy and Topel (1991).

The remainder of the paper is structured as follows. In Section 2 we briefly summarize the main features of the HIR framework. In Section 3 we characterize the unemployment rate as a function of worker ability and examine how the opening of trade affects the unemployment rates of workers with different abilities. In Section 4 we undertake a similar analysis for wages. Technical details of the derivations and proofs are provided in a web-based technical appendix (henceforth, the Appendix).

2 Model Setup

The key predictions of the HIR framework for wage inequality and unemployment are implications of sectoral equilibrium. Therefore in this paper we consider a single sector, taking as given expected worker income, prices in other sectors and aggregate income. These variables are determined in general equilibrium in HIR, which provides conditions under which expected worker income (ω) is constant and those under which it changes following the opening of trade. While for simplicity we focus here on the case where expected worker income is constant, we discuss below the implications of allowing it to change following the opening of trade.

We consider a world of two countries, each populated by a continuum of workers. The supply of workers to the sector is endogenously determined by expected worker income. The sector manufactures brands of a horizontally-differentiated product and preferences over these brands are CES with an elasticity of substitution $1/(1-\beta) > 1$. As a result, the revenue of a firm that sells q units of its brand in the domestic market is Aq^{β}, where A is a measure of the level of domestic demand, which is exogenous to the firm but endogenous to the industry. Similar assumptions apply to the foreign country, except that ω and A can obtain different values there, to be denoted with asterisks. In particular, in the foreign country revenue from sales of q units equals $A^{*}q^{\beta}$. In what follows, we develop the analysis of the sector for home, but analogous relationships hold for foreign.

As in Melitz (2003), a firm pays an entry cost f_e to discover its productivity θ, where θ is distributed Pareto with cumulative distribution function $G_{\theta}(\theta) = 1 - (\theta_{\min}/\theta)^{z}$ for $\theta \geq \theta_{\min} > 0$ and $z > 1$. Output of a firm with productivity θ which employs a measure h of workers with average ability $\bar{a}$ is:

$$y = \theta h^{\gamma} \bar{a}, \qquad 0 < \gamma < 1.$$

A key feature of this production technology is complementarities in workers' abilities, such that a worker's productivity is increasing in the abilities of other workers employed by the firm. The magnitude of these complementarities is increasing in firm productivity, because average worker ability has a larger effect on output in more productive firms. Output can be sold domestically or exported. If the firm decides to produce it has to bear a fixed cost of production f_d, and if it decides to export it has to bear a fixed exporting cost f_x and an iceberg variable trade cost $\tau > 1$.

There are search and matching frictions in the labor market, which take the standard Diamond-Mortensen-Pissarides form. Worker ability a is match-specific, drawn from a Pareto distribution $G_a(a) = 1 - (a_{\min}/a)^k$ for $a \geq a_{\min} > 0$ and $k > 1$.[1] Neither the worker nor the firm know the value a for an individual match. A firm can choose the measure of workers n to match with by incurring a search cost of b per unit measure of workers. This search cost is endogenous and depends on the tightness of the labor market, x, which equals the measure of workers matched with firms, N, divided by the measure of workers searching for employment in the sector, L. As shown in HIR, the equilibrium tightness of the labor market, x, and hence equilibrium search costs, b, depend solely on parameters and expected worker income, ω. As a result, the tightness of the labor market and search costs are constant as long as expected worker income is constant.

Although a firm does not know the ability a of individual workers with whom it has been matched, it can invest in screening in order to determine whether this ability is above or below a threshold a_c. The cost of this screening is increasing in a_c and takes the form $c \cdot (a_c)^\delta / \delta$.[2] Given a Pareto distribution of worker ability, a firm with screening threshold a_c hires a measure $h = n (a_{\min}/a_c)^k$ of workers with average ability $\bar{a} = k a_c/(k-1)$. Therefore a firm's output can be expressed as:

$$y = \kappa_y \theta n^\gamma a_c^{1-\gamma k}, \qquad \kappa_y \equiv \frac{k}{k-1} a_{\min}^{\gamma k}, \quad 0 < \gamma k < 1.$$

Once a firm has decided whether or not to produce, whether or not to export, the measure of workers to match with n, and the screening ability threshold a_c, it engages in strategic bargaining with its hired workers (i.e., those with an ability above the threshold) over the division of revenue, in the manner proposed by Stole and Zwiebel (1996a,b). We show in HIR that this results in the firm receiving a fraction $1/(1+\beta\gamma)$ of revenues, while the wage rate w equals a fraction $\beta\gamma/(1+\beta\gamma)$ of the average revenue per hired worker.

The solution to the firm's problem, outlined in the Appendix, has a number of features. The fixed production cost implies that only firms drawing a productivity above a zero-profit

[1] While we interpret worker ability as being match-specific, it can be instead interpreted as a general ability that is specific to the worker but common across all firms. As we develop a static model, these two interpretations are indistinguishable.

[2] While for simplicity we assume the screening cost is independent of the measure of workers matched with, n, the analysis generalizes in a straightforward way to the case where the screening cost increases linearly in n.

cutoff, θ_d, find it profitable to produce. Similarly, the fixed exporting cost implies that only firms drawing a productivity above an exporting cutoff, θ_x, find it profitable to export. Given the pervasive evidence of selection into export markets, we focus on values of fixed and variable trade costs for which only some firms export: $\theta_x > \theta_d$.

Production complementarities in workers' abilities provide firms with an incentive to screen workers to exclude those with the lowest abilities. While screening reduces output (and hence revenue and variable profits) by reducing the measure of workers hired, it increases output by raising average worker ability, and for $\gamma k < 1$ the second of these effects dominates. Since production complementarities are strongest for more productive firms, they have the greatest incentive to screen workers to exclude those with the lowest abilities.

Profit maximization implies that more productive firms both match with more workers and screen to a higher ability threshold. As long as screening costs are sufficiently convex ($\delta > k$), more productive firms also end up hiring more workers despite their greater selectivity. This greater selectivity implies that more productive firms have workforces of higher average ability, which are more costly to replace, resulting in higher bargained wages in these firms. As shown in HIR, all firm variables can be written as functions of firm productivity, θ, a firm market access variable, $\Upsilon(\theta)$, that captures a firm's decision whether or not to export, the productivity cutoffs for production, θ_d, and exporting, θ_x, and search costs, b:

$$\left.\begin{array}{ll}
n(\theta) = \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}} \cdot n_d \cdot \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\Gamma}}, & n_d \equiv \frac{\beta\gamma}{\Gamma}\frac{f_d}{b}, \\
a_c(\theta) = \Upsilon(\theta)^{\frac{1-\beta}{\delta\Gamma}} \cdot a_d \cdot \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta}{\delta\Gamma}}, & a_d \equiv \left[\frac{\beta(1-\gamma k)}{\Gamma}\frac{f_d}{c}\right]^{1/\delta}, \\
h(\theta) = \Upsilon(\theta)^{\frac{1-\beta}{\Gamma}(1-k/\delta)} \cdot h_d \cdot \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta(1-k/\delta)}{\Gamma}}, & h_d \equiv \frac{\beta\gamma}{\Gamma}\frac{f_d}{b}\left[\frac{\beta(1-\gamma k)}{\Gamma}\frac{f_d}{c a_{\min}^{\delta}}\right]^{-k/\delta}, \\
w(\theta) = \Upsilon(\theta)^{\frac{k(1-\beta)}{\delta\Gamma}} \cdot w_d \cdot \left(\frac{\theta}{\theta_d}\right)^{\frac{\beta k}{\delta\Gamma}}, & w_d \equiv b\left[\frac{\beta(1-\gamma k)}{\Gamma}\frac{f_d}{c a_{\min}^{\delta}}\right]^{k/\delta},
\end{array}\right\} \tag{1}$$

where

$$\Upsilon(\theta) = \begin{cases} 1, & \theta < \theta_x, \\ \Upsilon_x, & \theta \geq \theta_x, \end{cases} \qquad \Upsilon_x \equiv 1 + \tau^{-\frac{\beta}{1-\beta}}\left(\frac{A^*}{A}\right)^{\frac{1}{1-\beta}} > 1, \quad \Gamma \equiv 1 - \beta\gamma - \beta(1-\gamma k)/\delta > 0.$$

The equilibrium zero-profit and exporting cutoff productivities are determined by the free entry condition that expected profits equal the sunk entry cost and the indifference condition between exporting and serving only the domestic market for a firm with the exporting cutoff productivity, as shown in HIR. At this exporting cutoff productivity, $\Upsilon(\theta)$ jumps from 1 to $\Upsilon_x > 1$, as firm revenue jumps discretely such that the gain in export market revenue covers the fixed costs of exporting. As a result, all firm-specific variables (n, a_c, h and w) jump discretely at the exporting productivity cutoff. Exporting increases firm revenue, it induces firms to match with more workers and screen more intensively, which implies that exporters have workforces of higher average ability than non-exporters, and hence pay higher wages.

Note that Υ_x is a measure of the *intensive margin* of trade openness, which captures the extent to which exporting increases firm revenue. It is useful to also define a measure of the *extensive margin* of trade openness, $\rho \equiv \theta_d/\theta_x \in [0,1]$, where ρ^z equals the fraction of exporting firms given our assumption of Pareto-distributed firm productivity.

From the firm-specific solutions (1), the screening ability threshold, $a_c(\theta)$, is monotonically increasing in firm productivity, which implies that we can define ability cutoffs corresponding to the zero-profit and exporting productivity cutoffs introduced above. Thus $a_d = a_c(\theta_d)$ is the screening threshold for the least-productive surviving firm; $a_x^- = a_c(\theta_x^-) = a_d \rho^{-\beta/(\delta\Gamma)}$ is the screening threshold for the most-productive non-exporter; and $a_x^+ = a_c(\theta_x^+) = a_x^- \Upsilon^{(1-\beta)/(\delta\Gamma)}$ is the screening threshold for the least-productive exporter. Workers with ability $a < a_d$ are never hired and receive zero wage income. Note that a_d, defined in (1), depends solely on the parameters of the model and hence does not depend on the extent of trade openness of the industry.[3] In what follows we restrict attention to workers with ability $a \geq a_d$. Among them, workers with ability $a \in [a_d, a_x^-)$ are employed by non-exporting firms only; workers with ability $a \in [a_x^-, a_x^+)$ are employed by all non-exporting firms only; and workers with ability $a \geq a_x^+$ are employed by all non-exporting firms and some exporting firms.

3 Unemployment

In this section, we examine the relationship between worker ability and unemployment. Workers with ability $a \geq a_d$ can be unemployed for one of two reasons: either they are not matched with a firm, or they are matched with a firm but are not hired, because their ability, a, is below the firm's screening threshold, $a_c(\theta)$. Therefore the unemployment rate for workers with ability a can be written as one minus the product of the probability of being matched and the probability of being hired conditional on being matched:

$$u(a) = 1 - \frac{N}{L}\frac{H(a)}{N(a)} = 1 - x\sigma(a), \tag{2}$$

[3]The opening of trade leads to an increase in the zero-profit productivity cutoff, θ_d, so that only relatively more productive firms can survive in the open economy. Yet the screening cutoff of the least productive surviving firm remains unchanged. Similarly, the wage rate paid by the least productive surviving firm measured in terms of the numeraire, w_d, as well as other firm-specific variables (n_d, h_d), only depend on trade openness through the equilibrium search cost, b, which in turn remains unchanged as long as expected worker income, ω, remains constant.

where N and L are defined as above, $x \equiv N/L$ is the labor market tightness, $H(a)$ and $N(a)$ are the measures of workers with ability a hired and matched respectively, and $\sigma(a) \equiv H(a)/N(a)$ is the ability-specific hiring rate.

With random search, the probability of being matched is the same for all workers irrespective of their ability, and equals the tightness of the labor market, x. Therefore the unemployment rate only varies across workers with different abilities because of variation in the fraction of matched workers that are hired, $\sigma(a)$. To characterize this hiring rate for a worker with ability a, we define $\theta_c(a) \geq \theta_d$ as the productivity level of a firm that screens to the ability cutoff $a \geq a_d$, where $\theta_c(a)$ is implicitly defined by $a = a_c(\theta_c(a))$. Note that workers with ability a are randomly sampled by firms of all productivity $\theta \geq \theta_d$ in proportion to $n(\theta)$, while only firms with productivity $\theta \in [\theta_d, \theta_c(a)]$ retain these workers and more productive firms do not. Therefore, we can calculate the ability-specific hiring rate according to:

$$\sigma(a) = \frac{\int_{\theta_d}^{\theta_c(a)} n(\theta) \mathrm{d}G_\theta(\theta)}{\int_{\theta_d}^{\infty} n(\theta) \mathrm{d}G_\theta(\theta)} \qquad \text{for} \quad a \geq a_d. \tag{3}$$

Using (3) together with the solutions for firm-specific variables (1) and the Pareto distribution of firm productivity, we obtain:

$$\sigma^T(a) = \begin{cases} \frac{1}{1+\rho^{z-\beta/\Gamma}\left[\Upsilon_x^{(1-\beta)/\Gamma}-1\right]} \left[1 - \left(a_d/a\right)^{k/\mu}\right], & a_d \leq a \leq a_x^-, \\ \frac{1-\rho^{z-\beta/\Gamma}}{1+\rho^{z-\beta/\Gamma}\left[\Upsilon_x^{(1-\beta)/\Gamma}-1\right]}, & a_x^- < a < a_x^+, \\ 1 - \frac{\Upsilon_x^{z(1-\beta)/\beta}}{1+\rho^{z-\beta/\Gamma}\left[\Upsilon_x^{(1-\beta)/\Gamma}-1\right]} \left(a_d/a\right)^{k/\mu}, & a \geq a_x^+, \end{cases}$$

where $\mu \equiv \beta k / \left[\delta \left(z\Gamma - \beta\right)\right] > 0$ and the superscript T indicates a trade equilibrium (where only some firms export). The hiring rate under autarky can be obtained by considering the case where $\rho = 0$ (i.e., no firm exports so that $\theta_x = \infty$):

$$\sigma^A(a) = 1 - \left(a_d/a\right)^{k/\mu},$$

where the superscript A indicates an autarky equilibrium.

Inspection of the expressions for $\sigma^T(a)$ and $\sigma^A(a)$ together with the definition of the ability-specific unemployment rate (2) immediately leads us to:

Result 1 *In autarky, the ability-specific unemployment rate $u(a)$ is decreasing in a for all $a \geq a_d$. In a trade equilibrium, the unemployment rate decreases in a for abilities outside the interval $\left(a_x^-, a_x^+\right)$, on which it remains flat.*

The intuition for this result is straightforward. As more productive firms screen more intensively, workers with higher abilities are hired by firms with a wider range of productivities, and hence enjoy a lower unemployment rate than workers with lower abilities. In a trade equilibrium, workers with ability $a \in \left(a_x^-, a_x^+\right)$ experience exactly the same labor market outcomes as workers with ability $a = a_x^-$, because exporting firms are discontinuously more selective in their hiring practices than non-exporting firms. Since we show below that a worker's expected wage is increasing in her ability level, Result 1 also implies that the unemployment rate is decreasing across quantiles of the wage distribution (see Figure 3).

To examine the impact of opening the closed economy to trade, we consider the change in the unemployment rates in the open economy relative to autarky for workers with different abilities. To be precise, we look at $\left[u^T(a) - u^A(a)\right]/\left[1 - u^A(a)\right] = 1 - \sigma^T(a)/\sigma^A(a)$, that is one minus relative employment rates. We have (see the Appendix for a formal proof):

Result 2 *There exists a value of worker ability $\hat{a}_x > a_x^+$, such that workers with intermediate abilities $a \in (a_x^-, \hat{a}_x)$ experience a larger increase in the unemployment rate in the open economy relative to autarky than both workers with lower ability $a < a_x^-$ and workers with higher ability $a > \hat{a}_x$.*

Since the tightness of the labor market, x, remains constant as long as expected worker income, ω, is unchanged, the sole effect of the opening of trade on the unemployment rate is through the hiring rate, $\sigma(a)$.[4] The hiring rate falls for workers of all abilities following the opening of trade, because of the reallocation of employment towards more productive firms that screen more intensively. This implies an increase in unemployment rates across all abilities.

Additionally, there is a discrete increase in the screening ability threshold at θ_x, such that workers with abilities $a \in \left(a_x^-, a_x^+\right)$ are now only hired by non-exporting firms with productivities $\theta < \theta_x$. For workers with intermediate abilities in or just above this interval, the discrete increase in the screening ability threshold at θ_x involves a discrete reduction in the range of productivities for which they are hired. In contrast, workers with low abilities $a < a_x^-$ are not affected by the discrete increase in the screening ability threshold at θ_x, because they were not employed by high-productivity firms in the closed economy. Workers with high abilities $a \gg a_x^+$ are also less affected by the discrete increase in the screening ability threshold at θ_x.[5]

[4] It is straightforward to extend the analysis to also consider the case where expected worker income, ω, and hence the tightness of the labor market, x, change following the opening of trade (see HIR). Since changes in the tightness of the labor market have symmetric effects on workers of all abilities, our results for the impact of the opening of trade on relative unemployment rates for workers of different abilities remain unchanged.

[5] For concreteness, consider workers with ability $a \to \infty$ who are always retained by all firms in both the

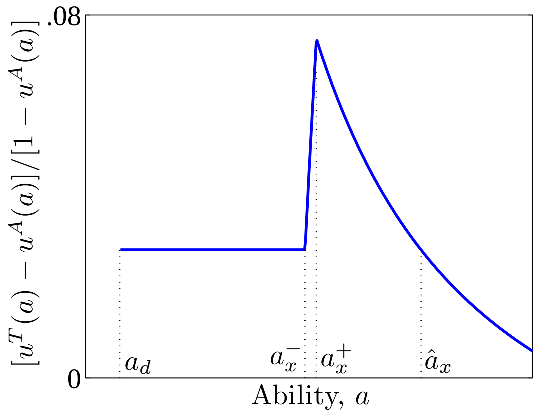

Figure 1: Change in the unemployment rates in the open economy relative to autarky

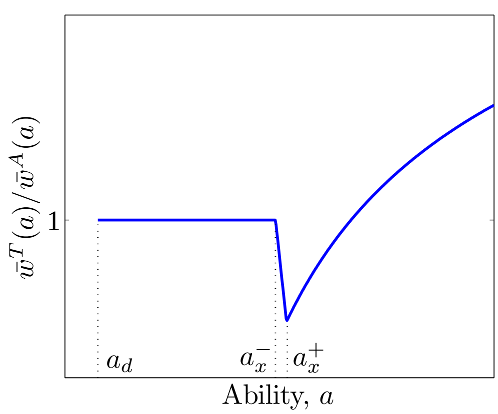

Figure 2: Relative average wages in the open economy and autarky

To summarize, the opening of trade leads to a larger proportionate rise in the unemployment rate for workers with intermediate abilities, as illustrated in Figure 1. While in autarky they were good enough to be hired by relatively high productivity firms, in a trade equilibrium they are no longer suitable for these firms and hence see their labor market outcomes deteriorate.[6]

4 Wages

In this section, we examine the relationship between wages and worker ability.[7] As discussed above, workers with ability $a \geq a_d$ are employed by firms with productivity $\theta \in \left[\theta_d, \theta_c(a)\right]$ and hence receive wages in the range $\left[w_d, w_c(a)\right]$, where $w_c(a) \equiv w\left(\theta_c(a)\right)$.[8] Using the solution for firm-specific variables (1) and our assumption of Pareto-distributed firm productivity, we can obtain the wage distributions for workers with abilities $a \geq a_d$ (see the Appendix).

In autarky, the wage distribution for workers with ability $a \geq a_d$ is a Truncated Pareto with shape parameter $1/\mu$ (where as before $\mu \equiv \beta k/\left[\delta\left(z\Gamma - \beta\right)\right]$), so that the cumulative distribution

closed and open economies so that $\sigma^A(\infty) = \sigma^T(\infty) = 1$. The unemployment rate of these workers is completely unaffected by an increase in the ability cutoff at θ_x.

[6] While these predictions for the change in relative unemployment rates are based on worker ability, Goos and Manning (2007) and Autor, Katz and Kearney (2008) provide empirical evidence of a "hollowing out" of the employment distribution in the form of a reduction in the density of employment at intermediate wages.

[7] Throughout we concentrate on wages defined in units of a numeraire as specified in HIR. Real wages also depend on the consumer price index, whose value changes with trade, but this change has symmetric effects on workers of all abilities. Therefore our comparative statics for relative wages across workers with different abilities also extend to relative real wages. While some workers suffer in relative terms, the opening of trade may increase real wages for workers of all abilities, because of the fall in the consumer price index.

[8] In an open economy, exporters pay a discontinuous wage premium to their employees. That is, the wage rate paid by the most productive non-exporter, $w\left(\theta_x^-\right)$, is discretely smaller than the wage rate paid by the least productive exporter, $w\left(\theta_x^+\right)$. As a result, no worker receives wages in the intermediate range $\left(w\left(\theta_x^-\right), w\left(\theta_x^+\right)\right)$.

function is given by:

$$F_w^A(w|a) = \frac{1-\left(w_d/w\right)^{1/\mu}}{1-\left(a_d/a\right)^{k/\mu}}, \qquad w_d \leq w \leq w_c(a) = w_d \cdot \left(a/a_d\right)^k. \tag{4}$$

This immediately implies (formal proof in the Appendix):

Result 3 *In autarky, both average wages and wage inequality are monotonically increasing in worker ability $a \geq a_d$.*

Since more productive firms screen to a higher ability threshold, a worker with a given ability is hired by all firms that hire workers of lower ability, and also by some more productive firms that do not hire workers of lower ability. Therefore higher ability workers face a wage distribution with a wider support than lower ability workers. As a result, higher ability workers have both higher average wages and greater wage inequality.[9] Furthermore, from (4), it is evident that the wage distribution of higher-ability workers first-order stochastically dominates the wage distribution of lower-ability workers.

This prediction of the model has observable implications. If we divide the wage distribution into quantiles with equal numbers of workers, higher quantiles contain greater fractions of high ability workers than lower quantiles. Therefore there is greater wage inequality within higher quantiles of the aggregate wage distribution (see Helpman, Itskhoki and Redding 2008 for details). As wage inequality in our model arises from unobserved match-specific ability, this prediction of the model is consistent with empirical findings of greater residual wage inequality for higher-wage workers (see for example Autor, Katz and Kearney 2008 and Lemieux 2006).

Now consider the distribution of wages conditional on ability in an open economy. For workers with ability $a \in \left[a_d, a_x^-\right]$ who are hired only by non-exporters, the wage distribution is exactly the same as in autarky and given by (4). Workers with abilities $a \in \left(a_x^-, a_x^+\right)$ are also hired by non-exporting firms only and hence experience exactly the same labor market outcomes (including the distribution of wages) as workers with ability $a = a_x^-$. Finally, the wage distribution of workers with abilities $a \geq a_x^+$ is a mix of two Truncated Pareto distributions (both with shape parameter $1/\mu$) corresponding to the wages paid by non-exporters and exporters respectively (see the Appendix for a closed-form expression).

[9] Recall that higher ability workers also have lower unemployment rates. As a result, income inequality, which takes into account both average wages conditional on finding employment and the zero income received by the unemployed, is non-monotonic in ability with intermediate-ability workers experiencing the lowest levels of income inequality (for details see Helpman, Itskohki and Redding 2008).

One can generalize Result 3 for the open economy conditional wage distributions: as in autarky, both average wages and wage inequality are increasing in worker ability in the open economy, because higher ability workers face wage distributions with wider support than lower ability workers. We leave the details to the Appendix, and contrast the closed and open economy conditional wage distributions in the following:

Result 4 *(i) For all $a \leq a_x^-$ the conditional wage distribution is the same in the open economy and autarky. (ii) For $a \in \left(a_x^-, a_x^+\right]$ the autarky wage distribution first-order stochastically dominates the open economy wage distribution. (iii) There exists $\tilde{a}_x > a_x^+$ such that for all $a \geq \tilde{a}_x$ the open economy wage distribution first-order stochastically dominates the autarky wage distribution.*

Opening the closed economy to trade has uneven effects across workers with different abilities. Low ability workers face the same wage distribution as in the closed economy, because they are only hired by low productivity firms that do not export in a trade equilibrium.[10] In contrast, workers with intermediate abilities experience a discrete reduction in their expected wages and an overall shift down of the wage distribution, because exporting firms with productivity just above θ_x become discontinuously more selective and no longer hire these workers. Therefore, opening to trade both limits employment opportunities and reduces the highest wages that can be received by these workers. Finally, for the highest-ability workers, the increase in wages at exporters and the reallocation of employment towards exporters dominate, and these workers enjoy higher average wages and an overall shift upwards of the wage distribution after opening to trade. We illustrate these results in Figure 2 above, where we plot the ratio of expected wage conditional on ability in a trade equilibrium and in autarky, $\bar{w}^T(a)/\bar{w}^A(a)$.[11] Paralleling our earlier results for unemployment, intermediate-ability workers are the ones most adversely affected by the opening of trade.

Finally, we have shown that the average wage, $\bar{w}(a)$, is increasing in worker ability a, and the unemployment rate, $u(a)$, is decreasing in worker ability. Therefore the average wage and the unemployment rate are negatively correlated across worker abilities. An observable implication of this result is that average unemployment rates decrease with the quantiles of the aggregate

[10]Recall from (1) that the wage rate paid by the least productive surviving firm measured in terms of the numeraire, w_d, is unchanged in the trade equilibrium as long as expected worker income, ω, and hence the hiring cost, b, are unchanged. While a change in ω affects w_d, this has the same proportionate effect on the wages of all workers, and hence our relative predictions for the wages of workers with different abilities continue to hold.

[11]A similar pattern emerges for wage inequality conditional on ability. While wage inequality increases with ability in both the closed and open economies, the opening of trade reduces wage inequality for intermediate-ability workers and increases wage inequality for high-ability workers. We omit these results for brevity.

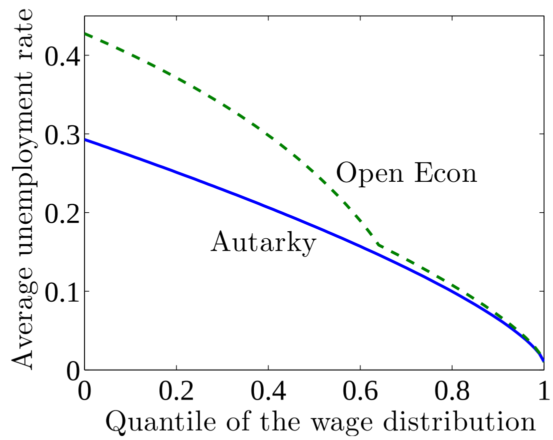

Figure 3: Average unemployment rate by wage quantiles

wage distribution, as found empirically by for example Juhn, Murphy and Topel (1991). We illustrate this feature of the model in Figure 3 for both the open and closed economy, where the construction of the figure is discussed in further detail in the Appendix. Although the opening of trade causes the largest increases in unemployment rates for intermediate-ability workers, it also induces a change in the distribution of abilities across quantiles of the wage distribution, because of the reallocation of employment towards more productive firms that are more selective. As a result, the largest increases in unemployment rates between the closed and open economies are observed for the lowest quantiles of the wage distribution in Figure 3.

In this paper, we have used a framework featuring heterogeneity across workers and firms, labor market frictions and selection into export markets to explore the determinants of wages and unemployment across workers with different abilities. While worker ability cannot be typically directly measured, our framework yields predictions for the observable variation in wage inequality and unemployment rates across quantiles of the wage distribution.

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