Globalization, Worker Mobility and Wage Inequality☆

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Abstract

In the present paper, I integrate frictional labor markets with on-the-job search into an otherwise standard heterogeneous firm model of intra-industry trade. Most importantly, I show that the returns to workers' inter-firm mobility are higher in a trade equilibrium than in autarky. Intuitively, by favoring large and productive firms, international trade amplifies the disparities in profitability between small and large firms. Hence, the returns to labor reallocation across firms rise. In view of the empirically observed higher inter-firm mobility among high-skill workers, this suggests a skill-biased impact of trade liberalization.

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1. Introduction

Recent empirical studies stress the roles of firm-specific wage premia and workers' sorting into firms in explaining the increase in wage inequality that so many countries have experienced over the last decades (see, e.g., Card et al., 2013). In the present paper, I explore the advancing integration of the world economy as a potential explanation for those patterns. The motivation is twofold. First, large and productive firms are more likely to gain access to foreign markets and to export (Tybout, 2008; Bernard et al., 2007). Therefore, international trade tends to amplify the disparities in revenue productivity between small and large firms, and, potentially, also the disparities in wage policies between small and large firms. Second, there are substantial differences in inter-firm mobility between lower- and higher-educated workers (Stijepic, 2015b).

In order to study the link between international trade and wage inequality, I integrate frictional labor markets with on-the-job search à la Burdett and Mortensen (1998) into an otherwise standard heterogeneous firm model of intra-industry trade à la Melitz (2003). I find, indeed, that the relative wage of the relatively mobile factor input is higher in a trade equilibrium where only a fraction of firms export than in autarky for a given supply of factor inputs. Intuitively, international trade amplifies the disparities in revenue productivity between small and large firms, and raises, therefore, the efficiency gains resulting from the reallocation of resources from small to large firms. If firms are similar in profitability, the returns from switching firms are low. However, if the disparities between firms are substantial, so will be the returns. Wage differences between worker groups who differ in inter-firm mobility are amplified.

The comparative statistics, presented in this paper, reflect differences in pre- and post-liberalization long-run steady state structures of the economy. This stands in contrast to the specific factors literature, which analyzes the short-run and medium-run implications of trade liberalization when factors are imperfectly mobile. Loosely speaking, specific factors models focus on the once-and-for-all reallocation of resources. On-the-job search models à la Burdett and Mortensen (1998) stress that—in the presence of allocation shocks—a continuous reallocation of factors is necessary in order to preserve any allocation. Hence, the importance, in the long-run steady state equilibrium, of mobility. While the once-and-for-all modeling of the reallocation process seems appropriate at the industry level, the volatility of employment at the firm level makes such an assumption hard to justify in the case of a disaggregated analysis.[1]

This paper is related to a large and influential body of literature that analyzes mechanisms linking trade openness to the skill premium (e.g., Feenstra and Hanson, 1996; Dinopoulos and Segerstrom, 1999; Grossman and Rossi-Hansberg, 2008; Burstein and Vogel, forthcomming). Furthermore, I also contribute to the literature on international trade and within-group wage inequality, which has recently gained momentum (e.g., Felbermayr et al., 2014; Egger et al., 2013; Egger and Kreickemeier, 2012, 2009; Amiti and Davis, 2012; Helpman et al., 2010; Davidson et al., 2008). As far as my knowledge extends, I am the first to emphasize the role of differences in inter-firm mobility between skill groups in explaining the effect of trade openness on long-run steady state wage inequality. Similar to my approach, Holzner and Larch (2011) integrate the Burdett and Mortensen (1998) model into the Melitz (2003) model. However, the focus of their study is on the effect on export patterns of capacity-constraining labor market frictions.

The remainder of this paper is organized as follows. I present the theoretical model in Section 2 and the equilibrium characterization in Section 3. The main theoretical results are in Section 4. In Section 5, I discuss the differences in inter-firm mobility between education groups and provide some statistics based on German linked employer–employee data to complement the theoretical analysis. Section 6 draws some conclusions. Proofs of the propositions are in Appendix A. I discuss the calibration of the model for the numerical illustrations in Appendix B.

2. Framework

I introduce frictional labor markets with on-the-job search à la Burdett and Mortensen (1998) into an otherwise standard Melitz (2003) model. The framework has two particularly important features. First, the channel through which international trade affects wage inequality in the model applies within, and not between, sectors. Until recently, research on the labor market effects of international trade has been heavily influenced by the Stolper–Samuelson Theorem, emphasizing trade-induced resource reallocation across sectors (Stolper and Samuelson, 1941). However, "[m]ost studies of trade liberalization in developing countries

[1] Nor do international trade models that feature labor markets with search and random matching à la Diamond–Mortensen–Pissarides typically account for the continuous reallocation of workers across firms that is so prevalent in the labor market. Moscarini and Thomsson (2007) document that 3.2 percent of employed male workers change employers each month in the United Sates.

find little evidence in support of [trade-induced labor] reallocation across sectors" (Goldberg and Pavcnik, 2007, pg. 59). To illustrate the within-sector nature of the proposed mechanism, I follow Helpman et al. (2010) and derive the results on sectoral wage inequality without assuming a specific general equilibrium setup. See Helpman et al. (2010) for illustrations of how the sector may be embedded into a specific aggregate economy.

Second, by predicting a rise in demand for unskilled labor in developing countries, the Stolper–Samuelson mechanism associates globalization with falling wage inequality in the developing world; a prediction not supported by the empirical evidence (see, e.g., Goldberg and Pavcnik, 2007). The results that I derive in the following analysis also hold for asymmetric countries. Therefore, they are consistent with increasing wage inequality in both the developed and the developing countries.[2]

In this section, I consider a differentiated product sector with frictional labor markets within the aggregate economy. Foreign variables are denoted by an asterisk. While I display expressions for the home variables, analogous relations hold for the foreign ones.

2.1. A Differentiated Product Sector with Frictional Labor Markets

Demand within the sector is defined over a continuum of horizontally differentiated varieties and takes the constant elasticity of substitution form. The real consumption index for the sector, Q, is, therefore, defined by

$$Q = \left[\int_{j \in J} q^{\beta}(j) dj \right]^{\frac{1}{\beta}}, \quad 0 < \beta < 1, \tag{1}$$

where j indicates the variety, J is the set of varieties within the sector, $q(j)$ denotes the consumption of variety j, and β determines the elasticity of substitution between varieties. The price index corresponding to Q is denoted by P and depends on the prices $p(j)$ of the individual varieties. Given this specification of sectoral demand, a firm's equilibrium revenues are

$$r(j) = p(j)q(j) = Bq^{\beta}(j), \tag{2}$$

[2] Another noteworthy feature is that firms post wages. This stands in contrast to the literature on foreign trade and wage inequality in search and matching frameworks à la Diamond–Mortensen–Pissarides, which typically assumes bargaining. In a survey conducted by Hall and Krueger (2012), only one-third of the respondents indicated having bargained with their current employer.

where B is the demand shifter for the sector and is defined as $B = E^{1-\beta}P^{\beta}$, and where E is the total expenditure on varieties within the sector. Each firm takes the demand shifter as given when making its decisions, because it supplies one of a continuum of varieties within the sector and is, therefore, of measure zero relative to the sector as a whole.

There is a competitive fringe of potential firms that can choose to enter the differentiated sector by committing to an infinite stream of payments, $f_e > 0$.[3] Once a firm incurs the entry cost, the cost is assumed to be sunk and the firm observes its total factor productivity, A, which is drawn from the Pareto distribution $\Gamma_{A_0}(A) = 1 - (A_0/A)^z$ for $A \geq A_0 > 0$ and $z > 1$. Furthermore, $\gamma_{A_0}(\cdot)$ denotes the density function associated with $\Gamma_{A_0}(\cdot)$. After a firm observes its productivity, it decides whether to exit, produce solely for the domestic market, or produce for both the domestic and the export market. Production involves a fixed cost of $f_d > 0$. Similarly, exporting involves a fixed cost of $f_x > 0$. In addition, exporting is also associated with an iceberg variable trade cost, so that $\tau > 1$ units of a variety must be exported for one unit to arrive in the foreign market.[4] Each firm operates a Cobb–Douglas production technology, where the two factor inputs are high-skill labor, l_H, and low-skill labor, l_L. Therefore, its output, $y(j)$, is determined by

$$y(j) = A(j)l_H^{\theta}(j)l_L^{1-\theta}(j), \quad \theta \in (0, 1), \tag{3}$$

where θ is the share parameter. I assume the elasticity of substitution to be equal to one for illustrative purposes. One way to motivate a skill-abundant workforce at large and productive firms consists in assuming a technology–skill complementarity (e.g., Burstein and Vogel, forthcomming). However, the Cobb–Douglas production function does not allow for skill-biased technology the way it is typically modeled in the literature. Therefore, the Cobb–Douglas specification emphasizes the novelty of the proposed mechanism, which stresses the role of differences in inter-firm mobility between skill groups rather than differences in production technologies between firms in explaining the effect of trade openness on wage

[3]In other words, the entry cost, f_e, is modeled as the perpetuity of a sunk cost. This is a slight modification of the Melitz (2003) model, however, it is necessary for internal consistency.

[4]I model the fixed exporting cost, f_x, as a per-period cost. Modeling the exporting cost as (the perpetuity of) a sunk cost does not affect the equilibrium outcome for the following reason. Following Burdett and Mortensen (1998), I confine the analysis to the equilibrium that arises as the firms' time preference rate tends to zero. Therefore, I abstract from any dynamic considerations in the firms' optimization problem. Fajgelbaum (2013) studies firm dynamics in frictional labor markets and explicitly addresses the timing of the investment or exporting decision.

inequality.[5]

There are two types of workers: high-skill workers, H, and low-skill workers, L. There is a continuum of each worker type, of masses m_H and m_L, respectively. All workers are ex-ante identical, risk neutral, and equally productive conditional on type.[6] In the following, I suppress the worker type subscript to save on notation. Both unemployed and employed workers receive job offers according to a Poisson process at rate $\lambda > 0$. Workers may only accept or reject a firm's wage offer. Therefore, they have no (exogenous) bargaining power.[7] Firms are bound by an equal treatment constraint. A firm must pay all of its workers of the same type the same wage, irrespective of when they were hired, from where, and of the outside offers that some of them may have received. In particular, a firm does not respond to outside offers to its employees, but lets them go if they receive a higher wage offer.[8] Once a match between a firm and a worker is formed, it is at risk of being dissolved at an exogenous rate $\delta > 0$. Additionally, separation occurs endogenously if a worker obtains another job offer and decides to accept it.

A worker may be employed or unemployed. In the first case, the worker receives the wage offered by the respective firm; in the second case, I normalize the flow utility enjoyed by the worker to zero. Worker types differ in mobility. Specifically, I assume high-skill workers to be more inter-firm mobile than low-skill workers, i.e., $\lambda_H/\delta_H > \lambda_L/\delta_L$. I discuss this assumption in Section 5.1. Let the ratio of the job-finding rate, λ, to the job-destruction rate, δ, be denoted by k. High-skill and low-skill workers are identical in all other respects; an assumption I make for the sake of argument. Workers' time preference rate is denoted by ρ.

I abstain from modeling human capital and its accumulation for the following two reasons. First, Kambourov and Manovskii (2009), relying on data from the

[5]The literature stressing technology–skill complementarity typically argues for a causal effect of technology on firms' skill composition. However, the skill abundance at the most productive and large firms may favor the implementation of skill-biased technologies, i.e., the causality may run from the workforce composition to the technology bias. See Acemoglu (2002), who stresses the endogeneity of the direction and the bias of technology.

[6]I assume workers to be risk neutral for the sake of simplicity. The results in Section 4 hold irrespective of workers being risk neutral or risk averse.

[7]Shimer (2006) studies bargaining in an otherwise standard Burdett and Mortensen (1998) model. Cahuc et al. (2006) allow for non-zero bargaining power of workers in the Postel-Vinay and Robin (2002) model.

[8]Here I follow Burdett and Mortensen (1998). Postel-Vinay and Robin (2002) consider a setup where firms condition their wage offers on a worker's outside option and incumbent firms match outside offers. See Moscarini (2008) for further reading.

Panel Study of Income Dynamics, show that *(i)* the returns to occupational tenure are substantial, and that *(ii)* when occupational experience is taken into account, tenure with an industry or employer has relatively little importance in accounting for the wage one receives. These findings are consistent with human capital being occupation-specific. Therefore, inter-firm mobility does not necessarily affect the human capital accumulation process. Second, Stijepic (2015b), relying on the *Survey of Income and Program Participation*, finds only a limited impact of general experience and occupation-specific human capital on workers' inter-firm mobility. While general experience or human capital decrease employer–employer transitions, they also reduce separations into unemployment. The ratio of employer–employer transitions to separations into unemployment remains mostly unaffected.

2.1.1. The Labor Market

In this section, I briefly describe the labor market structure. I refer the reader to Burdett and Mortensen (1998) and Bontemps et al. (2000) for a detailed exposition. Workers' optimal behavior is as follows. When information about new job opportunities arises, workers quit their current job and move to the new one provided that the new wage offer exceeds the current one. Given a flow utility of zero, unemployed workers accept any positive wage offer.

Following Burdett and Mortensen (1998), I confine the analysis to the steady state equilibrium. Let n denote the steady state equilibrium measure of firms in the sector, m the measure of the set of workers, u the measure of the set of unemployed workers, and $G(\cdot)$ the distribution of the firms' wage offers. In steady state, the flow of workers into employment, λu, equals the flow into unemployment, $\delta(m-u)$. Therefore, the steady state measure of the unemployed workers is given by $u = m/(1+k)$. Let $H(w)$ denote the steady state proportion of workers receiving a wage no greater than w, henceforth referred to as the cross-sectional wage distribution. In steady state, the flow of unemployed workers into firms offering a wage no greater than w, $\lambda G(w)u$, equals the flow of employed workers into unemployment, $\delta H(w)(m-u)$, and into higher paid jobs, $\lambda(1-G(w))H(w)(m-u)$. Therefore, the steady state cross-sectional wage distribution is given by $H(w) = G(w)/(1+k(1-G(w)))$.[9]

Firms with a workforce of mass l that offer a wage w lose workers when they

[9] Alternatively, one may derive the law of motion for the cross-sectional job distribution by the Fokker–Planck formalism (see Stijepic, 2015a; Bayer and Wälde, 2010).

separate into unemployment, δl, or are poached by other firms that offer higher wages, $\lambda(1-G(w))l$. Firms attract workers who are unemployed, $(\lambda/n)u$, or poach workers from firms that offer lower wages, $(\lambda/n)H(w)(m-u)$. Therefore, a firm's steady state workforce for a given wage offer, w, is

$$l(w) = \frac{k}{b(1+k(1-G(w)))^2}, \tag{4}$$

where $b \equiv n/m$ denotes the tightness of the labor market. Both worker separations and the attraction of new workers are affected by a firm's wage strategy. Since, from the worker's perspective, firms are identical in all dimensions except for the offered wage, it follows that a firm attains a higher steady state workforce by offering a higher wage. Therefore, firms face upward sloping supply curves in the labor markets.

2.1.2. The Product Market

Given consumers' love for variety, no firm will ever serve the export market without also serving the domestic market. If a firm exports, it allocates its output, $y(j)$, between the domestic and the export market, $y_d(j)$ and $y_x(j)$, respectively, to equate its marginal revenues in the two markets, which by Equation (2) implies $[y_x(j)/y_d(j)]^{1-\beta} = \tau^{-\beta}(B^*/B)$. Therefore, a firm's total revenues can be expressed as $r(j) = Y(j)By^{\beta}(j)$. The variable $Y(j)$ captures the firm's market access. It depends on whether the firm chooses to serve both the domestic and foreign market or only the domestic market:

$$Y(j) \equiv \left[1 + \mathbb{1}_x(j)\tau^{-\frac{\beta}{1-\beta}}\left(\frac{B^*}{B}\right)^{\frac{1}{1-\beta}}\right]^{1-\beta}, \tag{5}$$

where $\mathbb{1}_x(\cdot)$ is an indicator variable that equals one if the firm exports and is zero otherwise.

After having observed its productivity, a firm chooses whether or not to produce, whether or not to export, and the wage to post. Following Burdett and Mortensen (1998), I assume that firms maximize steady state profits. The profit maximization problem of an active firm is

$$\pi(j) \equiv \max_{w_H, w_L, \mathbb{1}_x} \left\{ \left[1 + \mathbb{1}_x\tau^{-\frac{\beta}{1-\beta}}\left(\frac{B^*}{B}\right)^{\frac{1}{1-\beta}}\right]^{1-\beta} B\left(A(j)l_H^{\theta}(w_H)l_L^{1-\theta}(w_L)\right)^{\beta} - w_H l(w_H) - w_L l(w_L) - f_d - \mathbb{1}_x f_x \right\}, \tag{6}$$

where the labor input is a function of the firm's wage offer (see Equation (4)). The firm's optimization problem consists in the trade-off that is induced by the ambivalent effect of wages on profits. On the one hand, higher wages decrease profits per worker. On the other hand, a higher posted wage allows the firm to attract and retain more workers.

In this framework, firms can only affect their steady state size through the posted wage. Therefore, firms possess a limited set of hiring instruments. Introducing additional hiring instruments is potentially quantitatively important, but unlikely to overturn the qualitative results presented in this paper as long as the instruments are complements. Davis et al. (2013) find that firms typically expand by both posting more vacancies and filling these vacancies faster. Specifically, they express log-gross-hires as the sum of two terms: one that depends only on the vacancy-filling rate, and one that depends on the number of old and new vacancies. They then show that the vacancy-posting margin alone accounts for only 14 and 38 percent of the variance in log-gross-hires across establishment size and growth rate classes, respectively.

2.2. The Aggregate Economy and International Trade

The aggregate economy may consist of several sectors, and the sectors may differ in their structure. For instance, I allow for homogeneous product sectors with frictional factor markets, differentiated product sectors with Neoclassical factor markets, etc. The results on wage inequality within a differentiated product sector with frictional labor markets do not depend on a specific general equilibrium structure. Workers allocate themselves to sectors in such a way that the expected utility from working or searching for work is equalized across sectors. As is standard practice in this strand of literature, I assume that factors are immobile between countries.

I consider a global economy that consists of two—potentially asymmetric—countries: home and foreign. The countries may differ in their factor endowments or in their production technology. Therefore, the results are consistent with increasing wage inequality in both the developed and the developing countries.

3. Sectoral Equilibrium

In this section, I characterize the sectoral equilibrium. I confine the analysis to equilibria where all firms are labor constrained and the wage distribution exhibits no mass points. See Holzner and Launov (2010) for further details. First, I state two propositions that allow of ranking firms by productivity. The following proposition imposes a rank property on firms' participation and exporting decisions.

Proposition 1 (Rank Equilibrium I). *There is a zero-profit productivity cutoff, A_d, so that a firm drawing a productivity below A_d exits without producing. Similarly, there is an exporting productivity cutoff, A_x, so that it is not profitable for a firm of productivity below A_x to serve the export market.*

In view of this proposition, the market access variable is

$$Y(A) = \begin{cases} 1, & A < A_x \\ Y_x & A \geq A_x \end{cases}, \qquad Y_x \equiv \left[1 + \tau^{-\frac{\beta}{1-\beta}} \left(\frac{B^*}{B}\right)^{\frac{1}{1-\beta}}\right]^{1-\beta} > 1. \tag{7}$$

The next proposition establishes a close link between a firm's productivity and its equilibrium wage posting strategy.

Proposition 2 (Rank Equilibrium II). *Firms of equal productivity choose the same wage strategy, and more productive firms offer higher wages to each worker type than do less productive firms.*

The first part of this proposition states that there is no wage dispersion among equally productive firms. Intuitively, a continuous productivity distribution leaves no room for wage dispersion among equally productive firms. In the case of a discrete productivity distribution, firms of the same productivity typically do not choose the same wage posting strategy in equilibrium (see, e.g., Burdett and Mortensen, 1998; Bontemps et al., 2000).

The second part of Proposition 2 stipulates that wages are increasing in productivity for both high-skill and low-skill workers. Therefore, there is, on the one hand, a positive correlation between productivity and wages, and, on the other hand, a positive correlation between high-skill and low-skill workers' wages. Intuitively, more productive firms enjoy higher marginal revenues for a given posted wage. Therefore, they find it optimal to offer wages that exceed those posted by less productive firms in order to attract and to retain more workers.

Formally, Proposition 2 establishes that there exists a non-decreasing wage offer function, denoted by $w_i(A)$, for each worker type, so that

$$G_i(w_i(A)) = \Gamma_{A_d}(A), \quad i \in \{H, L\}. \tag{8}$$

Equation (8) allows of substituting the known productivity distribution, $\Gamma_{A_d}(\cdot)$, for the wage offer distribution, $G(\cdot)$. This is a crucial step in the characterization of the equilibrium. For instance, it allows of rewriting revenues, $r(j)$, in terms of productivity, i.e., $r(A(j))$.

In view of Propositions 1 and 2, I henceforth index firms by productivity, A. In the remainder of this section, I solve for the zero-profit productivity cutoff, A_d, the exporting productivity cutoff, A_x, and the inverse cross-sectional wage distribution, $H^{-1}(\cdot)$. By that point, it will already be possible to derive some results on how trade openness affects sectoral wage inequality, because these results do not depend on the values of the other variables, such as the demand shifter, B, the mass of the firms, n, the price index, P, or the real consumption index, Q.

3.1. Productivity Cutoffs

The productivity cutoff below which firms exit, A_d, is determined by the condition that a firm of productivity A_d generates no profits. Furthermore, since it is optimal for the least productive active firm to offer the unemployed workers' reservation wage of zero, that firm faces no labor costs. Therefore, the zero-profit condition is

$$r(A_d) = f_d, \tag{9}$$

where I use Equation (8) to rewrite revenues in terms of a firm's productivity.[10]

The productivity cutoff below which firms serve only the domestic market, A_x, is determined by the condition that a firm of productivity A_x is indifferent between exporting and exclusively serving the domestic market, i.e., the additional profits from exporting equal the fixed cost of exporting. Thus, the exporting cutoff condition is

$$(Y_x - 1)\, By^{\beta}(A_x) = f_x, \tag{10}$$

where I use again Equation (8) to rewrite revenues in terms of productivity. Note that the exporting cutoff, A_x, does not depend on labor costs, but is solely determined by the additional revenues from exporting. A firm of productivity A_x posts the same wage irrespective of whether it exports or not. This stems from a kink in the equilibrium wage offer function, $w_i(\cdot)$, at A_x, and, therefore, from a discontinuity in the marginal costs that a firm of productivity A_x faces.

[10] It is optimal for the least productive active firm to offer a wage of zero. Otherwise, the firm could decrease its wage offer without reducing its steady state workforce, and, therefore, increase its profits (see, e.g., Bontemps et al., 2000).

3.2. Sectoral Wages

In this section, I derive the inverse cross-sectional wage distribution, $H^{-1}(\cdot)$. The first order conditions of the firm's maximization problem (6) with respect to w_L and w_H are

$$\beta\theta_i r(j)\frac{l_i'(w_i(j))}{l_i(w_i(j))} - l_i(w_i(j)) - w_i(j)l_i'(w_i(j)) = 0, \quad i \in \{H, L\}, \tag{11}$$

where $\theta_H = \theta$, $\theta_L = 1-\theta$, and where the primes denote the derivative with respect to w_i. From Propositions 1 and 2 then follows that

$$\frac{\beta\theta_i r(A)}{l_i(A)} - w_i(A) = \frac{1 + k_i(1 - \Gamma_{A_d}(A))}{2k_i\gamma_{A_d}(A)}\frac{dw_i}{dA}(A). \tag{12}$$

This is a linear differential equation in $w_i(A)$. With the boundary condition $w_i(A_d) = 0$, it admits the solution

$$w_i(A) = 2\beta\theta_i b_i(1 + k_i(1 - \Gamma_{A_d}(A)))^2 \int_{A_d}^{A} \frac{r(x)\gamma_{A_d}(x)}{1 + k_i(1 - \Gamma_{A_d}(x))}dx. \tag{13}$$

Using the steady state condition $H_i(w) = G_i(w)/(1 + k_i(1 - G_i(w)))$ to substitute the cross-sectional wage distribution, $H_i(\cdot)$, for productivity, A, and applying a change of variables formula, yields the inverse cross-sectional wage distribution

$$H_i^{-1}(q) = 2f_d\beta\theta_i b_i\left(\frac{1 + k_i}{1 + k_i q}\right)^2 \int_0^q \frac{\hat{Y}_i(x)\hat{r}_i(x)}{1 + k_i x}dx, \quad i \in \{H, L\}, \quad q \in [0, 1], \tag{14}$$

where $\hat{r}_i(x)$ denotes revenues net of the market access variable of the firm that pays wages corresponding to the xth quantile of the H_i-distribution relative to the least productive firm still active in the market:

$$\hat{r}_i(x) \equiv (1 - x)^{-\frac{\beta}{z}} (1 + k_i x)^{2\beta + \frac{\beta}{z}} \left(\frac{1 + k_j}{1 + k_j + (k_i - k_j)x}\right)^{2\beta\theta_j}, \quad j \in \{H, L\}, \quad i \neq j. \tag{15}$$

Furthermore, $\hat{Y}_i(x)$ denotes the market access variable relative to the least productive firm, i.e., $\hat{Y}_i(x)$ equals $Y_x/Y(A_d)$ if $x \geq \Gamma_x/(1 + k_i(1 - \Gamma_x))$ and 1 otherwise. Γ_x denotes the share of non-exporting firms, i.e., $\Gamma_x \equiv \Gamma_{A_d}(A_x)$.

Equation (14) describes the wages of workers of type i as a function of the quantiles of the respective cross-sectional wage distribution, $H_i(\cdot)$. Note, however, that Equation (14) does not characterize the wages in terms of the model's primitive parameters. Therefore, it is not possible to discuss how wages depend on specific parameters. This is because it is not yet solved for the general equilibrium and, in particular, labor market tightness, b. Wages are increasing in labor market tightness, following a standard supply–demand argument. How labor market tightness depends in turn on the primitive parameters of the model hinges on the specific general equilibrium structure. Furthermore, how labor market tightness responds to trade liberalization also depends on the impact of international trade on the other sectors, which is also still unspecified at this point. However, it is important to note that labor market tightness enters into Equation (14) multiplicatively. Therefore, it does not affect any scale invariant measure of wage inequality. Apart from labor market tightness, wages in autarky and in a trade equilibrium differ only in the upper tail, i.e., between potential exporters, as a result of foreign market access, Y_x.

4. Skill Composition and Wage Inequality

In this section, I present the main qualitative implications of the model. I state one proposition that characterizes the economy's equilibrium microstructure and two propositions that describe the impact of international trade on within-group wage inequality and the skill premium. Furthermore, to illustrate the theoretical results, I numerically solve a special case of the model, assuming two symmetric countries with a single sector each. See Appendix B for further details.

4.1. Skill Composition

The following proposition shows that differences in inter-firm mobility between skill groups are sufficient to generate a microstructure that is consistent with key stylized facts.

Proposition 3 (Skill Composition). *In equilibrium, high-productivity firms are larger in terms of employment and have a larger share of high-skill workers than low-productivity firms. Therefore, the economy exhibits a positive relation between skill and size. Similarly, exporters are larger in terms of employment and have a larger share of high-skill workers than do non-exporting firms.*

Firms face upward sloping supply curves. Since more productive firms exhibit higher marginal revenues for any given level of factor inputs, it is optimal for the most productive firms to offer higher wages in order to attract and to retain more workers (see Proposition 2). Therefore, in steady state, high-productivity firms are larger in terms of employment. In addition, the model generates an employer-size wage premium. Furthermore, since high-skill workers' inter-firm mobility exceeds that of low-skill workers, i.e., $k_H > k_L$, high-skill workers are more likely to match with high-productivity firms. Therefore, the model generates a positive skill–size relation. All these patterns are well-known stylized facts (see, e.g., Oi and Idson, 1999).

The second part of Proposition 3 follows from the self-selection, induced by the fixed cost of exporting, of the most productive firms into exporting. Exporters are more productive, larger both in terms of factor inputs and output, and pay higher wages. This is also in line with well-known stylized facts (see, e.g., Tybout, 2008; Bernard et al., 2007).[11]

4.2. International Trade and Within-Group Inequality

The next proposition summarizes the impact of international trade on within-group wage inequality, i.e., wage inequality among homogeneous workers.

Proposition 4 (Within-Group Wage Inequality). *Within-group wage inequality is greater in a trade equilibrium where only a fraction of firms export than in autarky. Within-group inequality is the same as in autarky if all firms export.*[12]

Access to foreign markets allows a firm to generate higher revenues even for a given production output. More specifically, marginal revenues increase, ceteris paribus, by $Y_x > 1$ since a firm's revenues are given by $r(j) = Y(j)By^{\beta}(j)$. Higher marginal revenues increase the value of a firm's workforce and induce exporting firms to offer higher wages to retain and to attract workers. However, since high-productivity firms are more likely to self-select into exporting and high-productivity firms are at the same time high-wage firms, a further increase in the wages posted by this subsample of firms raises wage inequality among workers of each type. It follows from Equation (14) that wages above the $\Gamma_x/(1+k_i(1-\Gamma_x))$ith quantile rise relative to wages below that quantile, since $Y_x > 1$. Figure 1 illustrates in a numerical example the impact of international trade on the wage distribution of high-skill workers.

[11]While the positive correlation between establishment size and wages is a well-known feature of the data, Kugler and Verhoogen (2012) provide evidence for a positive relation between input prices and establishment size, and between input prices and export status beyond labor markets.

[12]I use the concept of Lorenz dominance for the analysis of inequality. Lorenz dominance is consistent with lower inequality according to a wide class of inequality measures, most prominently, the Gini coefficient.

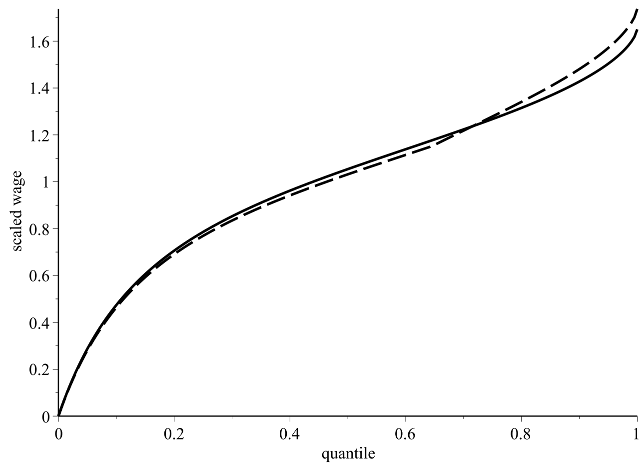

Figure 1: Numerical illustration of the high-skill workers' inverse cross-sectional wage distribution, $H_H^{-1}(\cdot)$, scaled by the overall average, $\int_0^1 H_H^{-1}(q)dq$, for the specific general equilibrium setup described in Appendix B. Autarky distribution ($\Gamma_x = 1$, solid line), and trade distribution ($\Gamma_x = 0.9$, dashed line).

The shape of the relation between trade openness and within-group wage inequality depends on the specific general equilibrium structure. However, it follows immediately from Equation (14) that within-group wage inequality is the same in autarky and in a trade equilibrium where all firms export. Wage inequality is driven by trade-induced disparities in wage strategies between exporting and non-exporting firms. It is the same whether all firms export or no firm exports. As a result, a given change in trade frictions can either raise or reduce wage inequality, depending on the initial level of trade openness. Helpman et al. (2010) also stress the non-monotonic and potentially inverted-'U' relation between trade openness and within-group wage inequality.

4.3. International Trade and the Skill Premium

The last proposition addresses the impact of international trade on the skill premium.

Proposition 5 (Skill Premium). *For a given supply of skill, the skill premium is higher in a trade equilibrium where only a fraction of firms export than in autarky, but it is the same as in autarky if all firms export.*

In line with the new view of international trade, the economy adapts to trade also through resource (re-)allocation across firms within sectors. The key idea is that it is mostly the large and productive firms that participate in international trade. Small and less productive firms are discouraged by the fixed exporting cost from supplying foreign markets. Therefore, trade amplifies the disparities in revenue productivity between small and large firms. This further encourages the resource reallocation from small to large firms. Indeed, the reallocation of resources from the less to the more productive, from the small to the large, and from the non-exporting to the exporting firms is crucial in order to fully realize the gains from trade. This demand for reallocation favors factor inputs that exhibit a high degree of inter-firm mobility, leading to relatively higher wages of the respective factor inputs. Given the positive correlation between education and inter-firm mobility, the skill premium rises in the aftermath of trade liberalization.

In order to further investigate the impact of international trade on the skill premium, I also construct two counterfactual skill premia. The first counterfactual skill premium imposes the same distribution over firms on both worker groups, i.e., the average wage of high-skill workers is measured relative to the average wage of low-skill workers that would have arisen if low-skill workers were matched with firms in the same pattern as high-skill workers. Differences in the average wage would then be solely determined by differences in wages within the same firm and not by differences in the distribution over firms. I refer to this difference in wages as the competition effect. The second counterfactual skill premium imposes the same wages within firms on both worker groups, i.e., high-skill workers' average wage is measured relative to the low-skill workers' average wage that would have arisen if low-skill workers were paid the same wage as high-skill workers in each firm. Differences in the average wage would then be solely determined by differences in the distribution over firms and not by differences in wage policies. I refer to this difference in wages as the composition effect.

Figure 2 illustrates in a numerical example the impact of international trade on the skill premium, depicting the skill premium itself and also the two counterfactual skill premia. For a given supply of skill, the model predicts an inverted-'U' relation between trade openness and the skill premium. The increase in the skill premium is driven by trade-induced disparities in wage strategies between exporting and non-exporting firms. The skill premium is the same whether all firms export or no firm exports. This contrasts with the canonical mechanisms that typically predict a monotonic relation between trade openness and the skill premium.[13] For instance, if exporting is assumed to be a skill-intensive activity, rising trade openness raises the high-skill workers' relative wage by increasing the demand for skill. A reversing trend is difficult to rationalize.[14]

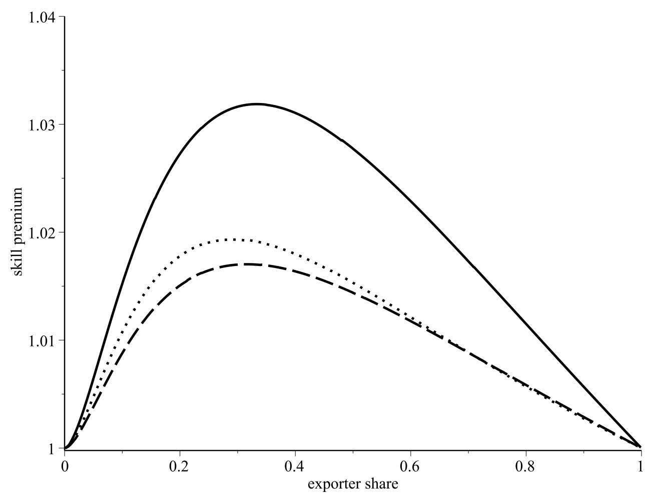

Figure 2: Numerical illustration of the impact of international trade on the skill premium for the specific general equilibrium setup described in Appendix B. Skill premium (solid line), composition effect (dashed line), and competition effect (dotted line).

The composition effect closely reflects the changes in the skill premium, but it is less pronounced. The composition effect is solely determined by differences

[13]I refer here to skill-premium–trade-openness mechanisms that apply within sectors. Changes in sector-specific prices or tariffs and the associated changes in the skill composition within and across sectors may affect the skill premium in either direction (see, e.g., Dix-Carneiro, 2014; Dix-Carneiro and Kovak, 2015).

[14]Helpman et al. (2010, Section 5.1.) extend their model to incorporate two worker types. The dispersion of the unobserved ability of the first group is assumed to be higher than that of the second group. In view of empirical evidence, one is inclined to think of the high-dispersion group as high-skill workers. Conditional on the relative expected income of the two groups, their model implies that (*i*) high-productivity firms employ relatively more high-dispersion/high-skill workers, which is in line with empirical evidence, and that (*ii*) trade liberalization induces a relative increase in the low-dispersion/low-skill workers' wages, i.e., a decline in the skill premium. Helpman et al. (2010) argue that changes in the relative expected income of the two groups might play a dominant role and offset the negative impact on the skill premium. However, changes in the relative expected income of the two groups have to be motivated within a specific general equilibrium setup. The core mechanism of Helpman et al. (2010) does not generate a positive impact of trade liberalization on the skill premium. This contrasts with my mechanism.

in the distribution of workers over firms. Intuitively, it is predominantly the large firms that start exporting and raise the offered wages. Since a disproportionately large share of high-skill workers is employed at large firms (see Proposition 3), high-skill workers also profit disproportionately from trade liberalization. This aspect of inter-firm mobility induces both higher wages and higher aggregate output, because of the positive correlation between wages and revenue productivity.[15] Recent empirical studies stress the roles of firm-specific wage premia and workers' sorting into firms in explaining the increase in wage inequality over the last decades. For instance, Card et al. (2013) fit linear models à la Abowd et al. (1999) with additive person and employer fixed effects for West Germany for the years 1985–2009. They find that two-thirds of the increase in the wage gap between lower- and higher-educated workers are attributable to a widening in the average employer wage premia received by differently educated groups.

However, high-skill workers' inter-firm mobility advantage is not only reflected in a more favorable distribution over firm productivity classes. Figure 2 also depicts the competition effect. As with the composition effect, the competition effect closely follows the changes in the skill premium, but it is less pronounced. The competition effect is solely determined by differences in wages within firms. Since in this numerical illustration I assume that revenues are linear in the factor inputs, workers are equally productive at a given firm. Hence, differences in wages reflect solely the differences in the rent shares that the workers are able to appropriate. Firms have monopsonistic power resulting from the workers' limited inter-firm mobility. A higher mobility intensifies the competition between firms for factor inputs and reduces their monopsonistic power. Indeed, without on-the-job search, it is optimal for all firms, irrespective of their productivity, to offer the workers' reservation wage in the Burdett and Mortensen (1998) model. With on-the-job search, workers are able to obtain wages above their reservation wage. High-skill workers, being more mobile, are able to appropriate a larger share of the surplus that is generated by trade. Hence, the skill premium rises in the aftermath of trade liberalization. This aspect of inter-firm mobility induces higher wages but has no direct effect on aggregate output.[16] Differences between groups

[15]While there is strong evidence that a positive skill–size relation has existed in recent decades, evidence for the 19th century suggests a negative skill–size relation (Holmes and Mitchell, 2008).

[16]Stijepic (2016a) documents the comovement of the skill premium with the differential employer-size wage premium between high- and low-skill workers in U.S. manufacturing during the postwar era. Most notably, the surge in the skill premium in the 1980s and 1990s coincides with the surge in the differential size premium. This suggests that differences between small and

of workers in their employers' monopsonistic power play a potentially important role in explaining relative wages. For instance, Ransom and Oaxaca (2010) estimate labor supply elasticities at the firm level in the U.S. retail grocery industry.[17] They find that differences in supply elasticities between women and men explain well the lower relative pay of women.[18]

Finally, while the results on within-group wage inequality are robust to other trends that the economy might be undergoing simultaneously, the skill premium is susceptible to general equilibrium effects through the sectoral supply of skill, m_H/m_L. Following a standard supply–demand argument, the skill premium is decreasing in the supply of skill. Therefore, the positive effect of international trade on the skill premium may be offset by a sufficiently pronounced positive trend in the relative supply of high-skill labor to the sector.

5. Empirical Relevance and Scope

Recent theoretical contributions, as well as the present paper, suggest that the link between international trade and wage inequality works through the wage differential between exporters and non-exporters, which can also arise in a setting of ex-ante identical workers. So far, the literature has stressed two channels, through which this wage gap can affect the total wage dispersion over time.[19] First, the share of workers employed at exporters may change, for instance, due to exporters becoming larger or due to an increasing number of exporting relative to non-exporting firms. Second, the size of the wage differential itself may change, for instance, due to exporters benefiting the most from increasing globalization, leading them to share some of the additional gains with their workers.

In the present paper, I argue for a subtle but crucial modification of the standard view of the second channel. Specifically, I do not assume the workers' rent share to be an exogenous constant, but motivate it by the competition between employers that results from the workers' search for better jobs while employed.

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large employers play a potentially important role in explaining the recent increases in wage inequality.

[17]Manning (2003) provides a detailed exposition of the dynamic monopsony model.

[18]Stijepic (2016b) shows that a mean-preserving spread of the employers' productivity distribution decreases the share of the production output that the workers receive in the canonical on-the-job search model. Exploiting the variation between the German federal states in the productivity dispersion, he finds that the elasticity of wages with respect to the employers' productivity has a negative correlation with the productivity dispersion across employers.

[19]See Baumgarten (2013) for an overview of the literature.

Indeed, Cahuc et al. (2006) estimate the workers' exogenous bargaining power to be only modest once on-the-job search is taken into account. In other words, workers' search for better jobs while employed suffices to explain the share of the output that the workers are able to appropriate. In that sense, the current framework is an extension of the constant rent share models à la Egger and Kreickemeier (2009, 2012). In the present paper's framework, the workers' rent share may react to changes in the state of the economy, and may also vary between worker groups. This variability of the rent share establishes a novel mechanism through which trade liberalization may affect the total wage inequality. The competition effect as illustrated in Figure 2 is one example.

In the following, I explore the empirical relevance and scope of the intra-industry trade model with on-the-job search that I develop in this paper. In Section 5.1, I discuss the relation between education and inter-firm mobility. Using linked employer–employee data for German manufacturing, I study the empirical scope of the proposed mechanisms for explaining the relation between trade openness and the skill premium in Section 5.2.

5.1. Mobility Patterns

Stijepic (2015b) shows that an increase in the employed workers' degree of inter-firm mobility as measured by the risk ratio of an employer–employer transition to a separation into unemployment induces, ceteris paribus, first order stochastic dominance in the distribution of workers over firms in the canonical on-the-job search model. In other words, the higher is this risk ratio, the larger is the share of workers employed at the preferred firms. Intuitively, separations into unemployment represent negative mobility shocks. The more pronounced the shocks, the less likely are individuals to sort into a specific firm. Therefore, employer–employer transitions are to be scaled by separations into unemployment in order to obtain an adequate measure of the workers' ability to reallocate across firms.

I rely on the 1996 panel of the *Survey of Income and Program Participation* in order to document differences in employer–employee separations between education groups. See Stijepic (2015b) for a detailed study of job mobility in the United States. The *Survey of Income and Program Participation* was designed to be a nationally representative sample of households in the civilian non-institutionalized U.S. population, for which interviews were conducted every four months for four years. In line with the present paper's focus on the steady state equilibrium, the U.S. economy was approximately in the same phase of the business cycle during the covered period, 1996–2000.

Figure 3 decomposes employer–employee separations into employer–employer transitions and separations into unemployment for five education groups: persons without a high school diploma (*no high school*), high school graduates (*high school*), persons with some college but either no degree or else an associate degree (*some college*), persons with a bachelor's degree (*college*), and persons with a master's, professional, or doctoral degree (*advanced*). The key pattern of interest in Figure 3 is that the share of employer–employer transitions in overall employer–employee separations is increasing in educational attainment. For instance, the share of employer–employer transitions is 69 percent among high school dropouts and 90 percent among survey participants with advanced education. Therefore, inter-firm mobility as measured by the risk ratio of an employer–employer transition to a separation into unemployment is increasing in educational attainment.[20]

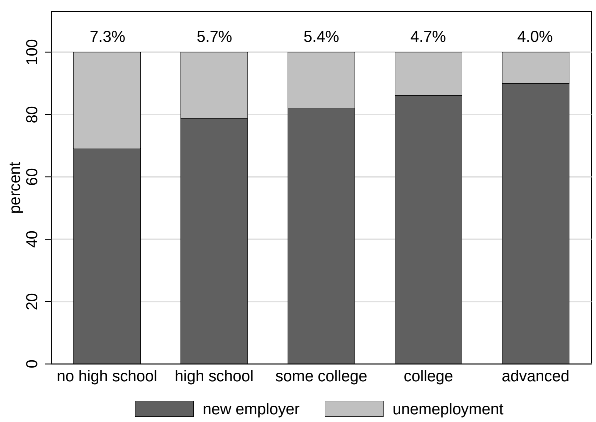

Figure 3: Employer–employee separations at four-month intervals for full-time employed male workers ages 25–55 in 1996–2000. Decomposition by percentage shares. Top bar values denote the share of initially employed workers experiencing an employer–employer transition or a separation into unemployment. Author's calculations based on the *Survey of Income and Program Participation* as provided by the National Bureau of Economic Research (`http://www.nber.org/data/survey-of-income-and-program-participation-sipp-data.html`).

Relying on the *Current Population Survey*, Fallick and Fleischman (2004) document monthly gross worker flows for the United States, 1994–2003. In line with

[20]Strictly speaking, the statistics refer to the employed worker's risk ratio of *being* employed at another firm to *being* unemployed after four months. It is only for infinitesimal changes in time that this ratio exactly corresponds to the employed worker's risk ratio of *separating* to another employer to *separating* into unemployment.

Figure 3, they find that while persons with higher educational attainment separate less often to another employer, they are disproportionately less likely to separate into unemployment. For instance, 8.6 percent of employed high school dropouts separate into unemployment or leave the labor force each month. Another 3.4 percent change employers. On the other hand, 2.0 percent of persons with advanced education change employers, but only 1.9 percent separate into unemployment or leave the labor force.[21]

This pattern is not specific to the United States. Cahuc et al. (2006) estimate the transition parameters of an on-the-job search model for four skill groups in four French industries. They find that the ratio of the job-finding rate to the separation rate into unemployment tends to increase with the individual's skill level.[22] For instance, they estimate this ratio to be 1.02 for the lowest skill category and 3.95 for the highest skill category in French manufacturing. Furthermore, I also compute the statistics for Germany for three education categories: no vocational training and no high school *(low)*, high school and/or vocational training *(medium)*, and university or technical college *(high)*. Specifically, I rely on the weakly anonymous *Sample of Integrated Labour Market Biographies* as provided by the Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research. vom Berge et al. (2013) give a detailed description of the data set. I find that the share of employer–employer transitions in employer–employee separations at four-month intervals is 39, 44, and 60 percent among low-, medium-, and high-educated full-time employed male workers ages 25–55 in 1996–2000, respectively.

Stijepic (2015c,d) highlights differences in versatility, in the sense of being able to perform various tasks or activities eventually even across occupations, between education groups as a rationale for differences in inter-firm mobility. In an environment where jobs differ in task requirements and workers differ in the tasks they are able to perform, a worker–firm match requires an overlap between the job requirements and the tasks the worker is able to fulfill. Being able to perform a wider range of tasks increases a worker's inter-firm mobility since *(i)* employer–employer transitions are less likely to be hindered by unmet job requirements, and

[21] Overall, Fallick and Fleischman (2004) report that 2.6 percent of employed workers separate to another employer, 1.3 percent separate into unemployment, and 2.7 percent leave the labor force each month.

[22] The risk ratio of separating to another employer to separating into unemployment is an ordinal transformation of the ratio of the job-finding rate to the separation rate into unemployment (see Stijepic, 2015b).

(ii) workers are more likely to adapt to changing job requirements and, hence, are less likely to separate into unemployment.[23] Therefore, a worker's versatility affects both the effective job-finding rate and the separation rate into unemployment. The latter rate plays a crucial role in explaining differences between worker groups in the ability to sort into the productive firms.[24]

5.2. Trade Openness and the Skill Premium

In order to study the link between trade openness and the skill premium, I make use of linked employer–employee data for the German manufacturing sector.[25] Following Baumgarten (2013), I restrict the sample to full-time employed male workers ages 18–65 in the time period 1996–2007. Additional to the three education categories low, medium and high, I also include a category for missing educational information. The wage information is right-censored at the contribution ceiling to the social security system. In order not to bias the regression results, I impute the censored logarithmized daily wages separately for East and West German and separately for each year and education category under the assumption of normality.

Table 1 displays the ordinary least squares estimates of the effect of education and the establishment's exporting activity on the logarithm of the daily wage for full-time employed male workers ages 18–65. In the first specification, the set of control variables also includes a third-order polynomial in age, three-digit occupation and industry level fixed effects, and state level fixed effects. The key pattern of interest is that the exporter wage premium substantially differs between the education groups. For instance, the exporter wage premium of the high-education individuals exceeded that of the low-education individuals by 6.6 log-points in 1996. Furthermore, the exporter wage premium of the low-education workers increased by 6.7 log-points between 1996 and 2007, whereas the exporter wage premium of the high-education workers decreased by 2.3 log-points.

[23] Stijepic (2015b) finds *(i)* a strong positive correlation between a worker's education and versatility, and *(ii)* a substantially higher inter-firm mobility among versatile workers even after controlling for an extensive set of covariates.

[24] Concepts like that of endogenous search effort do not typically address differences in the separation rate into unemployment between worker groups.

[25] This study uses the cross-sectional model of the linked employer–employee data (LIAB version 2, years 1993–2010) from the Institute for Employment Research. Data access was provided via on-site use at the Research Data Centre of the German Federal Employment Agency at the Institute for Employment Research and subsequently via remote data access. Heining et al. (2013) give a detailed description of the data set.

	1996		2007 (difference to 1996)	
	(1)	(2)	(1)	(2)
Education				
Medium	0.055*** (0.002)	0.090*** (0.002)	0.055*** (0.003)	−0.012*** (0.003)
High	0.221*** (0.003)	0.184*** (0.003)	0.108*** (0.005)	0.046*** (0.005)
Exporting	0.074*** (0.002)	–	0.067*** (0.003)	–
Exporting interacted with education				
Medium	0.034*** (0.002)	−0.007*** (0.002)	−0.065*** (0.003)	−0.006* (0.003)
High	0.066*** (0.004)	0.077*** (0.003)	−0.090*** (0.005)	−0.033*** (0.005)
Establishment	–	x	–	x
Further controls	x	x	x	x

Table 1: Ordinary least squares estimates of the effect of the displayed variables on the logarithmized daily wage. Sample restricted to full-time employed male workers ages 18–65. Persons with a low education serve as base group. The further controls are a third-order polynomial in age, three-digit occupation and industry level fixed effects, and state level fixed effects. The R-squared is 0.6251 and 0.7495 in the first and second specification, respectively. 1,137,958 observations. Regressions make use of sampling weights. Standard errors in parentheses. Statistical significance at the 10, 5, and 1 percent level denoted by *, **, and ***, respectively. Author's calculations based on the cross-sectional model 2 of the LIAB.

In the second specification, I also include establishment level fixed effects as a control for the workers' distribution over establishments. The qualitative implications are unaltered. While this simple empirical exercise does not reflect the full complexity of the subject, it does not, nevertheless, provide evidence in support of the idea that all worker groups enjoy the same exporter wage premium, nor that their wage premia exhibit similar time patterns—even conditional on establishment level fixed effects.

Given the empirically observed differences in inter-firm mobility, the present paper's framework suggests a heterogeneous impact of trade liberalization on the education groups' wages even conditional on the workers' distribution over establishments. This is illustrated in Figure 2 as the competition effect. The statistics presented in this section are consistent with this prediction. Interestingly, I show that modifications of the labor market structure are sufficient to generate such patterns. Hence, adjustments of the exporting or production technologies are not necessary to qualitatively match those patterns.

6. Conclusion

In this paper, I integrate frictional labor markets with on-the-job search à la Burdett and Mortensen (1998) into an otherwise standard heterogeneous firm model of intra-industry trade à la Melitz (2003). It is mostly the large and productive firms that participate in international trade. Small and less productive firms are discouraged by the fixed exporting cost from supplying foreign markets. Therefore, trade amplifies the disparities in revenue productivity between small and large firms, further encouraging the resource reallocation from small to large firms. This demand for reallocation favors factor inputs that exhibit a high degree of inter-firm mobility, leading to higher relative wages of the respective factor inputs. Given the positive correlation between education and inter-firm mobility, the skill premium rises in the aftermath of trade liberalization.

References

Abowd, J. M., Kramarz, F., Margolis, D. N., 1999. High Wage Workers and High Wage Firms. Econometrica 67 (2), 251–334.

Acemoglu, D., 2002. Directed Technical Change. Review of Economic Studies 69 (4), 781–809.

Amiti, M., Davis, D. R., 2012. Trade, Firms, and Wages: Theory and Evidence. Review of Economic Studies 79 (1), 1–36.

Anderson, J. E., van Wincoop, E., 2004. Trade Costs. Journal of Economic Literature 42 (3), 691–751.

Baumgarten, D., 2013. Exporters and the Rise in Wage Inequality: Evidence from German Linked Employer–Employee Data. Journal of International Economics 90 (1), 201–217.

Bayer, C., Wälde, K., 2010. Matching and Saving in Continuous Time: Theory. CESifo Working Paper Series 3026, CESifo Group Munich.

Bernard, A. B., Jensen, J. B., Redding, S. J., Schott, P. K., 2007. Firms in International Trade. Journal of Economic Perspectives 21 (3), 105–130.

Bontemps, C., Robin, J.-M., van den Berg, G. J., 2000. Equilibrium Search with Continuous Productivity Dispersion: Theory and Nonparametric Estimation. International Economic Review 41 (2), 305–58.

Broda, C., Weinstein, D. E., 2006. Globalization and the Gains from Variety. The Quarterly Journal of Economics 121 (2), 541–585.

Burdett, K., Mortensen, D. T., 1998. Wage Differentials, Employer Size, and Unemployment. International Economic Review 39 (2), pp. 257–273.

Burstein, A., Vogel, J., forthcomming. Globalization, Technology, and the Skill Premium. Journal of Political Economy.

Cahuc, P., Postel-Vinay, F., Robin, J.-M., 2006. Wage Bargaining with On-the-Job Search: Theory and Evidence. Econometrica 74 (2), 323–364.

Card, D., Heining, J., Kline, P., 2013. Workplace Heterogeneity and the Rise of West German Wage Inequality. The Quarterly Journal of Economics 128 (3), 967–1015.

Davidson, C., Matusz, S. J., Shevchenko, A., 2008. Globalization and Firm Level Adjustment with Imperfect Labor Markets. Journal of International Economics 75 (2), 295–309.

Davis, S. J., Faberman, R. J., Haltiwanger, J. C., 2013. The Establishment-Level Behavior of Vacancies and Hiring. The Quarterly Journal of Economics 128 (2), 581–622.

Dinopoulos, E., Segerstrom, P., 1999. A Schumpeterian Model of Protection and Relative Wages. American Economic Review 89 (3), 450–472.

Dix-Carneiro, R., 2014. Trade Liberalization and Labor Market Dynamics. Econometrica 82 (3), 825–885.

Dix-Carneiro, R., Kovak, B. K., 2015. Trade Liberalization and the Skill Premium: A Local Labor Markets Approach. American Economic Review 105 (5), 551–57.

Egger, H., Egger, P., Kreickemeier, U., 2013. Trade, Wages, and Profits. European Economic Review 64 (C), 332–350.

Egger, H., Kreickemeier, U., 2009. Firm Heterogeneity and the Labor Market Effects of Trade Liberalization. International Economic Review 50 (1), 187–216.

Egger, H., Kreickemeier, U., 2012. Fairness, Trade, and Inequality. Journal of International Economics 86 (2), 184–196.

Fajgelbaum, P. D., 2013. Labor Market Frictions, Firm Growth, and International Trade. NBER Working Papers 19492, National Bureau of Economic Research, Inc.

Fallick, B., Fleischman, C. A., 2004. Employer-to-Employer Flows in the U.S. Labor Market: The Complete Picture of Gross Worker Flows. Finance and Economics Discussion Series 2004-34, Board of Governors of the Federal Reserve System (U.S.).

Feenstra, R. C., Hanson, G. H., 1996. Globalization, Outsourcing, and Wage Inequality. American Economic Review 86 (2), 240–45.

Felbermayr, G., Impullitti, G., Prat, J., 2014. Firm Dynamics and Residual Inequality in Open Economies. IZA Discussion Papers 7960, Institute for the Study of Labor (IZA).

Goldberg, P. K., Pavcnik, N., 2007. Distributional Effects of Globalization in Developing Countries. Journal of Economic Literature 45 (1), 39–82.

Grossman, G. M., Rossi-Hansberg, E., 2008. Trading Tasks: A Simple Theory of Offshoring. American Economic Review 98 (5), 1978–97.

Hall, R. E., Krueger, A. B., 2012. Evidence on the Incidence of Wage Posting, Wage Bargaining, and On-the-Job Search. American Economic Journal: Macroeconomics 4 (4), 56–67.

Heining, J., Scholz, T., Seth, S., 2013. Linked-Employer-Employee Data from the IAB: LIAB Cross-Sectional Model 2 1993-2010 (LIAB QM2 9310). FDZ-Datenreport (02).

Helpman, E., Itskhoki, O., Redding, S., 2010. Inequality and Unemployment in a Global Economy. Econometrica 78 (4), 1239–1283.

Holmes, T. J., Mitchell, M. F., 2008. A Theory of Factor Allocation and Plant Size. RAND Journal of Economics 39 (2), 329–351.

Holzner, C., Larch, M., 2011. Capacity Constraining Labor Market Frictions in a Global Economy. CESifo Working Paper Series 3597, CESifo Group Munich.

Holzner, C., Launov, A., 2010. Search Equilibrium and Social and Private Returns to Education. European Economic Review 54 (1), 39–59.

Hsieh, C.-T., Klenow, P. J., 2009. Misallocation and Manufacturing TFP in China and India. The Quarterly Journal of Economics 124 (4), 1403–1448.

Kambourov, G., Manovskii, I., 2009. Occupational Specificity of Human Capital. International Economic Review 50 (1), 63–115.

Kugler, M., Verhoogen, E., 2012. Prices, Plant Size, and Product Quality. Review of Economic Studies 79 (1), 307–339.

Manning, A., 2003. Monopsony in Motion: Imperfect Competition in Labor Markets. Princeton University Press.

Melitz, M. J., 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. Econometrica 71 (6), pp. 1695–1725.

Moscarini, G., 2008. Job-to-Job Quits and Corporate Culture: New Results. 2008 Meeting Papers 153, Society for Economic Dynamics.

Moscarini, G., Thomsson, K., 2007. Occupational and Job Mobility in the US. Scandinavian Journal of Economics 109 (4), 807–836.

Oi, W. Y., Idson, T. L., 1999. Firm Size and Wages. In: Ashenfelter, O., Card, D. (Eds.), Handbook of Labor Economics. Vol. 3. Elsevier, Ch. 33, pp. 2165–2214.

Postel-Vinay, F., Robin, J.-M., 2002. Equilibrium Wage Dispersion with Worker and Employer Heterogeneity. Econometrica 70 (6), 2295–2350.

Ransom, M. R., Oaxaca, R. L., 2010. New Market Power Models and Sex Differences in Pay. Journal of Labor Economics 28 (2), 267–289.

Ridder, G., van den Berg, G. J., 2003. Measuring Labor Market Frictions: A Cross-Country Comparison. Journal of the European Economic Association 1 (1), 224–244.

Shimer, R., 2006. On-the-Job Search and Strategic Bargaining. European Economic Review 50 (4), 811–830.

Stijepic, D., 2015a. A Note on Laws of Motion for Aggregate Distributions. Available at http://ssrn.com/abstract=2644742.

Stijepic, D., 2015b. Job Mobility and Sorting: Theory and Evidence. Available at http://dx.doi.org/10.2139/ssrn.2635518.

Stijepic, D., 2015c. Technology Diffusion, Worker Mobility and the Returns to Skill. Available at http://dx.doi.org/10.2139/ssrn.2635538.

Stijepic, D., 2015d. Workplace Heterogeneity and the Returns to Versatility. Available at http://dx.doi.org/10.2139/ssrn.2635542.

Stijepic, D., 2016a. Small Employers, Large Employers and the Skill Premium. Economics Bulletin 36 (1), 381–387.

Stijepic, D., 2016b. The Impact of the Productivity Dispersion across Employers on the Labor's Income Share. Available at http://ssrn.com/abstract=2803460.

Stolper, W. F., Samuelson, P. A., 1941. Protection and Real Wages. The Review of Economic Studies 9 (1), pp. 58–73.

Tybout, J. R., 2008. Plant- and Firm-Level Evidence on New Trade Theories. In: Handbook of International Trade. Blackwell Publishing Ltd, pp. 388–415.

vom Berge, P., König, M., Seth, S., 2013. Sample of Integrated Labour Market Biographies (SIAB) 1975-2010. FDZ-Datenreport (01).

Appendix A. Proofs

PROOF OF PROPOSITION 1. I begin by establishing an intermediate result from which Proposition 1 follows.

Lemma 6. *An equilibrium of the wage posting game satisfies*

$$Y(A) \geq Y(A') \text{ and } \tilde{r}(A) \geq \tilde{r}(A') \text{ if } A > A', \tag{A.1}$$

where $\tilde{r}(A)$ denotes the equilibrium revenues of a firm of productivity A scaled by A^{β} and the market access variable $Y(A)$.

PROOF. Let $W(A)$ denote the costs of a firm of productivity A. If $A > A'$, profit maximization implies

$$\begin{aligned} A^{\beta}Y(A)\tilde{r}(A) - W(A) &\geq A^{\beta}Y(A')\tilde{r}(A') - W(A') \\ &> A'^{\beta}Y(A')\tilde{r}(A') - W(A') \geq A'^{\beta}Y(A)\tilde{r}(A) - W(A). \end{aligned} \tag{A.2}$$

Subtracting the last inequality from the first one yields

$$(A^{\beta} - A'^{\beta})Y(A)\tilde{r}(A) \geq (A^{\beta} - A'^{\beta})Y(A')\tilde{r}(A'). \tag{A.3}$$

Given monopolistic competition and fixed costs of exporting, a firm's decision to export depends positively on a firm's total production. □

Given fixed costs of production, Proposition 1 follows from Lemma 6. □

PROOF OF PROPOSITION 2. Following Holzner and Launov (2010), I begin by establishing an intermediate result.

Lemma 7. *An equilibrium of the wage posting game satisfies*

$$w_H(A) \geq w_H(A') \text{ and } w_L(A) \geq w_L(A') \text{ if } A > A'. \tag{A.4}$$

PROOF. Revenues are supermodular in high-skill and low-skill labor given monopolistic competition and a Cobb–Douglas production function, where supermodularity is defined as follows.

Definition 1 (Supermodularity). A function $f : R^k \to R$ is supermodular if

$$f(x \vee y) + f(x \wedge y) \geq f(x) + f(y) \ \ \forall x, y \in R^k, \tag{A.5}$$

where $\vee$ denotes the component-wise minimum and $\wedge$ the component-wise maximum of x and y.

The proof is by contradiction. Assume $w_H(A) < w_H(A')$ and $w_L(A) > w_L(A')$, and note that labor input is non-decreasing in the offered wage by Equation (4). Let $\pi(A, w_H, w_L)$ be defined as $A^\beta Y(A)\tilde{r}(w_H, w_L) - w_H l_H(w_H) - w_L l_L(w_L)$. Then

$$\begin{aligned} 0 &< \pi(A', w_H(A'), w_L(A')) - \pi(A', w_H(A), w_L(A')) \\ &\leq \pi(A', w_H(A'), w_L(A)) - \pi(A', w_H(A), w_L(A)) \\ &\leq \pi(A, w_H(A'), w_L(A)) - \pi(A, w_H(A), w_L(A)) < 0. \end{aligned} \tag{A.6}$$

The first and last inequality follow from the optimality of the firms' wage offers. The second inequality results from the supermodularity of revenues, and the third inequality from $A > A'$. □

Finally, in view of Lemma 7, it only remains to be shown that (almost) all firms of the same productivity offer the same wage. Following Bontemps et al. (2000), I show that the continuity of the productivity distribution, Γ, leaves no room for wage dispersion among firms of the same productivity. But first note that the support of each cross-sectional wage distribution is necessarily connected in equilibrium, since otherwise firms could increase profits by lowering their wage offers (see Bontemps et al., 2000). The proof is by contradiction. Without loss of generality, assume that the set of productivity values for which the optimal wage is not a singleton is given by $[A_0, A_1]$, where $A_0 < A_1$. As those optimal wage sets do not intersect and are connected (Lemma 7), this implies that the non-negative real half-line contains uncountably many disjoint non-trivial intervals, which provides the desired contradiction.[26] □

PROOF OF PROPOSITION 3. It follows immediately from Proposition 2 and Equation (4) that firm size is increasing in productivity. Furthermore, using Equation (4) and Proposition 2 results in the following expression for the share of high-skill workers at firms with rank Γ in the productivity distribution

$$s(\Gamma) = \frac{l_H(\Gamma)}{l_H(\Gamma) + l_L(\Gamma)} = \frac{k_H m_H}{k_H m_H + k_L m_L \left(\frac{1+k_H\bar{\Gamma}}{1+k_L\bar{\Gamma}}\right)^2}. \tag{A.7}$$

[26]While the support of the physical productivity distribution, i.e., the distribution of A, is connected in both autarky and trade equilibria, the support of the revenue productivity distribution, i.e., the distribution of $Y(A)A$, is not connected in trade equilibria provided that only a fraction of firms exports. That is, there are no active firms in the interval $(A_x, Y_x A_x)$. However, the proof of Proposition 2 does not rely on the connectedness of neither the physical nor the revenue productivity distribution. What is important is that the distributions are continuous, which does indeed hold in all the discussed autarky and trade equilibria.

From the last expression it follows that the share of high-skill workers is increasing in productivity, i.e., $\partial s/\partial\Gamma > 0$ since $k_H > k_L$. Finally, an analogous relation for exporting and non-exporting firms follows from Proposition 1. □

PROOF OF PROPOSITION 4. Lorenz Dominance is defined as follows:

Definition 2 (Lorenz Dominance). Let $H_A(w)$ and $H_T(w)$ be two cumulative distribution functions and let their mean values be denoted by μ_{H_A} and μ_{H_T}, respectively. H_A Lorenz dominates H_T if and only if $L(H_A, q) \geq L(H_T, q)$ for all $q \in [0,1]$ and for some q with strict inequality, where $L(H,q) = \frac{1}{\mu_H}\int_0^{H^{-1}(q)} w dH(w)$.

Since the wage functions are given by Equation (14) in terms of the quantiles of the respective cross-sectional wage distributions, H, $L(H,q)$ can be written as $\int_0^q H^{-1}(x)dx \Big/ \int_0^1 H^{-1}(x)dx$. With $Y_x > 1$, Proposition 4 follows directly from the last expression. □

PROOF OF PROPOSITION 5. First, note that the average wage of a skill group admits the representation

$$\bar{w}_i = 2\beta b_i\theta_i f_d(1+k_i)\int_0^1 \frac{(1-x)\hat{r}(x)}{1+k_i(1-x)}dx + \left(\hat{Y}_x - 1\right)2\beta b_i\theta_i f_d(1+k_i)\int_{\Gamma_x}^1 \frac{(1-x)\hat{r}(x)}{1+k_i(1-x)}dx \equiv \bar{w}_i^A + \bar{w}_i^{-A}, \quad \text{(A.8)}$$

where $\hat{r}(x)$ are revenues net of the market excess variable of the firm with rank x in the productivity distribution of active firms relative to the least productive firm still active in the market:

$$\hat{r}(x) \equiv (1-x)^{-\frac{\beta}{z}}\left(\frac{1+k_H}{1+k_H(1-x)}\right)^{2\beta\theta}\left(\frac{1+k_L}{1+k_L(1-x)}\right)^{2\beta(1-\theta)}, \quad \text{(A.9)}$$

and where $\hat{Y}(x)$ is equal $Y_x/Y(A_d)$ if $x \geq \Gamma_{A_d}(A_x)$, but one otherwise. Proposition 5 claims

$$\bar{w}_H/\bar{w}_L > \bar{w}_H^A/\bar{w}_L^A \quad \text{if } \Gamma_x \in (0,1), \quad \text{(A.10)}$$

which is equivalent to

$$\bar{w}_H^{-A}/\bar{w}_H^A > \bar{w}_L^{-A}/\bar{w}_L^A \quad \text{if } \Gamma_x \in (0,1). \quad \text{(A.11)}$$

Using the definitions of $\bar{w}_i^A$ and $\bar{w}_i^{-A}$, it can be shown that the last expression is implied by

$$\int_{\Gamma_x}^{1} \frac{(1-x)\hat{r}(x)}{1+k_H(1-x)} dx \bigg/ \int_0^1 \frac{(1-x)\hat{r}(x)}{1+k_H(1-x)} dx > \int_{\Gamma_x}^{1} \frac{(1-x)\hat{r}(x)}{1+k_L(1-x)} dx \bigg/ \int_0^1 \frac{(1-x)\hat{r}(x)}{1+k_L(1-x)} dx , \quad \text{(A.12)}$$

where the inequality follows from $k_H > k_L$. This establishes Proposition 5. □

Appendix B. Model Calibration for Numerical Illustrations

In order to illustrate the theoretical results, I numerically solve a special case of the model assuming two symmetric countries each consisting of a single sector. The model is calibrated as follows. I set $\beta = 0.68$, which corresponds to an elasticity of substitution of 3.1 between the varieties in the differentiated sector; this is the median estimate from Broda and Weinstein (2006). The parameter τ equals 1.5, which implies a variable trade cost of 50 percent, in line with the estimates in Anderson and van Wincoop (2004). I assume a simple increasing returns production function of the form $y(j) = A(j)\left[l_H(j) + l_L(j)\right]^{\kappa}$, where κ equals $1/\beta$, which is the lowest value that preserves the supermodularity of revenues. With this specification of the production technology, revenues are linear in the two factor inputs, i.e., in this example I abstract from interdependencies between factors within a firm. Therefore, the wage difference between worker groups are only driven by differences in the distribution of workers over firms, i.e., the composition effect, and the differences in the rent shares that workers are able to appropriate, i.e., the competition effect. Furthermore, I set $z = 3$, which implies a coefficient of variation of the exogenous firm productivity distribution of 0.58. Given an increasing returns production function, this is broadly consistent with the findings of Hsieh and Klenow (2009). I use the estimates of Cahuc et al. (2006) for the lowest and highest skill groups in French manufacturing and set the ratio of the job-finding rate to the job-destruction rate, k, to 1.02 for the low-skill workers and 3.95 for the high-skill workers. This is also broadly consistent with the conditional hazard estimate of 2.50 for the United States of Ridder and van den Berg (2003).