Globalization, Worker Mobility and Wage Inequality☆

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Abstract

The (re-)allocation of resources across economic activities is a core issue in international trade. In line with the new view of international trade that stresses firm heterogeneity within sectors, I propose a new framework that explicitly takes account of *limited factor mobility across firms within sectors*. A disaggregated approach allows new insights into the link between trade openness and wage inequality. While the model predictions on within-group wage inequality are in line with the literature, I show, furthermore, that empirically observed differences in inter-firm mobility provide a rationale for the heterogeneous effect of international trade on skill groups.

Keywords: international trade, heterogeneous firms, wage inequality, frictional labor markets, on-the-job search
JEL: F16, J31, J62, J63

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1. Introduction

Motivated by the advancing integration of the world economy and rising wage inequality in both developed and developing countries, the objective of this paper is to shed further light on the link between international trade and wages. In doing so, I explicitly take account of limited factor mobility across firms. The motivation is twofold: First, the (re-)allocation of resources across economic activities is a core issue in international trade and a realistic modeling of the process is important for understanding the mechanisms at work. Second, a disaggregated firm level approach is well in line with the new view of international trade that stresses the importance of firm heterogeneity in horizontally differentiated product markets (e.g., Melitz, 2003). Accounting for limited factor mobility across firms generates a rich microstructure that is consistent with a broad set of stylized facts. The model predictions on the impact of trade openness on within-group wage inequality are in line with the literature. Furthermore, I show that empirically observed differences in inter-firm mobility provide a rationale for the heterogeneous effect of international trade on skill groups.

The framework relies on two canonical models. The product market and the trade structure are modeled following Melitz (2003). Firms are heterogeneous in productivity, product markets are horizontally differentiated, and market entry, production and exporting are associated with fixed costs. The labor market is modeled following Burdett and Mortensen (1998). Information frictions hinder the allocation of workers to the most productive firms and wages are posted. The labor market frictions determine the workers' mobility across firms and it is in this paper's scope to explore the impact of (limited) inter-firm mobility on the relationship between trade and wage inequality. The two models are workhorses in their respective fields and the modeling assumptions have proven to be fruitful. The mechanisms discussed in the subsequent analysis are inherent to the models and this paper's contribution consists in providing a concise account.

The first main theoretical result describes the relationship between international trade and within-group wage inequality. I show that within-group wage inequality is higher in a trade equilibrium where only a fraction of firms export than in autarky. The key equilibrium outcome of the Burdett and Mortensen (1998) framework is that it generates wage inequality among homogeneous workers. Loosely speaking, firms face upward sloping supply curves and more productive firms post higher wages in order to attract and retain more workers. It is indeed optimal for more productive firms to post higher wages since they enjoy higher marginal revenues for any given level of factor inputs. Therefore, similar workers may earn different wages depending on the firm with which they match.[1] The opening to trade represents a relative demand shock to highly productive firms since it is only profitable for highly productive firms to incur the fixed cost in order to export. The most productive firms raise the posted wages relative to less productive and non-exporting firms in response to the demand shock. Since high-productivity firms are already high-wage firms, a further increase in the offered wages of this subsample of firms results in overall higher wage inequality.

The second main theoretical result describes the impact of international trade on the skill premium. I show 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 increases disparities in profitability between firms by favoring large and productive firms, and, therefore, the efficiency gains resulting from reallocation of resources from less to more productive firms. In an environment that stresses efficiency gains from reallocation of resources, a mobility advantage is more pronounced and likely to result in higher relative wages. In other words, if firms are similar in profitability, the returns form switching firms are low. However, if the disparities across firms are substantial, so will be the returns. Wage differences across worker groups who differ in inter-firm mobility are amplified. Finally, given the empirically observed positive relationship between skill and inter-firm mobility, this suggests a skill-biased nature of trade liberalizations.

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 that analyzes short-run and medium-run implications of trade liberalizations 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 of mobility in the long-run steady state equilibrium. 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.[2]

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[1]The finding of Burdett and Mortensen (1998) is more general. They show that wage posting and information frictions are sufficient to generate wage inequality even in the case of homogeneous workers *and* homogeneous firms.

[2]Nor do international trade models that feature labor markets with search and random matching

The 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; Grossman and Rossi-Hansberg, 2008; Dinopoulos and Segerstrom, 1999; Burstein and Vogel, 2010). Furthermore, the article is also related to the literature on international trade and within-group wage inequality, which has recently gained momentum (e.g., Helpman et al., 2010; Egger and Kreickemeier, 2012; Davidson et al., 2008). To the best of my knowledge, I am the first to emphasize limited worker mobility *across firms* and, in particular, differences in inter-firm mobility between skill groups for understanding the effect of trade openness on long-run steady state wage inequality.[3]

The paper is structured as follows. I document worker mobility patterns based on the Current Population Survey Basic Monthly data in Section 2. In Section 3 I present the framework before characterizing the equilibrium in Section 4. The main theoretical results are in Section 5. Section 6 draws some conclusions. Proofs to propositions in the text are in Appendix A.

2. Mobility Patterns

In this section I document monthly mobility patterns for education groups in the United States using the Current Population Basic Monthly data for the years 1996–2009.[4] The Current Population Survey is administered by the United States Bureau of the Census under the auspice of the Bureau of Labor Statistics. Currently, a nationally representative sample of about 65 thousand households is inter-

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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.

[3] 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 the effect of capacity constraining labor market frictions on export patterns. Fajgelbaum (2013) develops a model to study the effect of search frictions with job-to-job mobility on the growth and investment decisions of firms. The paper differs in scope from my contribution and, more importantly, the assumption that workers have no bargaining power together with outside-offer matching à la Postel-Vinay and Robin (2002) prevents a meaningful analysis of the effect of differences in inter-firm mobility between worker groups on relative wages. Ritter (2012) studies the impact of trade on wage inequality in a directed search framework. This constitutes a different modeling approach and the author assumes, e.g., technology–skill complementarity to replicate key features of the data. This stands in contrast to this paper's aim to illustrate the richness of a model that solely exploits limited inter-firm worker mobility and differences in mobility between worker groups.

[4] See Stijepic (2014a) for a detailed study of job mobility in the United States.

viewed monthly. Each household is interviewed once a month for four consecutive months, and again for the corresponding four months period a year later, resulting in eight total months in the survey. Each month, new households are added and old ones who complete eight months in the survey are dropped.

I consider employer–employee separations that are either due to employer–employer transitions or transitions into unemployment. Following Fallick and Fleischman (2004), I exploit the dependent interviewing techniques, employed by the Bureau of the Census since January 1994, to identify employer–employer transitions.[5] The sample is restricted to full-time employed individuals aged 30 to 55. Furthermore, I exclude individuals who are self-employed or employed in public administration.

Figure 1 depicts, on the one hand, the percentage shares of employer–employer transitions and transitions into unemployment in overall separations, and, on the other hand, the extent of separations in percent of total employment.[6] The decomposition is shown for five education groups, i.e., individuals who have completed at most 11th grade (*no high school*), individuals who have completed at most 12th grade (*high school*), individuals with some college but no degree or an associate degree (*some college*), individuals with a bachelor's degree (*college*), and individuals with further schooling including master's and doctorate degrees (*advanced*). First, note that higher educational attainment is associated with lower separation rates. For instance, while on average 4.3 percent of individuals without high school separate from their employer each month, the respective share of individuals with advanced education is only 1.9 percent. Second, the composition of separations differs between education groups as well. More educated individuals experience rather employer–employer transitions than separations into unemployment. For instance, the share of employer–employer transitions in overall separations is 50 percent among individuals without high school and 81 percent among individuals with advanced education.

The relevant measure of inter-firm mobility in on-the-job search models is not the extent of employer–employer transitions alone, but rather employer–employer transitions relative to separations into unemployment. Intuitively, separations into

[5] Due to changes in the household identification methodology of the Bureau of the Census in 1995, it is not possible to link respondents across all months in the year 1995. Therefore, I report transition statistics only from the year 1996 on.

[6] It is not a comprehensive account of all reported employer–employee separations. Additionally, employer–employee separations occur when workers leave the labor force or become self-employed.

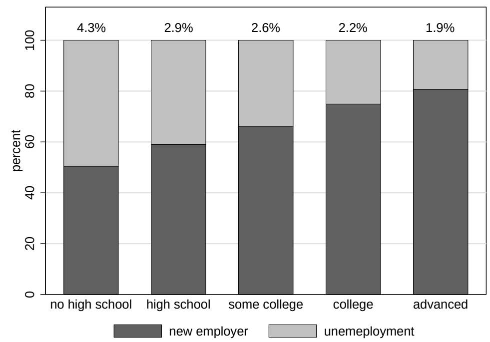

Figure 1: Transition statistics for the years 1996–2009. Decomposition of monthly changes in the employment status by percentage shares. Top bar values denote the share of workers experiencing one of the respective changes in the employment status in percent of total employment. Author's calculations based on the Current Population Survey Basic Monthly data as provided by the National Bureau of Economic Research (`http://www.nber.org/data/cps_basic.html`).

unemployment represent negative mobility shocks. The more pronounced the latter shocks, the less likely are individuals to allocate to a specific job. Therefore, employer–employer transitions are to be scaled by separations into unemployment. Furthermore, the ratio of employer–employer transitions relative to separations into unemployment is related to key concepts of the model presented in the next section. See Stijepic (2014a) for further details. Finally, note that the ratio is increasing in educational attainment. For instance, the ratio is 1.02 among individuals without high school and 4.22 among individuals with advanced education. Therefore, more educated individuals exhibit indeed a higher degree of inter-firm mobility according to the given measure.

In the subsequent analysis I take differences in inter-firm mobility between education groups as exogenously given. However, the positive relationship between education and inter-firm mobility is likely to be beyond a mere correlation. One argument is that education increases a worker's versatility, i.e., the ability to perform various tasks even across occupations. In an environment where jobs differ in task requirements and workers differ in tasks they are able to perform, a worker–firm match requires an overlap in 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, for instance, an employer–employer transition is less likely to be hindered by unmet job requirements. See Stijepic (2014b) for an explicit microfoundation.

Stijepic (2014a), relying on the Survey of Income and Program Participation, studies the determinants of inter-firm mobility. In particular, he also accounts for an individual's versatility using a direct measure based on the number of different courses attended in high school. Stijepic (2014a) 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. Specifically, individuals with above-median versatility are 1.43 times likelier to switch employers than to separate into unemployment relative to individuals with below-median versatility. The effect of versatility on inter-firm mobility is, therefore, of a similar magnitude as the effect of a college degree on a high school dropout's inter-firm mobility.

3. Framework

I introduce frictional labor markets à la Burdett and Mortensen (1998) into an otherwise standard Melitz (2003) model. The Burdett and Mortensen (1998) model is part of the search and matching literature with the particularity that both unemployed *and* employed workers are searching for job offers, i.e., it is an on-the-job search model. Therefore, the framework explicitly takes account of (limited) inter-firm factor mobility. Furthermore, note that the Burdett and Mortensen (1998) model can be interpreted as a wage-ladder model. Workers climb the wage-ladder by finding firms that offer higher wages and fall down the wage-ladder in the event of a job destruction shock. The ratio of the job-finding rate to the job-destruction rate is a key determinant of workers' expected position on the wage-ladder, i.e., their earnings prospects. A higher ratio implies ceteris paribus higher wages in expectation.

I want to stress two distinctive features of the framework. First, the channel through which international trade affects wage inequality in the model applies *within sectors* 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 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, i.e., the results do not depend on the impact of trade on aggregate variables and variables in other sectors. I refer the reader to Helpman et al. (2010) for illustrations how the sector may be embedded into an 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 empirical evidence (e.g., Goldberg and Pavcnik, 2007). The results, that I derive in the subsequent analysis, also hold for asymmetric countries and are, therefore, consistent with increasing wage inequality in both developed and developing countries.[7]

In this section I consider a differentiated product sector with frictional labor markets within the aggregate economy. Foreign variables are denoted by an asterisk and while I display expressions for home, analogous relationships hold for foreign. Furthermore, since only scale invariant statistics are discussed, there is no need to specify the numeraire.

3.1. 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 as

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

where j indexes varieties, J is the set of varieties within the sector, $q(j)$ denotes 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 individual varieties j. Given this specification of sectoral demand, a firm's equilibrium revenue is

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

[7]There is another noteworthy feature of the framework. Firms post wages and, therefore, it is assumed that workers have no (exogenous) bargaining power. The link between trade openness and wage inequality in the model does not rely on the assumption of bargaining, but is based on strategic interactions between firms that result from workers' search for better-paid jobs while employed, i.e., inter-firm factor mobility. This stands in contrast to the literature on foreign trade and wage inequality in search and matching frameworks that assumes bargaining, and is an important extension of the existing literature for the following reasons. Empirical evidence is neither in favor of wage posting nor bargaining. In a survey conducted by Hall and Krueger (2012) only a third of respondents indicate to have bargained with their current employer. Furthermore, Cahuc et al. (2006) estimate bargaining power in an on-the-job search model and obtain values of virtually zero for several worker groups.

where B is the demand shifter for the sector and is defined as $B = E^{1-\beta}P^{\beta}$, where E is 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, $f_e > 0$.[8] 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 $z > 1$.[9] Furthermore, let $\gamma_{A_0}(\cdot)$ designate 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 $f_x > 0$ and an iceberg variable trade cost, such that $\tau > 1$ units of a variety must be exported for one unit to arrive in the foreign market.[10] 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 technology–skill complementarity (e.g., Burstein and Vogel, 2010). 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

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

[9]The Pareto distribution is scale invariant. Hence, the productivity distribution of active firms is always Pareto in equilibrium irrespective of the zero-profit productivity cutoff. Therefore, the results on wage inequality are not driven by trade-induced changes in the productivity distribution of active firms, but by differences in wage strategies between exporting and non-exporting firms.

[10]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 exporting decision.

novelty of the proposed mechanism that stresses differences in inter-firm mobility across skill groups rather than differences in production technologies across firms for understanding the effect of trade openness on wage inequality.[11]

There are two worker types - high-skill workers, H, and low-skill workers, L - and there is a continuum of each worker type of mass m_H and m_L, respectively. All workers are ex-ante identical, risk neutral, and equally productive conditional on type.[12] 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 and, therefore, are assumed to have no (exogenous) bargaining power.[13] 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.[14] 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. Therefore, a worker may be employed or unemployed. In the first case the worker receives the wage offered by the respective firm, and 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 exhibit a higher degree of inter-firm mobility than low-skill workers, i.e., $\lambda_H/\delta_H > \lambda_L/\delta_L$, in line with empirical evidence presented in Section 2. Let the ratio of the job-offer 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.

[11]The literature stressing technology–skill complementary 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.

[12]I assume workers to be risk neutral for the sake of simplicity. The results in Section 5 hold irrespective of workers being risk neutral or risk averse.

[13]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.

[14]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 a treatment of the subject and further references.

Workers' time preference rate is denoted by ρ.

I abstain from modeling human capital and its accumulation mainly for the following two reasons. First, Kambourov and Manovskii (2009), relying on data from the Panel Study of Income Dynamics, show that returns to occupational tenure are substantial. Five years of occupational tenure are ceteris paribus associated with an increase in wages of 12 to 20 percent. More importantly, 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 and vice versa provided that inter-firm and occupational mobility are not too highly correlated.[15] Second, Stijepic (2014a), 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 unaffected.

3.1.1. 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 workers, u the measure of unemployed workers, and $G(\cdot)$ firms' equilibrium wage offer distribution. In steady state, the flow of workers into employment, λu, equals the flow into unemployment, $\delta(m - u)$. Therefore, the steady state measure of 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

[15] Moscarini and Thomsson (2007), relying on data from the Current Population Survey, find that 40 percent of occupational movers stay with the same employer and that 33 percent of job-to-job movers keep the same occupation.

w, $\lambda G(w)u$, equals the flow 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 $H(w) = G(w)\Big/(1+k\bar{G}(w))$, where $\bar{G}(\cdot) = 1 - G(\cdot)$ designates the survivor function associated with $G(\cdot)$. Firms with a workforce of mass l offering a wage w lose workers when they separate into unemployment, δl, or are poached by other firms that offer higher wages, $\lambda\bar{G}(w)l$. Firms attract workers who are unemployed, $(\lambda/n)u$, or poach workers from firms that offer lower wages, $(\lambda/n)(m-u)H(w)$. Therefore, a firm's steady state workforce for a given wage offer, w, satisfies

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

where $b \equiv n/m$ denotes labor market tightness.[16] 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.

3.1.2. Product Market

Given consumers' love for variety and a fixed production cost, 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 $\left[y_x(j)/y_d(j)\right]^{1-\beta} = \tau^{-\beta}(B^*/B)$. Therefore, a firm's total revenue can be expressed as $r(j) = Y(j)By(j)^{\beta}$, where the variable $Y(j)$ captures a firm's market access, which depends on whether it chooses to serve both the domestic and foreign market or only the domestic market, i.e.,

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

where $\mathbb{1}_x(\cdot)$ is an indicator variable that equals one if the firm exports and zero otherwise. For a more detailed exposition see, for instance, Helpman et al. (2010).

[16] Following standard practice, I implicitly impose a law of large numbers at the individual firm's level and treat firm size as deterministic.

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 firms to maximize steady state profits. The profit maximization problem of an active firm is

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

where labor input is a function of a firm's wage offer and is given by 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. However, on the other hand, a higher posted wage allows the firm to attract and retain more workers.

Firms can only affect their steady state size through the posted wage in this framework. Therefore, firms face a very limited set of hiring instruments. Introducing additional hiring instruments is potentially quantitatively important, but unlikely to overturn any of the qualitative results presented in this paper as long as the instruments are strategic complements. For instance, firms can only affect the rate at which vacancies are filled through the posted wage in this framework. However, firms may also find it optimal to rely on the extensive margin, i.e., the number of posted vacancies. 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 accounts for only 14 and 38 percent of the variance in log gross hires across establishment size classes and growth rate classes, respectively.[17]

3.2. Aggregate Economy and International Trade

The aggregate economy may consist of several sectors, where sectors in turn may differ in their structure. For instance, I allow for homogeneous product sectors with frictional factor markets, differentiated product sectors with Neoclassical

[17]For a quantitative perspective on the link between international trade and wage inequality see, e.g., Helpman et al. (2012), Felbermayr et al. (2014), and Cosar et al. (2011).

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 such that expected utility from working or searching for work is equalized across sectors. As is standard practice in this strand of the literature, I assume that factors are not mobile 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 developed and developing countries.

4. 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. I first state two propositions that allow to rank firms by productivity. The proofs of the prepositions are in Appendix A. Proposition 1 imposes a rank property on firms' participation and exporting decisions.

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

Firms' decisions whether or not to produce and whether or not to export take a standard form; similar to, for instance, Melitz (2003). Given Proposition 1, the market access variable (5) reads

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

Proposition 2 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 relative to less productive firms to each worker type.*

The first part of Proposition 2 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 across firms. Loosely speaking, more productive firms enjoy a higher marginal revenue for a given posted wage, and, therefore, find it optimal to offer wages that exceed the ones posted by less productive firms in order to attract and retain more workers. The positive correlation between high-skill and low-skill wages stems predominately from the complementarity of high-skill and low-skill labor in production. Formally, Proposition 2 establishes that there exists a non-decreasing wage offer function, denoted $w_i(A)$, for each worker type such that

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

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

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

4.1. 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, the respective firm faces no labor costs. Therefore, the zero-profit condition is

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

where I use relationship (8) to rewrite revenues in terms of a firm's productivity.[18]

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 relationship (8) to rewrite revenues in terms of a firm's 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 marginal costs that a firm of productivity A_x faces.

4.2. Sectoral Wages

In this section I derive the inverse cross sectional wage distribution, $H^{-1}(\cdot)$. First consider the firm's maximization problem (6). The first order conditions 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 primes denote the derivative with respect to w_i. With Propositions 1 and 2 it follows

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

where $\bar{\Gamma}_{A_d}(\cdot) = 1 - \Gamma_{A_d}(\cdot)$ designates the survivor function associated with $\Gamma_{A_d}(\cdot)$. Equation (12) is a linear differential equation in $w_i(A)$. With the boundary condition $w_i(A_d) = 0$ it admits following solution

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

[18]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).

Furthermore, using the steady state condition $H(w) = G(w) \Big/ (1 + k\bar{G}(w))$ to substitute for productivity, A, with the cross sectional wage distribution, $H(\cdot)$, and applying a change of variable formula yields the inverse cross sectional wage distribution

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

where $\hat{r}_i(x)$ denotes revenues net of the market access variable of the firm that pays wages corresponding to the x-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 $x \geq \Gamma_x / (1 + k_i \bar{\Gamma}_x)$ and 1 otherwise, where Γ_x denotes the share of non-exporting firms, i.e., $\Gamma_x \equiv \Gamma_{A_d}(A_x)$.

Equation (14) describes type i workers' wages as a function of quantiles of the respective cross sectional wage distribution, $H_i(\cdot)$. It provides all the information necessary for the discussion of the qualitative effects of international trade on wage inequality in the following section. Note, however, that equation (14) does not characterize wages in terms of the model's primitive parameters. Therefore, it is not possible to discuss how wages depend on specific parameters. This is the case since it is not yet solved for the general equilibrium and, in particular, labor market tightness, b. Wages are increasing in labor markets 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 liberalizations also depends on the impact of international trade on other sectors, which is neither specified at this point. However, it is important to note that labor market tightness enters wage equation (14) multiplicatively, and, therefore, 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.

5. 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, respectively. Furthermore, to illustrate the theoretical results, I numerically solve a special case of the model assuming two symmetric countries each consisting of a single sector.[19]

5.1. Skill Composition

Proposition 3 shows that differences in inter-firm mobility between skill groups are sufficient to generate a microstructure that is consistent with key stylized facts of the literature.

Proposition 3 (Skill Composition). *High-productivity firms are larger in terms of employment and have a larger share of high-skill workers relative to low-productivity firms in equilibrium. Therefore, the economy exhibits a positive skill–size relationship. Similarly, exporters are larger in terms of employment and have a larger share of high-skill workers relative to non-exporting firms.*[20]

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 retain more workers (Proposition 2). Therefore, high-productivity firms are larger in terms of

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[19]The model is calibrated as follows. I set $\beta = 0.68$ which corresponds to an elasticity of substitution of 3.1 between varieties in the differentiated sector; the median estimate from Broda and Weinstein (2006). The parameter τ equals 1.5 which implies a variable trade cost of 50% in line with the estimates in Anderson and van Wincoop (2004). I assume a simple increasing returns production function of the form $y(j) = A(j)\,[l_H(j) + l_L(j)]^{\kappa}$, where κ equals $1/\beta$, which is the lowest value that preserves supermodularity of revenues. With this specification of the production technology, revenues are linear in the two factor inputs, i.e., I abstract from interdependencies between factors at the firm level in this example. Therefore, wage difference across worker groups are only driven by differences in the distribution of workers across firms (composition effect) and differences in rent shares that workers are able to appropriate (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). High-skill workers are defined as individuals with completed college; low-skill workers as individuals with at most some college. The transition parameters are calibrated to match the average monthly worker flows in the Current Population Survey data over the period from January 1996 to December 2008: $\lambda_L = 0.073$, $\delta_L = 0.025$, $\lambda_H = 0.101$ and $\delta_H = 0.011$.

[20]I formulate Proposition 3 in terms of skill. Referring directly to mobility Proposition 3 reads: Firms enjoying an absolute advantage in production use the relatively mobile factor input intensively.

employment in steady state and, additionally, 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 relationship. All the patterns are well-known stylized facts (see, e.g., Oi and Idson, 1999). The second part of Proposition 3 follows from the self-selection of the most productive firms into exporting that is induced by the fixed cost of 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).[21]

5.2. International Trade and Within-Group Inequality

Proposition 4 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 exports than in autarky. Within-group inequality is the same as in autarky if all firms export.*[22]

Access to foreign markets allows firms to generate higher revenues for a given production output. Specifically, marginal revenues increase ceteris paribus by $\Upsilon_x > 1$ since a firm's revenues are given by $r(j) = \Upsilon(j) B y^{\beta}(j)$. A higher marginal revenue increases the value of a firm's workforce and induces exporting firms to offer higher wages to retain and 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 $\Gamma_x/(1 + k_i \bar{\Gamma}_x)$-quantile rise relative to wages below that quantile since $\Upsilon_x > 1$.

Figure 2 illustrates in a numerical example the impact of international trade on high-skill workers' wage distribution. Depicted is the inverse cross sectional wage

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

[22]I use the concept of Lorenz dominance for the analysis of inequality. Lorenz dominance is a general concept and consistent with lower inequality according to a wide class of inequality measures; most prominently the Gini-coefficient.

distribution, $H_H^{-1}(\cdot)$, scaled by high-skill workers' average wage, $\int_0^1 H_H^{-1}(q)dq$. The solid line represents the inverse cross sectional distribution in autarky, i.e., $\Gamma_x = 1$. The dashed line corresponds to the inverse cross sectional wage distribution in a trade equilibrium in which ten percent of firms are exporting, i.e., $\Gamma_x = 0.9$. The juxtaposition of the two distribution reveals two important features of the model.

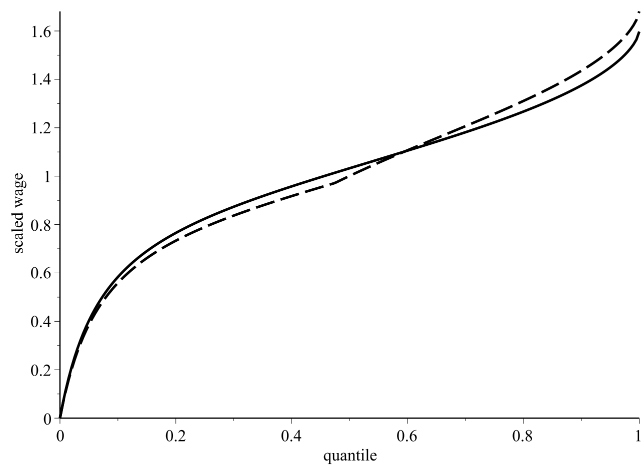

Figure 2: Numerical illustration of high-skill workers' inverse cross sectional wage distribution, $H_H^{-1}(\cdot)$, scaled by the overall average, $\int_0^1 H_H^{-1}(q)dq$, for a specific general equilibrium setup as described in the main text. Autarky distribution ($\Gamma_x = 1$): solid line. Trade distribution ($\Gamma_x = 0.9$): dashed line.

First, as the economy opens to trade, only firms above the endogenously determined productivity quantile, Γ_x, start exporting. Firms' marginal revenues feature a discontinuity at that exporting cutoff, since the market access variable, $Y(\cdot)$, jumps from one to Y_x. While marginal revenues are a key determinant of firms' wage offers, the discontinuity in marginal revenues does not translate into a discontinuity of the wage offer function, $w_H(\cdot)$, at the exporting cutoff, Γ_x, but merely a kink. Indeed, the wage offer function cannot have any discontinuities in this framework. Otherwise a firm above the discontinuity could decrease its wage offer without reducing its steady state workforce, and, hence, increase its profits (see, e.g., Bontemps et al., 2000). Therefore, the inverse cross sectional wage distribution, $H_H^{-1}(\cdot)$, exhibits a kink at $\Gamma_x \big/ 1 + k_H \bar{\Gamma}_x$, reflecting the kink in the wage offer function, $w_H(\cdot)$, at the exporting cutoff, Γ_x. Given a ten percent share of exporting firms, high-skill workers inverse cross sectional wage distribution, $H_H^{-1}(\cdot)$, exhibits a kink at 0.475 in the numerical example here.

Second, Figure 2 shows that the scaled inverse cross sectional wage distribution, $H_H^{-1}(\cdot)$, in a trade equilibrium is flatter below the $\Gamma_x \big/ 1 + k_H \bar{\Gamma}_x$-quantile and steeper above the $\Gamma_x \big/ 1 + k_H \bar{\Gamma}_x$-quantile relative to the respective distribution in autarky. Hence, scaled wages in autarky are above the respective wages in a trade equilibrium at the bottom of the distribution and below the respective wages at the top of the distribution inducing second order stochastic dominance. Therefore, within-group wage inequality in a trade equilibrium exceeds the level of wage inequality in autarky for all inequality measures that respect second order stochastic dominance.

As the share of exporting firms rises, wage inequality eventually falls. The shape of the relationship 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. This is, because the inverse wage offer distribution differs only by a multiplicative constant, $b_{(\Gamma_x=1)}/(Y_x b_{(\Gamma_x=0)})$, between the two equilibria. Wage inequality is driven by trade-induced disparities in wage strategies between exporting and non-exporting firms, and is the same if either 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 hump-shaped relationship between international trade and within-group wage inequality.

5.3. International Trade and the Skill Premium

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

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

In line with the new view of international trade, it is primarily through resource (re-)allocation *across firms within sectors* that an economy adapts to trade. The key idea is that it is mostly the large and highly productive firms that participate in international trade. Small and less productive firms are discouraged from supplying to foreign markets by the fixed exporting cost. Therefore, trade is amplifying the disparities in revenue productivity between small and large firms incentivizing further resource reallocation from small to large firms. Indeed, the reallocation of resources from less to more productive, from small to large and from non-exporting to 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 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 a trade liberalization.

In order to further investigate the impact of international trade on the skill premium, I additionally construct two counterfactual skill premia. Consider the following expression for a worker group's average wage $\bar{w}_{ij} \equiv \int w_i(A)dH_j(w_j(A))$ for $i, j \in \{L, H\}$. For instance, high-skill workers' average wage is then simply given by $\bar{w}_{HH}$. The skill premium reads $\bar{w}_{HH}/\bar{w}_{LL}$. Distinct subscripts yield counterfactual average wages. I focus on the two counterfactual skill premia $\bar{w}_{HH}/\bar{w}_{HL}$ and $\bar{w}_{HH}/\bar{w}_{LH}$. The first counterfactual skill premium, $\bar{w}_{HH}/\bar{w}_{LH}$, imposes the same distribution over firms on both worker groups. Specifically, high-skill workers' average wage is measured relative to the low-skill workers average wage that would arise if low-skill workers were matched with firms as high-skill workers. Differences in the average wage are 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, $\bar{w}_{HH}/\bar{w}_{HL}$, imposes the same wages within firms on both worker groups. Specifically, high-skill workers' average wage is measured relative to the low-skill workers average wage that would arise if low-skill workers were payed the same wage as high-skill workers in each firm. Differences in the average wage are 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 3 illustrates in a numerical example the impact of international trade on the skill premium, depicting the skill premium itself and additionally the two counterfactual skill premia. Note that the skill premium is higher in a trade equilibrium where only a fraction of firms exports than in autarky. Furthermore, the skill premium is the same in autarky and in a trade equilibrium where all firms export. The model predicts a non-monotonic relationship between trade openness and the skill premium for a given supply of skill. Similar to within-group wage inequality, the rise 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 if either all firms export or no firm exports. In the numerical example here the relationship between the skill premium and the share of exporting firms is hump-shaped.

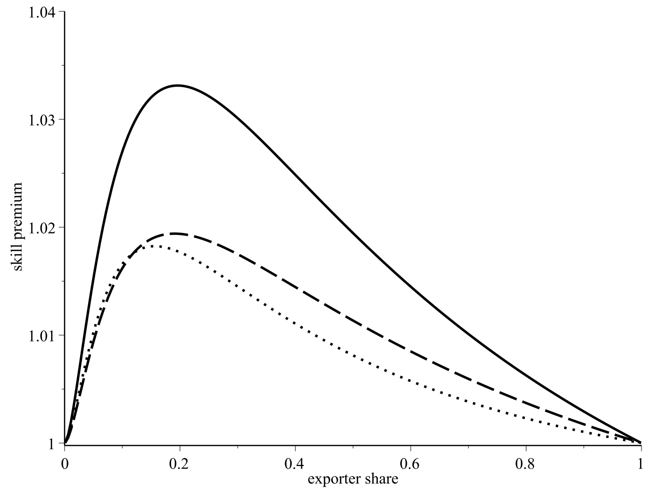

Figure 3: Numerical illustration of the impact of international trade on the skill premium for a specific general equilibrium setup as described in the main text. Skill premium ($\bar{w}_{HH}/\bar{w}_{LL}$): solid line. Competition effect ($\bar{w}_{HH}/\bar{w}_{LH}$): dashed line. Composition effect ($\bar{w}_{HH}/\bar{w}_{HL}$): dotted line.

The composition effect reflects closely the changes in the skill premium, however, less pronounced. The composition effect is solely determined by differences in the distribution of workers over firms.[23] Intuitively, it is predominately 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 (Proposition 3), high-skill workers also profit disproportionately from trade liberalizations. This aspect of inter-firm mobility induces both higher wages and higher aggregate output given the positive correlation between wages and revenue productivity.[24]

[23]Recently, the literature is stressing the allocation of resources across firms for understanding aggregate outcomes. Hsieh and Klenow (2009) analyze the resource allocation across firms in a cross country study. They argue that aggregate productivity could rise by as much as 50 percent in China and 60 percent in India if resources were as efficiently allocated in those countries as in the United States. Lentz and Mortensen (2008) estimate a Schumpeterian growth model using Danish data. They find that more than half of the aggregate growth is accounted for by resource reallocation from less to more productive firms.

[24]It is the positive relationship between skill and inter-firm mobility that generates a positive skill–size relationship in the model and finally a positive impact of trade liberalization on the skill premium. Indeed, a negative relationship between skill and mobility implies a negative skill–size

However, high-skill workers' inter-firm mobility advantage is not only reflected in a more favorable distribution over firm productivity classes. Figure 3 also depicts the competition effect. Similar to the composition effect, the competition effect follows closely the changes in the skill premium, however, less pronounced. The competition effect is solely determined by differences in wages within firms. Since I assume that revenues are linear in factor inputs in the numerical exercise here, workers are equally productive at a given firm. Hence, differences in wages reflect solely differences in rent shares that workers are able to appropriate. First, note that firms have monopsonistic power resulting from workers' limited inter-firm mobility. A higher mobility intensifies 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 a trade liberalization. This aspect of inter-firm mobility induces higher wages but has no direct effect on aggregate output.[25]

In conclusion, workers benefit from inter-firm mobility twice. On the one hand, it allows them to match with the most productive firms, and on the other hand, it allows them to appropriate a larger share of the surplus, that is generated by, e.g., trade liberalizations, even for a given allocation over firms. Finally, note that 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. The skill premium is given by $\int_0^1 H_H^{-1}(x)dx \Big/ \int_0^1 H_L^{-1}(x)dx$. Following a standard supply–demand argument, the skill premium is decreasing in the relative supply of skill. Therefore, the positive effect of international trade on the skill premium

relationship and a dampening effect of foreign trade on the skill premium. I do not argue that the positive relationship between skill and inter-firm mobility holds across space and time. In this vein note that while there is strong evidence that a positive skill–size relationship has existed in recent decades, evidence for the 19th century suggests a negative skill–size relationship (Holmes and Mitchell, 2008).

[25] A branch of the literature exploits differences in monopsonistic power between workers in order to explain cross sectional wages. For instance, Ransom and Oaxaca (2010) estimate labor supply elasticities at the firm level in the U.S. retail grocery industry. They find that differences in supply elasticities between women and men explain well the lower relative pay of women.

may be offset by a sufficiently pronounced positive trend in the relative supply of high-skill labor to the sector.

6. Conclusion

The distribution of wages is one of the most studied objects in economics. It serves as a central measure for equality or inequality of a society. In this paper, I explore the impact of foreign trade on wages focusing on the role of limited factor mobility across firms. The motivation is twofold: First, the (re-)allocation of resources across economic activities is a core issue in international trade and a realistic modeling of the process is important for understanding the mechanisms at work. Second, a disaggregated firm level approach is well in line with the new view of international trade that stresses the importance of firm heterogeneity in horizontally differentiated product markets.

The model exhibits a rich microstructure that is consistent with a broad set of stylized facts and allows new insights into the link between trade openness and wage inequality. International trade increases disparities in profitability between firms by favoring large and productive firms and, therefore, the efficiency gains resulting from reallocation of resources from less to more productive firms. In an environment that stresses efficiency gains from reallocation of resources, the empirically observed inter-firm mobility advantage of high-skill workers is more pronounced. This is likely to be reflected in a higher skill premium. Trade-induced disparities in profitability between firms also raise within-group wage inequality, where the link is driven by strategic interactions between firms resulting from limited factor mobility across firms.

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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 following condition:*

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

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. Profit maximization of firms implies following chain of inequalities if $A > A'$:

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

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 following condition:*

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

PROOF. First, note that 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

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

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

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

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

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

Finally, given Lemma 7 it 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 may increase profits by lowering wage offers (see Bontemps et al., 2000). I proceed by a proof by contradiction. With no 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 $A_0 < A_1$. Furthermore, as those optimal wage sets do not intersect and are connected (Lemma 7), the segment of the real line of admissible wage values $[0, \infty)$ can only be divided into countably many intervals. Therefore, this establishes the countability of a segment of the real line, i.e. $[A_0, A_1]$, which provides the desired contradiction.[26] □

[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 export. Specifically, there are no active firms in the interval $(A_x, Y_x A_x)$. However, the Proof of Proposition 2 does not rely on connectedness of the physical nor the revenue productivity distribution. What is important is that the distributions are *continuous*, which is indeed given in all the discussed autarky and trade equilibria.

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

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

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, it follows an analogous relationship for exporting and non-exporting firms 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 iff $L(H_A, q) \geq L(H_T, q)$ 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 quantiles of the respective cross sectional distributions, H, $L(H, q)$ reads $\int_0^q H^{-1}(x)dx \Big/ \int_0^1 H^{-1}(x)dx$. 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 following representation:

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

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, i.e.,

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

and where $\hat{Y}(x)$ is equal $Y_x/Y(A_d)$ if $x \geq \Gamma_{A_d}(A_x)$ and 1 otherwise. Proposition 5 claims

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

which is equivalent to

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

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

$$\int_{\Gamma_x}^1 \frac{\bar{x}\hat{r}(x)}{1+k_H\bar{x}}dx \Bigg/ \int_0^1 \frac{\bar{x}\hat{r}(x)}{1+k_H\bar{x}}dx > \int_{\Gamma_x}^1 \frac{\bar{x}\hat{r}(x)}{1+k_L\bar{x}}dx \Bigg/ \int_0^1 \frac{\bar{x}\hat{r}(x)}{1+k_L\bar{x}}dx\ , \tag{A.12}$$

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