RESEARCH INSTITUTE OF INDUSTRIAL ECONOMICS

IFN Working Paper No. 1249, 2018

# Globalization and the Jobs Ladder

Carl Davidson, Fredrik Heyman, Steven Matusz, Fredrik Sjöholm and Susan Chun Zhu

Research Institute of Industrial Economics
P.O. Box 55665
SE-102 15 Stockholm, Sweden
info@ifn.se
www.ifn.se

**Globalization and the Jobs Ladder**

Carl Davidson[a], Fredrik Heyman[b,c], Steven Matusz[a], Fredrik Sjöholm[c,b] and Susan Chun Zhu[a]

May 2018
This Version: July 2019

Abstract: Globalization affects the mix of jobs available in an economy and the rate at which workers gain skills. We develop a model in which firms differ in terms of productivity and workers differ in skills, and use the model to examine how globalization affects the wage distribution and the career path of workers as they move up the jobs ladder. We calibrate the model using many of the same parameters and targeting the same moments of the US economy as Melitz and Redding (2015) and then investigate the impact of globalization. Our results indicate that although falling trade costs results in greater wage inequality, it also leads to a wider path up the jobs ladders and less time spent in entry level jobs. The key assumptions and predictions are confirmed in data on recruitments and job mobility in Sweden.

**JEL:** F10, F20, J30
**Keywords**: Job Ladders, Globalization, Wages, Inequality, Export

We are grateful to seminar participants at the IFN's Research Conference on Globalization and New Technology: Firms and Workers (Stockholm, June 2017), the Kentucky International Trade Conference (Lexington, April 2018) and the 2019 Australasian Trade Workshop (Melbourne) for very helpful comments on earlier versions of this paper. We are especially indebted to David Wildasin and Erhan Artuc for their suggestions. Fredrik Heyman and Fredrik Sjöholm acknowledge financial support from the Jan Wallander and Tom Hedelius Research Foundation (P2016-0099:1). Fredrik Heyman also acknowledges financial support from the Johan och Jakob Söderbergs Stiftelse (69/16). Susan Chun Zhu gratefully acknowledges financial support from Lund University.

[a] Department of Economics; Michigan State University; East Lansing, MI 48824
[b] Research Institute of Industrial Economics; Stockholm, Sweden
[c] Department of Economics; Lund University; Lund Sweden

## Introduction

The impact of globalization on the labor market is one of the most heavily researched and hotly debated topics in economics. In the academic arena, researchers primarily focus on connecting globalization with wage inequality, using this connection as a way to identify those that benefit and those that are harmed by globalization. A narrow focus on wages may be misleading, however, in that jobs carry with them more than just a wage. Workers gain different skills while carrying out their duties and the skills they acquire may open up new paths for them as they move from job to job.[1] An engineer at Ford gains valuable experience in the auto industry that may result in a higher paying job with GM or Chrysler. Alternatively, a manager at a company that exports some of its products to China may be a prime target for another firm that is hoping to break into the Chinese market. Thus, the rate at which workers gain skills, the types of skills they acquire and the rate at which they move up the jobs ladder can play a large role in determining lifetime earnings.[2] By impacting the level of international engagement by firms and the types of jobs available, globalization can significantly impact the skill sets that workers acquire and thus, their career paths. And, while the literature on the impact of globalization on wage inequality is vast and growing (see Harrison, McLaren and McMillan 2011 and Helpman 2017 for surveys), not much attention has been paid to the link between globalization and these dynamic properties of the labor market. The purpose of this paper is to provide a framework in which to examine such issues, with attention focused on the link between globalization and economic mobility.

To do so, we introduce a dynamic heterogeneous firm model of trade in which workers gain skills on the job and move from job to job as their careers progress. There are two types of skills that matter for productivity – the ability to work with the appropriate technology, which we call "basic experience", and

[1] A typical worker holds a large number of jobs while young, before transitioning to a more stable employment pattern with maturity. However, even prime-age adults transition from job to job as their careers progress – the average duration of a job in the US is about 8 years, with a median duration slightly lower than that. Moreover, job stability has been declining. For example, average job tenure for males at age 50 has declined from 13.6 years in the 1970s to 11.8 years in the early 2000s (classic references on job stability are Hall 1982 and Farber 1994, 1998 – Farber 2010 provides a survey of the literature).

[2] For an excellent discussion the importance of economic mobility in determining lifetime earnings see Bernhardt, Morris, Handcock and Scott (2001).

the ability to facilitate international commerce, which we call “international experience”. We assume that firms cannot directly observe the skills embodied in a worker, but they can observe each recruit’s employment history. Firms differ in productivity and self-select into different recruiting networks based on their own productivity and the signals embedded in each recruit’s job application. Some firms hire inexperienced workers and pay a low wage while others poach workers with experience by offering a higher wage. Firms also differ in their level of international engagement with only high productivity firms able to cover the costs of exporting. Since a firm’s trade costs depend on the level of international experience embedded in their workforce, international experience is valuable to firms that export a large share of their output. Our goal is to examine how globalization affects the distribution of wages offered by firms and the rates at which workers move up the jobs ladder as they gain skills. This provides us with a more complete picture of how globalization affects the labor market experience of workers.

Our framework is motivated by the empirical findings of Haltiwanger, Hyatt, Kahn and McEntarfer (2018) that firms with different levels of productivity tend to use different strategies to fill their vacancies. Their study focuses on job flows across firms that offer different wages along the jobs ladder. It reveals that firms that are low on the jobs ladder tend to hire new workers from the pool of unemployed, while firms at the top tend to poach workers from lower paying firms. We posit that one of the main reasons for this is that high-productivity, high-wage firms are concerned about the skills that workers carry with them. By recruiting workers that have been able to hold steady jobs, high-wage firms can be confident that they are adding workers that have proven to be reliable and effective. If these workers are poached from firms within the same industry, they are also likely to be more productive, since they have experience with the technology that the firm is using.

Knowledge of and experience with the production process is only one aspect of productivity that may matter for firms. By poaching workers from exporters, a firm may be able to build a workforce that includes skills that may lower trade costs. The notion that internationally engaged firms hire workers with international experience to lower trade costs is consistent with recent empirical findings. For example, Labanca, Molina and Muendler (2014) find that as firms prepare to export, they poach workers from other exporters. This leads to deeper market penetration by the poacher and reduced market penetration by the firm that loses the worker. In addition, Mion, Opromolla and Sforza (2017) show that export experience gained by a manager at a previous firm leads to better export performance by the worker's current employer and a large wage premium for the manager.

To formalize ideas, in section 2 we develop a model of a jobs ladder in which firms differ in productivity and workers differ in the skills that they have acquired. The firm side is modeled as in Melitz (2003) in that each firm draws a productivity parameter after paying a sunk cost of entry. Worker productivity is determined by experiences on the job and imperfectly observable factors. All workers begin life inexperienced and start their climb up the jobs ladder with an entry level job that pays a low wage. They gain "basic skill" via a Poisson process at rate $s_b$. The acquisition of basic skill increases their sector-specific productivity, preparing them to move to the next rung on the ladder. Random skill acquisition captures the idea that some workers pick up the production process quickly while others never seem to grasp the essential details. Thus, some workers see their productivity rise right away, while others remain at their initial low-productivity rate for a very long time. However, without additional information, firms cannot distinguish employed workers with basic experience from their counterparts that are still inexperienced. To obtain this information, firms can screen workers at a cost. This means that firms face a trade-off. They can offer a low wage and hire workers without screening, so that some share of their workforce will be inexperienced. Alternatively, firms can offer a higher wage, poach workers from low-wage firms and screen for basic experience. These firms bear higher costs in filling out their workforce, but their employees will be more productive.

Workers go through a similar process to gain international experience. If they are employed by an exporter, they gain international experience through a Poisson process at rate $s_i$. The firm's trade costs are assumed to be a decreasing function of the fraction of its workforce that has international experience. As with basic experience, international experience cannot directly be observed, but firms can use a costly screening process to identify those workers that have acquired it.

In equilibrium, active firms self-select into four categories, defined by the wage they pay, the workers they hire and their level of international engagement. Low-productivity firms hire inexperienced workers, pay a low wage and serve only their domestic market. While employed at these entry-level firms, some workers gain basic experience, which makes them eligible to apply for higher paying jobs. Medium-productivity firms pay a higher wage and poach workers from entry-level firms. To ensure that these workers have basic experience, these firms screen potential employees before hiring them. Among this group of medium-productivity firms, those at the low-end of the productivity scale do not earn enough revenue to cover the costs associated with exporting, so they sell all their output domestically. The remaining medium-productivity firms export a portion of their output, enabling some of their workers to gain international experience. Finally, high productivity firms pay the highest wage, poach workers from medium-productivity exporters, screen for international experience and export a portion of their output.

We assume that opportunities to move up the jobs ladder arrive randomly to those who have gained experience and that changing jobs is costly. The latter assumption captures the notion that a new job might require the worker to move to a new location, disrupt family or social networks, and/or require the adaptation to a new routine. We aggregate these costs into a single worker-specific measure that is randomly drawn at the time that the job opportunity becomes available. The worker accepts the job offer if and only if the increase in expected lifetime income exceeds the cost of moving.[3]

In section 3, we analyze a symmetric trade model in which globalization reduces variable trade costs. As trade costs fall, firms reconsider their decisions with the most important changes coming from medium-productivity firms. Amongst this class of firms, those that were already internationally engaged expand their exports and see their revenues rise enough to enable them to become high-wage firms. Their lower-productivity non-exporting counterparts are harmed by an inflow of imports, forcing them to become low-wage firms. Finally, higher-productivity non-exporters take advantage of the lower trade costs and begin to export. As a result, the employment share for high-wage firms increases, while the employment

[3] This method of modelling worker movement across jobs follows Artuc, Chaudhuri and McLaren (2010).

share for medium-productivity non-exporters falls. We then calibrate the model, following an approach similar to Melitz and Redding (2015), and show that the fall in trade costs increases wage inequality, with high-wage workers gaining more than their low-wage and medium-wage counterparts.

The shift in jobs from non-exporters towards exporters and the link between globalization and wage inequality are in line with what we would expect from a trade model with heterogeneous firms (e.g., Egger and Kreickemeier 2012; Helpman, Itskhoki and Redding 2010a,b or Sampson 2014).[4] The wage effects are also consistent with the empirical findings of Helpman, Itskhoki, Muendler and Redding (2017). However, in the context of our model, taken together these results have implications for the way in which workers move up the jobs ladder. To see this, note first that while the total number jobs associated with medium-productivity firms falls as trade becomes less costly, there is a significant shift in the make-up of those jobs. In particular, since some medium-productivity non-exporters start to export, it is possible for the number of medium-productivity exporters to rise. An increase in the number of medium-productivity exporters is important, since these are the jobs that provide workers with the skills needed to make it to the top of the jobs ladder. Thus, the change in the *composition* of the medium-productivity jobs can alter the path that allows workers to cap off their careers by landing the highest paying jobs in the economy. Our results indicate that globalization tends to increase economic mobility by widening the path up the jobs ladder for low-wage workers.[5] As a result, the increase in economic mobility moderates the rise in inequality by allowing low-wage workers to climb up the jobs ladder at a faster pace.[6]

---

[4] Although our results are consistent with these papers, the mechanism behind our results differs. This follows from the fact that we assume competitive labor markets, while Egger and Kreickemeier use a fair wage model and Helpman, Itskhoki and Redding (2010a,b) and Sampson (2014) assume labor market frictions and wage bargaining. In their settings, increased inequality comes from an increase in the export wage premium. In addition, in those models workers do not move from low-wage to high-wage jobs, so that low-wage workers always remain low-wage workers.

[5] Increased wage inequality provides another reason that economic mobility might rise with globalization. When an opportunity to move arises, a worker accepts the wage offer if the expected benefit from moving exceeds the cost of doing so. Since wage inequality increases as trade costs fall, the expected benefit from taking an offer from a higher-paying firm grows with globalization. Thus, an increase in wage inequality should reduce the expected duration jobs, implying that workers reach the top of the jobs ladder quicker. This mechanism is discussed in Section 3.

[6] Guner, Ruggieri and Tybout (2018) present an alternative model of the jobs ladder that has some overlap with ours (job poaching and on the job training) as well as significant differences (e.g., the way in which experience alters firm productivity and trade costs; unemployment and search frictions in the labor market). Most importantly, the main mechanism that links globalization to economic mobility differs. Their focus is on offshoring (which is not present

The implication of our main result is that by focusing simply on the impact of globalization on wage inequality, either across or within industries, one can miss potentially important changes in labor market dynamics that impact expected lifetime earnings. Although falling trade costs may result in greater wage inequality, it can also lead to a wider path up the jobs ladder and to greater economic mobility, implying that workers spend less time in entry level jobs.

Workers only move up the jobs ladder in our base model. They are never forced to move back down and take a job at a lower wage. The reality is that workers are sometimes fired or demoted and forced to take a new job at lower pay. We account for downward mobility in Section 4, where we assume that once a worker gains a new skill, they must exert effort to keep that skill from deteriorating. Workers that put forth effort remain highly productive, while those that choose not to do so see their skills erode. Firms cannot observe effort and thus must monitor workers, with those caught shirking being subsequently dismissed. And, since the dismissed workers have lost their skills, they must move back down the ladder and seek reemployment at a lower wage. In this setting, workers make the choice between effort and shirking by comparing the cost of effort with the expected loss from shirking. This extension yields a new insight – since globalization increases wage inequality, it increases the expected loss in earnings associated with shirking. As a result, fewer workers shirk as trade costs fall and there are fewer demotions. The implications for job duration follow. Since fewer medium-wage workers are demoted, the fraction of a worker's lifetime spent in entry-level jobs decreases. And, since fewer high-wage workers shirk, the fraction of a worker's lifetime spent at the top of the jobs ladder increases. As for medium-wage workers, the impact of globalization on job duration becomes uncertain. On the one hand, the forces uncovered in section 3 imply that as trade costs fall, a worker at a medium-wage firm will move up and accept a higher paying job more rapidly. On the other hand, since globalization reduces the number of medium-wage

in our model) and the way in which it alters the outside option of workers. They find that offshoring slows down labor market turnover by limiting the outside options of workers and that this results in reduced economic mobility and slower wage growth. The main mechanism in our model is the way in which workers gain international experience and how that international experience lowers trade costs for exporting firms. Globalization increases the number of firms that export, making it easier for workers to gain international experience and this can, in turn, lead to greater economic mobility.

workers that shirk, these workers are less likely to be fired and forced to take lower paying jobs. The former effect reduces the expected duration of a medium-wage job while the latter effect increases it.

Our highly stylized model yields several testable hypotheses about the manner in which globalization affects the career paths of workers. In Section 5 we present some descriptive statistics based on matched worker-firm data from Sweden that provide support both for our model's key assumptions and our more novel predictions. Concluding remarks are offered in Section 6.

## 2. The Jobs Ladder

### *A. Types of Workers and Firms*

We begin by providing an overview of the structure of the economy. Our model consists of a single industry with heterogeneous firms. At each point in time, there are $\mathcal{M}_d$ firms in the process of developing plans to enter the industry. Each developing firm draws a productivity measure $(\phi)$ as in Melitz (2003) and becomes active if it can at least break-even. We use $\mathcal{M}$ to denote the mass of active firms. Active firms produce output with labor as the only input.

The lifecycle of a worker is based on the model of perpetual youth (Blanchard 1985), with workers "dying" (exiting the workforce) at rate $\delta_w$ regardless of age. This is also the birth rate in a stationary economy. Upon birth, each worker makes a choice to become an entrepreneur, and spend their life developing new firms, or to begin climbing the jobs ladder. All workers are born with equal productivity but differ in entrepreneurial ability. Workers with sufficiently high entrepreneurial ability become developers. For now, we delay discussion of how this decision is made and how new firms are developed and focus instead on the novel feature of our model, the jobs ladder.

Workers enter the jobs ladder without experience but have the potential of gaining two kinds of experience (or skill) as they age. Basic experience lowers the cost of production, while international experience reduces the cost of exporting. Experience is not directly observable, but firms can pay a fixed cost to screen for either type of skill.

Labor markets are competitive, with wages adjusting to equate supply and demand in each sub-market and firms taking those wages as given. There are four market-clearing wages that make up the jobs ladder. We use $w_l$ and $w_h$ to represent the lowest and highest wages which are paid by the least productive and most productive firms. The two intermediate (or "medium") wages are paid by medium-productivity firms, only some of which export. We use $w_x$ to represent the wage paid by medium-productivity exporters, and $w_n$ to represent the wage paid by medium-productivity non-exporters. We choose unskilled labor as numeraire, therefore $w_l = 1$. We discuss the rank order of $w_x$ and $w_n$ below.

Firms can choose to hire only new labor market entrants, pay the low wage, and save the fixed cost of screening. Firms weigh the lower fixed cost against the fact that these inexperienced workers are relatively less productive, resulting in higher marginal cost. Using standard analysis, it is easy to show that this is the profit-maximizing strategy for the lowest productivity firms since their sales are too low to earn enough operating profit to cover the cost of screening. Using similar reasoning, it follows that firms can choose to screen for basic experience and pay one of the two medium wages ($w_n$ or $w_x$), or they can screen for international experience as well and pay the high wage. In addition to choosing their screening strategy, firms choose whether to export. Following Melitz (2003), we assume a fixed cost of exporting so that only the most productive firms can afford to do so.

The firm's decision tree is illustrated in Figure 1. Firms are characterized by the wage that they pay and by whether they choose to export. In equilibrium, no low-wage firm exports and all high-wage firms export. In contrast, some medium-wage firms export while others do not. We use the subscript $l$ to represent all variables associated with low-wage firms; the subscript $h$ to represent variables associated with high-wage firms; the sub-script *n* to identify variables related to medium-wage non-exporters; and the subscript $x$ to identify those associated with medium-wage exporters.

We model the acquisition of basic experience as a Poisson process (some inexperienced workers catch on faster than others; some never catch on), using $s_b$ to represent the rate at which workers gain this experience. In a similar way, workers with only basic experience may acquire international experience via an independent Poisson process with at rate $s_i$. Since international experience can only be gained by working for an exporter, $s_i = 0$ for all workers employed by non-exporters.

The transition rates $s_b$ and $s_i$ are key parameters of our model.[7] They capture the complexity of the production process, the difficulty of the tasks involved in carrying out international commerce and the intricacies of the trading process. A high value for $s_b$ indicates that workers gain basic experience quickly, suggesting that the production process is easy to grasp. Thus, more sophisticated and complicated production processes should be associated with lower values for $s_b$. There are two issues that are likely to influence the value of $s_i$. First, there is the difficulty of mastering the tasks needed to export a product. If these tasks are straightforward, workers should catch on quickly and $s_i$ should be relatively large. For example, if the task is managing the supply chain, we would expect a high value of $s_i$ if the supply chain is relatively short and easy to manage and a low value of $s_i$ if the supply chain is more complex. Second, there is the nature of the trading relationship. For example, one could imagine that the supply chain would be more difficult to manage if the firm faced significant language barriers and/or geographical and cultural hurdles in order to do business in a specific country. In such a situation, we would expect $s_i$ to be low.

In our base model, experience does not depreciate in that once a worker acquires either form of experience, it remains with them throughout their life. Experience is not directly observable. To really know if a worker has the type of experience desired, a firm must screen. By construction, all workers with international experience also have basic experience, therefore firms screening for international experience need not also screen for basic experience.

We argued above that active firms with the lowest productivity measures do not earn enough revenue to cover the cost of screening nor the cost of exporting, so they offer the low wage and serve only their home market. The new hires for these firms come entirely from new labor market entrants. As these workers age, some gain basic experience, and are poached by more productive firms. As a result, low-wage firms employ a mixture of inexperienced workers and workers with basic experience.

We also argued that the highest productivity firms derive substantial export opportunities. This

[7] As usual, these parameters imply that the expected length of time needed to acquire basic experience is $1/s_b$; after which the expected length of time needed to acquire international experience is $1/s_i$.

tips the balance in favor of poaching workers from lower-productivity exporting firms by offering a higher wage and paying to screen for international experience to ensure a workforce that minimizes trade costs.

The analysis of firms between these two extremes is more subtle. For all firms with intermediate productivity, the domestic market is sufficiently large to justify poaching workers from low-productivity, low-wage firms and screening for basic experience; but potential export opportunities are insufficient to justify the cost of screening for and paying a wage commensurate with international experience. Indeed, the fixed cost of exporting precludes firms at the low end of the middle range of productivities from entering foreign markets. In contrast, those at the upper end can export enough to overcome the fixed exporting cost. These two sets of firms pay wages $w_n$, and $w_x$, respectively.

Medium-productivity exporters offer workers a chance to gain international experience and provide a path to a higher wage at high-productivity exporters while non-exporters do not. Therefore, non-exporters pay a higher wage in order to induce workers to accept their offers. It follows that $w_n > w_x$.[8] With $w_n > w_x$ the relationship between wages and firm productivity is surprisingly non-monotonic. However, since low wage firms do not export and high-wage firms do, the *average* wage paid by exporters exceeds the *average* wage paid by non-exporters (consistent with the stylized facts on heterogeneous firms and trade).

Some of the workers employed by medium-productivity exporters eventually acquire international experience and are poached by high-productivity, high-wage exporters. Thus, medium-productivity exporters employ a mix of workers with basic experience and workers with international experience. This contrasts with the highest productivity firms that employ only fully experienced workers.

We conclude this subsection by emphasizing the fact that as productivity increases, firms take on more fixed costs, due to screening and exporting, in order to lower marginal costs (the increase in productivity outweighs the higher wages).

[8] Depending on the parameters, it might be possible to have an equilibrium in which medium-productivity exporters poach from medium-wage non-exporters (rather than low-wage firms). This would allow the firm to avoid the fixed cost of screening but would require them to pay a higher wage (since it would be more difficult to induce such workers to move). However, in such an equilibrium all workers recruited by medium-wage exporters would be taking a pay cut when switching jobs. While some workers actually do take pay cuts to move, we would argue that an equilibrium in which all workers recruited by a particular class of firm take a pay cut to move is not empirically relevant.

*B. Labor Market Dynamics*

We illustrate worker flows along the jobs ladder in Figure 2. Since $\delta_w$ is the death rate for workers, it is also the transition rate for workers into the labor force. In addition to the notation already described, $L_{EF}$ denotes the number of workers with experience $E$ employed at a type-$F$ firm and $L_J$ represents the total number of workers attached to the jobs ladder. Workers get the opportunity to move to a higher paying job if they have the appropriate experience and do so if the cost of moving is sufficiently low. To be precise, when given an opportunity to move, each worker randomly draws a cost $\kappa$ and moves if the expected benefit from doing so exceeds this cost. Thus, moving costs are a random variable ($\kappa$) with cumulative distribution $G(\kappa)$ and density $g(\kappa)$.

Job offers arrive according to a Poisson process. We could use $a_F$ to denote the arrival rate of opportunities to move to a type-F firm. However, for simplicity, we set all arrival rates equal to one.

The stationary equilibrium conditions related to the flows in Figure 2 are given in (1) below. In each case, the flow into the labor market state is on the left-hand-side while the flow out is on the right-hand-side. We start with (1.a), which applies to labor market state $L_{0l}$ (inexperienced workers at low-wage firms). Since we only consider stationary equilibria, we hold constant the total measure of workers tied to the jobs ladder, $L_J$. The number of deaths ($\delta_w L_J$) must be offset with an equal number of births, with each newborn taking a job at a low-wage firm. Thus, $\delta_w L_J$ is the flow into labor market state $L_{0l}$. As for the outflow, we know that every new entrant is inexperienced. Some inexperienced workers eventually obtain basic experience (at rate $s_b$), while others die without ever having done so. Thus, the outflow of inexperienced workers is $(\delta_w + s_b)L_{0l}$.

(1.a) $\delta_w L_J = (\delta_w + s_b)L_{0l}$

(1.b) $s_b L_{ol} = \big(\delta_w + G(\kappa_n) + G(\kappa_x)\big)L_{bl}$

(1.c) $G(\kappa_n)L_{bl} = \delta_w L_{bn}$

(1.d) $G(\kappa_x)L_{bl} = (\delta_w + s_i)L_{bx}$

(1.e) $s_i L_{bx} = \big(\delta_w + G(\kappa_i)\big)L_{ix}$

(1.f) $G(\kappa_i)L_{ix} = \delta_w L_{ih}$

Turn next to (1.b), which equates the inflow and outflow from state $L_{bl}$ (workers with basic experience at low-wage firms). The rate at which inexperienced workers gain basic experience is $s_b$, therefore the left-hand side of (1.b), which is the flow into state $L_{bl}$, is the measure of workers at low-wage firms that gain basic experience. Opportunities for low-wage experienced workers to move up the jobs ladder come from medium-productivity firms at rate one. We define $\kappa_F$ as a critical moving cost such that workers drawing $\kappa \leq \kappa_F$ accept an offer from a type-$F$ firm and move up the ladder. Therefore, $G(\kappa_F)$ represents the fraction of workers who accept an offer from a type-$F$ firm. The right-hand side of (1.b) then represents the measure of experienced low-wage workers who transition out of that state due to death ($\delta_w L_{bl}$), acceptance of jobs at medium-productivity non-exporting firms ($G(\kappa_n)L_{bl}$), or acceptance of jobs at medium-productivity exporting firms ($G(\kappa_x)L_{bl}$). The remaining conditions are derived similarly.

*C. Lifetime Real Income*

Workers make decisions in order to maximize expected lifetime real income. Let $V_{EF}(w_j)$ denote the expected lifetime real income for a worker with experience level $E$ employed by a type-$F$ firm earning wage $w_j$. In addition, we use $\rho$ to denote the discount rate and $\tilde{p}$ to denote the price index (to be defined below). The right-hand side for each of the following value functions represents instantaneous income plus the expected capital gain (or minus the expected capital loss) from transitioning to a new labor-market state.

(2.a) $\rho V_{ol}(w_l) = \frac{w_l}{\tilde{p}} + s_b[V_{bl}(w_l) - V_{ol}(w_l)] - \delta_w V_{ol}(w_l)$

(2.b) $\rho V_{bl}(w_l) = \frac{w_l}{\tilde{p}} + G(\kappa_n)\left(V_{bn}(w_n) - V_{bl}(w_l) - \frac{1}{G(\kappa_n)}\int_0^{\kappa_n} \kappa g(\kappa)d\kappa\right) +$

$$G(\kappa_x)\left(V_{bx}(w_x) - V_{bl}(w_l) - \frac{1}{G(\kappa_x)}\int_0^{\kappa_x} \kappa g(\kappa)d\kappa\right) - \delta_w V_{bl}(w_l)$$

(2.c) $\rho V_{bn}(w_n) = \frac{w_n}{\tilde{p}} - \delta_w V_{bn}(w_n)$

(2.d) $\rho V_{bx}(w_x) = \frac{w_x}{\tilde{p}} + s_i\big(V_{ix}(w_x) - V_{bx}(w_x)\big) - \delta_w V_{bx}(w_x)$

(2.e) $\rho V_{ix}(w_x) = \frac{w_x}{\tilde{p}} + G(\kappa_i)\left(V_{ih}(w_h) - V_{ix}(w_x) - \frac{1}{G(\kappa_i)}\int_0^{\kappa_i} \kappa g(\kappa)d\kappa\right) - \delta_w V_{ix}(w_x)$

(2.f) $\rho V_{ih}(w_h) = \frac{w_h}{\tilde{p}} - \delta_w V_{ih}(w_h)$

Starting with the first equation, the only possible transitions for an inexperienced worker are to either gain basic experience with a resulting capital gain $V_{bl}(w_l) - V_{ol}(w_l)$, or to exit the labor force and suffer a capital loss of $V_{ol}(w_l)$. These occur at rates $s_b$ and $\delta_w$, explaining (2.a).

A low-wage worker with basic experience has more possibilities. Such a worker might move to a medium-productivity non-exporting firm, earning a capital gain of $V_{bn}(w_n) - V_{bl}(w_l) - \frac{1}{G(\kappa_n)}\int_0^{\kappa_n} \kappa g(\kappa) d\kappa$, or move to a medium-productivity exporter, in which case the capital gain would be $V_{bx}(w_x) - V_{bl}(w_l) - \frac{1}{G(\kappa_x)}\int_0^{\kappa_x} \kappa g(\kappa) d\kappa$. In both cases, the capital gains account for expected moving costs. Of course, the worker could also exit the labor force and suffer a capital loss of $V_{bl}(w_l)$. These transitions occur at rates $G(\kappa_n)$, $G(\kappa_x)$, and $\delta_w$, respectively. Derivation of the remaining asset-value equations follows the same logic.

As stated earlier the $\kappa_F$ terms are defined such that a worker would accept an offer from a type-F firm if $\kappa \leq \kappa_F$. Formally, these critical values equal the difference between the value of climbing up one rung on the jobs ladder or remaining on the lower rung:

(3.a) $\kappa_n = V_{bn}(w_n) - V_{bl}(w_l)$

(3.b) $\kappa_x = V_{bx}(w_x) - V_{bl}(w_l)$

(3.c) $\kappa_i = V_{ih}(w_h) - V_{ix}(w_x)$

We now turn to the entrepreneurship/jobs ladder decision that each newborn worker faces. We assume that each newborn is randomly endowed with some level of entrepreneurial talent, $\varepsilon$, with $H(\varepsilon)$ representing the cumulative distribution for this random variable. If we think of $\varepsilon$ as efficiency units and use $w_\varepsilon$ to denote the return to entrepreneurship per efficiency unit, then the flow income for an entrepreneur with ability $\varepsilon$ is $\varepsilon w_\varepsilon$. It follows that the expected lifetime real income for an entrepreneur is

(2.g) $\rho V_\varepsilon(\varepsilon) = \frac{\varepsilon w_\varepsilon}{\tilde{p}} - \delta_w V_\varepsilon(\varepsilon)$

Newborns will choose to become an entrepreneur and spend their life developing new firms if $V_\varepsilon(\varepsilon)$ exceeds the return to entering the jobs ladder, $V_{0l}(w_l)$. Thus, if we let $\varepsilon_0$ denote the value that solves

(3.d) $V_\varepsilon(\varepsilon_0) = V_{0l}(w_l)$,

then all newborns with $\varepsilon \geq \varepsilon_0$ become entrepreneurs, while the remaining newborns enter the jobs ladder. If we use $L$ to denote the total size of the labor force, it follows that

(4) $L_J = H(\varepsilon_0)L$

Conceptually, (2) and (3) provide the cutoff values for moving costs and entrepreneurial ability. These depend on endogenously determined wages along with the model's parameters. Substituting these cutoffs into equations (1) and (4) then generates the supplies of labor for all combinations of experience and firm-types. The next step is to derive the demands by each type of firm for each level of experience.

*D. Prices and Output*

We assume two identical countries populated by heterogeneous firms. Since the Foreign market is symmetric with Home, we focus on the Home country. As in Melitz (2003), prospective entrants incur a cost to draw a productivity parameter $\phi$, a random variable with density $z(\phi)$ and cumulative distribution $Z(\phi)$. The firm's productivity combines with the experience of new hires to determine the productivity of labor. Specifically, we assume that the productivity of an inexperienced worker is zero, while the marginal productivity of a worker with basic experience is $\phi$. We assume that basic experience reduces the cost of production, while international experience lowers the cost of exporting. In particular, we assume iceberg transportation costs that are diminishing in the share of the firm's workforce with international experience.

We make the standard assumption that goods are horizontally differentiated and use $\sigma > 1$ to represent the constant elasticity of demand. Demand for a variety $\upsilon$ is given by

$$q(\upsilon) = \frac{R}{\tilde{p}^{1-\sigma}} p(\upsilon)^{-\sigma}$$

where $R$ is total expenditure (and equal to firm revenue in equilibrium), $p(\upsilon)$ is the price of variety $\upsilon$ and $\tilde{p} \equiv [\int p(\upsilon)^{1-\sigma} \, d\upsilon]^{\frac{1}{1-\sigma}}$ is the price index.

Firms select into wage and export status based on productivity. Define $\phi_0 < \phi_l < \phi_n < \phi_x$ as a set of cutoff productivities. Firms with productivity below $\phi_0$ cannot break even and do not produce. Firms with $\phi \in [\phi_0, \phi_l]$ forego screening and $w_l$. Firms with $\phi \in (\phi_l, \phi_n]$ screen for basic experience, pay $w_n$, and do not export. Firms with $\phi \in (\phi_n, \phi_x]$ screen for basic experience, pay $w_x$, and export. High productivity firms with $\phi > \phi_x$ screen for international experience, pay $w_h$, and export.

The prices that maximize profit are given in (5) below. All employees of medium-productivity and high-wage firms have marginal product of $\phi$, meaning that the marginal costs for these firms are $w/\phi$. Things are not as straight-forward for low-wage firms, where a fraction of their workers are inexperienced and have marginal productivity of zero, while the remaining workers are experienced with marginal productivity of $\phi$. Therefore, the average product of labor for a low-wage firm is $(1-\lambda_{0l})\phi$, where $\lambda_{0l}$ is the fraction of the low-wage workforce that is inexperienced. We have:[9]

(5.a) $p_l(\phi) = \frac{\sigma}{\sigma-1}\frac{w_l}{(1-\lambda_{ol})\phi}, \ \ \phi \in [\phi_0, \phi_l]$

(5.b) $p_F(\phi) = \frac{\sigma}{\sigma-1}\frac{w_F}{\phi}$, with $F = n$ for $\phi \in (\phi_l, \phi_n]$; $F = x$ for $\phi \in (\phi_n, \phi_x]$; and $F = h$ for $\phi > \phi_x$

Things are a bit more complicated for the export market, because we want a firm's iceberg transportation costs to depend on the fraction of its workforce with international experience. With this in mind, let $\lambda_{EF}$ denote the fraction of workers with experience $E = o, b, i$ employed by a firm of type $F = l, n, x, h$. A type-F firm's cost of exporting is a function of $\lambda_{iF}$; in particular, we assume that a type-F firm must produce and ship $\frac{\tau q^*}{\lambda_{iF}}$ units of the product if it wishes to deliver $q^*$ units to the foreign country. Note that we use $\tau$ to measure the degree of openness, with $\tau = 1$ denoting free and costless trade. In equilibrium, all high-wage firms export and these firms only hire workers with international experience, so $\lambda_{ih} = 1$. Similarly, no employee of a non-exporter can gain international experience, implying that $\lambda_{il} = \lambda_{in} = 0$. Finally, for the medium-productivity exporters, a fraction of their workforce has international experience,

[9] In Melitz (2003) prices are a constant mark-up over marginal cost and workers are identical, so that marginal and average product are equal. In our model, the marginal worker hired by a low-wage firm is inexperienced and has a productivity of zero. This differs from average product, which is $(1-\lambda_{0l})\phi$. In our dynamic model the firm's goal is to maximize its aggregate discounted stream of profits. With zero discounting (an assumption that we borrow from Melitz), this amounts to maximizing steady-state profits. For low-wage firms, this occurs when price is set as a mark-up over average product, as given in (5.a).

so $0 < \lambda_{ix} \equiv \frac{L_{ix}}{L_{ix}+L_{bx}} < 1$. Therefore, prices for goods produced by Home firms for export are

(5.d) $p_x^*(\phi) = \frac{\sigma}{\sigma-1}\frac{w_m}{\phi}\frac{\tau}{\lambda_{ix}},\ \phi \in (\phi_n, \phi_x]$

(5.e) $p_h^*(\phi) = \frac{\sigma}{\sigma-1}\frac{\tau w_h}{\phi},\ \phi > \phi_x$

*E. Labor Demand*

Firms cannot costlessly identify experience among existing workers since experience acquisition is a Poisson process and identification requires costly screening. However, firms do know the average product of labor since they know the share of their workforce with experience and they know how productivity varies with experience. As described above, the average product of labor for a low-wage firm is $(1-\lambda_{0l})\phi$, while the average product of labor for all other firms is $\phi$. Therefore, the demand for labor needed to produce output for domestic sales is:

(6.a) $\ell_l(\phi) = f + \frac{q_l}{(1-\lambda_{ol})\phi}$

(6.b) $\ell_F(\phi) = f + f_b + \frac{q_F}{\phi}$ for $F = n, x$

(6.c) $\ell_h(\phi) = f + \frac{q_h}{\phi}$

where $f$ is a fixed amount of labor needed for production, $f_b$ is a fixed amount of labor needed to screen for basic experience and $q_j$ follows from preferences in the obvious manner.[10]

Similarly, we can write the amount of labor needed to produce output for export. For medium-productivity exporters and for high-wage firms, we have

(7.a) $\ell_x^*(\phi) = f_x + \frac{q_x^*}{\phi}\frac{\tau}{\lambda_{ix}}$

(7.b) $\ell_h^*(\phi) = f_x + f_i + \frac{\tau q_h^*}{\phi}$

The fixed cost of exporting is $f_x$, while the cost of screening for international experience is $f_i$ in (7.b).

Let $\tilde{z}(\phi)$ represent the productivity distribution of firms conditional on successful entry. For now, take as given the critical productivity cutoffs that determine the of distribution firms. Then wages must

[10] We attribute the cost of screening for international experience to the cost of exporting.

adjust to equate the demand for each type of labor with the supply of that type. The demands by each firm $F$ for workers with experience $E$ are represented by (6.a) - (6.c) and (7.a) - (7.b). Integrating over the appropriate ranges of $\phi$ then yields total labor demand for each type. The supplies of each type of labor are given by the solutions to (1.a) - (1.f). Equating supply and demand for each type of labor gives us the equilibrium conditions in (8).

(8.a) $L_{ol} + L_{bl} = \mathcal{M} \int_{\phi_0}^{\phi_l} \ell_l(\phi)\tilde{z}(\phi)d\phi$

(8.b) $L_{bn} = \mathcal{M} \int_{\phi_l}^{\phi_n} \ell_n(\phi)\tilde{z}(\phi)d\phi$

(8.c) $L_{bx} + L_{ix} = \mathcal{M} \int_{\phi_n}^{\phi_x} [\ell_x(\phi) + \ell_x^*(\phi)]\tilde{z}(\phi)d\phi$

(8.d) $L_{ih} = \mathcal{M} \int_{\phi_x}^{\infty} [\ell_h(\phi) + \ell_h^*(\phi)]\tilde{z}(\phi)d\phi$

*F. Firm Selection and Dynamics*

Firms select their hiring and export strategies to maximize profit conditional on their productivity. Using $r_F(\phi)$ and $r_F^*(\phi)$ to represent revenue from domestic and export sales for a type-$F$ firm, profits for the four types of firms are

(9.a) $\Pi_l(\phi) = \frac{r_l(\phi)}{\sigma} - w_l f$ for $\phi \in [\phi_0, \phi_l]$

(9.b) $\Pi_n(\phi) = \frac{r_n(\phi)}{\sigma} - w_n(f + f_b)$ for $\phi \in (\phi_l, \phi_n]$

(9.c) $\Pi_x(\phi) = \frac{r_x(\phi)+r_x^*(\phi)}{\sigma} - w_x[f + f_b + f_x]$ for $\phi \in (\phi_n, \phi_x]$

(9.d) $\Pi_h(\phi) = \frac{r_h(\phi)+r_h^*(\phi)}{\sigma} - w_h[f + f_i + f_x]$ for $\phi \geq \phi_x$

The critical productivity cutoffs satisfy the following equal profit conditions:

(10.a) $\Pi_l(\phi_0) = 0$

(10.b) $\Pi_l(\phi_l) = \Pi_n(\phi_l)$

(10.c) $\Pi_n(\phi_n) = \Pi_x(\phi_n)$

(10.d) $\Pi_x(\phi_x) = \Pi_h(\phi_x)$

Finally, we have a free entry condition stating that the sunk cost of developing a business plan must equal expected discounted profit. We assume that firms die (and are replaced) at rate $\delta_f$. For tractability, we assume that each new entrant hires all the workers employed by the firm it replaces. If we assume that the development of a new firm requires $f_d$ units of entrepreneurial inputs, then the sunk cost of development is $w_\varepsilon f_d$. Since the probability of successful entry is $1 - Z(\phi_0)$, the free entry condition is

$$(11) \qquad \frac{1-Z(\phi_0)}{\rho+\delta_f}\int_{\phi_0}^{\infty} \Pi_F(\phi)\tilde{z}(\phi)d\phi = w_\varepsilon f_d$$

If the discount rate is zero, all profit earned by the firm during its existence is paid to development labor (see Melitz 2003, footnote 16 for details). Combining this with wage income earned by production workers, we arrive at the final equation of the model, which equates aggregate labor income with aggregate revenue, $R$. Thus, in equilibrium we have

$$(12) \qquad R = w_l(L_{ol} + L_{bl}) + w_n L_{bn} + w_x(L_{bx}+L_{ix}) + w_h L_{ih} + w_\varepsilon \bar{\varepsilon}(\varepsilon_0)(L - L_J)$$

where $\bar{\varepsilon}(\varepsilon_0)$ is the mean of $\varepsilon$ conditional on $\varepsilon \geq \varepsilon_0$ and $L_J = L_{ol} + L_{bl} + L_{bn} + L_{bx} + L_{ix} + L_{ih}$.

Equilibrium is characterized by the four job ladder wages $(w_l, w_n, w_x, w_h)$, the return to entrepreneurship $(w_\varepsilon)$, four critical productivities $(\phi_0, \phi_l, \phi_n, \phi_x)$, three critical moving costs $(\kappa_n, \kappa_x, \kappa_i)$, the critical level of entrepreneurial ability $(\varepsilon_0)$, the mass of prospective firms $(M_d)$, and national income $(R)$. These fifteen variables are determined by five labor-market clearing conditions (4) and (8.a)–(8.d), four equal-profit conditions (10.a)–(10.d), four worker-indifference conditions (3.a)–(3.d), the free-entry condition (11), and the national income identity (12).[11]

## 3. Globalization

### A. *Trade Costs and the Mix of Firm Types*

We model globalization as a reduction in variable trade costs $(\tau)$. We know that a reduction in trade costs affects both the intensive and extensive margins of trade. Let $\hat{\phi}_0, \hat{\phi}_l, \hat{\phi}_n$, and $\hat{\phi}_x$ represent the

[11] The $L_{EF}$ terms in (1) are also endogenous and appear in (8) and (12). However, there are six such terms and six equations in (1). These equations can be solved to obtain the $L_{EF}$ terms as functions of our parameters and the cost cut-offs. In a similar vein, the equations in (2) can be solved allowing us to write the $V_{EF}$ terms as functions of wages, cost cut-offs and $\varepsilon_0$. The resulting functions can then be substituted into (3), (8) and (12) to solve for equilibrium.

initial values of the productivity cutoffs. We know that a reduction in trade costs results in higher profit for firms that already export. However, new competition from abroad reduces profits for any non-exporter. Therefore, given a fall in trade costs; (i) $\Pi_h(\phi)$ increases for all $\phi \in (\phi_x, \infty)$; (ii) $\Pi_x(\phi)$ increases for all $\phi \in (\phi_n, \phi_x]$; (iii) $\Pi_n(\phi)$ falls for all $\phi \in (\phi_l, \phi_n]$; and (iv) $\Pi_l(\phi)$ falls for all $\phi \in [\phi_0, \phi_l]$.

Now consider the equal profit condition (10.d), $\Pi_x(\phi_x) = \Pi_h(\phi_x)$. Workers at both types of firms are equally productive in domestic sales. The higher wage means higher marginal cost, higher price, and lower domestic output for high-wage exporters versus medium-productivity exporters. It also means lower profit on domestic sales for the high-wage firm. However, total profits for high-wage firms and medium-productivity exporters are, by definition, the same at $\phi_x$. It follows that the reduction in trade costs leads to more exports for the high-wage firm compared with the medium-productivity exporter, while the increased domestic competition is less significant for the high-wage firm compared with the medium-wage firm. On both counts, it is evident that the profit-enhancing effect is larger for the high-wage firm, so that $\Pi_h(\hat{\phi}_x) > \Pi_m(\hat{\phi}_x)$ after trade costs drop. This implies that $\phi_x$ falls with globalization, so that a larger fraction of firms are high-wage exporters.

Using a similar argument, medium-productivity non-exporters have lower marginal costs (but higher fixed costs) than low-wage firms. The increased competition due to lower trade costs is therefore more significant for the medium-productivity non-exporter, so $\Pi_n(\phi_l)$ falls by more than $\Pi_l(\phi_l)$, allowing us to conclude that $\Pi_l(\hat{\phi}_l) > \Pi_n(\hat{\phi}_l)$ after the reduction in trade costs. The implication is that $\phi_l$ rises with globalization. Parts (ii) and (iii) of our statement above imply that $\phi_n$ falls as trade costs drop. The result is that medium-productivity non-exporters are squeezed from both ends. The more productive firms in this range become medium-productivity exporters, while the least productive become low-wage firms.

Finally, we know that, conditional on a firm being active, a reduction in trade costs results in an increase in expected profit (the term excluding $1 - Z(\phi_0)$ on the left-hand side of eq. 11). The free entry condition requires that unconditional expected profit equals sunk costs. In the Meltiz model, sunk cost are parametrically determined, therefore the only margin of adjustment is that the likelihood of successful entry must fall ($\phi_0$ increases). But in our framework, sunk costs depend on the wage paid to development workers. This wage changes as trade costs fall, thereby changing sunk costs. If the return to entrepreneurship rises, the increase in sunk costs could outpace the increase in ex-post expected profit, making entry easier. Otherwise, entry becomes more difficult as trade costs fall, resulting in exit by low-productivity, low-wage firms, as in the Melitz framework.

### *B. Calibration*

In order to push our analysis further, we calibrate the model using many of the same parameters and targeting the same moments of the U.S. economy as in Melitz and Redding (2015). In what follows, we focus on how globalization affects the novel features of our model: the jobs ladder and economic mobility. Hence, we focus largely on production wages and transition rates. As discussed below, we find that our model yields robust predictions about the way in which lower trade costs impact the distribution of workers, firms, and income.

To begin, we assume that productivity, entrepreneurial ability and moving costs are drawn from independent Pareto distributions with all having minimum values of one. We set the shape parameter for the firm-productivity distribution equal to 4.25, so that we have the same degree of firm heterogeneity as Melitz and Redding (2015). Our numeric analysis indicates that while the spread of the moving cost distribution does plays a role in determining the amount of movement in the economy (and hence, overall economic mobility and the degree of responsiveness to changes in variable trade costs), it does not influence the qualitative properties of the model. We prove in Appendix A that any non-degenerate distribution of entrepreneurial ability with any parameterization results in qualitatively identical results since the distribution of ability only affects the split of work versus entrepreneurship, and the number of workers choosing the jobs ladder only affects the scale of economic activity.[12]

As for our parameters, we set $\delta_w = \frac{1}{40}$, so that workers have careers that last, on average, 40 years,

[12] In order to explore the quantitative effects of alternative assumptions, we re-calibrated the model assuming a uniform distribution of ability with $\varepsilon \in [0,1]$. The re-calibrated equilibrium was identical to the initial equilibrium (assuming the Pareto distribution) out to the third decimal place (or further) for all relevant variables.

and set $\delta_f = \frac{1}{18}$ so that the average life of a firm is 18 years (which, according to McKinsey, was the average life of firms in the S&P 500 in 2011). For our base case, we set $s_b = \frac{1}{3}$ which implies that basic experience is picked up quickly (three years, on average), so that firms are willing to target low-wage workers that have only a few years of experience. We set the elasticity of substitution ($\sigma$) at 2.7, which is in the middle of the range reported by Borda and Weinstein (2006); and we take our initial value for trade costs ($\tau$) from Anderson and van Wincoop (2004), setting $\tau = 1.7$.

Following Melitz and Redding, we require that in the initial equilibrium 18% of firms export; 14% of the revenue earned by exporting firms comes from their exports; and that the log difference between the revenue earned by exporters and the revenue earned by non-exporters is 1.48.[13] We add an additional target, requiring the success rate of new firms to be 80% (20% of all new firms fail within their first two years). For given values of the fixed costs of screening ($f_b$ and $f_i$), these four targets allow us to pin down the remaining parameters of the model ($f$, $f_x$, $f_d$, and $s_i$). For our base case we set $f_b = f_i = 0.01$. Since $w_h > w_n > w_x$, this implies that the cost of screening for international experience exceeds the cost of screening for basic experience.

To ensure that our results are not sensitive to our parameter choices, we then carry-out sensitivity analysis with respect to our choices for $s_b, f_b$ and $f_i$. Finally, as an additional check on the model, after calibration is complete, we calculate the elasticity of trade and ensure the value predicted by our model falls within the range of estimates reported by Waugh and Simonovska (2014). For our base case, the elasticity of trade is 3.68, in the middle of the 2.79-4.46 range from Waugh and Simonovska.

### *C. Results*

To explore the characteristics of our model, we vary $\tau$ from 1.45 to 1.90, with, as noted above, $\tau$ =1.7 serving as our base case. The lower bound for this range is taken from Anderson and van Wincoop (2004), who report estimates of trade costs for a variety of countries in their Table 6, with a low value near

[13] Melitz and Redding take these targets from Bernard, Jensen, Redding and Schott (2007).

1.45 (Belgium) and high values near 1.7 (US and Japan). The upper bound is set to include $\tau = 1.83$, which is the value Melitz and Redding (2015) use in their analysis.

We illustrate results for our base case with respect to production wages and employment in Figures 3 and 4. Real wages are plotted against trade costs in Figure 3.[14] As the figure indicates, in the neighborhood of the initial equilibrium ($\tau = 1.7$) and for most of the parameter space, globalization results in real wage gains for those earning the two highest wages ($w_h$ and $w_n$) and a reduction in the real wage earned by those in entry-level jobs. The sharpest wages gains accrue to high-wage workers. Thus, globalization increases inequality and can harm the lowest-paid production workers in the economy.

Since unskilled labor is the numeraire, the real-wage paid by low-wage firms is simply the inverse of the price index. A reduction in trade costs necessarily reduces the price index and raises the real wage for all workers in a plain-vanilla Melitz model. That is not the case in our model. Lower trade costs shuffle the mix of firms resulting in a number of offsetting effects. For example, the highest productivity medium-wage firms switch to become high-wage firms when trade costs fall. This increases their marginal cost of serving the domestic market, thereby increasing the price of their output. In addition, the lower-productivity medium-wage firms become low-wage firms in order to eliminate the fixed cost of screening. The lower wage, however, is more than offset by lower worker productivity.[15] Therefore the marginal cost of production increases for this group of firms as well. These two effects can offset the lower cost of imports when the volume of imports is relatively small but are eventually dominated by lower import prices when trade costs fall far enough. Therefore low-income workers are harmed as trade costs fall over most of parameter space but start to see their real wages rise as $\tau$ approaches our lower bound (1.45). This non-monotonicity in the real income of low-wage workers is a general feature of the model, arising in all cases that we considered, with the increase always occurring for a value of $\tau$ below 1.7.

Turn next to Figure 4, where we report the share of each worker type relative to all production

[14] Because of scale differences, we illustrate the three highest wages in the first panel of Figure 3 and the lowest wage in the second panel of the figure.

[15] Recall that the difference between medium-wage and high-wage workers lies in their differential ability to reduce trade costs, with both groups equally productive in serving the domestic market.

workers. Increased globalization has a small impact on low-wage jobs as a share of all production jobs. While the lowest productivity firms usually exit the market as trade costs fall, the lowest productivity non-exporting firms replace them. The former can be smaller or larger than the latter. As a result, low-wage employment as a share of production employment can rise or fall. In our base case, entry–level employment is non-monotonic in trade costs, dropping from 8.46% to (roughly) 8.13% and then rising back to 8.15%.

The reduction in trade costs results in more exports (intensive margin) and more exporters (extensive margin). The combined effect is to increase the share of high-wage jobs; rising from about 20% of production employment when $\tau$ is 1.83 to over 28% when $\tau$ drops to 1.4. Combined with the very small change in the share of low-wage jobs, the share of medium-wage jobs must fall.

Figure 4 also shows the breakdown of the two types of middle-wage jobs. As is evident, the reduction in the share of these jobs results from a precipitous fall in workers employed by non-exporting firms. Specifically, employment at medium-productivity non-exporters falls from about 60% of all production jobs to 44% over the range of trade costs that we consider. In the example depicted in Figure 4, employment at medium-productivity exporters grows from just under 13% to over 19%. This increase in the availability of jobs with medium-productivity exporters is important, since it makes it easier for workers to gain international experience and climb to the top of the jobs ladder.

To summarize, we find that lower trade costs are usually associated with increased wage inequality among production workers and that the share of production workers in medium-wage jobs shrinks as employment moves towards high-wage firms. As emphasized in the introduction, these predictions are broadly consistent with what we would see in most heterogeneous-firm trade models in which firms hire from the same pool of workers (e.g., Egger and Kreickemeir 2012, Helpman, Itskhoki and Redding 2010a,b or Sampson 2014). They are also consistent with recent empirical findings of Helpman, Itskhoki, Muendler and Redding (2017). However, as we stressed in the introduction, for workers that have careers in which they change jobs overtime, information about wage inequality and employment shares is not sufficient to fully address the link between globalization and inequality.

We now turn to the issue of economic mobility. In our model, low-wage workers see their relative wages fall with globalization. However, workers take low-wage jobs in order to acquire skills and hope to move on to higher paying jobs as quickly as possible. Thus, their welfare depends on all wages they earn over their lifetimes and the rates at which they move from job to job. If globalization reduces the average time spent in low-wage and medium-wage jobs, current low-wage workers might not care that much even if the reduction in trade costs lowers their real wage, since they know that better prospects lie ahead and that they will get to these better prospects more quickly. To investigate this issue, we calculate the expected duration in low-wage jobs and the expected duration of a job with a medium-productivity exporter. In both cases, we are interested in the expected duration conditional on the worker having already gained the skills necessary to move to the next rung of the ladder (since this is the only part of job duration that varies with behavior in our model). These measures, denoted by $D_{bl}$ and $D_{ix}$, respectively, are given in (13) below.

(13.a) $$D_{bl} = \frac{1}{\delta_w + G(\kappa_n) + G(\kappa_x)}$$

(13.b) $$D_{ix} = \frac{1}{\delta_w + G(\kappa_i)}$$

In each case, expected duration is the inverse of the overall transition rate out of that particular labor market state (see section 2.B above for a discussion of these transition rates).

The impact of globalization on the duration of medium-wage jobs with exporters is straightforward. Since globalization increases the gap between $w_x$ and $w_h$, workers are more anxious to accept high wage offers. Thus, globalization increases the critical cost cut-off for workers employed in medium-productivity exporting jobs ($\kappa_i$), thereby increasing $G(\kappa_i)$ and reducing $D_{ix}$.

The impact of globalization on the duration of low-wage jobs is more complicated. There are two effects that work in opposite directions. With high-wage jobs becoming more valuable, low-wage workers become more willing to accept jobs from medium-productivity exporters, but less willing to accept the dead-end jobs offered by medium-productivity non-exporters. Thus, $G(\kappa_x)$ rises while $G(\kappa_n)$ falls, making the overall impact on $D_{bl}$ ambiguous. In our base case, the impact of globalization on the expected duration of a low-wage job is non-monotonic, falling as trade costs fall for most of the parameter space, turning up only as $\tau$ approaches our lower bound (see Figure 5). This u-shaped pattern appears to be quite general, with the only difference in the examples that we have examined being the point at which $D_{bl}$ is minimized.

Our results indicate that globalization tends to produce two *countervailing* forces that affect the welfare of low-wage workers. On the one hand, their relative standing in the labor market is eroded, as wage inequality increases. On the other hand, globalization allows them to move up the jobs ladder more quickly and, as they reach higher rungs, they enjoy the enhanced benefits of the higher real wages generated by freer trade. In this case, a focus on wage inequality can be misleading in that low-wage workers do not lose as much relative to others in the labor market as would be indicated by standard analysis.

In this framework, the proper way to measure the effect of globalization on a worker is to examine its impact on that worker's expected lifetime real income. That measure considers both the change in real wages and the degree of economic mobility faced by that worker. Thus, we can get a better view of how globalization affects inequality by examining the changes in expected lifetime real incomes for workers in different labor market states. There are many ways to measure inequality, especially in a framework such as this one which includes many labor markets states. For simplicity, we focus on the impact of globalization on the relative standing of the workers at the bottom and the top of the jobs ladder. For our measure of wage inequality, we investigate how globalization impacts the ratio of the wages paid to highest-paid workers to those earning the lowest wage; that is, $\frac{w_h}{w_l}$. Based on our calibration, this value is 2.08 for our highest trade cost, rising to 2.47 as trade costs fall to our lowest value, an increase of 18.8%.

Turn next to expected lifetime real income. Our measure on inequality in this dimension is $\frac{V_{ih}}{V_{ol}}$. The numerator is the expected lifetime real income for a worker that has international experience and has managed to secure a job at a high-wage exporter. The denominator is the expected lifetime real income of a newborn worker – a worker with no experience employed by a low-wage firm. This ratio, as a function of trade costs, is shown in Figure 6 for our base case example, along with the ratio of wages. There are several features of Figure 6 that are worth emphasizing. First, this ratio is 1.09 for the highest level of trade costs that we consider. That this measure is lower than the ratio of wages shows how misleading it can be to focus on wages and ignore economic mobility. Inexperienced workers only hold low-wage jobs for a small portion of their lifetime, moving on to better jobs as they gain skills. As they mature, they benefit from the higher real wages paid to medium-wage and high-wage production workers if they can gain the proper skills and land better jobs. The fact that using current wages as a proxy for lifetime earnings can lead to misleading conclusions is not a new insight. This issue is well understood and heavily researched in many sub-fields of economics; but, as far as we know, it has not received much attention from those investigating the link between globalization and inequality.[16]

The second feature in Figure 6 worth noting is that, in our example, $\frac{V_{ih}}{V_{ol}}$ rises much more modestly than our measure of wage inequality. The overstatement of inequality based on looking only at current wages becomes more severe as trade costs fall. The third point to make about Figure 6 is that the positive relationship between $\frac{V_{ih}}{V_{ol}}$ and trade costs depicted in Figure 6 is *not* a general result – in some examples, this value actually *falls* as trade costs approach our lower bound.

*D. Sensitivity Analysis*

We close this section by describing the sensitivity analysis that we carried out to check on the robustness of our results. There are three dimensions that we focused on: our parameter choices; assumptions made about the distributions of random variables; and the overall structure of the model.

We begin with our assumptions about two distributions, those describing entrepreneurial ability and moving costs. As we noted above, equilibrium on the jobs ladder is independent of the parameters that characterize the distribution of entrepreneurial ability. To understand this, consider the two conditions that determine the equilibrium for entrepreneurial labor. First, expected lifetime income for the marginal entrepreneur $\left(\frac{w_\varepsilon \varepsilon_0}{\rho+\delta_w}\right)$ must equal the expected lifetime income for an inexperienced low-wage worker. Second, aggregate entrepreneurial income $(w_\varepsilon L_\varepsilon)$ must equal aggregate profit. Expected lifetime income

[16] In labor economics, a classic reference is Lillard (1977). Haider and Solon (2006) discuss the determinants that make current earnings either a good or bad proxy for lifetime earnings. For an example of the importance of this distinction in public economics (in calculating tax incidence), see Davies, St-Hilaire and Whalley (1984) or Fullerton and Rogers (1993).

and aggregate profit are both unchanged if there is no disturbance to the jobs ladder. Given the distribution of entrepreneurial ability, $L_\varepsilon$ is a function of $\varepsilon_0$. Therefore, these two conditions fully determine $w_\varepsilon$ and $\varepsilon_0$. Any change in the distribution of entrepreneurial ability (including any distribution function other than Pareto) only affects the equilibrium marginal ability and the wage per unit of entrepreneurial skill.

As for moving costs, we vary the shape parameter of the Pareto distribution from a very low value, so that moving costs are quite spread out, to a very high value, so that moving costs are quite concentrated. For low values, economic mobility is low, with workers accepting (on average) about 10% of the offers they receive; while for high values, economic mobility is much higher, with workers accepting (on average) about 98% of their offers. In turn, more mobility results in higher trade elasticity in the neighborhood of the initial equilibrium. However, in all cases, the qualitative impact of globalization is consistent with our base case, indicating that our results do not hinge on choices that we make with respect to moving costs.

Turn next to our parameter choices. In our sensitivity analysis we focus on three key values: the elasticity of substitution ($\sigma$), the transition rate for workers gaining basic experience ($s_b$) and the relative values of the cost of screening for basic and international experience ($f_b$ and $f_i$). Our values for $\sigma$ come from Broda and Weinstein (2006), who report estimates ranging from 2.2 to 3.1 with a median of 2.7 (see their Table 4). While we used 2.7 as our base case, we also carried out our analysis for the two extreme values, 2.2 and 3.1. In Table 1 we report our results for all three cases, with the trade elasticity for the case in which $\tau = 1.7$ listed below the value for $\sigma$. The entries in the table are elasticities with respect to trade costs. As trade costs fall, one would expect real wages to rise and job durations to fall, so wage elasticities should generally be negative and the elasticities for job durations should be positive. The results in Table 1 show that the properties of the model displayed in Figures 3 and 5 are robust. In all cases, as trade costs fall, the two highest real wages increase and the real wage earned by entry-level workers is u-shaped, falling at first and then eventually rising. The entries also reveal that the second-lowest wage in the economy, that earned by workers at medium-productivity exporters is also non-monotonic in trade cost, following a pattern similar to that of the low wage. However, workers earning $w_x$ start to enjoy real wage gains much sooner than low wage workers, with their gains always kicking in around $\tau = 1.7$, while entry-level workers do not gain in real terms until $\tau$ drops to 1.54 (when $\sigma$ = 2.7 or 3.1). One new feature revealed by Table 1 is that in some very rare cases a reduction in trade costs can cause inequality to actually fall, with entry-level workers gaining the most from globalization. This never happens when $\sigma = 2.7$, it happens only as $\tau$ approaches our lower bound when $\sigma = 3.1$, and it happens when $\tau$ falls below 1.55 when $\sigma = 2.2$. The dramatic increase in the real income for low wage workers when trade costs are low is driven by the difficulty that entry-level firms face in retaining workers as exporting firms expand.[17] Finally, the impact of globalization on job durations is completely consistent with our base case – as trade costs fall, the duration of medium-wage jobs always drops (although the effect is quite small for low $\sigma$), while the impact on the duration of low-wage jobs is u-shaped with duration eventually rising for very low trade costs. As for the remaining parameters, we carried out our analysis varying $s_b$ from .25 to .5 and $\frac{f_i}{f_b}$ from 1 to 2 and found no noteworthy change in the comparative statics predictions of the model.

Finally, we turn to the structure of our model. Two key assumptions that we have made in setting up our model are that workers make their entrepreneurial/jobs ladder decision at birth, and that medium-productivity exporters and non-exporters pay different wages. In an earlier version of this paper, we made different choices. In particular, we assumed that workers needed to gain both basic and international experience before starting to develop new firms, so that entrepreneurs held jobs at the very top of the jobs ladder, and we restricted all medium-productivity firms to pay the same wage regardless of exporting status. This model yields comparative statics predictions that are almost identical to those reported above (see Davidson el at 2018 for details). There are only two differences. In Davidson el at (2018) employment at

[17] Helpman, Itskhoki and Redding (2010a) also find that inequality is non-monotonic in trade costs but for different reasons. In their model, as the economy moves away from autarky, inequality rises as the most productive firms start to export – in that case, globalization magnifies firm heterogeneity as only the most productive firms are able to access world markets. As trade costs continue to fall, a greater fraction of firms export; and, eventually trade costs fall to the level at which *all* firms export. At that point, inequality *is decreasing in trade costs.* This is because as the weakest firms begin to export, firm heterogeneity falls. This effect does not arise in our setting since we only consider equilibria in which some firms do not export.

low-wage firms always rises (but very modestly) as trade costs fall and in our base case our measure of inequality that relies on expected lifetime earnings *falls* by 15% as trade costs drop. As a further check for robustness, we took the model with entrepreneurs at the top of the jobs ladder and relaxed the assumption that all medium-productivity firms must offer the same wage. Relaxing this assumption did not overturn a single result reported above.

## 4. Downward Mobility and Globalization

As constructed, each worker in this economy follows a similar path up to the top of the jobs ladder. They take an entry level job to gain basic skills, move to a medium-productivity exporter to gain international skills and then move to a high-wage exporter. There are no moves back down the ladder. However, in reality, some workers are demoted by their employer and others are let go and forced to accept a new, lower wage to gain reemployment. Using US data covering 1994 to 2016 Forsythe (2017) finds that "approximately 7% of employed individuals move down the occupational ladder each year." Accordingly, using Danish data, Groes, Kirchner and Manovskii (2013) and Frederiksen, Halliday and Koch (2016) find substantial rates of downward economic mobility. Such movements back down the jobs ladder can be devastating for individual workers, resulting in large losses in lifetime earnings.[18] These downward movements can also retard the development of an effective career. Our goal in this section is to sketch an extension of our model that allows for downward economic mobility and use it to explain how globalization is likely to impact rates of displacement. We provide a brief description of the extension in this section, but relegate the details of how the equations of our model are altered to an online appendix.

To allow for downward economic mobility, we assume that once a worker gains a skill and uses it to secure a better job, they must then exert effort to keep that skill from deteriorating. Effort is costly, with the cost varying across workers. The cost of effort is modeled in the same manner as moving costs – once a skill is gained and a better job is secured, the worker gets a random draw that determines the cost of effort. The skill does not deteriorate if the worker exerts effort, but disappears with a reversion to the previous

[18] The classic references on the losses from job displacement are Jacobson, LaLonde and Sullivan (1993) and Kletzer (1998). For more recent discussion, see Davis and von Wachter (2011) or Krolikowski (2017).

productivity level if the worker does not. To prevent shirking, firms monitor workers and fire those that have lost their skills. Thus, shirking workers risk detection with the prospect of falling back one level on the ladder where they must then re-acquire that skill if they want to move back up and earn a higher wage.

Worker flows in the extended model are illustrated in Figure 7. The dashed arrows indicate that medium-wage workers caught shirking are fired and forced to take low-wage jobs. These workers no longer have basic experience and therefore are indistinguishable from inexperienced workers. The solid arrows indicate that high-wage workers caught shirking are fired and forced to take medium-wage jobs. A fraction of these workers ($\lambda_n$) are matched with medium-productivity non-exporters, with the remainder matched with medium-productivity exporters. These workers have lost their international skills and can only re-acquire those skills if they are fortunate enough to land a job at an exporter.

Workers use standard cost-benefit analysis to decide whether to shirk. Consider, for example, a worker with basic experience employed by a medium-productivity exporter. This worker has an expected lifetime income of $V_{bx}(w_x, c)$ if the cost of effort is $c$ and they do not shirk, where

(14.a) $$V_{bx}(w_x, c) = \frac{w_x}{\tilde{p}} - c + s_i[V_{ix}(w_x) - V_{bx}(w_x, c)] - \delta_w V_{bx}(w_x, c)$$

The explanation for (14.a) is the same as for (2.d), it just now includes the cost of effort. If we use $d_x$ to denote the probability of detection when shirking at a medium-productivity exporter, then this worker expects to earn $V_{bx}^s(w_x)$ if they shirk, (where $\bar{\kappa}$ is mean of the distribution of moving costs)

(14.b) $$\rho V_{bx}^s(w_x) = \frac{w_x}{\tilde{p}} - \delta_w V_{bx}^s(w_x) + d_x[V_{ol}(w_l) - V_{bx}^s(w_x) - \bar{\kappa}]$$

Note that because this worker is shirking, they do not pay the cost of effort. However, shirking risks detection and, if caught, the worker sees their expected lifetime income drop to $V_{ol}(w_l)$. Moreover, because this worker is forced to move, they expect to incur moving costs of $\bar{\kappa}$. A worker is indifferent between shirking and exerting effort if $c = c_x$ where $V_{bx}(w_x, c_x) = \rho V_{bx}^s(w_x)$. All workers with $c \leq c_x$ put forth effort, while the remainder shirk.

Similar analysis can be used to solve for the critical cost of effort for workers employed by medium-productivity non-exporters ($c_n$) and for high-wage workers ($c_h$). In both cases, these are the costs that make workers indifferent between shirking and putting forth the effort required to maintain their skills. Workers with higher costs shirk and a fraction of those workers are caught and fired, forcing them to move back down the jobs ladder. These critical cut-offs can be used to solve for the rate of shirking, which allows us to determine the flows associated with the red and blue arrows in Figure 7. Any increase in $c_x, c_n$ or $c_h$ means that fewer workers are shirking, implying less downward economic mobility in the economy.

In this setting, the impact of globalization on downward economic mobility is rather straight-forward. As we saw in Section 3, as trade costs fall, wage inequality increases. The direct implication is that the expected cost of shirking rises with globalization. As a result, all three critical cost cut-offs rise, leading to less shirking and less downward economic mobility.

We can combine this result, with those derived in Section 3 to summarize the link between globalization and economic mobility. In section 3 we found that globalization reduces the average duration of both low-wage and medium-wage jobs. It also leads to less shirking, so that there is less downward mobility. The overall effect of this is to increase the fraction of their lives that workers spend in high-wage jobs and decrease the fraction of their lives they spend in entry-level jobs.

For workers at medium-productivity exporters, globalization speeds up the rate at which they move on to high-wage jobs. But, that globalization also makes it (a) less likely that they will be fired and forced back down the ladder and (b) less likely that once they secure a high-wage job they will lose it. The overall impact on the expected duration of a job with a medium-productivity exporter is therefore ambiguous.

## 5. Empirical Evidence

Our model makes use of two key assumptions to derive a variety of testable predictions about the impact of globalization on the career-paths of workers. The two assumptions are that heterogeneous firms use different recruiting networks to fill their vacancies and that the international experience of a firm's workforce can lower its trade costs. The second assumption has strong support from the empirical studies cited in the introduction (e.g., see the discussion of Labanca et al. 2014 and Mion et al. 2017). However, with respect to our first assumption, we know of no study of the role that international engagement plays in determining firms' recruitment strategies. While a detailed empirical analysis is beyond the scope of this paper, we provide below some descriptive statistics that are largely in line with our premise.

Our empirical analysis uses matched worker-firm data from Sweden for 1997-2013 (see Appendix B for details about the data). Since our data does not include information on service trade, the evidence presented below is for manufacturing only. We separate firms into three groups based on exports as a share of total sales: (*i*) firms that do not export (non-exporters), (*ii*) firms that have export shares below the sample median of exporting firms across all industries (low export firms), and (*iii*) firms that have export shares above the sample median of exporting firms across all industries (high export firms). Our theory assumes that high exporting firms pay relatively high wages and firms with no export pay relatively low wages. This relationship is firmly established in the empirical literature: exporting firms pay higher wages than non-exporting firms even after controlling for worker characteristics (e.g. Schank, Schnabel and Wagner 2007; Munch and Skaksen 2008; Baumgarten 2013). As a result, dividing our firms by wages or export give similar results in the empirical part below.

We start by examining recruitment patterns in firms with different levels of export. A recruitment is defined as a worker who is employed in a firm in year $t$ (November) but not in that firm in year $t$ -1 (November). A worker who is recruited in year $t$ is linked to the character of the previous employer in year $t$ -1. We examine the recruitment from non-exporters by different firm groups in Figure 8. As seen from panel (a), compared to other firm groups, non-exporters are more likely to hire workers from firms that also do not export. In contrast, panel (c) shows that out of the total recruitment by high export firms, substantially more recruits come from other high export firms (60-80% over the sample period).

Figure 8 also reveals that there is substantial amount of worker mobility across firm groups. For example, in 2005, 24 percent of new hires by high export firms came from firms that either did not export or had an export share below the median in 2005, while 61 percent of new hires by non-exporters came from firms that exported in 2005.[19] Below we will examine worker mobility in more detail. In particular, we are interested in the possible link between worker mobility and globalization as implied by our model above. Before presenting the results, we first provide an interpretation of our model designed to lay the foundation for an empirical assessment.

In our model, firms employ workers to perform just two tasks – production of output and, if the firm is an exporter, shipment of goods abroad. The firm's ability to produce output depends on how much basic experience is embedded in its workforce; while its trade costs depend on the faction of its workforce with international experience. In addition, the economy-wide wage distribution applies to all workers, regardless of experience. In reality, firms are far more complex than this, requiring a large number of tasks to be carried out both for production and distribution. Firms employ workers in a wide variety of occupations to carry out these tasks and the wage distributions for different occupations are largely distinct. Thus, the most appropriate way to view our model is that it describes a jobs ladder for workers in a particular occupation. Further, it is easy to imagine that international experience plays a larger role in lowering trade costs in some occupations (e.g., supply chain or business development managers, business tax or global trade lawyers, experts in international finance) relative to others (e.g., clerical support). That is, we expect that our predictions are more likely to find support in occupations that play a major role in international commerce, such as professionals and managers.

Table 2 presents some suggestive evidence at the industry level for the link between trade openness and worker mobility. In panel A we focus on upward mobility – worker movement from firms that do not export (or export less) to the firms that export (or export more). To capture this type of upward mobility, for each industry we first divide firms into three groups as above. Let $i$ (and $j$) = 1, 2, 3 indicate the group of non-exporters, low export firms, and high export firms, respectively. Let $S_{ijt}$ be the number of workers who move from a firm in the $i$ group to another firm in the $j$ group as a share of all movers between $t-1$

[19] We also looked at hiring practices by firms in different wage categories (not shown). Not surprisingly, considering the strong correlation between wages and export, a similar pattern was detected: high wage firms recruit mainly from other high wage firms and low wage firms hire more than medium or high wage firms from other low wage firms.

and $t$.[20] We define the upward mobility index as $\sum_{ij} S_{ijt} \cdot (j - i)/(k - 1)$ for $i < j$ where $k$ is the number of firm groups and $j - i$ can be interpreted as the number of "steps" by which workers move upward (this is a variant of the measure proposed by Bartholomew 1982). This measure is bounded by 0 and 1. If no workers moved upward during the period, the index equals zero. If all workers started at non-exporting firms in $t - 1$ and moved to high export firms in $t$, the index equals one. Thus, the index is larger when there is more upward mobility. For each industry we compute the upward mobility index separately for professionals and managers, and for clerks.[21] We focus on these two broad occupational categories because we expect them to differ in their impacts on reducing the costs associated with international businesses.

To investigate the link between upward mobility and trade openness, we regress our mobility index on industry export shares and control for both industry and year fixed effects. Export shares are computed as an industry's total exports as a share of total sales and used to capture the extent of trade openness for that industry.[22] The coefficient on export shares is identified by within-industry over-time variation in export shares. The estimate in column 1 (based on three firm groups) suggests a statistically significant positive correlation between increased industry export shares and upward mobility for professionals and managers. In contrast, the results in column 6 do not suggest any significant link between increased openness and upward mobility for clerks. Columns 2 and 7 in panel A display a similar pattern when firms are divided into five groups in which the first group still consists of non-exporters, and the other four groups are based on quartiles of the distribution for firm export shares. Finally, allowing for ten firm groups does not alter our results (columns 3 and 8).[23]

[20] For workers who moved across industries, industry affiliation is based on the industry where the workers ended up.
[21] Based on the *Swedish Standard Classification of Occupations* (*SSYK96*), professionals and managers include occupations with SSYK96 = 1, 2, and 3, and clerks are occupations with SSYK96 = 4.
[22] We have also used industry tariffs on Swedish exports to capture trade openness. The results are qualitatively similar to those reported in Table 2. However, since around 70 percent of Swedish exports are to other EU countries and the variation in industry tariffs is relatively small, the estimates are less precise. These results are available upon request.
[23] The classification by export shares in Table 2 is based on the entire sample of exporting firms across all industries. We have also grouped firms based on the distribution of export shares within each industry. For example, in the case of three firm groups, high export firms are defined as those with export shares above the industry median of exporting firms, and low export firms are those with export shares below the industry median of exporting firms. The regression results based on this alternative firm grouping are very similar to those reported in Table 2. These results are shown in Table A1.

An alternative way to capture upward mobility is to use the share of workers who move up to firms that have a larger export share compared to the worker's previous employee. As shown in panel A columns 4-5, for professionals and managers a 10 percentage point increase in industry export shares is associated with a 8.5 percentage point increase in the share of workers who move up to firms that have a higher export share, and most of upward mobility is to firms that have a larger export share by more than 10 percentage points compared to the worker's previous employee. In contrast, in columns 9-10 we again find no evidence for a link between industry export expansion and upward mobility for clerks.

In panel B, we turn to downward mobility, with all measures defined in a way similar to those of upward mobility. We find some evidence for a negative relationship between industry export shares and downward mobility. In particular, the estimates in columns 4-5 for professionals and managers suggest that a 10 percentage point increase in industry export shares is associated with a 10.5 percentage point decrease in the share of workers who move downward to firms that export less compared to the worker's previous employee, and a 12.9 percentage point decrease in the share of workers who move down to firms that export less by 10 percentage points than the worker's previous employee did. Again, dividing our firms by wages rather than export gives similar results as the ones shown in Table 2 (not shown).

Overall, the results in Table 2 provide some preliminary and suggestive evidence for the link between trade openness and worker mobility for professionals and managers. On the other hand, we find little evidence for such a link for clerks. These different patterns of worker mobility for different occupations (e.g., professionals and managers versus clerks) could have further implications for wage mobility between occupations.

## 6. Conclusion

Most workers land their first full-time job in their 20s and then spend 40 to 50 years in the labor market trying to earn a living. Over their careers, workers acquire new skills, which enables them to change jobs and (sometimes) occupations in order to increase job satisfaction and career earnings. It follows that a complete picture of the impact of globalization on a typical worker should take into account its impact on skill acquisition and the rate at which workers are able to secure better jobs (that is, economic mobility).

In this paper, we have provided a framework to investigate such issues. In particular, we have developed a model of a jobs ladder in which workers gain skills on the job that qualify them for higher-paying jobs at more productive firms. Productivity is not directly observable, requiring firms to screen workers during the recruiting process. Firms then self-select into different groups based on the wages that they pay, their level of international engagement, the type of screening that they use and networks that they use to recruit workers. Low-productivity firms pay low wages and recruit only inexperienced workers. These firms do not earn enough revenue to cover the cost of accessing world markets, and thus, sell their output domestically. Medium-productivity firms pay higher wages, recruit workers away from low-wage firms and screen them to ensure that they have acquired skills that reduce the marginal cost of production. High-productivity medium-wage firms export a portion of their output, while low-productivity medium-wage firms do not engage in international markets. Finally, high-productivity firms pay high-wages, export a fraction of their output, and poach workers from medium-wage exporters. These firms screen for the type of skills that reduce the cost of exporting. Globalization alters the mix of jobs available and thus changes the rate at which workers gain skills and move up the jobs ladder.

Our main finding is that globalization increases economic mobility through two channels. First, the reduction in trade costs leads to more international engagement by firms. As the number of exporting firms grows, the ability of workers to gain skills that reduce trade costs is enhanced. This makes it easier for workers to qualify for jobs at the top of the jobs ladder. Second, since high-productivity firms gain disproportionally from falling trade costs, globalization increases wage inequality. And, as the gaps between the wages paid by different groups of firms increase, workers become more willing to (a) incur the moving costs associated with changing jobs and (b) expend effort to keep their skills from deteriorating. As a result, upward economic mobility rises and downward economic mobility (due to demotions or terminations) falls. These changes in economic mobility reduce the differences in expected lifetime incomes forecast by workers in high-wage and low-wage jobs, resulting in the possibility that inequality in lifetime incomes might fall with globalization (even though wage inequality is rising). Even the case in which globalization increases inequality in terms of lifetime incomes, the impact is smaller than its impact on wage inequality. Thus, our model yields several potentially important predictions that deserve detailed empirical scrutiny. In section 5, we presented initial empirical findings using data on recruitments and job mobility in Sweden that support the key assumptions of our model and some of its predictions concerning the link between globalization and economic mobility for certain occupations.

Finally, we note that recent empirical work has found shrinking employment in middle-wage occupations in favor of employment gains in both low-wage and high-wage occupations (see Goos and Manning 2007; Goos, Manning, and Salomons 2009; Autor, Katz and Kearney 2006, 2008 and Autor and Dorn 2013). This job polarization has been largely linked with offshoring. Complementary with this work, our results indicate that globalization can result in a shrinking middle-class *even within a given occupation and even without offshoring*. In particular, the labor market in our model consists of workers in a single occupation and we model globalization as a reduction in trade costs. In this context, we show that globalization alters the networks that firms use to fill their vacancies and that this reduces the number of jobs that pay midlevel wages. This is because expanded export opportunities increase the incentives for the strongest firms to recruit the most experienced workers by paying the high wages; while more intense import competition causes weak firms to re-orient their hiring toward inexperienced low-wage workers.

## Appendix A

The distribution of entrepreneurial ability has no effect on the equilibrium jobs ladder. In any equilibrium, expected lifetime utility for an entrepreneur must equal expected lifetime income for an inexperienced worker (from eq. 3.d in the text):

$$(A.1) \quad V_{\varepsilon}(\varepsilon_0) = V_{0l}(w_l)$$

It must also be true that total entrepreneurial income absorbs all expected profit (from eq. 11 in the text, slightly re-written):

$$(A.2) \quad w_{\varepsilon}\, \bar{\varepsilon}(\varepsilon_0) L_{\varepsilon}(\varepsilon_0) = \frac{1-Z(\phi_0)}{\rho+\delta_f} \mathcal{M} \int_{\phi_0}^{\infty} \Pi_F(\phi)\tilde{z}(\phi)d\phi$$

where, as in the text, $\bar{\varepsilon}(\varepsilon_0)$ is the mean of $\varepsilon$ conditional on $\varepsilon \geq \varepsilon_0$. Since $H(\varepsilon)$ represents the distribution function of entrepreneurial ability, $L_{\varepsilon}(\varepsilon_0) = \left(1 - H(\varepsilon_0)\right)L$, and $\bar{\varepsilon}(\varepsilon_0) = \int_{\varepsilon_0}^{\infty} \varepsilon\tilde{h}(\varepsilon)d\varepsilon$ so we can re-write $(A.2)$

$$(A.3) \quad w_{\varepsilon} \int_{\varepsilon_0}^{\infty} \varepsilon\tilde{h}(\varepsilon)d\varepsilon \left(1 - H(\varepsilon_0)\right)L = \frac{1-Z(\phi_0)}{\rho+\delta_f} \mathcal{M} \int_{\phi_0}^{\infty} \Pi_F(\phi)\tilde{z}(\phi)d\phi$$

Given all of the equilibrium values of the variables along the jobs ladder, equations $(A.1)$ and $(A.3)$ determine the equilibrium values of $w_{\varepsilon}$ and $\varepsilon_0$. Any change in the distribution of entrepreneurial ability is reflected in a change in these two equilibrium values, which in turn affect only the distribution of workers between entrepreneurship and production. Changes in the mass of production workers affects only the scale of economic activity without any impact on the qualitative properties of the jobs ladder.

## Appendix B

Our data originate from several register-based data sets from Statistics Sweden. Our empirical analysis uses two main datasets. The first one is the Swedish firm data base containing detailed information on all Swedish private sector firms. Firm level information on export for these firms originate from the Swedish Foreign Trade Statistics, collected by Statistics Sweden. Based on compulsory registration at Swedish Customs, the data cover all trade transactions outside the EU. Trade data for EU countries are available for all firms with a yearly import or export of around 1.5 million SEK and above. According to figures from Statistics Sweden, the data cover around 92% of total goods trade within the EU. The trade data cover export of goods but not on export of services.

The second data set includes detailed information all Swedish individuals at the age 16 or above. For our purpose, a crucial feature of the data is that we know if the person is in the labor force or not. Persons in the labor force can be linked to the firm level data set. The information on the individuals comes in two forms. Firstly, the main part of the information concerns the status in the month of November. Secondly, there are some additional information on the status in the rest of the year, such as the number of days being unemployed.

## References

Artuc, Erhan; Shubham Chaudhuri, and John McLaren (2010). "Trade Shocks and Labor Adjustment: A Structural Empirical Approach." *American Economic Review*, 100:3 (June 2010), 1008-45.

Anderson, James and Eric van Wincoop (2004). "Trade Costs." *American Economic Review*, 42(3): 691-751.

Autor, David; Lawrence Katz and Melissa Kearney (2006). "The Polarization of the U.S. Labor Market." *American Economic Review*, 96:2 (May 2006): 189-194.

Autor, David; Lawrence Katz and Melissa Kearney (2008): "Trends in U.S. Wage Inequality: Revising the Revisionists." *Review of Economics and Statistics*, 90:2 (May 2008): 300-323.

Autor, David and David Dorn (2013). "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market." *American Economic Review*, 103(5): 1553-1597.

Bartholomew, David J. (1982). *Stochastic Models for Social Processes*, 3rd ed. Wiley, London.

Baumgarten, Daniel (2013). "Exporters and the Rise in Wage Inequality: Evidence from German Linked Employer-Employee Data." *Journal of International Economics*, 90(1): 2001-2017.

Bernard, Andrew; J. Bradford Jensen; Stephen Redding and Peter Schott (2007). "Firms in International Trade." *Journal of Economic Perspectives*, 21(3): 105-130.

Bernhardt, Annette; Martina Morris; Marl Handcock and Mark Scott (2001). *Divergent Paths: Economic Mobility in the New American Labor Market.* Russell Sage Foundation.

Blanchard, Olivier (1985). "Debts, Deficits and Finite Horizons. *Journal of Political Economy*, 93(2): 223-47.

Broda, Christian and David Weinstein (2006). "Globalization and the Gains from Variety." *Quarterly Journal of Economics*, 121(2): 541-85.

Davidson, Carl; Fredrik Heyman; Steven Matusz; Fredrik Sjöholm and Susan Chun Zhu (2018). "Globalization and the Jobs Ladder." *Michigan State University Working Paper.*

Davies, James; France St-Hilaire and John Whalley (1984). "Some Calculations of Lifetime Tax Incidence." *American Economic Review*, 74(4): 633-49.

Davis, Steven and Till von Wachter (2011). "Recessions and the Costs of Job Loss." *Brookings Papers on Economic Activity*, 41(2): 1-72.

Egger, Hartmut and Udo Kreickemeier (2012). "Fairness, Trade and Inequality." *Journal of International Economics,* 86(2): 184-196.

Farber, Henry (1994). "The Analysis of Interfirm Worker Mobility." *Journal of Labor Economics,* 12(4): 554-93.

Farber, Henry (1998). "Are Lifetime Jobs Disappearing? Job Duration in the United States 1973-1993." In *Labor Statistic Measurement Issues* (Haltiwanger, Manser and and Topel, editors). University of Chicago Press: 157-206.

Farber, Henry (2010). "Job Loss and the Decline in Job Security in the United States." In *Labor in the New Economy* (Abraham, Spletzer and Harper, editors). University of Chicago Press: 223-62.

Forsythe, Eliza (2017). "Occupational Job Ladders and the Efficient Reallocation of Displaced Workers." University of Illinois Working Paper.

Frederiksen, Anders; Timothy Halliday and Alexander Koch (2016). "Within- and Cross-Firm Mobility and Earnings Growth." *ILR Review*, 69(2): 320-53.

Fullerton, Don and Diane Lim Rogers (1993). *Who Bears the Lifetime Tax Burden?* Brookings Institute.

Goos, Marteen and Alan Manning (2007). "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain." *Review of Economic and Statistics,* 89:1 (February 2007): 118-33.

Goos, Marteen; Alan Manning and Anna Salomons (2009). "Job Polarization in Europe." *American Economic Review,* 99:2 (May 2009): 58-63.

Groes, Fane; Philipp Kircher and Iourii Manovskii (2014). "The U-Shapes of Occupational Mobility." *Review of Economic Studies,* 82(2): 659-92.

Guner, Nezih; Alessandro Ruggieri and James Tybout (2018). "Training, Offshoring and the Jobs Ladder." Pennsylvania State University Working Paper.

Haider, Steven and Gary Solon (2006). "Life-Cycle Variation in the Association between Current and Lifetime Earnings." *American Economic Review,* 96(4): 1308-20.

Hall, Robert (1982). "The Importance of Lifetime Jobs in the U.S. Economy." *American Economic Review,* 72(4): 716-24.

Haltiwanger, John; Henry Hyatt, Lisa Kahn and Erika McEntarfer (2018). "Cyclical Reallocation of Workers Across Employers by Firm Size and Firm Wage." *American Economic Journal: Macroeconomics,* 10(2) 52-85.

Harrison, Anne; John McLaren and Margaret McMillan (2011). "Recent Perspectives on Trade and Inequality." *Annual Review of Economics,* 3: 261-89.

Helpman, Elhanan (2017). "Globalization and Wage Inequality." *Journal of the British Academy,* 5: 125-62.

Helpman, Elhanan; Oleg Itskhoki and Stephen Redding (2010a). "Inequality and Unemployment in a Global Economy." *Econometrica,* 78:4 (July 2010): 1239-1283.

Helpman, Elhanan; Oleg Itskhoki and Stephen Redding (2010b). "Unequal Effects of Trade on Workers with Different Abilities." *Journal of the European Economic Association*, 8:2-3 (April-May 2010): 421-433.

Helpman, Elhanan; Oleg Itskhoki, Marc-Andreas Muendler and Stephen Redding (2017). "Trade and Inequality: From Theory to Estimation." *Review of Economic Studies*, 84: 357-405.

Jacobson, Louis; Robert LaLonde and Dan Sullivan (1993). "Earnings Losses of Displaced Workers." *American Economic Review,* 83(4): 685-709.

Kletzer, Lori (1998). "Job Displacement." *Journal of Economic Perspectives*, 12(1): 115-36.

Krolikowski, Pawel (2016). "Job Ladders and Earnings of Displaced Workers." *American Economic Journal: Macroeconomics,* 9(2): 1-31.

Labanca, Claudio; Danielken Molina and Marc-Andreas Muendler (2014). "Preparing to Export." University of California – San Diego Working Paper.

Lillard, Lee (1977). "Inequality: Earnings vs. Human Wealth." *American Economic Review,* 67(2): 42- 53.

Melitz, Marc (2003). "The Impact of Trade on Intra-Industry Reallocations and Aggregate Productivity." *Econometrica,* 71(6): 1695-1725.

Melitz, Marc and Stephen Redding (2015). "New Trade Models, New Implications." *American Economic Review,* 105(3): 1105-46.

Mion, Giordano; Luca David Opromolla and Alessandro Sforza (2017). "The Diffusion of Knowledge via Manager's Mobility." CESifo Working Paper 6256.

Munch, Jacob and Jan Skaksen ((2008). "Human Capital and Wages in Exporting Firms." *Journal of International Economics,* 75(2): 363-372.

Sampson, Thomas (2014). "Selection into Trade and Wage Inequality." *American Economics Journal: Microeconomics,* 6(3): 157-202.

Schank, Torsten; Claus Schnabel and Joachim Wagner (2007). "Do Exporters Really Pay Higher Wages? First Evidence from German Linked Employer-Employee Data*." Journal of International Economics*, 72(1): 52-74.

Waugh, Michael and Ina Simonovska (2014). "The Elasticity of Trade: Estimates and Evidence." *Journal of International Economics,* 92(1): 34-50.

Figure 1: The Firm's Decision Tree

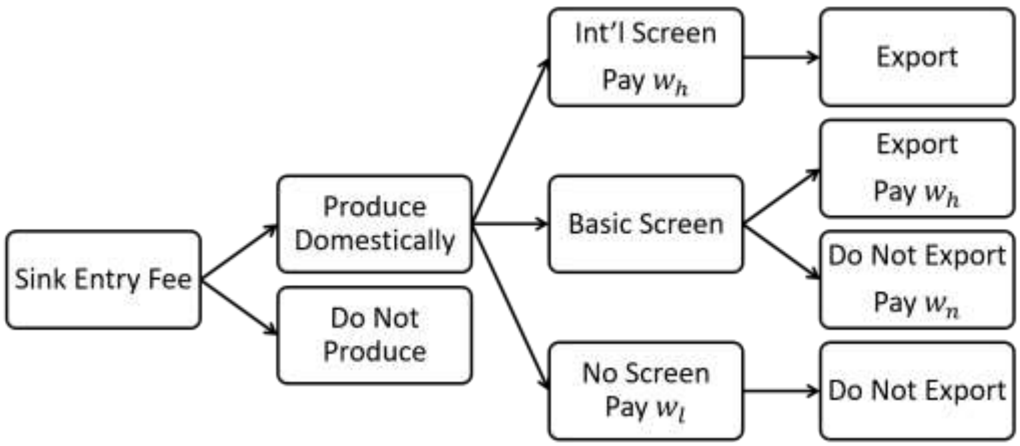



Figure 2: Worker Flows

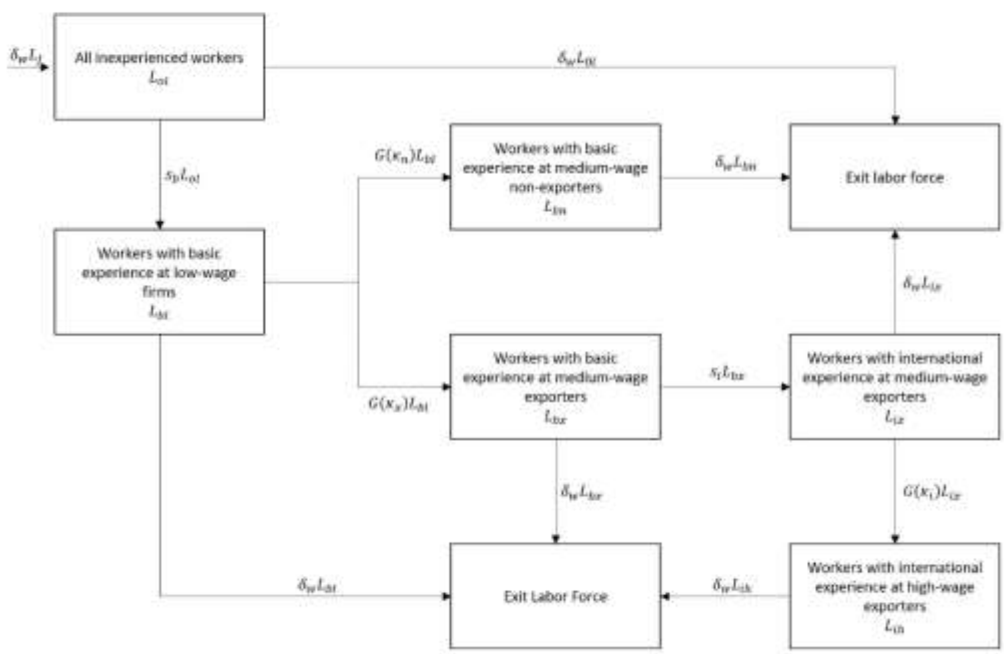
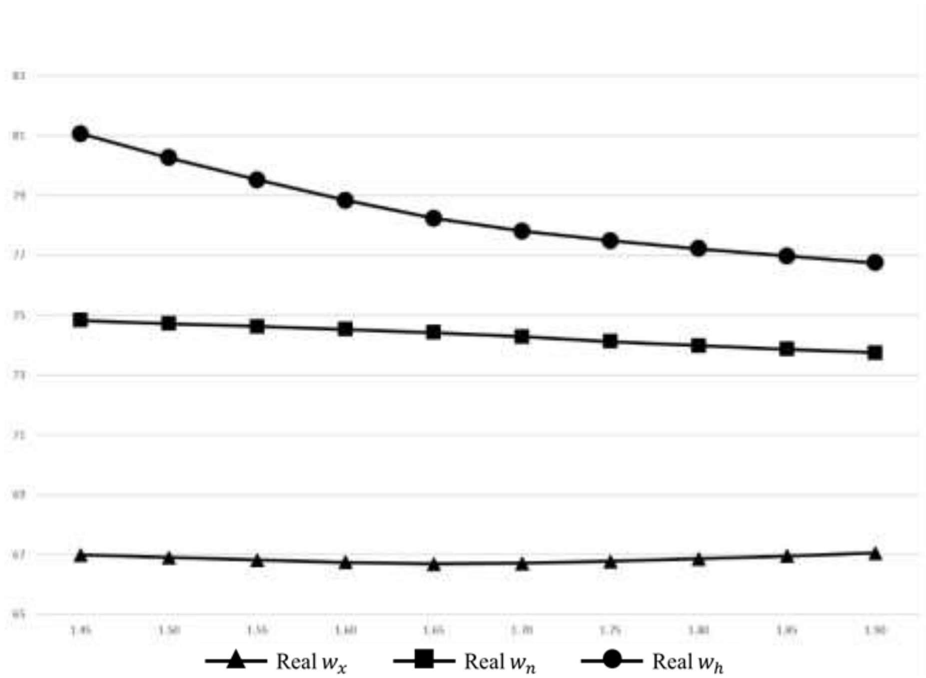


Figure 3: Real Wage Effects



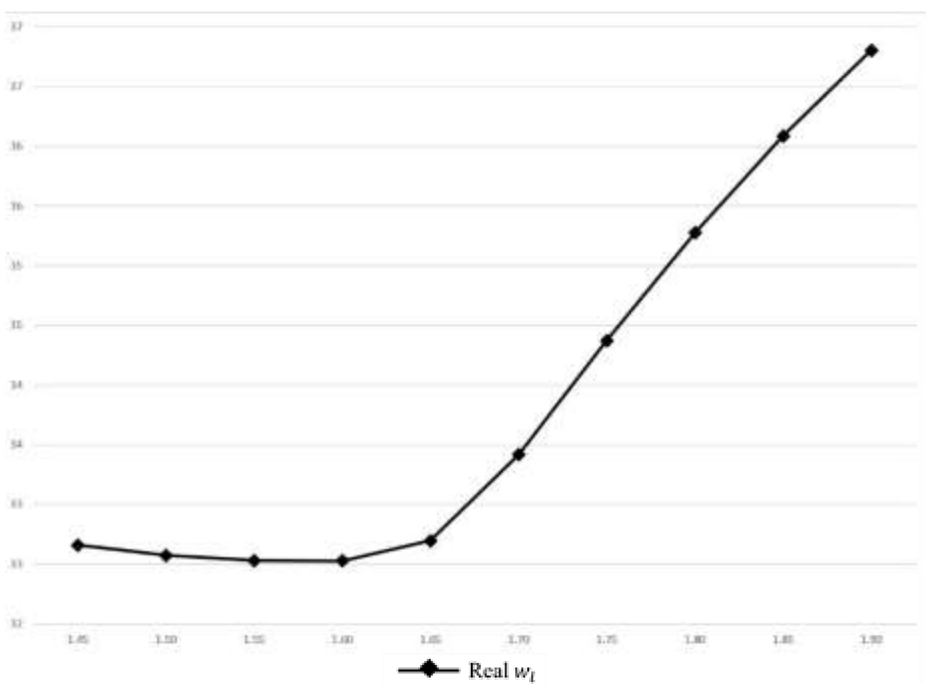



Figure 4: Employment Shares by Firm Type

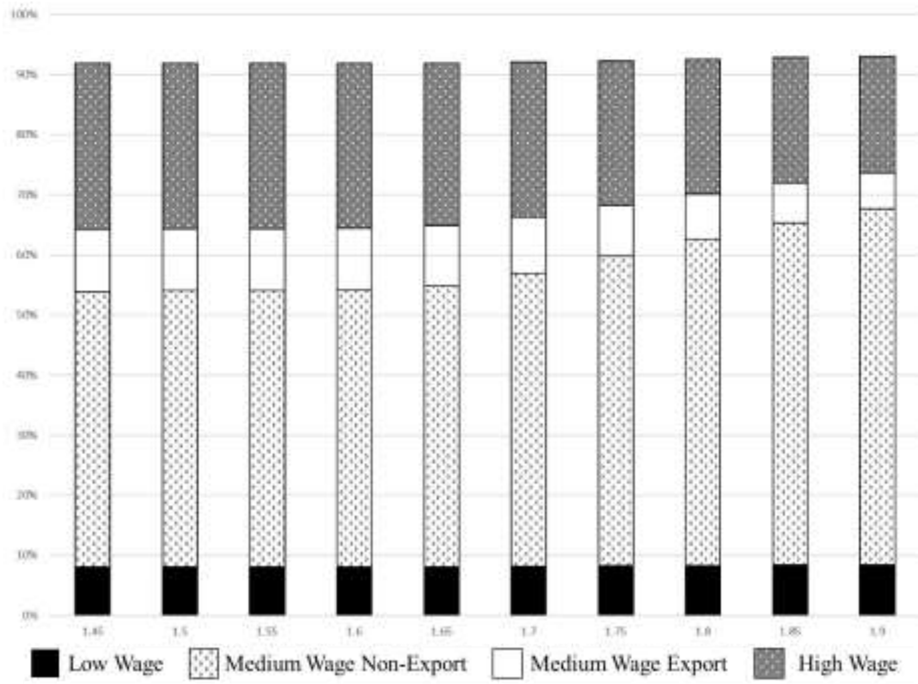



Figure 5: Average Duration of Low-Wage Jobs

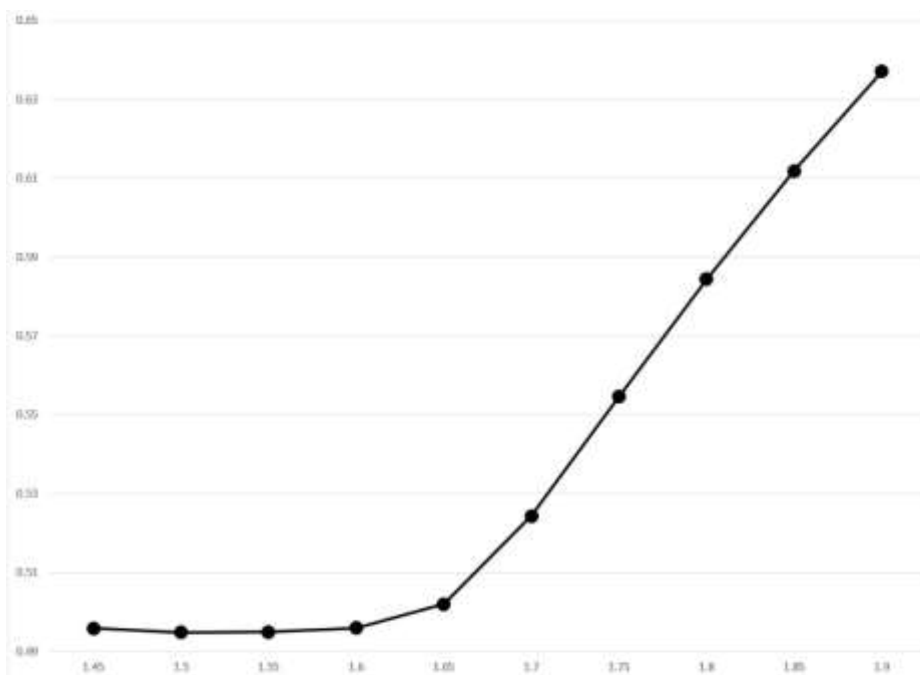


Figure 6: Measures of Inequality

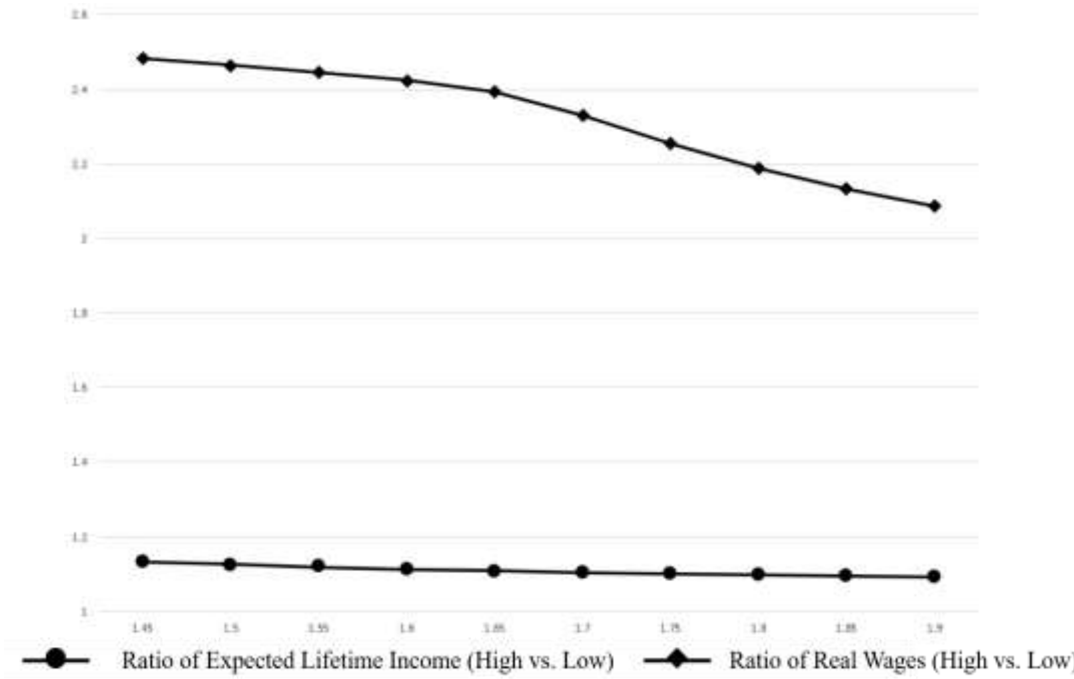



Figure 7: Worker Flows with Downward Economic Mobility

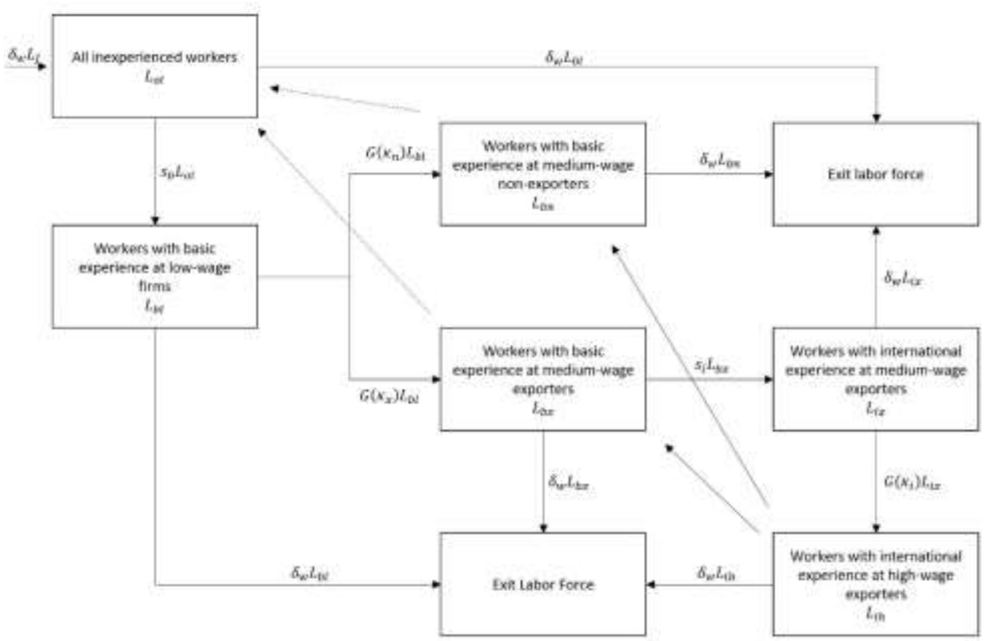
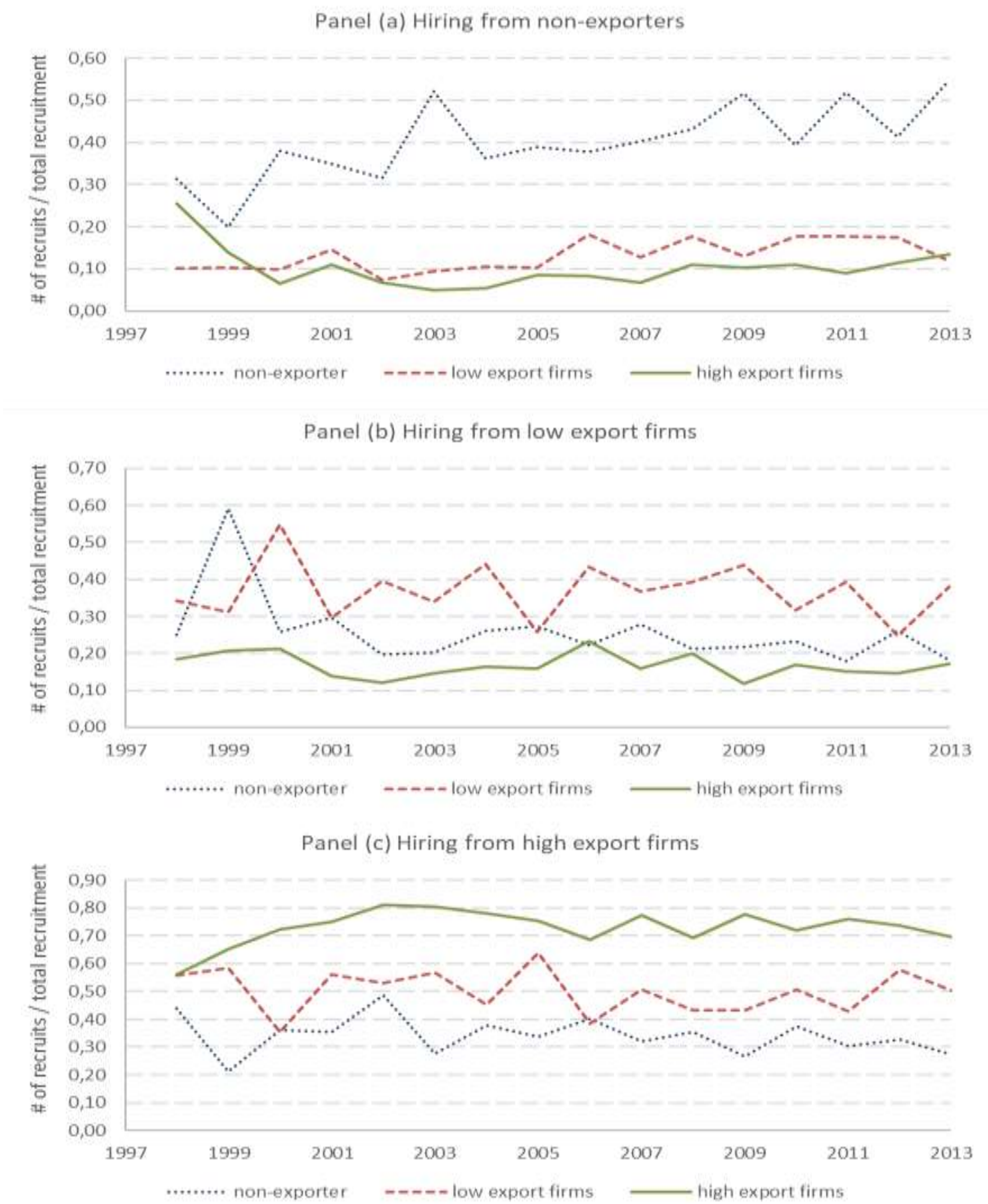


Figure 8: Hiring Practice by Firm Types




*Notes:* This figure displays the pattern of recruitment by three firm groups: (i) firms that do not export ("non-exporters"); (ii) firms that have export-to-sales ratios below the sample median of exporting firms across all industries ("low export firms"); and (iii) firms that have export-to-sales ratios above the sample median of exporting firms across all industries ("high export firms"). Panels (a)-(c) show the number of recruits from non-exporters, low export firms and high export firms, respectively, as a share of total recruitment by each firm group. For example, in 2005, out of the total recruitment by high export firms, about 8% came from non-exporters (see panel a), 16% from low export firms (see panel b), and 76% from other high export firms (see panel c).

**Table 1A: Sensitivity Analysis**

$\sigma = 2.7$

(Trade Elasticity = 3.68)

| | $\boldsymbol{\tau}$ | **1.45** | **1.50** | **1.55** | **1.60** | **1.65** | **1.70** | **1.75** | **1.80** | **1.85** | **1.90** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Real Wage Elasticities** | $w_l$ | -.125 | -.051 | -.026 | .037 | .420 | .948 | .962 | .874 | .781 | .698 |
| | $w_x$ | -.041 | -.040 | -.037 | -.033 | -.011 | .027 | .041 | .048 | .053 | .057 |
| | $w_n$ | -.048 | -.042 | -.040 | -.040 | -.054 | -.072 | -.070 | -.064 | -.058 | -.052 |
| | $w_h$ | -.296 | -.289 | -.278 | -.263 | -.219 | -.155 | -.131 | -.120 | -.111 | -.104 |
| **Duration Elasticities** | $D_{bl}$ | -.145 | -.017 | .026 | .143 | .871 | 1.89 | 1.92 | 1.76 | 1.59 | 1.43 |
| | $D_{ix}$ | .011 | .012 | .013 | .014 | .014 | .013 | .013 | .014 | .015 | .016 |

**Table 1B: Sensitivity Analysis**

$\sigma = 3.1$

(Trade Elasticity = 3.01)

| | $\boldsymbol{\tau}$ | **1.45** | **1.50** | **1.55** | **1.60** | **1.65** | **1.70** | **1.75** | **1.80** | **1.85** | **1.90** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Real Wage Elasticities** | $w_l$ | -.391 | -.224 | -.089 | .023 | .115 | .192 | .225 | .304 | .342 | .368 |
| | $w_x$ | -.023 | -.018 | -.014 | -.009 | -.005 | .000 | .005 | .010 | .015 | .019 |
| | $w_n$ | -.089 | -.077 | -.069 | -.063 | -.059 | -.056 | -.054 | -.051 | -.049 | -.047 |
| | $w_h$ | -.250 | -.239 | -.227 | -.214 | -.201 | -.188 | -.175 | -.162 | -.150 | -.139 |
| **Duration Elasticities** | $D_{bl}$ | -.551 | -.271 | -.041 | .150 | .310 | .443 | .552 | .640 | .706 | .753 |
| | $D_{ix}$ | .600 | .625 | .647 | .667 | .685 | .702 | .718 | .734 | .749 | .765 |

**Table 1C: Sensitivity Analysis**

$\sigma = 2.2$

(Trade Elasticity = 4.54)

| | $\tau$ | **1.45** | **1.50** | **1.55** | **1.60** | **1.65** | **1.70** | **1.75** | **1.80** | **1.85** | **1.90** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Real Wage Elasticities** | $w_l$ | -1.97 | -2.04 | -2.02 | -.063 | -.034 | 1.45 | 1.30 | 1.06 | .887 | .75 |
| | $w_x$ | -.169 | -.141 | -.114 | -.049 | -.046 | .053 | .064 | .065 | .066 | .066 |
| | $w_n$ | -.276 | -.248 | -.214 | -.047 | -.044 | -.036 | -.032 | -.028 | -.025 | -.022 |
| | $w_h$ | -.297 | -.270 | -.249 | -.278 | -.271 | -.087 | -.070 | -.071 | -.071 | -.072 |
| **Duration Elasticities** | $D_{bl}$ | -4.00 | -4.09 | -3.99 | -.035 | .023 | 3.16 | 2.86 | 2.38 | 2.01 | 1.73 |
| | $D_{ix}$ | $4x10^{-5}$ | $4x10^{-5}$ | $5x10^{-5}$ | $8x10^{-5}$ | $8x10^{-5}$ | $5x10^{-5}$ | $5x10^{-5}$ | $5x10^{-5}$ | $5x10^{-5}$ | $6x10^{-5}$ |

**Table 2: Mobility regressions**

| | Professionals and managers | | | | | Clerks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3 firm groups | 5 firm groups | 10 firm groups | > 0% | > 10% | 3 firm groups | 5 firm groups | 10 firm groups | > 0% | > 10% |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | *Panel A: Upward mobility* | | | | | | | | | |
| Industry export share | 0.0173** | 0.0203** | 0.0158** | 0.853* | 0.837* | 0.00785 | 0.00898 | -0.00323 | 0.626 | 0.626 |
| | (2.20) | (2.61) | (2.34) | (2.07) | (1.90) | (0.75) | (0.79) | (-0.45) | (1.22) | (1.16) |
| Observations | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 |
| Adjusted R2 | 0.089 | 0.121 | 0.117 | 0.188 | 0.120 | 0.006 | -0.005 | 0.036 | 0.121 | 0.074 |
| | *Panel B: Downward mobility* | | | | | | | | | |
| Industry export share | -0.0487 | -0.103 | -0.0820 | -1.047** | -1.288*** | -0.0202 | -0.0484 | -0.0364 | -0.754 | -1.034* |
| | (-1.33) | (-1.49) | (-1.32) | (-2.87) | (-3.21) | (-1.40) | (-1.46) | (-1.19) | (-1.57) | (-1.85) |
| Observations | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 |
| Adjusted R2 | 0.065 | 0.109 | 0.099 | 0.169 | 0.229 | 0.108 | 0.087 | 0.078 | 0.081 | 0.099 |

*Notes*: This table examines the link between worker mobility and trade openness at the industry level. Industry export share is computed as an industry's total exports as a share of total sales. In panel A columns 1 and 6, upward mobility is defined as $\square_{ij}S_{ijt}(j-i)/(k-1)$ for $i < j$ where i (and j) = 1, 2, 3 indicate, respectively, the group of non-exporters, low export firms (those with export-to-sales ratios below the sample median of exporting firms across all industries), and high export firms (those with export-to-sales ratios above the sample median of exporting firms across all industries); $S_{ijt}$ is the number of workers who move from a firm in the i group to another firm in the j group as a share of all movers between year t-1 to year t; and k is the number of firm groups. In panel A columns 2 and 7, firms are divided into 5 groups in which the first group consists of non-exporters, and the other four groups are based on quartiles of the distribution for export-to-sales ratios of exporting firms across all industries. In columns 3 and 8, firms are separated into 10 groups. In panel A columns 4 and 9, upward mobility is computed as the share of workers who move up to firms that have a larger export-to-sales ratio compared to the worker's previous employee. In panel A columns 5 and 10, upward mobility is computed as the share of workers who move up to firms that have a larger export-to-sales ratio by more than 10 percentage points compared to the worker's previous employee. In panel B all measures of downward mobility are constructed in a way similar to those of upward mobility in panel A. In all regressions, both industry and year fixed effects are included. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table A1: Mobility regressions: robustness to alternative firm -grouping**

| | Professionals and managers | | | Clerks | | |
|---|---|---|---|---|---|---|
| | 3 firm groups | 5 firm groups | 10 firm groups | 3 firm groups | 5 firm groups | 10 firm groups |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | *Panel A: Upward mobility* | | | | | |
| Industry export share | 0.0154** | 0.0191** | 0.0151* | -0.0132 | -0.00223 | -0.00367 |
| | (2.36) | (2.91) | (1.89) | (-0.80) | (-0.29) | (-0.55) |
| Observations | 192 | 192 | 192 | 192 | 192 | 192 |
| Adjusted R2 | 0.146 | 0.092 | 0.087 | 0.066 | 0.077 | 0.070 |
| | *Panel B: Downward mobility* | | | | | |
| Industry export share | -0.000104 | -0.0885 | -0.0812 | -0.00584 | -0.0464 | -0.0465 |
| | (-0.01) | (-1.24) | (-1.28) | (-0.49) | (-1.39) | (-1.53) |
| Observations | 192 | 192 | 192 | 192 | 192 | 192 |
| Adjusted R2 | 0.108 | 0.081 | 0.088 | 0.021 | 0.041 | 0.064 |

*Notes*: This table examines the link between worker mobility and trade openness at the industry level. Industry export share is computed as an industry's total exports as a share of total sales. Differing from Table 1, in this table firms are grouped based on the distribution of export-to-sales ratios of exporting firms within each industry. In panel A columns 1 and 4, upward mobility is defined as $\square_{ij}S_{ijt}(j-i)/(k-1)$ for $i < j$ where i (and j) = 1, 2, 3 indicate, respectively, the group of non-exporters, low export firms (those with export-to-sales ratios below the industry median of exporting firms), and high export firms (those with export-to-sales ratios above the industry median of exporting firms); $S_{ijt}$ is the number of workers who move from a firm in the i group to another firm in the j group as a share of all movers between year t-1 to year t; and k is the number of firm groups. In panel A columns 2 and 5, firms are divided into 5 groups in which the first group consists of non-exporters, and the other four groups are based on quartiles of the distribution for export-to-sales ratios of exporting firms within an industry. In columns 3 and 6, firms are separated into 10 groups. In panel B all measures of downward mobility are constructed in a way similar to those of upward mobility in panel A. In all regressions, both industry and year fixed effects are included. ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

Online Appendix (for the referees)

Our goal is to extend our model to allow for downward economic mobility. The basic idea is as described in the text. Once a worker gains a skill and secures a new job, they must exert effort to maintain that skill. If effort is exerted, the worker's productivity remains at its new, higher level. If the worker does not put forth effort, their new skill erodes, their productivity reverts to its old level and they risk detection and termination. Terminated workers must go back down the ladder one rung, take a new job at a lower wage, and try and reacquire their skills. The cost of effort is drawn from a distribution once the skill is acquired and thus, varies across workers. Workers make the effort decision based on cost benefit analysis.

We introduce the following new notation:

$d_j$ = the detection rate at firms that pay wage $w_j$ (for $j = n,,x,h$)

$\gamma_{gj}$ = the shirking rate for workers with experience $g$ (for $g = b,i$) employed by type $j$ firms (for $j = n,x,h$)

$c_j$ = the critical cost of maintaining your most recently acquired skill if you work for a type $j$ firm (for $j = n,x,h$)

Workers at a type $j$ firm that draw a cost below $c_j$ exert effort and maintain their skill. Workers that draw a cost above $c_j$ shirk and risk detection.

Our new notation allows us to explain how the labor market dynamics, as described in (1), are altered by downward mobility -- (1.b) is not altered, while the remaining equations become

(1.a) $\delta_w L_J + d_m(\gamma_{bn}L_{bn} + \gamma_{bx}L_{ex} + \gamma_{ix}L_{ix}) = (\delta_w + s_b)L_{0l}$

(1.c) $G(\kappa_n)L_{bl} + d_h\lambda_n\gamma_{ih}L_{ih} = (\delta_w + d_n\gamma_{bn})L_{bn}$

(1.d) $G(\kappa_x)L_{bl} + d_h(1-\lambda_n)s_{ih}L_{ih} = [\delta_w + (1-\gamma_{bx})s_i + d_x\gamma_{bx}]L_{bx}$

(1.e) $(1-\gamma_{bx})s_iL_{bx} = [\delta_w + G(\kappa_i) + d_x\gamma_{ix}]L_{ix}$

(1.f) $G(\kappa_i)L_{ix} = [\delta_w + d_h\gamma_{ih}]L_{ih}$

As before, the left-hand-side gives the flow into a labor market state. Equation (1.a) now reflects the fact that some workers earning employed by medium-productivity firms are caught shirking and are fired, forcing them back to the bottom rung of the jobs ladder. To be fired, a worker must shirk and must be detected shirking by the firm. Thus, the measure of workers entering labor market state $L_{ol}$ is now made up of the newborns (the first term on the left-hand-side of 1.a) and those workers at medium-productivity firms that shirk and are then fired by their firms (the second term on the left-hand-side of 1.a). Similar logic explains the remaining equations. For (1.c), which refers to flows into and out of state $L_{bn}$, there is now a new flow into that state made up of high-wage workers that were fired for shirking ($d_h\lambda_n\gamma_{ih}L_{ih}$) and a new flow out of that state made up of current employees that were fired ($d_n\gamma_{bn}L_{bn}$). Note that flows into and out of state $L_{bl}$ and $L_d$ are not affected by the extension, since workers at medium-productivity firms that are fired are equivalent to inexperience workers.[24]

Turn next to expected lifetime income, described in (2). Nothing changes in (2.a) or (2.g), since we assume that you do not have to put in effort to maintain your basic skills until you take a job with a medium-productivity firm (this simplification captures the idea that you do not lose skills right away, rather that they erode over time, beginning when you move to a job requiring basic experience). For the remaining terms, define

$V_{gj}^{s}(w_t)$ = expected lifetime real income for a <u>shirking</u> worker with experience $g$ (for $g = b, i$) that is earning $w_t$ while employed by a type $t$ firm (for $t = n, x, h$)

$V_{gj}(w_t, c)$ = expected lifetime real income for a worker with experience $g$ (for $g = b, i$) that is earning $w_t$ while employed by a type $t$ firm (for $t = n, x, h$) that is <u>exerting effort</u> at a cost of $c$ to keep their skills from eroding

Then, if we use $h(c)$ to denote the distribution of the cost of effort, (2) becomes:

(2.b) $\rho V_{bl}(w_l) = \frac{w_l}{\tilde{p}} + G(\kappa_n)\left(EV_n(w_n) - V_{bl}(w_l) - \frac{1}{G(\kappa_n)}\int_0^{\kappa_n} \kappa g(\kappa)d\kappa\right) + G(\kappa_x)\left(EV_x(w_x) - V_{bl}(w_l) - \frac{1}{G(\kappa_x)}\int_0^{\kappa_x} \kappa g(\kappa)d\kappa\right) - \delta_w V_{bl}(w_l)$

where $EV_n(w_n) = \int_0^{c_n} V_{bn}(w_n, c)h(c)dc + [1 - \mathrm{H}(c_n)]V_{bn}^{s}(w_n)$

$EV_x(w_x) = \int_0^{c_x} V_{bx}(w_x, c)h(c)dc + [1 - \mathrm{H}(c_x)]V_{bx}^{s}(w_x)$

(2.c) $\rho V_{bn}(w_n, c) = \frac{w_n}{\tilde{p}} - c - \delta_w V_{bn}(w_n, c)$

(2.c') $\rho V_{bn}^{s}(w_n) = \frac{w_n}{\tilde{p}} - \delta_w V_{bn}^{s}(w_n) + d_n[V_{ol}(w_l) - V_{bn}^{s}(w_n) - \bar{\kappa}]$

(2.d) $\rho V_{bx}(w_x, c) = \frac{w_x}{\tilde{p}} - c + s_i[V_{ix}(w_x) - V_{bx}(w_x, c)] - \delta_w V_{bx}(w_x, c)$

(2.d') $\rho V_{bx}^{s}(w_x) = \frac{w_x}{\tilde{p}} - \delta_w V_{bx}^{s}(w_x) + d_x[V_{ol}(w_l) - V_{bx}^{s}(w_x) - \bar{\kappa}]$

(2.e) $\rho V_{ix}(w_x) = \frac{w_x}{\tilde{p}} + G(\kappa_i)\left(EV_h(w_h) - V_{ix}(w_x) - \frac{1}{G(\kappa_i)}\int_0^{\kappa_i} \kappa g(\kappa)d\kappa\right) - \delta_w V_{ix}(w_x)$

where $EV_h(w_h) = \int_0^{c_i} V_{ih}(w_h, c)h(c)dc + [1 - \mathrm{H}(c_i)]V_{ih}^{s}(w_h)$

(2.f) $\rho V_{ih}(w_h, c) = \frac{w_h}{\tilde{p}} - c - \delta_w V_{ih}(w_h, c)$

[24] We assume that workers employed by medium-productivity exporters must be maintaining those skills in order to gain international experience. With this assumption in place (1.a) and (1.e) can be simplified because in equilibrium we will have $\gamma_{ix} = 0$. The logic is as follows. While working for a medium-productivity exporter a worker exerts effort if the cost of effort is lower than the expected loss from being caught shirking. The expected cost of being caught shirking *rises* once this worker gains international experience. Thus, if the workers was exerting effort *before* gaining international experience, it will be optimal to continue to exert effort *after* gaining international experience.

(2.f') $\rho V_{ih}^{s}(w_h) = \frac{w_h}{\tilde{p}} - \delta_w V_{ih}^{s}(w_{ih}) + d_h[\lambda_n EV_n(w_n) + (1-\lambda_n)EV_x(w_x) - V_{ih}^{s}(w_h) - \bar{\kappa}]$

Note that (2.a) and (2.g) are unaffected by the extension since you cannot be demoted when you are inexperienced or working as an entrepreneur. Equation (2.b) changes only slightly in that when the worker receives an offer to move they are not sure of their cost of effort and therefore the capital gain from accepting the offer is based on a convex combination of what they earn if they draw a low cost of effort (and exert effort) and what they earn if they draw a high cost of effort (and shirk). This convex combination is denoted by $EV_n(w_n)$ if the offer comes from a medium-productivity non-exporter and $EV_x(w_x)$ if the offer comes from a medium-productivity exporter. Similar logic explains the change to (2.e).

Equations (2.c), (2.d) and (2.f) apply to workers that are exerting effort and therefore do not need to worry about being fired. The only change to these equations is that we now must account for the cost of effort, $c$. The remaining equations apply to those workers that draw a high cost of effort and shirk. These equations account for the expected capital loss from shirking. Note that fired workers incur a cost of moving, which, in expected value terms is $\bar{\kappa}$, the mean of the cost of moving distribution.

Since the marginal worker is just indifferent between shirking and exerting effort, the new critical cost cut-offs are determined as follows

(3.e) $V_{bn}(w_n, c_n) = V_{bn}^{s}(w_n)$

(3.f) $V_{bx}(w_x, c_x) = V_{bx}^{s}(w_x)$

(3.g) $V_{ih}(w_h, c_i) = V_{ih}^{s}(w_h)$

Since we know that workers with costs below these critical cut-off rates exert effort, we can now define the shirking rates as

(15.a) $\gamma_{bn} = 1 - H(c_n)$

(15.b) $\gamma_{bx} = 1 - H(c_x)$

(15.c) $\gamma_{ih} = 1 - H(c_i)$

The pricing equation for domestic market for medium-productivity firms is different under this extension, because prices depend on worker productivity and productivity in domestic production for these firms depends on the shirking rate. In particular, (5.b) becomes

(5.b) $p_n(\phi) = \frac{\sigma}{\sigma-1}\frac{w_n}{[1-\gamma_{bn}]\phi},\ \phi \in [\phi_l, \phi_n]$

(5.b') $p_x(\phi) = \frac{\sigma}{\sigma-1}\frac{w_x}{[1-\gamma_{bx}]\phi},\ \phi \in [\phi_n, \phi_x]$

Workers exerting effort keep their basic skills and have a productivity of $\phi$, while shirking workers lose their basic skills and have their productivity revert to zero. Note that (5.a) and (5.c) do not change. This follows from two assumptions. First, we assume that workers do not need to exert effort to maintain their basic skills until securing a job at a medium-productivity firm, implying that productivity at low-wage firms is still described by $(1-\lambda_{ol})\phi$. Second, we assume that high-wage workers need to exert effort to maintain their *international* experience, implying that all such workers have basic experience and thus, productivity in production of $\phi$.

The pricing equation for foreign markets changes only for high-wage firms. For medium-productivity exporters, trade costs do not change since all workers gaining international experience keep it until moving to high-wage firms – thus, (5.d) still applies. However, for high-wage firms, some workers shirk and see their international experience disappear. The fraction of workers that shirk is $\gamma_{ih}$, so that (5.e) becomes

(5.e) $$p_h^*(\phi) = \frac{\sigma}{\sigma-1}\frac{w_h}{\phi}\frac{\tau}{1-\gamma_{ih}}$$

Since shirking affects the average product of the workforce at medium-productivity firms, the labor demand functions also change. Start with the demand for workers used to satisfy domestic demand. We now have

(6.b) $$\ell_F(\phi) = f + f_b + \frac{q_F}{[1-\gamma_{bF}]\phi} \qquad \text{for } F = n, x$$

All workers at high-wage firms have basic experience, so (6.c) does not change.

Finally, consider the labor used to satisfy foreign demand. Workers do not shirk at medium-productivity exporters and their workers that gain international experience keep it until they get to high-wage firms. Thus, (7.a) does not change. However, (7.b) becomes

(7.b) $$\ell_h^*(\phi) = f_x + f_i + \frac{q_h^*}{\phi}\frac{\tau}{1-\gamma_{ih}}$$

No other equations in the model change. Note that, in essence, this extension adds three new endogenous variables (the cut-offs that define the shirking rates) and three new equilibrium conditions, given in (3).