

# **Firing the Wrong Workers: Financing Constraints and Labor Misallocation**

Andrea Caggese  
Pompeu Fabra University, CREI, BGSE

Vicente Cuñat  
London School of Economics

Daniel Metzger  
Stockholm School of Economics\*

January 2017

## **Abstract**

This paper studies the effect of firms' financing constraints on the decision of which workers to fire. Firms need to consider wages, current and expected productivity as well as firing and hiring costs when firing a worker. Financing constraints distort this inter-temporal trade-off leading firms to sub-optimal firing decisions. In particular, financially constrained firms may fire the wrong type of workers (e.g., workers with steeper productivity profiles or lower firing costs) relative to unconstrained firms. We provide empirical evidence of this distortion using matched employer-employee data from the Swedish population between 1990 and 2010. Financing constraints are identified using a regression discontinuity approach on the determination of a public discrete credit rating and a within firm-year estimator. Negative firm shocks are identified from firm-specific trade patterns and exchange rate fluctuations. Our empirical results reveal an important new misallocation effect of financial frictions that operates within firms across different types of workers.

\* Caggese: [andrea.caggese@upf.edu](mailto:andrea.caggese@upf.edu), Cuñat: [v.cunat@lse.ac.uk](mailto:v.cunat@lse.ac.uk), Metzger: [daniel.metzger@hhs.se](mailto:daniel.metzger@hhs.se). We would like to thank Xavier Giroud, Harald Hau, and Markus Schmid, as well as seminar participants at the NBER Summer Institute 2016, CSEF-EIEF-SITE Conference on Finance and Labor, AFA 2017 for helpful comments and suggestions. The authors acknowledge the financial support of Resercaixa.

## 1 Introduction

The effect of financing frictions on the investment decisions of firms is a long-standing question in economics. Asymmetric information, transaction costs or agency problems may limit the ability of firms to pledge future expected profits in order to raise funding, making them financially constrained, and unable to finance profitable investment opportunities. The existing empirical literature has mostly focused on how the lack of funding can reduce the size of total physical investment.<sup>1</sup> More generally, however, financing constraints distort any intertemporal decision of the firm that has cash flow implications, by favoring projects that generate more cash or save costs in the short term.<sup>2</sup> This type of trade-off is also relevant for many employment related decisions that involve paying an upfront cost to improve the future expected productivity of the workforce, such as searching, screening, training, and firing.

The objective of this paper is to study the effect of financing constraints on the firing decisions of firms. In particular, we argue that financing constraints affect the types of workers who are fired across firms, and have an important distortionary effect on the optimal allocation of employees even when they have little effect on the total employment level. Firms consider several factors when deciding on which workers to fire, such as the current and future expected productivity and wages of a worker, as well as firing and hiring costs. A firm may, for instance, be indifferent between firing a recently hired promising worker with low firing costs, or a more tenured worker with low productivity growth but higher firing costs. Although all firms face similar trade-offs, financing constraints distort this decision, as constrained firms place more weight on current cash flows than on future ones.

To illustrate these ideas and to guide our empirical analysis, we develop a stylized partial equilibrium model of a firm that makes hiring and firing decisions of heterogeneous workers and is subject to financial frictions. The key elements of the model are as follows. The productivity of workers varies during their tenures, so firms need to keep

---

<sup>1</sup> See Hubbard 1998 for a review of the early literature. More recent contributions which studied the recent great recession include, among others, Campello, Graham and Harvey, (2010) and Almeida, Campello, Laranjeira and Weisbenner (2012).

<sup>2</sup> This type of trade-off is relevant, for example, for the decision to buy new or used capital (Eisfeldt and Rampini, 2006).

replacing them to maximize productivity, even in the presence of firing costs. Moreover, recently hired young workers have the potential to become more productive in the future, and, therefore, their value for the firm includes an option component. Another key feature of the model is that wages are rigid and do not fully adjust to compensate fluctuations in productivity of workers. Firing costs increase with workers' tenure in the firm.

In equilibrium, financial frictions not only affect the overall level of firm employment, but also the optimal mix of short-tenured and long-tenured workers. More financially constrained firms have a higher opportunity cost of money and discount the option value of short-tenured workers more heavily, placing a larger weight on short-term returns. Moreover, long-tenured workers are less likely to be fired in constrained firms that have a higher opportunity cost of paying their firing costs. Finally, the higher firing hazard of young workers in constrained firms implies that a smaller fraction of them become long-tenured workers. As a consequence, the model implies the following three testable hypotheses: First, all else equal, the more financially constrained a firm, the more likely it will fire a short-tenured worker, and the less likely it will fire a long-tenured worker. Second, the more financially constrained a firm, the younger the tenure profile of its labour force. Third, in the event of an exogenous shock that requires a reduction in employment, a more financially constrained firm will fire relatively more short-tenured workers than a less constrained firm. These distortions imply, in equilibrium, that financing constraints induce firms to have a less productive pool of workers. This effect operates through a labor demand channel.

To understand the empirical relevance of these distortions, we analyze (i) the average firing policies of firms, (ii) the tenure profile of the labor force, and (iii) the firing policies after an exogenous negative shock. We test the predictions of the model using matched employer-employee data from the whole active population of Sweden over two decades – between 1990 and 2010. We match worker information with employer information, for which we have extensive balance sheet and credit score data. The exceptional quantity and quality of information available in this dataset makes it ideal for our objective.

We identify financing constraints in three different ways. First, we use three discrete rating categories, provided by the main rating company in Sweden, that measure the creditworthiness of firms. This specification captures the within-firm equilibrium correlations between firing and financing constraints. Second, we use a regression discontinuity design (RDD) that uses the thresholds (on a continuous risk measure) that determine credit ratings. Small differences in an underlying continuous default probability measure lead to discrete changes in a public rating that have important consequences for the perception of the creditworthiness of the firm. Our design exploits this discrete change in perceived creditworthiness by comparing firms that are arbitrarily close to a rating boundary but are on either side of the threshold. Finally, the detail and structure of the data allows us to compare high and low-tenured workers within a firm on a given year. The specification absorbs any time-varying characteristics that affect both types of workers within a firm.

To identify exogenous changes in firing, we use shocks to the exchange rate of a firm-specific basket of currencies. We construct it using the country composition of the firm's exports at the beginning of the sample period.

Our analysis concentrates on comparing the firing of short-tenured workers – who, on average have steeper productivity profiles and lower firing costs – with long-tenured workers. We show that: first, financially constrained firms employ more short-tenured workers on average than unconstrained firms. Second, after suffering an exchange rate appreciation shock, both constrained and unconstrained firms are more likely to fire workers. Importantly, however, we find significant differences in the types of workers fired across firms. The shock causes relatively more firing of short-tenured workers than long-tenured ones in financially constrained firms, but relatively less firing of short-tenured workers in unconstrained firms.

Quantitatively, we find that small exogenous changes in financing friction generate potentially large distortions in the form of excessive firings of short-tenured workers. When we identify differences in financial frictions using the boundary between the highest credit rating categories, we find that a 0.15% increase in the cost of external financing, implies that following an exogenous appreciation shocks the firing of short-

tenured workers increase by around 20%. We also construct empirical measures of average productivity and expected productivity growth of workers and provide direct evidence that these firing decisions of constrained firms are inefficient, because they involve workers with relatively higher expected productivity growth than the workers fired by unconstrained firms.

These empirical results are consistent with our analytical predictions and highlight an important – yet, relatively unexplored – form of misallocation. Namely, that, financially constrained firms fire low-tenured workers with high skills and positive productivity growth prospects, who would be retained by less constrained firms.

We believe that the results of the paper can be easily extrapolated to other labour market settings. In any dual labor markets, with fixed-term and permanent workers, or in a labor market where severance payments is increasing in tenure, the studied effects are likely to be relevant and very strong. Moreover, even in the absence of regulatory frictions or severance pay, the productivity profiles of workers with age and tenure in the firm would also create similar effects. Overall, therefore, the main effects identified in the paper are generally applicable to most labor markets. Given that both financing constraints and labour frictions are, in relative terms, low in Sweden, one might interpret the results as a lower bound for the effect in other European countries.

## **2 Related literature**

This paper is related to the recent empirical literature that studies the effects of financial frictions and financial shocks on the employment decisions of firms, such as Chodorow-Reich (2014) for the U.S. and Bentolila, Jansen, Jiménez and Ruano (2013) for Spain.<sup>3</sup> Both papers study the causal link from financial shocks to fluctuations in net employment levels, focusing on the quasi-natural experiment of the financial crisis. Our paper differs from these studies because it focuses on exogenous profitability shocks at the firm level rather than on aggregate financial shocks, and on their differential effect on constrained versus unconstrained firms. More importantly, it focuses on the effects of such shocks not

---

<sup>3</sup> For a more comprehensive review of the literature on labor and finance, see Pagano and Pica, 2012.

on the level of employment, but more specifically on how financial frictions affect the type of workers fired.

Our theoretical model and its predictions are based on the key insight that financial frictions, by increasing the opportunity cost of capital in the short term, reduce the net present value of any project that has short run costs and long run gains. Other papers that use the same insights are Eisfeldt and Rampini (2006), who study the effect of financial frictions on the trade-off between the decisions to buy new or used capital, and Caggese and Cuñat (2008), who study the effects of financial frictions on the trade-off between hiring with fixed-term or permanent contracts, whereby the latter can be a useful instrument to attract more productive workers but comes with larger expected termination costs.

More generally, the theoretical model of this paper is related to the recent literature on financial frictions and the misallocation of resources across firms (see, for example, Buera, Kaboski and Shin, 2011, Caggese, and Cuñat, 2013, Midrigan and Xu, 2014) and on the literature on financial frictions, the dynamics of hiring and firing, and employment fluctuations (among others, see Wasmer and Weil, 2004; Monacelli, Quadrini, and Trigari, 2011; Petrosky-Nadeau, 2014; Petrosky-Nadeau and Wasmer 2015; Caggese and Perez, 2016).

### **3 Analytical Framework**

In this section, we analyse a stylised model of a firm with heterogeneous workers, and provide a set of testable predictions on the relation between financial frictions and firing decisions. The model focuses on the implications of the following three key features. First, wages are rigid, and do not fully adjust to compensate fluctuations in productivity of workers. Second, recently hired workers have more upside potential than long-tenured workers. Third, firing costs increase with workers tenure in the firm.

For simplicity, the model considers the trade-off between firing short-tenured workers vs. long-tenured workers regardless of their age. However, the assumption that short-tenured workers have steeper productivity profiles than long-tenured ones implies that the model

can also be interpreted as predicting how financing constraints affect the firings of younger versus older workers.

### 3.1 The model

Each worker produces an output equal to  $\frac{A}{n_t^{1-\beta}} \mu$ , where  $A$  is firm-specific productivity,  $\mu$  is worker specific productivity,  $n_t$  is the number of workers and  $\beta \in (0,1)$  is a parameter capturing the elasticity of total firm output to total labour input  $n_t$ .

A newly hired *short-tenured* worker has an initial productivity equal to  $\mu^Y$ , drawn from a uniform distribution  $[\mu^L, \mu^H]$ . Every short-tenured worker has a probability  $\eta$  of becoming *long-tenured*.

Conditional on becoming long-tenured the worker draws a new productivity value  $\mu^O$  from a uniform distribution  $[\mu^L, \phi\mu^H]$  where  $\phi > 1$  is the parameter that measures the ability of workers to become more productive as they accumulate more experience in the firm. This simple structure implies that while, on average, workers become more productive with tenure, some of them may become less productive.<sup>4</sup>

Firms can fire short-tenured workers without cost and long-tenured workers by paying a fixed firing cost  $F > 0$ , and they can hire new short-tenured workers by paying a fixed hiring cost  $v > 0$ . For simplicity we assume that the productivity of new workers is observed only after the wage is decided, and that the wage cannot be changed afterwards, and we derive the optimal decisions in the steady state, with constant interest rate  $r$  and firm level productivity  $A$ . It follows that the optimal wage  $w$  is constant both over time and across workers, and the optimal number of workers is also constant over time,  $n_t = n$ . Therefore, in order to simplify the analysis, we fix the wage  $w$ , and the associated division of surplus between firm and workers, at an arbitrary value.<sup>5</sup> At the end of this

---

<sup>4</sup> This assumption implies that the distribution of productivities is more dispersed among long-tenured workers. However, this feature is not essential and could be relaxed by assuming that the productivity of long tenured workers is drawn from a less dispersed distribution.

<sup>5</sup> Nonetheless it would be straightforward to microfound it as the outcome of a bargaining process.

section we relax this assumption, and allow the wage to partly adjust to reflect fluctuations in workers productivity.<sup>6</sup>

The timing of the interaction between the firm and the workers is as follows: at the beginning of each period with probability  $\delta$  workers leave the firm exogenously, and the firm decides whether or not to fire those that stay.<sup>7</sup> Among continuing workers a fraction  $\eta$  of the short-tenured workers become long-tenured, while some new short-tenured workers are hired. Then all workers produce and are paid a wage  $w > 0$ .

### **Value of long-tenured workers:**

We define  $V^o(\mu_t^o)$  as the value of a long-tenured worker who is employed in the firm until she quits, as a function of her productivity:

$$V^o(\mu_t^o) = \left( \frac{A}{n^{1-\beta}} \mu^H - w \right) + \frac{(1-\delta)}{1+r+\lambda} E_t[V^o(\mu_{t+1}^o)] \quad (1)$$

where  $r$  is the market interest rate, and  $\lambda$  is a wedge which incorporates financial considerations, i.e. it is higher for more financially constrained firms. This wedge is a shortcut for higher cost of borrowing and/or higher bankruptcy probability. Since productivity is constant over time,  $\mu_t^o = \mu^o$ , it follows that:

$$V^o(\mu^o) = \left( \frac{A}{n^{1-\beta}} \mu^o - w \right) \frac{1+r+\lambda}{\delta+r+\lambda} \quad (2)$$

A short-tenured worker with current productivity  $\mu^Y$  who has not been fired in the current period has the following value:

---

<sup>6</sup> Sweden is one of the countries with highest wage compression in the world, so the assumption that wages do not fully react to workers' productivity is particularly relevant in our empirical setting.

<sup>7</sup> We assume that separations are exogenous and not driven by equilibrium outcomes. In other words, we assume that the value of the workers' outside option is sufficiently low so that workers never want to leave the firm voluntarily other than for exogenous reasons. This assumption simplifies the analysis, but it is not essential for the results of this model.



$$V^Y(\mu^Y) = \left( \frac{A}{n^{1-\beta}} \mu^Y - w \right) + \frac{(1-\delta)}{1+r+\lambda} \eta \{E[V^O(\mu^O)]\} + \frac{(1-\delta)}{1+r+\lambda} (1-\eta) V^Y(\mu^Y) \quad (3)$$

Which can be simplified as follows:

$$V^Y(\mu^Y) = (1+r+\lambda)\Theta \left( \frac{A}{n^{1-\beta}} \mu^Y - w \right) + \Theta \eta (1-\delta) E[V^O(\mu^O)] \quad (4)$$

where  $\Theta = \frac{1}{\delta+r+\lambda(1-\eta)+\eta}$  and the expected value conditional on becoming long-tenured,  $E[V^O(\mu^O)]$ , is equal to:

$$E[V^O(\mu^O)] = \left[ \frac{A}{n^{1-\beta}} \left( \frac{1}{2} \phi \mu^H + \frac{1}{2} \mu_{min}^O \right) - w \right] \frac{1+r+\lambda}{\delta+r+\lambda} \quad (5)$$

Where  $\mu_{min}^O$  is the minimum productivity of continuing long-tenured workers, and it will be determined in the next section.

### 3.2 Employment level decisions

The optimal employment level  $n$  is determined by the following free entry condition:

$$E_t[V^Y(\mu^Y)] - v = 0 \quad (6)$$

Since  $V^Y(\mu^Y)$  is linear in  $\mu^Y$ , and workers are uniformly distributed across the values of  $\mu^Y$ , it follows that the expected value of a new short-tenured worker is:

$$E_t[V^Y(\mu^Y)] = \frac{1}{2} V^Y(\mu^H) + \frac{1}{2} V^Y(\mu_{min}^Y) \quad (7)$$

Where  $\mu_{min}^Y$  is the minimum productivity of a short-tenured worker to avoid being fired. By using equation 4 to substitute  $V^Y$  in 7 it is possible to derive the optimal number of workers  $n$ , which are inversely related to financing frictions:

**Proposition 1:** *an higher value of financing frictions  $\lambda$  increases both the opportunity cost of hiring new workers,  $v(1+r+\lambda)$ , and reduces  $V^Y$ . Therefore  $n$  is negatively related to  $\lambda$*

The proof of Proposition 1 is straightforward since  $V^Y$  is inversely related to  $\lambda$ , because the firm discounts the future at a higher rate (for a formal proof, see Appendix 2).

### 3.3 Firing decisions in the steady state

Given the free entry condition, short-tenured workers who reveal too low productivity, and have a negative value for the firm, will be fired and replaced by a new worker, so that the minimum productivity  $\mu_{min}^Y$  satisfies:

$$V^Y(\mu_{min}^Y) = 0, \quad (8)$$

and any short-tenured worker with productivity  $\mu^Y < \mu_{min}^Y$  is fired and replaced with a new worker. A firm will replace a long-tenured worker if her value is negative and larger in absolute value than firing costs, so that the minimum productivity  $\mu_{min}^O$  satisfies

$$V^O(\mu_{min}^O) = -F \quad (9)$$

The relation between  $\mu_{min}^O$  and  $\mu_{min}^Y$  is affected by two counteracting forces. On the one hand, the value of a short-tenured worker benefits from the option value of becoming very productive in the future. From equations 2, 4 and 5 it follows immediately that  $V^Y(\mu_{min}^O) > V^O(\mu_{min}^O)$ . In other words, at the productivity level  $\mu_{min}^O$  a short-tenured worker is more valuable than a long-tenured one. The difference  $V^Y(\mu_{min}^O) - V^O(\mu_{min}^O)$  increases in the value of the parameter  $\phi$ , which measures the growth opportunities of short-tenured workers. If this difference is larger than firing costs  $F$ , then  $\mu_{min}^Y < \mu_{min}^O$ , and the firm is more likely to fire a long-tenured than a short-tenured workers conditional on a given productivity level  $\mu$ , despite the long-tenured workers are more costly to fire.

An higher value of financing frictions  $\lambda$  reduces the value of long-tenured workers relative to the opportunity cost of firing  $F$ , and reduces  $\mu_{min}^O$ , meaning that a more financially constrained firm will fire less frequently long-tenured workers. Moreover it reduces the net present value of the future productivity of short tenured workers, thereby reducing their option value, and increasing  $\mu_{min}^Y$ . Therefore both effects imply that  $\mu_{min}^Y$  increases relative to  $\mu_{min}^O$ :

**Proposition 2:** *A more financially constrained firm is likely to fire short tenured workers more frequently than a less financially constrained firm with the same profitability  $A$  and the same quality of workers*

See Appendix 2 for a formal proof. Taken together, the above analysis shows that constrained firms are likely to fire short tenured workers more frequently than unconstrained firms, because financial frictions reduce the option value of these workers. Moreover, the higher firing hazard of short-tenured workers implies that a smaller fraction of them become long-tenured workers, thus increasing the share of short tenured workers in the firm's labour force. Conversely, conditional on becoming long-tenured, workers become more difficult to fire, and therefore this effect increases the relative share of long-tenured workers. If firing costs are relatively low, as is the case of Sweden, the first effect is likely to prevail, and therefore we have the additional prediction that a more financially constrained firm will, in equilibrium, have a younger work force.

### 3.4 Firing decisions after a shock

In this section we assume that a temporary shock hits a firm at the beginning of a period, reducing  $A$ . This reduced-form shock can be interpreted as any productivity or demand shock that reduces the revenues of the firm. For simplicity we assume that this shock only lasts one period, so that the firm will temporarily reduce its workforce for that period. The above equations imply that the value of workers decrease, so that  $\mu_{min}^Y$  and  $\mu_{min}^O$  increase and the firm fires both some short tenured and long-tenured workers. What is the effect of financing frictions on the mix of short tenured and long-tenured workers that are fired?

In the previous section, we have shown that the more a firm is constrained (higher value of  $\lambda$ ), the more it discounts the option value of short tenured workers, and only keeps those with relatively high current productivity  $\mu^Y$ . From equation 4 it follows that the more a firm is financially constrained, the more the value of its short tenured workers is driven by current profitability  $\left(\frac{A}{n^{1-\beta}}\mu^Y - w\right)$  rather than by the option value of becoming more productive in the future  $E[V^O(\mu^O)]$ . Therefore a temporary drop in  $A$  will have a

much large negative effect on the value of short tenured workers for the more financially constrained firms:

**Proposition 3:** *Following a temporary drop in  $A$ , the more constrained is a firm, the more it will fire the short-tenured relative to the long-tenured workers.*

See Appendix 2 for a formal proof. It is important to note that financial frictions determine these predictions, as well as the steady state predictions, by two distinct channels: first, by lowering the opportunity value of keeping short tenured workers, and second, by increasing the opportunity cost of firing long-tenured workers. Both channels operate in the same direction and their joint presence reinforces these predictions. However each of the two channels would be sufficient in generating the predictions. In other words, frictions distort the incentives to keep short tenured versus long-tenured workers, either because they reduce the expected value of short tenured workers (option value channel) or because they increase the opportunity cost of laying off more senior worker (firing cost channel), or because of both effect simultaneously.

### **3.5 Empirical predictions and empirical strategy**

The Model described above implies the following testable predictions:

Hypothesis 1: *The more financially constrained is a firm, the more likely it will fire a short-tenured worker, and the less likely it will fire a long tenured worker, compared to a less financially constrained firm.*

Hypothesis 2: *The more financially constrained is a firm, the younger is the tenure profile of its labour force.*

Hypothesis 3: *After an exogenous shock which requires a reduction in employment, a more financially constrained firm will fire workers with relatively shorter tenures.*

### **3.6 Firing and misallocation**

Hypotheses 1 and 3 imply that more financially constrained firms inefficiently fire productive workers that would be retained by less financially constrained ones. In order to discuss the empirical testing of this effect, we relax the assumption of complete wage

compression and assume that workers are paid a wage  $\frac{A}{n^{1-\beta}}\gamma\mu + w > 0$ , where  $0 < \gamma < 1$  indicates the sensitivity of wages to labour productivity, and  $w$  is the fixed component. This assumption implies that more productive workers are paid more, but they are also more profitable for the firm. The per-period profit that the firm receives from the worker becomes  $\frac{A}{n^{1-\beta}}(1 - \gamma)\mu - w$ , but it does not otherwise affect the optimality conditions of the model, nor the three above hypotheses. However, assuming that  $\gamma$  is greater than zero, in the empirical section we identify both different productivity levels across workers, and their expected productivity growth, using worker-level wage estimation models. Therefore we are able to directly verify the misallocation consequences of the firing decisions of firms.

## 4 Data and Descriptive Statistics

### 4.1 Firm Data

We test our hypotheses using a matched employer-employee dataset of the universe of Swedish firms available for the 1998-2010 period. We obtain accounting data and business group information from the Swedish Companies Registration Office (Bolagsverket), processed by the private data vendor PAR/Bisnode. The data includes balance sheets and income statements of all Swedish limited liability companies (Aktiebolaget or AB) between 1998 and 2010. As the matched employer-employee data in “Longitudinal integration database for health insurance and labor market studies” (LISA) is collected in December each year but the fiscal years of firms may not span from January to December, we standardize all firm data into January to December fiscal years. We do so by converting all accounting data into monthly data (dividing by 12 months for flow data and keeping stock data constant across months) and aggregating (summing for flow data and taking averages for stock data) the monthly data for the corresponding year afterwards.

We obtain rating information from UC AB, a rating agency owned by the large four banks in Sweden. It provides yearly, automated credit reports on all enterprises registered

in Sweden. We obtain the credit rating as well as a continuous default probability for the years between 2001 and 2011.

International trade data is provided by Statistics Sweden and contains value information by traded type (import/export), product (8-digit classification), and country for each organization between 2000 and 2011. In terms of volume the biggest export markets are Germany (10.2%), the USA (9.4%), Norway (9.0%), Great Britain (7.7%), Denmark (6.0%), and Finland (5.3%). This diverse distribution of export markets is favorable for our purpose as they are located in different currency zones. In our empirical strategy, we use changes in exchange rates and companies' differential exposure in terms of exports towards these currencies. Exchange rates are taken from the Penn World Table.

In order to include a firm in our sample we impose the following additional requirements: i) the firm employs at least 5 workers, ii) the firm appears at least for 5 consecutive years in our sample, and iii) the yearly workforce growth is restricted to be within -50% and +50%.

Our final firm sample consists of 129,193 firm-year observations of 20,880 unique firms. On average, we have about 13,000 firms per year. The distribution of firm-years over our sample period of 10 years is relatively balanced over time with a minimum of 6.69% of all observations in 2001 and a maximum of 12.02% in 2007. The average age of firms is about 13 years. The mean (median) employment is 72 (17) workers. The average annual growth rate of companies' labor force is 0.9%. 34% of the workforce has been with the firms for less than 3 years on average.

## **4.2 Worker Data**

Our basic sample is the “longitudinal integration database for health insurance and labor market studies” (LISA) provided by Statistics Sweden (SCB). The database presently holds annual registers since 1990 and includes all individuals 16 years of age and older that were registered in Sweden as of December 31 for each year. The dataset contains employment information (such as employment status, the identity of the employer and wages) as well as demographic information (such as age or family composition).

We define individuals' sectors according to the Swedish Standard Industrial Classification (SNI) code reported by the establishment that they are employed at. Our sample years are covered by the SNI1992 (1990-2001), SNI2002 (2002-2010), and SNI2007 (2011) classification. We construct a balanced SNI industry code for the years 1990-2010 based on the SNI2002 by aggregating non-unique mappings between SNI1992 and SNI2002.

Even though our firm sample contains data only from 2001 onwards, we make full use of the whole sample period of LISA as it allows us to calculate the tenure of each worker more accurately and run our auxiliary regressions more efficiently. Applying the firm data requirements to the worker data results in a sample of about 7.1M person-year observations. The average (median) worker is 39 (38) years old and male (66%). He has been with the firm for 3.5 years on average. About 6.3% of all workers are fired every year. We consider a worker as fired if i) she moves to a new firm / no firm in the next year and ii) claims unemployment benefits in the current or in the next year. There is substantial variation depending on tenure. About 10% of short-tenured workers (0-2 years with the firm) are fired every year but only about 3% of the long-tenured workers.

## **5 Empirical Strategy**

The main objective of the paper is to understand the firing policies of financially constrained and unconstrained companies in good and bad times across types of workers. In this section, we provide details about how do we proxy for each of these measures as well as the specifications used in the paper. Jointly, they determine the identification strategy of the paper.

### **5.1 Measuring financing constraints**

We use firm ratings as a measure of financing constraints. Firm ratings measure directly the likelihood of default of a company and, as such, they are a good proxy for the availability and the cost of credit of a firm.

Company ratings are produced by a company UC AB whose standard report provides a discrete rating commercially called "credit score". Credit score ranges from 1 (least

constrained) to 5 (most constrained).<sup>8</sup> These discrete ratings are based on a continuous measure “Risk Forecast” of the annual probability of default of the firm. Discrete thresholds of the continuous measure determine the 5 discrete ratings.<sup>9</sup> The average (median) rating throughout the whole population of firms is 1.97 (2) suggesting that the firms in our sample are relatively unconstrained on average. Importantly, there is quite some variation and ratings range from the best rating (highest quartile) to low rating (lowest quartile). We focus on firms with credit scores ranging from 1 to 3. This leaves out the firms with rating equals to 4 and 5, which are potentially subject to financial distress. While distressed firms are clearly also financially constrained, they also have characteristics that may make them undesirable for our analysis. In particular, they may have incentives for risk-shifting through going concern and their incentives to fire or restructure the firm may be very different from those of regular firms. Workers may also feel reluctant to join or stay in financially distressed companies. This is unlikely to be the case in our sample, as the worst firms that we consider have an annual probability of a distress episode of 3% and an even lower probability of bankruptcy.

These discrete ratings are a good proxy for the availability of credit for firms. They are also well known. In particular, ratings 1, 2, and 3 are associated with three public certifications that firms can request and put physically in their businesses and electronically on their web pages. The three categories correspond to a *gold badge* for “*highest creditworthiness*” a *silver badge* for “*high creditworthiness*” and a *bronze badge* for “*creditworthy*” respectively. This form of public certification implies that these discrete categories may have important consequences themselves for the availability of credit of firms. In other words, they measure financing constraints, but also, a drop in ratings may exacerbate financing constraints. In that sense, they cause financing constraints as well as being affected by financing constraints.

Firm ratings are determined by many firm characteristics that may include the firm’s productivity and employment policies. It is useful to run regressions that use ratings

---

<sup>8</sup> In the original UC AB data 5 corresponds to “most constrained” and 1 to “least constrained” we have reversed the order for our empirical analysis and stick to a higher number being associated with higher financing constraints throughout the paper.

<sup>9</sup> The thresholds on the risk score are 0.245%, 0.745%, 3.045%, and 8.045% and are determined by UC AB.



directly as financing constraints and they have to be interpreted as equilibrium relationships between employment policies and financing constraints. Hence, our first set of regressions for each specification uses the first three discrete ratings of UC AB as a measure of financing constraints, with and without including firm fixed effects.

However, it is also useful to run regressions in which we estimate the causal effect of an exogenous change in financing constraints. In order to do so we use two further identification strategies: a regression discontinuity design (RDD) and a within-firm-year estimator. Next, we describe these two identification strategies.

In the RDD approach we use the continuous risk forecast as the running variable of our analysis and the boundaries between the first two ratings as the thresholds of our analysis. The RDD approach relies on two main assumptions. First, we assume that asymptotically, the only source of heterogeneity is the running variable. That is, two firms with the same continuous risk forecast can be different, but asymptotically, they can be treated as being sampled from the same population of firms. Second, there is a discrete jump in the perception of financiers when a firm crosses a rating (credit score) threshold. We discuss the validity of these two assumptions in the following paragraph and present some evidence in the Appendix.

The first assumption implies as a corollary that the assignment to the running variable around a rating threshold is continuous and, in particular, that firms are not able to manipulate their risk forecast with precision near a credit score boundary. There are several characteristics of the credit score that support this assumption. First, the inter-annual variation in the running variable is quite large and it is hard for firms to predict with precision their continuous risk forecast. The within firm standard deviation of the running variable (risk forecast) for the whole population of Swedish firms is 2.3% and the average inter-annual absolute change of the risk score is 1.7%. This variation is quite large when compared with the thresholds that determine the discrete ratings, which are: 0.25%, and 0.75%. Table A1 reports this within-firm inter-annual variation on a neighbourhood of 5% of the whole population of firms around each of these thresholds. Second, firms often change their credit rating from year to year. Table A2 shows the transition matrix between the first three ratings. This implies that it is hard for firms to

predict with enough precision their risk score in advance and to manipulate their risk score around the discontinuity. Finally, it is also worth noting that UC-AB's rating is an absolute rating that adjusts to the business cycle to make the default probabilities valid at any given point in time (Jacobson and Lindé 2000). This implies that if a firm's balance sheet does not change much from one year to the next, its risk forecast and credit rating may still change.<sup>10</sup>

In Figure A1 we show the density of firms around the discontinuity for the two boundaries analyzed.<sup>11</sup> While the distribution of firms seems to reflect that firms are trying to belong to the higher categories, there does not seem to be evidence of manipulation on a narrow band around the discontinuity threshold.

The second assumption requires that the discrete "credit scores" not only reflect the financial health of the firm, but also that exogenous changes in the "credit scores" also cause the financing constraints to the firm. This is a reasonable assumption, as the discrete credit scores are observable to many agents, while the continuous risk forecast is only available to subscribers to the rating services. This is particularly relevant for the three first ratings, as firms can receive certification services about their credit ratings that depend exclusively on these discrete ratings. Some financiers may also have rules that allow/preclude giving credit to firms depending on their credit score. The Central Bank of Sweden (Riksbank) also explicitly reports that their risk assessments of aggregate default corporate risk are based on the discrete ratings provided by UC AB (Jacobson and Lindé 2000).

Table A3 shows an additional specification check for both assumptions. We perform RDD regressions on contemporaneous and lead effects in which the dependent variables are leverage, interest rate paid to financial institutions and total interest rate paid.<sup>12</sup> The results in Panel B and C show that firms at the threshold are indistinguishable in terms of

---

<sup>10</sup> UC AB claim that their ratings accurately reflect default probabilities at any point in time of the business cycle and that they should be interpreted as absolute ratings and not relative ones.

<sup>11</sup> There are some probability mass points at rounded numbers. These correspond to the risk forecasts pre-2006 that are reported in rounded numbers. The rounding is symmetric around the discontinuity and, although these firms are likely to identify a small part of the effect, it is useful to keep them for comparability with the other specifications.

<sup>12</sup> More specifically, we follow the specification in expression (14) as shown in the next section.

their characteristics the previous years (thus supporting the first assumption). However, Panel A shows that they differ in their contemporaneous leverage and cost of debt variables (lending support to the second assumption). In particular, firms seem to have lower leverage once they become constrained (Columns 1 to 6) and higher bank interest rates (Columns 7-9). These estimated coefficients have all the expected sign and are statistically significant in some of the models, especially regarding the threshold between ratings 2 and 3. Overall, these results show that firms are ex-ante comparable at the rating threshold, but that the threshold has some impact on their financial outcomes.

The identification strategy of this specification relies on two firms with a very similar risk score, but with a different credit rating. Given that the credit rating is a very visible measure of the creditworthiness of a firm, while the credit score is a much more opaque one, this generates a discontinuity in financing constraints on a dimension that is continuous in terms of other factors.

The third set of regressions consists on a within-firm estimator. We saturate the model with firm-year dummies, and financing constraints are measured using the discrete credit rating variable. This specification absorbs any common additive variation across worker types that is firm-specific. We therefore measure the differential effect of financing constraints across types of workers (long-tenured and a short-tenure) for a given firm on a given year and compare this difference across different levels of financing constraints. This is an appealing specification, as many firm policies and characteristics are common to all types of workers.

## 5.2 Measuring firm shocks

We construct empirical measures of negative shocks at a firm level that induce firms to fire workers. To isolate shocks that cause firing, we focus on firm-specific exchange rate shocks that hurt the export market of each firm.<sup>13</sup> More specifically, we construct firm-specific currency weights  $\omega_{f,c,t=0}$  that represent the share of each currency  $c$  in the exports of the firm  $f$  at the beginning of the sample. We follow Park et al. (2010) and construct a weighted exchange rate *Shock Index* with respect to a basket of currencies that

---

<sup>13</sup> Related identification strategies can be found in Revenga (1992), Bertrand (2004), or Cuñat and Guadalupe (2009).

uses the constant firm-specific weights as follows:  $Shock\ Index_{f,t} = \sum_c \omega_{f,c,0} * e\_change_{c,t}$ , where  $e\_change$  is the change of exchange rate with currency  $c$  over the last year, i.e.,  $e\_change_{c,t} = \ln(FX_{c,t}) - \ln(FX_{c,t-1})$ . Figure 1 shows the exchange rates between the Swedish Krona and the currencies of Sweden's main trading partners. There is some independent variation across currencies so different combinations of trading partners may imply that appreciations and depreciations of the firm specific baskets coexist on a given year. Note that, even though the export-based weights are kept constant throughout the sample, the Shock Index varies at a firm-year level. Employment shocks are determined by large appreciations of the Swedish Krona, with respect to the basket of representative currencies of a given firm. A sudden appreciation of the Krona makes the firm temporarily less competitive and may force the firm to lay off some workers and re-structure production.

Only large negative shocks should induce firms to fire. Small shocks are probably absorbed on other margins (e.g., hours worked, inventories, prices, or domestic sales), however large negative shocks may induce the firm to reduce production and fire workers. We use the weighted exchange rate *Shock Index* to construct an employment shock variable  $Shock\ (small)_{ft}$  as a categorical variable that takes value one if the firm is within the 20% highest appreciation quantile within a year, and zero otherwise. That is, our shock variable measures those firms that suffered a particularly bad exchange rate appreciation relative to the other firms the same year. We also compute a refined measure of this shock, *Shock (large)*, which captures observations within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample in all years.

Table 1, Panel A shows that about 20% of the firms are hit by an exchange rate shock by year. When we impose the additional condition that the shock must also be above the median across all years, this number declines to 11.2% on average.

### 5.3 Measuring Tenure and Firing

We measure the tenure (in years) of each worker in a given firm and create an indicator dummy *Short-tenured* that takes the value one if the worker has been less than two full years working for the company.<sup>14</sup>

Unfortunately, there is no direct measure of firing in the data. The richness of the data, however, allows us to approximate firing quite precisely. We define a *Fired* dummy that is equal to one if a worker is becoming unemployed or if she changes job but receives unemployment benefits during the year of the transition. By imposing these restrictions, we aim to separate voluntary turnover from firing.

One of the assumptions of the model in Section 3 is that firing costs are higher for long-tenured workers. Swedish employment protection law indeed establishes that a firm firing workers because of “shortage of work” must: i) give a notice period of 1 month, which increases by 1 month every 2 years of tenure, up to a maximum of 6 months; ii) fire according to a Last in First out Rule (LIFO) within a given job role, which applies to all firms larger than 10 employees. Firms can circumvent the LIFO rule by bargaining with the unions a narrow definition of the specific task to which the LIFO rule applies, so to manage to retain a valuable newly hired worker (von Below and Thoursie, 2010), or simply by proposing to the protected workers a severance package. In both cases, this rule clearly tends to increase the firing costs of more senior workers, as does the tenure-specific notice period.

Table 1 reveals that workers have been with firms for about 3.5 years on average. Note that the date when a worker joins the firm is not recorded in the data, so we measure in-sample tenure and, therefore, we cannot identify very long tenure workers, as our worker sample starts in 1990 only. The yearly turnover rate is between 16 and 18%. When we restrict turnovers to cases that can clearly be identified as firings (see above) this rate declines to about 6.3%.

---

<sup>14</sup> The results are robust to other similar thresholds such as 1 year or 3 years.

## 5.4 Specifications

### 5.4.1 Firm level regressions

Consider the following firm-level specification:

$$y_{ft} = \alpha + \theta \text{Shock}_{ft-1} + \beta_1 (C_{ft} * \text{Shock}_{ft-1}) + \beta_2 C_{ft} + \varepsilon_{ft} \quad (10)$$

In which the dependent variable is the fraction of short-tenured workers employed at the firm, or other outcome variables related to employment or firm characteristics such as the average skill of workers or their expected wage profile.  $\text{Shock}_{ft-1}$  is a firm-level appreciation shock lagged one period and  $C_{ft}$  is a measure of financing constraints based on the firm credit ratings. In most specifications  $C_{ft}$  takes value 1 if the firm belongs to rating 1 (gold badge), value 2 if the firm belongs to rating 2 (silver badge) and value 3 if the firm belongs to rating 3 (bronze badge).

### 5.4.2 Worker level regressions

Alternatively, we can use worker-level data where each observation is measured at a worker (i), firm (f), year (t) level. The following is the worker level regression with double interaction

$$y_{ift} = \alpha + \theta \text{Shock}_{ft-1} + \beta_1 C_{ft} \text{Shock}_{ft-1} + \beta_2 C_{ft} + \varepsilon_{it} \quad (11)$$

where  $y_{ift}$  is a proxy for a worker being fired that measures whether the worker involuntarily leaves the firm in the following period. We would like to estimate this relationship for workers of long and short tenure inside the firm. One possibility would be to estimate the regressions for different types of workers and compare the results across regressions to assess the differential impact of a shock for workers across financing constraints. Instead, we run a nested fully interacted version of the regression, so we can directly compare the coefficients across the different types of workers.

The fully interacted version of the regression is as follows:

$$\begin{aligned}
y_{ift} = & \alpha + \beta_1 Shock_{ft-1} + \beta_2 Short\_tenured_{it} + \beta_3 C_{ft} \\
& + \beta_4 (C_{j,f} * Shock_{ft-1}) + \beta_5 (Short\_tenured_{it} * Shock_{ft-1}) \\
& + \beta_6 C_{ft} Short\_tenured_{it} * Shock_{ft-1} + \varepsilon_{it}
\end{aligned} \tag{12}$$

The estimation can be interpreted as a linear probability model of the likelihood of being fired. We pool all the years of each worker, so the results can be interpreted as a proportional hazard.

### 5.4.3 Identification Strategy

We use three different sets of specifications within both the firm-level regressions and the worker level regressions.

The first specification includes firm fixed effects and sector-year fixed effects. So the firm-level regression takes the following form.

$$y_{ft} = \alpha + \delta_f + \gamma_{st} + \beta_1 Shock_{ft-1} + \beta_2 (C_{ft} * Shock_{ft-1}) + \beta_3 C_{ft} + \varepsilon_{ft} \tag{13}$$

where  $\delta_f$  is a firm fixed effect, and  $\gamma_{st}$  is a sector-year fixed effect. Similarly, the worker-level specification is equivalent to (13) with the same additional terms.

The effect in both specifications is therefore identified within firm, net of any aggregate sector variation over time. Therefore, in this specification, any time invariant characteristics of the firm or time varying sector condition that enter the firing decision in an additive way are controlled for.

The second specification takes advantage of the discrete nature of the credit ratings and estimates the effect of financing constraints at the boundaries of the discrete ratings. To do so, in the firm level regressions, we include as additional control variables a polynomial of order 12 on the continuous credit score variable  $P(risk\ forecast)$ . The firm-level specification becomes therefore.

$$y_{ft} = \alpha + \delta_f + \gamma_{st} + P(risk\ forecast) + \beta_1 Shock_{ft-1} + \beta_2 (C_{ft} * Shock_{ft-1}) + \beta_3 C_{ft} + \varepsilon_{ft} \tag{14}$$

The worker-level specification includes separate polynomials for long-tenured and short-tenured workers,  $P_h(risk\ forecast)$  and  $P_l(risk\ forecast)$  :

$$\begin{aligned}
y_{ift} = & \alpha + \delta_f + \gamma_{st} + P_h(\text{risk forecast}) + P_l(\text{risk forecast}) & (15) \\
& + \beta_1 \text{Shock}_{ft-1} + \beta_2 \text{Short\_tenured}_{it} + \beta_3 C_{ft} \\
& + \beta_4 (C_{j,f} * \text{Shock}_{ft-1}) + \beta_5 (\text{Short\_tenured}_{it} * \text{Shock}_{st-1}) \\
& + \beta_6 C_{ft} \text{Short\_tenured}_{it} * \text{Shock}_{ft-1} + \varepsilon_{it}
\end{aligned}$$

The effect in both specifications is, therefore, identified at the boundaries between two ratings. As discussed in Section 5.1 it is hard for firms to observe and manipulate their continuous credit rating with precision around a rating threshold. Therefore, on a close boundary around the threshold we can treat the assignment of a firm to each side of the threshold as random.

The final specification is a within-firm-year specification in which we include firm-year fixed effects. The worker-level specification takes the following form:

$$\begin{aligned}
y_{ift} = & \alpha + \delta_{ft} + \beta_1 \text{Short\_tenured}_{it} + \beta_2 (\text{Short\_tenured}_{it} * \text{Shock}_{st-1} + \\
& \beta_3 C_{ft} \text{Short\_tenured}_{it} * \text{Shock}_{ft-1} + \varepsilon_{it} & (16)
\end{aligned}$$

The firm-year fixed effects absorb any effects that are common to both types of workers within the firm, even if they are time varying. Note that firm fixed effects, sector-year fixed effects, the constraints variable and the shock variable are all absorbed by the firm-year fixed effect. For this reason, the firm-level specification cannot be estimated with firm-year fixed effects. Note also that the second and third specifications are non-nested, as we use different risk forecast polynomials for long-tenured and short-tenured workers. However, the within-firm estimator is nested with an RDD specification in which one single time-varying polynomial on the running variable is used to absorb the continuous effect of the risk forecast variable on both types of workers.

## 6 Results

### 6.1 Firm-level Regressions

We start our analysis by showing firm-level regressions in which the dependent variable is the fraction of workers with tenure between 0 and 2 years inside the firm. Table 2 shows three different specifications. The results in columns 1, 2 and 3 are consistent



across each other and indicate that a Shock increases the fraction of low-tenure workers. The effect ranges between 1.7% and 0.8% across specifications. This is a relatively small effect considering that the fraction of workers with tenure under 2 years is 34%. Constrained firms (one rating higher) have on average between 1.4% and 4.7% more short-tenured workers, although the effect is not significant for the RDD specification. This effect is measured per rating boundary, so the effect needs to be doubled if a firm changed from a gold category to a bronze one. Finally, constrained firms tend to have less short-tenured workers when exposed to a negative export shock. The effect is between 1.4% and 0.6% per boundary. Overall, the firm regressions suggest that constrained firms tend to buffer low-tenure workers in good times that are easier to fire in bad times. These results are consistent with those in Caggese and Cuñat (2008). They are also consistent with the model which predicts that financially constrained firms employ more short-tenured workers on average and, conditional on firing workers, they fire relatively more short-tenured than long-tenured workers, compared to less financially constrained firms.

The main limitation of the firm results is that they capture simultaneously the effect of hiring, firing, separations and workers accumulating tenure inside the firm. For this reason, in the next sets of regressions, we focus on worker level regressions and specifically on firing.

## **6.2 Worker-level regressions**

In Table 3 we report worker level regressions in which the dependent variable is a dummy variable that takes value 1 if a worker is fired within one year. The first set of specifications in columns (1) to (4) does not contain the shock variable or its interactions. The results are quite consistent across specifications Short-tenured workers are more likely to leave a firm at any point in time as the estimated likelihood of being fired is 6 to 7 percentage points higher for them. These effects are also very large in relative terms given an unconditional probability of being fired of 6.3% across all workers. Constrained firms show ambiguous results with respect to firing a long-tenured worker. In particular, the specification in Column (2) shows that they are less likely to fire long-tenured workers, while the RDD specification in Column (3) shows that they are more likely to

fire them. The size of both effects is small and a more saturated model helps to explain these ambiguous results (see below). The final result of the first three columns is that short-tenured workers are more likely to be fired in constrained firms. The effect ranges from 0.7% per rating boundary in the two regressions with firm and firm-year fixed effects to 0.2% per boundary in the RDD specification.

Columns 5 to 8 of Table 3 show the fully interacted specification including exchange rate appreciation shocks. The non-interacted coefficients follow largely the same pattern as in columns 1 to 4. However, “Rating” now has a clearer negative coefficient in the more saturated regressions, showing that, in good times, constrained firms are less likely to fire long-tenured workers. The shock variable is associated with a positive and significant coefficient. These two results explain the ambiguous results in columns 1 to 4 when we do not distinguish between normal times and shock times. Firms that suffer a negative shock are more likely to fire workers across all types. When unconstrained firms are hit by a shock, the last in first out firing norm is relaxed in unconstrained firms. This *broad firing* effect of unconstrained firms may have long-term positive effects, as it allows unconstrained firms to fire the least productive workers across all tenure categories. This effect also explains the result of the firm regressions, showing that tenure decreases when firms are exposed to a shock.

The effect of the shock for the firing of long-tenured workers by financially constrained firms (the coefficient of shock\*rating) is marginally negative, although only significant in the RDD specification. This result is consistent with the predictions of the model. If constrained firms have firing policies that resemble a last-in-first-out rule, long-tenured workers are protected by the presence of a larger fraction of short-tenured workers that are fired first in constrained firms. Finally, the interaction between short-tenured, constrained and a negative shock has a clear positive coefficient across all specifications. Financially constrained firms fire an abnormally large fraction of short-tenured workers when they face a negative shock. The effect in columns 5 to 8 ranges between 0.6% and 0.7%. This represents an increase of 10% of the average firing probability. Taken together, the results show that, in normal times, the firing rate of short tenured workers is three times higher than that of long tenured workers for unconstrained firms (gold badge)

but five times higher for constrained firms (bronze badge). During shock times, the firing differential narrows down to a factor below two for unconstrained firms. However, this effect is absent for constrained firms.

The magnitude of these effects appears even more striking, once put in perspective to the size of financing constraints captured by the rating. Given that we focus on relatively healthy firms, the differences in financing constraints across ratings are also small. For example, our estimates in Table A3 in the Appendix show increases in average interest rates paid between 0.16% and 0.30%. A risk neutral calculation with an expected return of 6%, a recovery rate of 35% and the average default rates across ratings shows that the difference in average interest rates is 0.16% across gold-silver ratings and 0.54% across silver-bronze ratings. Junior loans could have a higher rate differential, but, in any case, the effect is bounded between 0.24% for the gold-silver transition and 0.82% for the silver-bronze transition.

In Table 3, we are pooling the average effect of dropping a rating notch between categories 1, 2 and 3. In Tables 4 and 5, we perform the same regressions as in Table 3 but for the individual boundaries between the gold-silver categories and the silver-bronze categories. In particular, we only include firms with ratings 1 and 2 in Table 4 and firms with ratings 2 and 3 in Table 5. The results are quite consistent across the two individual categories. The effect is slightly stronger for the gold-silver threshold. This may be at odds with the fact that, in terms of interest rates, it is a less important threshold than the silver-bronze threshold. However, the gold category (equivalent to a risk free triple A rating in other rating system) may contain a lot of long-term information, as it has more persistence (see Table A2), so leaving the gold category may predict further future downgrades.

### **6.3 Robustness Checks**

In Table 6 we replicate the analysis in Table 3, but we re-define the shock variable. The shock variable takes value 1 if the firm is in the highest appreciation quantile within a year and zero otherwise. That is, relative to our previous shock definition, we drop the condition that the shock needs to be large in absolute terms and focus only on relative differences within the year. The main advantage of this variable is that it is evenly

distributed across years, so it does not capture any aggregate variation of the exchange rate of the Swedish Krona. The results in Table 6 are consistent with those in Table 3 with slightly smaller point estimates on the coefficients that involve the shock definition.

In Table 7 we perform an additional robustness check. We restrict the sample to firms that obtained the highest rating (“gold”) for two years in a row and focus on the boundary between gold and silver ratings. The rationale for this specification is that firms that transition from gold to silver rating for the first time are more likely to be surprised to be downgraded to the silver category and, hence, less likely to “manage” their rating results in the short run. The results on this subpopulation are qualitatively similar to our previous results in Table 3. However, they are quantitatively much more sizeable compared to our baseline. For instance, the estimated coefficient on the triple interaction is between 2 to 3 times larger and more precisely estimated. In other words, the firms for which a change in the rating is closest to an exogenous unexpected shock are the ones for which the pattern of results is clearer, with larger and more significant coefficients. This lends support to the identification strategies of the paper.

#### **6.4 Direct Evidence of Misallocation**

The previous section shows evidence of firing policies being distorted by the presence of financing constraints. In light of the model, these distortions imply lower firm productivity because of a deteriorated labor force composition. In other words, there is misallocation of productivity in firm as financially constrained firms fire the wrong workers relative to financially unconstrained ones. In this section, we aim to provide direct evidence of this misallocation induced by non-optimal firing of financially constrained firms. We focus on the quality of workers fired and retained by constrained and unconstrained firms. The quality of workers is determined by measures of their permanent productivity and their future productivity. In particular, two different productivity measures are approximated in different wage regressions. First, we obtain a worker’s predicted wage fixed effect. Secondly, we use a rich model to predict a worker’s expected wage growth. We relate the permanent level and the inter-temporal profile of workers’ productivity to the firing policies of constrained and unconstrained firms during normal times and when experiencing negative shocks.

We explore the skill composition of short-tenured workers fired and retained by constrained and unconstrained firms. We estimate a wage regression in which we include a third order polynomial on worker's potential experience (age minus 6 minus education), year and firm fixed effects as well as a worker fixed effect. The worker fixed effect is an estimate of the worker's time invariant ability.<sup>15</sup> We then calculate the average ability of workers (average worker fixed effects) for each firm and year. We then run follow-up regressions (reported in Table 8) in which the dependent variable is the average skill of workers fired or retained on a given year.<sup>16</sup> The regressions follow a similar structure as the two first columns of Table 2. To interpret the results of Table 8 it is important to put them in perspective with the results of both Table 2 and Table 3, as the interpretation of the average skill of fired and retained workers depends on the intensity of firing of the firm.

Columns 1 and 2 show the skill profile of short-tenured workers that are fired. The first observed effect is that a Shock reduces the skill of fired workers. The effect is quite sizeable, shocks decrease the average salary fixed effect of fired worker by 2.6% to 3.9%, depending on the specification. This skill reduction is consistent with the results in Table 3; large negative shocks are used by firms to fire across the tenure spectrum. More long-tenured workers are fired and less short-tenured workers are fired. The negative coefficient is therefore reflecting that when less short-tenured workers are fired, those fired have lower skills (i.e. are more selected). More generally, if we think of tenure as a continuum; given that the last-in-first-out pattern in firing is relaxed during negative shocks, we expect that the sorting of workers according to their skill becomes better, hence worse workers get fired. Next, the coefficient on Constrained is also negative and statistically different from zero. This reflects the average skill effect of fired workers in constrained firms, relative to unconstrained firms during normal times. As shown in Tables 2 and 3, constrained firms hoard short-term workers during good times and fire more of them during periods with a negative trade shock. Finally, the effect of financing

---

<sup>15</sup> See Abowd et al (1999).

<sup>16</sup> The model has clear predictions about the firms' firing policies of short-term workers. The predictions with respect to long term workers are also present, but more dependent on assumptions about the productivity transitions between short-term and long-term workers. For this reason, we focus on short-term workers only.

constraints, interacted with a Shock is positive and significant. This shows that the effects of negative export shocks on unconstrained firms are lower for mid constrained firms (rating 2) or non-existent for the most constrained firms in our sample (rating 3). This is evidence of a misallocation effect, during negative shocks, constrained firms are forced to fire more skilled workers to avoid incurring on severance costs or because they find them too costly to retain, given their inter-temporal wage profiles.

The analysis of stayers is performed in Columns 3 and 4 of Table 8. In general, the coefficients of stayers co-move with the coefficients of fired workers. The coherence of the coefficients on fired and stayers is consistent with firms tending to fire less skilled workers than those that they retain workers. It is also consistent with the missing category (workers that leave the firm voluntarily) not being highly correlated with the variables of interest. Note that, if firms used a strict threshold strategy to fire their least able workers and there were no voluntary separations, the two coefficients would co-move by construction. A positive coefficient indicates a higher firing threshold (the average worker fired is better) and a higher skill of the retained worker. The interpretation of the results is similar to that of columns 1 and 2. For unconstrained firms exposed to a negative export shock, stayers tend to have a lower skill, which is consistent with more firing at higher tenures and less firing at lower tenures. Constrained firms tend to hoard more short-tenured workers in good times, hence their average skill is lower. Note, however, that this effect is large in the cross section with 2.1% wage difference, but very small once we add fixed effects (0.3% wage difference). This is consistent with the results in columns 2 and 5 of Table 2, which show that the accumulation of short-tenured workers is largely a cross sectional phenomenon and it is less prominent when we focus on temporary shocks to financing constraints. Finally, the main result of interest is that the interaction between negative export shocks and constraints is positive. As seen in Tables 2 and 3, constrained firms fire more short-tenured workers when exposed to a negative shock, the average quality of the workers that stay is higher for these firms, precisely because they are letting some of their good workers go. The size of the coefficient is similar to the one for unconstrained firms, this means that the *broad firing* effect that shocks have on unconstrained firms, cancels out for mid-constrained firms (rating 2) while for firms with high constraints (rating 3) the effect is reversed.

The results in Table 8, taken jointly with the results in the previous section, show first, that the skill profile of workers that are fired or stay in the firm is consistent with the use of a rule that resemble a threshold strategy within a tenure category. Second, that unconstrained firms retain more short-tenured workers in downturns, they fire across all tenures and retain more skilled workers. Finally, constrained firms use a stricter last in first out policy, they fire more short tenured workers in downturns and these are of higher skill levels.

In Table 9 we explore the expected wage profiles of workers fired by constrained and unconstrained firms. As shown in the model, keeping workers with a steep inter-temporal productivity profile in the firm is akin to an investment decision. Wage compression plays a dual role in this prediction: First, wages smooth the intertemporal changes in workers' productivity, so workers with a low productivity are over-paid with respect to their productivity and workers with a high productivity are relatively under-paid. Second, wages under react to differences in workers' productivity, so they are a good proxy of the profit that a firm extracts from a given worker (i.e. on average, a higher paid worker over-compensates the higher wage paid with even higher productivity levels). To approach this question, we first run a regression of the three-year future wage growth of a worker as a function of a potential experience (age minus 6 minus education), demographic information and family composition (gender, number of children and marital status), as well as very detailed educational achievements (grades and program in high school and highest level of education). The model is similar to the model in Boehm, Metzger, and Stromberg (2016) who estimate predicted cognitive skills for the whole Swedish population. We focus on unconstrained firms in the regression (Rating=1) to avoid that the distortions associated with financing constraints introduce any biases. We then predict the wage growth for all the workers in the sample and create a dummy variable (High wage growth) that takes value one if the worker is predicted to have a wage growth above the median wage growth of the whole population. We include the same specifications as in Columns 2, 3 and 4 of Table 3 (RDD, RDD with fixed effects and Firm-Year fixed effects).

Columns 1-3 of Table 9 include only short-tenured workers, and columns 4-6 include only long-tenured workers. The results show, in the first row, that workers with a low productivity today (relative to their future productivity) tend to be fired more often. This effect is stronger for short-tenured workers, and is an intuitive result, if retaining some workers (e.g. younger workers) is akin to an investment decision; it is likely that these workers get fired more often than those that already have a high realized productivity. This effect is emphasized for constrained firms - as shown by the coefficients on Rating. Given that retaining these workers is a form of investment, constrained firms fire them more often. The effect is substantial, about 10% higher likelihood to be fired per rating (i.e. 20% higher when going from gold to bronze rating).

The second row shows that when firms experience productivity shocks, this effect is attenuated, and less workers with high expected future wage growth are fired. Moreover, the coefficient of Shock is positive (in the regressions with firm fixed effects), indicating that more workers with low future expected wage growth are fired. This is quite in line with the results of Table 3 and Table 9. Negative shocks are used by firms to fire more tenured workers, those with higher firing costs and also those with low future expected productivity growth. However, this effect is significantly attenuated for constrained firms. The positive coefficient of the triple interaction High wage growth X Shock (large) X Rating indicates that constrained firms facing a shock fire their most promising workers in contrast with the policy of unconstrained firms. These results are consistent throughout the three specifications.

The results are also consistent for both short-tenured workers and long-tenured workers. However, they are more intense for short-tenured workers. This is consistent with steeper wage profiles among short-tenured workers. In previous sections, we proxied wage profiles (jointly with firing costs) directly using tenure, in this section, we have direct measures of the expected wage growth, but tenure is still likely to capture workers that are cheaper to fire and with higher average productivity growth rates.

Overall, the results of this section independently confirm that there are distortions associated with financing constraints in the process of firing. These distortions imply a lower composition of productivity in constrained firms due to firing.



## 7 Conclusions

Firing is an intertemporal decision that can be interpreted as a particular form of investment. As such, it is reasonable to assume that it will be affected by the presence of financing constraints. This paper studies the effects of financing constraints on the firing decisions of firms of financing constraints.

We illustrate the main forces at play in a partial equilibrium dynamic stochastic model of a firm, which makes hiring and firing decisions of workers that are heterogeneous in their productivity paths and firing costs, and which may be subject to financial frictions. The model predicts that financing constraints affect the types of workers that are fired across firms, and have potentially important distortionary effects on the optimal allocation of employees, even if they have little effect on the total employment level.

We estimate firing decisions at the firm and worker level using a rich dataset of matched employer-employee data from the whole active population of Sweden between 1990 and 2010. The results show that financially constrained firms: i) accumulate more short-tenured workers as a fraction of their labour force than unconstrained firms. ii) They tend to fire more sort-tenure workers. iii) The effect in ii) is more pronounced when financially constrained firms experience negative shocks. In contrast, financially unconstrained firms have a less pronounced last in first out firing policy in general and this is particularly the case when they experience negative shocks. Relatedly, our results regarding worker skills and wage profiles of fired workers show that unconstrained firms are more efficient in general in retaining good and promising workers and that they use periods of negative shocks to fire the least productive workers across all tenures. These creative destruction effects of negative shocks are absent or even reversed for constrained firms.

Long-tenured workers are relatively more protected against firm shocks in financially constrained firms, as financing constraints tend to emphasize a last-in-first-out firing policy. The additional firing of short-tenured workers by financially constrained firms after a shock, accounts for an increase of about 7% in the firing probability. This is a sizeable effect, especially considering that financing constraints, in our sample account for up to 0.82% in marginal interest rates.

These results uncover a novel empirical fact: financial frictions distort firm firing decisions towards the inefficient firing of short-tenured workers, resulting in more dual labor markets within constrained firms with highly protected long tenured workers and more exposed short tenured workers, with potentially important negative consequences both for the misallocation of resources across firms, and for the process of human capital accumulation and the career paths of young workers.

## 8 References

- Abowd, J.M., Kramarz, F. and Margolis, D.N., 1999. High wage workers and high wage firms. *Econometrica*, 67(2), pp.251-333.
- Almeida, H., Campello, M., Laranjeira, B., Weisbenner, S. 2012. Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis. *Critical Finance Review*, 1: 3-58
- Bertrand, Marianne. 2004. From the invisible handshake to the invisible hand? How import competition changes the employment relationship. *Journal of Labor Economics* 22, no.4: 723-766.
- Caggese, A. and V. Cuñat (2008), Financing Constraints and Fixed-Term Employment Contracts, *Economic Journal* 118, 2013-2046.
- Caggese, A. and Perez, A. (2016), The Interaction Between Household and Firm Dynamics and the Amplification of Financial Shocks, Barcelona GSE working paper.
- Campello, Murillo & John Graham & Campbell R. Harvey, 2010."The Real Effects of Financial Constraints: Evidence from a Financial Crisis", *Journal of Financial Economics*, Volume 97, Issue 3, September 2010, Pages 470–487.
- Cuñat, Vicente and Maria Guadalupe. 2009 Globalization and the Provision of Incentives Inside the Firm. *The Journal of Labor Economics* - Volume 27, Number 2, April
- Eisfeldt, Andrea L. and Adriano Rampini. 2007 New or used? Investment with credit constraints, *Journal of Monetary Economics* 54 2656–2681.
- Hubbard, G.R., 1998. Capital-market imperfections and investment. *Journal of Economic Literature* 36, 193-225.
- Jacobson, T. and J. Lindé, 2000. Credit rating and the business cycle: Can bankruptcies be forecast? *Economic Review* 4/2000, Riksbank.
- Midrigan, Virgiliu, and Daniel Yi Xu. 2014. "Finance and Misallocation: Evidence from Plant-Level Data." *American Economic Review*, 104(2): 422-58
- Monacelli, T., Quadrini, V. and A. Trigari (2011). "Financial Markets and Unemployment," NBER Working Papers 17389, National Bureau of Economic Research
- Pagano M. and G. Pica, Finance and Employment, *Economic Policy* , (2012), Volume 27, Issue 69, 5-55
- Park, A, D. Yang, X. Shi, and Y. Jiang (2010). "Exporting and Firm Performance: Chinese Exporters and the Asian Financial Crisis". *Review of Economics and Statistics* 2010 92:4, 822-842

Petrosky-Nadeau, N. (2014). "Credit, vacancies and unemployment fluctuations," *Review of Economic Dynamics*, 17(2), 191-205.

Petrosky-Nadeau, Wasmer, E., (2015). Macroeconomic Dynamics in a Model of Goods, Labor and Credit Market Frictions, *Journal of Monetary Economics* 72, May 2015.

Reventa, Ana L. 1992. Exporting jobs? The impact of import competition on employment and wages in U.S. manufacturing. *Quarterly Journal of Economics* 107, no.1: 255-284.

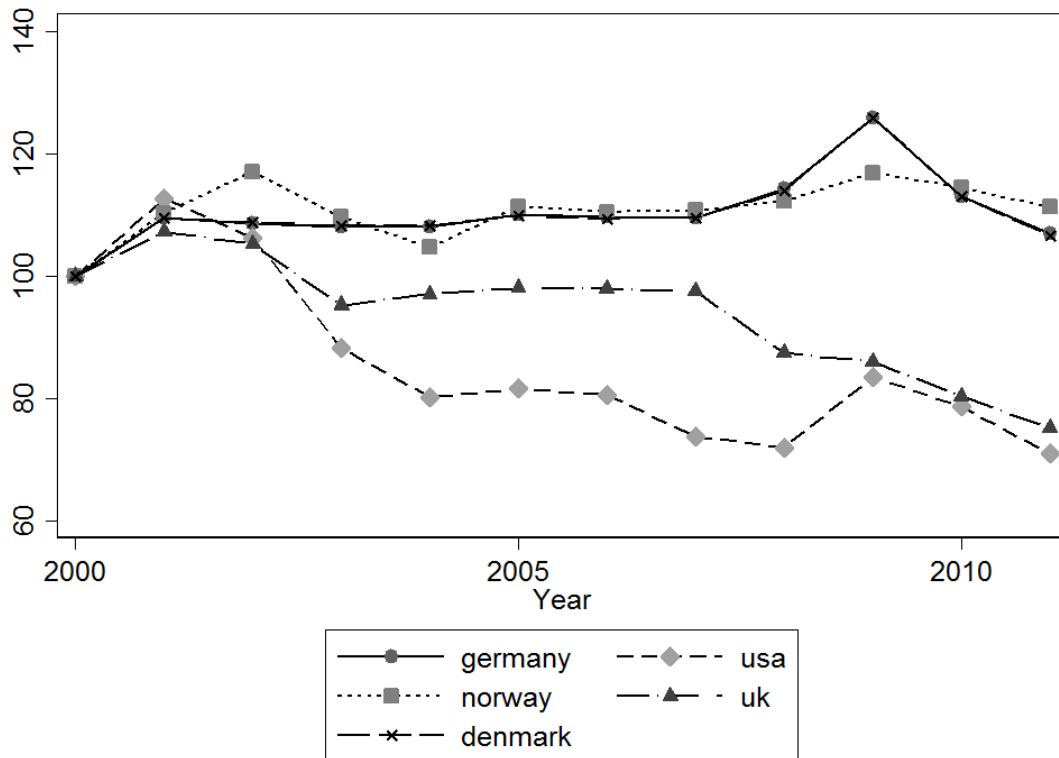
Von Below, David, Peter Skogman Thoursie, 2010, Last in, first out?: Estimating the effect of seniority rules in Sweden, *Labour Economics*, Volume 17, Issue 6, December 2010, Pages 987-997.

Wasmer, E. and P. Weil (2004). "The Macroeconomics of Labor and Credit Market Imperfections," *American Economic Review*, 94(4), 944-63.

## 9 Figures

**Figure 1: FX rates**

This figure shows the exchange rate development of the Swedish Kronor relative to selected foreign currencies between 2000 and 2011. The graphs are normalized to year 2000 levels. Source: Penn World Tables.



## 10 Tables

**Table 1: Summary Statistics**

This table shows summary statistics for firms (Panel A) and workers (Panel B). The sample period is 2001 – 2010. Shock is an exchange rate shock. In “Shock (small)” the exchange rate shock is equal to one for the 20% highest appreciation quantile within a year, and zero otherwise. Otherwise we denote with “Shock (large)” the regressions where we qualify as shocks larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Rating is a categorical variable equal to 1...3 (1=best rating, 3=worst rating). Rating 1 vs. 2 is a dummy that takes the value of one if the rating is 2. It is defined for firms with a rating of 1 or 2. Rating 2 vs. 3 is a dummy that takes the value of one if the rating is 3. It is defined for firms with a rating of 2 or 3. Assets (log) measures the logarithm of total assets at the end of the calendar year. Firm age is the age of the firm in years (the variable is calculated from worker data (LISA) and, hence, truncated at year 1990). In our regression specifications we create categorical variables for firm age to deal with this issue. Workforce denotes the number of workers that are working in a firm (calculated from LISA). Workforce growth is the growth of the workforce between year t and t+1 in percent. Tenure 0-2 years | fired is the fraction of fired workers with tenure of 0-2 years among all fired workers. Tenure 0-2 years denotes the Fraction of workers with tenure 0-2 years. Sources: SCB LISA, UC AB, Bolagsverket.

*Panel A: Firm Characteristics*

|   | <b>mean</b> | <b>p25</b> | <b>p50</b> | <b>p75</b> | <b>N</b> |
|---|-------------|------------|------------|------------|----------|
| Assets (log)                              | 16.794      | 15.759     | 16.563     | 17.570     | 129193   |
| Firm age                                  | 12.623      | 10.000     | 13.000     | 16.000     | 129206   |
| Workforce                                 | 72.088      | 9.000      | 17.000     | 40.000     | 129206   |
| Workforce growth                          | 0.009       | -0.083     | 0.000      | 0.100      | 129206   |
| Tenure 0-2 years   fired                  | 0.678       | 0.500      | 0.833      | 1.000      | 65245    |
| Fraction of workers with tenure 0-2 years | 0.339       | 0.182      | 0.308      | 0.462      | 129206   |
| Shock (small)                             | 0.199       | 0.000      | 0.000      | 0.000      | 129206   |
| Shock (large)                             | 0.112       | 0.000      | 0.000      | 0.000      | 129206   |
| Rating                                    | 1.968       | 1.000      | 2.000      | 3.000      | 129206   |
| Rating 1 vs. 2                            | 0.441       | 0.000      | 0.000      | 1.000      | 85515    |
| Rating 2 vs. 3                            | 0.537       | 0.000      | 1.000      | 1.000      | 81392    |

Panel B shows summary statistics for workers. The sample period is 1999 – 2010. Fired is a dummy variable that is equal to one if a worker is fired in a given year. We consider a worker as fired if i) she moves to a new firm / no firm in the next year and ii) claims unemployment benefits in the current or in the next year. Tenure denotes the number of years a worker is with a given firm. Fired conditional on short and long tenure is based on short tenure (0-2 years) and long tenure (3 and more years). Age is the age of the worker in years Female is a variable that takes the value of 0 for men and 1 for women.

Sources: SCB LISA.

*Panel B: Worker Characteristics*

|                       | <b>mean</b> | <b>p25</b> | <b>p50</b> | <b>p75</b> | <b>N</b> |
|-----------------------|-------------|------------|------------|------------|----------|
| Age                   | 39.008      | 29.000     | 38.000     | 48.000     | 7130309  |
| Female                | 0.334       | 0.000      | 0.000      | 1.000      | 7130309  |
| Tenure                | 3.532       | 1.000      | 3.000      | 6.000      | 7130309  |
| Fired                 | 0.063       | 0.000      | 0.000      | 0.000      | 7130309  |
| Fired   Short-tenured | 0.104       | 0.000      | 0.000      | 0.000      | 3256913  |
| Fired   Long-tenured  | 0.029       | 0.000      | 0.000      | 0.000      | 3873396  |

**Table 2: Financing Constraints and Workers Tenure**

The dependent variable is the fraction of young tenured workers (0-2 years with the firm). Constraint is a categorical variable equal to 1,2,3 (1=best rating, 3=worst rating). Shock is an exchange rate shock. “Shock (large)” is equal to one for the 20% highest appreciation quantile within a year but also in the 50% highest appreciation quantile for the whole sample, and zero otherwise. Specifications (1) and (4) are simple OLS regressions with industry-year dummies. Specifications (2)-(3) and (5)-(6) include firm fixed effects. Specifications (3) and (6) use a regression discontinuity design (RDD) with polynomials. Polynomial indicates a polynomial of order 12 of the running variable “risk forecast”. Sources: SCB LISA, UC AB, Bolagsverket. \*\*\* p<0.01 \*\* p<0.05 \* p<0.1

|                             | Fraction of workers with tenure 0-2 years |                      |                      |                     |                     |                    |
|-----------------------------|---|----------------------|----------------------|---------------------|---------------------|--------------------|
|                             | (1)                                       | (2)                  | (3)                  | (4)                 | (5)                 | (6)                |
| Shock (large)               | 0.017***<br>(0.004)                       | 0.008**<br>(0.004)   | 0.008**<br>(0.004)   |                     |                     |                    |
| Constrained                 | 0.047***<br>(0.001)                       | 0.014***<br>(0.001)  | -0.003<br>(0.002)    | 0.046***<br>(0.001) | 0.014***<br>(0.001) | -0.004*<br>(0.002) |
| Shock (large) X Constrained | -0.014***<br>(0.002)                      | -0.006***<br>(0.002) | -0.006***<br>(0.002) |                     |                     |                    |
| Observations                | 129029                                    | 129029               | 129029               | 129029              | 129029              | 129029             |
| Polynomial                  | No  | No                   | Yes                  | No                  | No                  | Yes                |
| Industry-Year fixed effects | Yes                                       | Yes                  | Yes                  | Yes                 | Yes                 | Yes                |
| Firm fixed effects          | No  | Yes                  | Yes                  | No                  | Yes                 | Yes                |



**Table 3: Financing Constraints and Firing**

This table estimates regressions at the worker level. The dependent variable is binary variable equal to 1 if the worker leaves the firm in period t and receives unemployment benefits afterwards, and zero otherwise. Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Rating is a categorical variable equal to 1,2,3 (1=best rating, 3=worst rating). Short-tenured is a dummy equal to one for workers with 0 to 2 years of tenure, and zero otherwise. Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". Sources: SCB LISA, UC AB, Bolagsverket. \*\*\* p<0.01 \*\* p<0.05 \* p<0.1

|  | Fired Next Year     |                      |                     |                     |                      |                      |                      |                      |
|--|---------------------|----------------------|---------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
|  | (1)                 | (2)                  | (3)                 | (4)                 | (5)                  | (6)                  | (7)                  | (8)                  |
| Short-tenured                          | 0.058***<br>(0.000) | 0.060***<br>(0.000)  | 0.074***<br>(0.001) | 0.066***<br>(0.000) | 0.065***<br>(0.000)  | 0.064***<br>(0.000)  | 0.057***<br>(0.007)  | 0.070***<br>(0.001)  |
| Shock (large)                          | -                   | -                    | -                   | -                   | 0.002***<br>(0.001)  | 0.009***<br>(0.001)  | 0.002***<br>(0.001)  | -                    |
| Short-tenured X Shock (large)          | -                   | -                    | -                   | -                   | -0.034***<br>(0.001) | -0.024***<br>(0.001) | -0.031***<br>(0.001) | -0.024***<br>(0.001) |
| Rating                                 | 0.007***<br>(0.000) | -0.003***<br>(0.000) | 0.001***<br>(0.000) | -                   | 0.007***<br>(0.000)  | -0.002***<br>(0.000) | -0.005*<br>(0.002)   | -                    |
| Short-tenured X Rating                 | 0.009***<br>(0.000) | 0.007***<br>(0.000)  | 0.002***<br>(0.001) | 0.007***<br>(0.000) | 0.007***<br>(0.000)  | 0.006***<br>(0.000)  | 0.016***<br>(0.003)  | 0.006***<br>(0.000)  |
| Shock (large) X Rating                 | -                   | -                    | -                   | -                   | -0.000<br>(0.000)    | -0.002***<br>(0.000) | -0.000<br>(0.000)    | -                    |
| Short-tenured X Shock (large) X Rating | -                   | -                    | -                   | -                   | 0.008***<br>(0.001)  | 0.006***<br>(0.001)  | 0.007***<br>(0.001)  | 0.006***<br>(0.001)  |
| Observations                           | 7123973             | 7123973              | 7123973             | 7123973             | 7123973              | 7123973              | 7123973              | 7123973              |
| Polynomials                            | No                  | No                   | Yes                 | No                  | No                   | No                   | Yes                  | No                   |
| Industry-Year fixed effects            | Yes                 | Yes                  | Yes                 | Yes                 | Yes                  | Yes                  | Yes                  | Yes                  |
| Firm fixed effects                     | No                  | Firm                 | Firm                | Firm-Year           | No                   | Firm                 | Firm                 | Firm-Year            |

**Table 4: Financing Constraints and Firing (Thresholds 1 and 2)**

This table estimates regressions at the worker level. The dependent variable is binary variable equal to 1 if the worker leaves the firm in period t and receives unemployment benefits afterwards, and zero otherwise. Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample.. Rating 1 vs. 2 is a dummy that takes the value of one if the rating is 2. It is defined for firms with a rating of 1 or 2. Short-tenured is a dummy equal to one for workers with 0 to 2 years of tenure, and zero otherwise. Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". Sources: SCB LISA, UC AB, Bolagsverket. \*\*\* p<0.01 \*\* p<0.05 \* p<0.1

|  | Fired Next Year      |                      |                      |                      |
|--|----------------------|----------------------|----------------------|----------------------|
|  | (1)                  | (2)                  | (3)                  | (4)                  |
| Short-tenured                                  | 0.070***<br>(0.000)  | 0.069***<br>(0.000)  | 0.064***<br>(0.002)  | 0.054***<br>(0.003)  |
| Shock (large)                                  | 0.002***<br>(0.000)  | 0.007***<br>(0.000)  | 0.007***<br>(0.000)  | -<br>-               |
| Short-tenured X Shock (large)                  | -0.025***<br>(0.001) | -0.020***<br>(0.001) | -0.020***<br>(0.001) | -0.018***<br>(0.001) |
| Rating 1 vs. 2                                 | 0.009***<br>(0.000)  | -0.006***<br>(0.000) | -0.009***<br>(0.002) | -<br>-               |
| Short-tenured X Rating 1 vs. 2                 | 0.017***<br>(0.001)  | 0.014***<br>(0.001)  | 0.021***<br>(0.003)  | 0.029***<br>(0.004)  |
| Shock (large) X Rating 1 vs. 2                 | -0.005***<br>(0.001) | -0.001<br>(0.001)    | -0.001<br>(0.001)    | -<br>-               |
| Short-tenured X Shock (large) X Rating 1 vs. 2 | 0.015***<br>(0.001)  | 0.013***<br>(0.001)  | 0.013***<br>(0.001)  | 0.006***<br>(0.002)  |
| Observations                                   | 5342003              | 5342004              | 5342005              | 5342006              |
| Polynomials                                    | No                   | No                   | Yes                  | No                   |
| Industry-Year fixed effects                    | Yes                  | Yes                  | Yes                  | Yes                  |
| Firm fixed effects                             | No                   | Firm                 | Firm                 | Firm-Year            |

**Table 5: Financing Constraints and Firing (Thresholds 2 and 3)**

This table estimates regressions at the worker level. The dependent variable is binary variable equal to 1 if the worker leaves the firm in period  $t$  and receives unemployment benefits afterwards, and zero otherwise. Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Rating 2 vs. 3 is a dummy that takes the value of one if the rating is 3. It is defined for firms with a rating of 2 or 3. Short-tenured is a dummy equal to one for workers with 0 to 2 years of tenure, and zero otherwise. Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". Sources: SCB LISA, UC AB, Bolagsverket. \*\*\*  $p < 0.01$  \*\*  $p < 0.05$  \*  $p < 0.1$

|  | Fired Next Year      |                      |                      |                      |
|--|----------------------|----------------------|----------------------|----------------------|
|  | (1)                  | (2)                  | (3)                  | (4)                  |
| Short-tenured                                  | 0.087***<br>(0.000)  | 0.084***<br>(0.001)  | 0.315***<br>(0.046)  | 0.277***<br>(0.052)  |
| Shock (large)                                  | -0.004***<br>(0.001) | 0.004***<br>(0.001)  | 0.004***<br>(0.001)  | -<br>-               |
| Short-tenured X Shock (large)                  | -0.010***<br>(0.001) | -0.008***<br>(0.001) | -0.008***<br>(0.001) | -0.012***<br>(0.001) |
| Rating 2 vs. 3                                 | 0.004***<br>(0.000)  | 0.002***<br>(0.000)  | -0.001<br>(0.001)    | -<br>-               |
| Short-tenured X Rating 2 vs. 3                 | -0.003***<br>(0.001) | -0.004***<br>(0.001) | -0.003<br>(0.002)    | -0.002<br>(0.002)    |
| Shock (large) X Rating 2 vs. 3                 | 0.007***<br>(0.001)  | -0.003**<br>(0.001)  | -0.003**<br>(0.001)  | -<br>-               |
| Short-tenured X Shock (large) X Rating 2 vs. 3 | -0.004**<br>(0.002)  | 0.003<br>(0.002)     | 0.003*<br>(0.002)    | 0.006***<br>(0.002)  |
| Observations                                   | 3178299              | 3178300              | 3178301              | 3178302              |
| Polynomials                                    | No                   | No                   | Yes                  | No                   |
| Industry-Year fixed effects                    | Yes                  | Yes                  | Yes                  | Yes                  |
| Firm fixed effects                             | No                   | Firm                 | Firm                 | Firm-Year            |

**Table 6:** Financing Constraints and Firing (Small Shock)

This table estimates regressions at the worker level. The dependent variable is binary variable equal to 1 if the worker leaves the firm in period  $t$  and receives unemployment benefits afterwards, and zero otherwise. Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Rating is a categorical variable equal to 1,2,3 (1=best rating, 3=worst rating). Short-tenured is a dummy equal to one for workers with 0 to 2 years of tenure, and zero otherwise. Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". Sources: SCB LISA, UC AB, Bolagsverket. \*\*\*  $p < 0.01$  \*\*  $p < 0.05$  \*  $p < 0.1$

|  | Fired Next Year      |                      |                      |                      |
|--|----------------------|----------------------|----------------------|----------------------|
|  | (1)                  | (2)                  | (3)                  | (4)                  |
| Short-tenured                          | 0.066***<br>(0.000)  | 0.066***<br>(0.001)  | 0.082***<br>(0.002)  | 0.087***<br>(0.002)  |
| Shock (small)                          | 0.002***<br>(0.000)  | 0.010***<br>(0.001)  | 0.009***<br>(0.001)  | -<br>-               |
| Short-tenured X Shock (small)          | -0.027***<br>(0.001) | -0.022***<br>(0.001) | -0.022***<br>(0.001) | -0.021***<br>(0.001) |
| Rating                                 | 0.007***<br>(0.000)  | -0.002***<br>(0.000) | 0.002***<br>(0.001)  | -<br>-               |
| Short-tenured X Rating                 | 0.007***<br>(0.000)  | 0.005***<br>(0.000)  | 0.000<br>(0.001)     | -0.002<br>(0.001)    |
| Shock (small) X Rating                 | -0.001***<br>(0.000) | -0.003***<br>(0.000) | -0.003***<br>(0.000) | -<br>-               |
| Short-tenured X Shock (small) X Rating | 0.005***<br>(0.001)  | 0.005***<br>(0.001)  | 0.005***<br>(0.001)  | 0.005***<br>(0.001)  |
| Observations                           | 7123973              | 7123973              | 7123973              | 7123973              |
| Polynomials                            | No                   | No                   | Yes                  | No                   |
| Industry-Year fixed effects            | Yes                  | Yes                  | Yes                  | Yes                  |
| Firm fixed effects                     | No                   | Firm                 | Firm                 | Firm-Year            |

**Table 7: Financing Constraints and Firing (Previous Gold Firms)**

This table estimates regressions at the worker level. We restrict the sample to firms that were categorized as gold rating for the previous 2 years. The dependent variable is binary variable equal to 1 if the worker leaves the firm in period t and receives unemployment benefits afterwards, and zero otherwise. Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Rating is a categorical variable equal to 1,2,3 (1=best rating, 3=worst rating). Short-tenured is a dummy equal to one for workers with 0 to 2 years of tenure, and zero otherwise. Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". Sources: SCB LISA, UC AB, Bolagsverket. \*\*\* p<0.01 \*\* p<0.05 \* p<0.1

|  | Fired Next Year |           |           |           |
|--|-----------------|-----------|-----------|-----------|
|  | (1)             | (2)       | (3)       | (4)       |
|  | 0.070***        | 0.069***  | 0.097***  | 0.073***  |
| Short-tenured                                  | (0.001)         | (0.001)   | (0.003)   | (0.001)   |
|  | 0.009***        | 0.022***  | 0.022***  |           |
| Shock (large)                                  | (0.001)         | (0.002)   | (0.002)   |           |
|  | -0.058***       | -0.046*** | -0.044*** | -0.033*** |
| Short-tenured X Shock (large)                  | (0.002)         | (0.003)   | (0.003)   | (0.003)   |
|  | 0.006***        | 0.002***  | 0.011***  |           |
| Rating 1 vs. 2                                 | (0.000)         | (0.001)   | (0.002)   |           |
|  | -0.002**        | -0.000    | -0.007*** | -0.002**  |
| Short-tenured X Rating 1 vs. 2                 | (0.001)         | (0.001)   | (0.003)   | (0.001)   |
|  | -0.007***       | -0.012*** | -0.013*** |           |
| Shock (large) X Rating 1 vs. 2                 | (0.001)         | (0.001)   | (0.001)   |           |
|  | 0.026***        | 0.021***  | 0.019***  | 0.013***  |
| Short-tenured X Shock (large) X Rating 1 vs. 2 | (0.002)         | (0.002)   | (0.002)   | (0.002)   |
| Observations                                   | 2611297         | 2611297   | 2611297   | 2611298   |
| Polynomials                                    | No              | No        | Yes       | No        |
| Industry-Year fixed effects                    | Yes             | Yes       | Yes       | Yes       |
| Firm fixed effects                             | No              | Firm      | Firm      | Firm-Year |

**Table 8:** Worker Profiles. Short-tenure: Fired vs. Stayers

The dependent variable is the average worker fixed effect of a wage regression including a third order polynomial on age, firm and year fixed effects averaged at a firm level for low tenured workers (0-2 years with the firm) that are fired or stay with the firm. Rating is a categorical variable equal to 1, 2 or 3 (1=best rating, 3=worst rating). Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Sources: SCB LISA, UC AB, Bolagsverket. \*\*\* p<0.01 \*\* p<0.05 \* p<0.1

|                             | Fired                |                     | Stayers              |                      |
|-----------------------------|----------------------|---------------------|----------------------|----------------------|
|                             | (1)                  | (2)                 | (3)                  | (4)                  |
| Shock (large)               | -0.039**<br>(0.018)  | -0.026*<br>(0.016)  | -0.014**<br>(0.006)  | -0.012***<br>(0.004) |
| Rating                      | -0.013***<br>(0.003) | -0.008**<br>(0.004) | -0.021***<br>(0.001) | -0.003***<br>(0.001) |
| Shock (large) X Rating      | 0.021**<br>(0.009)   | 0.015*<br>(0.008)   | 0.012***<br>(0.003)  | 0.009***<br>(0.002)  |
| Observations                | 4956                 | 4956                | 36329                | 36329                |
| Industry-Year fixed effects | Yes                  | Yes                 | Yes                  | Yes                  |
| Firm fixed effects          | No                   | Yes                 | no                   | Yes                  |

**Table 9:** Financing Constraints and Wage Profiles

This table estimates regressions at the worker level. The dependent variable is binary variable equal to 1 if the worker leaves the firm in period t and receives unemployment benefits afterwards, and zero otherwise. Specifications (1) to (3) focus on short-tenured workers and (4) to (6) on long-tenured workers. Short-tenured is a dummy equal to one for workers with 0 to 2 years of tenure, and zero otherwise. Long-tenured is a dummy equal to one for workers with more than 2 years of tenure, and zero otherwise. High wage growth takes value one if the worker is above the median predicted wage growth in a regression that uses only unconstrained firms. Shock (large) is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 20% highest appreciation quantile within a year, but also in the 50% highest appreciation quantile for the whole sample. Rating is a categorical variable equal to 1,2, 3. (1=best rating, 3=worst rating). Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". Sources: SCB LISA, UC AB, Bolagsverket. \*\*\* p<0.01 \*\* p<0.05 \* p<0.1

|   | Fired Next Year      |                      |                      |                      |                      |                     |
|---|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
|   | Short-tenured        |                      |                      | Long-tenured         |                      |                     |
|   | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  | (6)                 |
| High wage growth                          | 0.050***<br>(0.001)  | 0.039***<br>(0.001)  | 0.038***<br>(0.001)  | 0.008***<br>(0.000)  | 0.008***<br>(0.000)  | 0.008***<br>(0.000) |
| High wage growth X Shock (large)          | -0.030***<br>(0.002) | -0.023***<br>(0.002) | -0.014***<br>(0.002) | -0.000<br>(0.001)    | -0.002**<br>(0.001)  | -0.002**<br>(0.001) |
| High wage growth X Rating                 | 0.006***<br>(0.000)  | 0.004***<br>(0.000)  | 0.004***<br>(0.000)  | 0.004***<br>(0.000)  | 0.003***<br>(0.000)  | 0.003***<br>(0.000) |
| High wage growth X Shock (large) X Rating | 0.010***<br>(0.001)  | 0.009***<br>(0.001)  | 0.004***<br>(0.001)  | -0.000<br>(0.001)    | 0.001*<br>(0.001)    | 0.001*<br>(0.001)   |
| Shock (large)=1                           | -0.005***<br>(0.002) | 0.020***<br>(0.002)  | -<br>-               | 0.000<br>(0.001)     | 0.005***<br>(0.001)  | -<br>-              |
| Rating                                    | 0.004***<br>(0.001)  | -0.004***<br>(0.001) | -<br>-               | -0.002***<br>(0.001) | -0.003***<br>(0.001) | -<br>-              |

|                             |         |           |           |         |           |           |
|-----------------------------|---------|-----------|-----------|---------|-----------|-----------|
| Shock (large) X Rating      | -0.001  | -0.008*** | -         | 0.001   | -0.002*** | -         |
|                             | (0.001) | (0.001)   | -         | (0.001) | (0.001)   | -         |
| Observations                | 3254043 | 3254043   | 3254043   | 3869930 | 3869930   | 3869930   |
| Polynomials                 | Yes     | Yes       | No        | Yes     | Yes       | No        |
| Industry-Year fixed effects | Yes     | Yes       | Yes       | Yes     | Yes       | Yes       |
| Firm fixed effects          | No      | Firm      | Firm-Year | No      | Firm      | Firm-Year |



## Appendix 1 – RDD specification checks.

**Table A1**

This table computes the mean and the median absolute inter-annual deviation of the continuous "risk forecast" variable for firms that are in a window of +5%/-5% observations of the whole sample around the thresholds that determine the discrete ratings.

| Rating boundary  | Gold-Silver | Silver-Bronze |
|--|-------------|---------------|
| Threshold Risk Forecast  | 0.245       | 0.745         |
| <b>Risk forecast, annual absolute deviation on a 5% neighborhood</b> |             |               |
| Mean   | 0.15        | 0.43          |
| Median   | 0.36        | 0.91          |

**Table A2**

This table computes the transition probabilities across the first three rating categories. Transitions outside or from lower ratings are not included in the computation.

|                           |        | <i>This year's rating</i> |        |        |
|---------------------------|--------|---------------------------|--------|--------|
|                           |        | Gold                      | Silver | Bronze |
| <i>Last year's rating</i> | Gold   | 78%                       | 18%    | 4%     |
|                           | Silver | 28%                       | 54%    | 18%    |
|                           | Bronze | 8%                        | 36%    | 56%    |



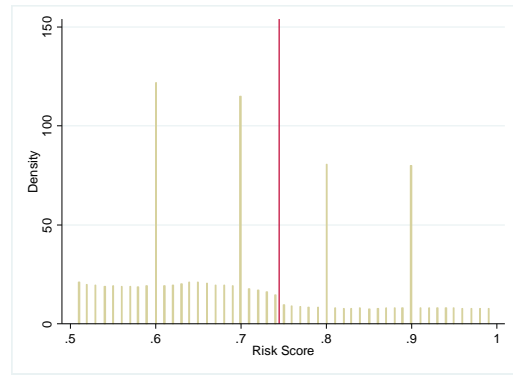
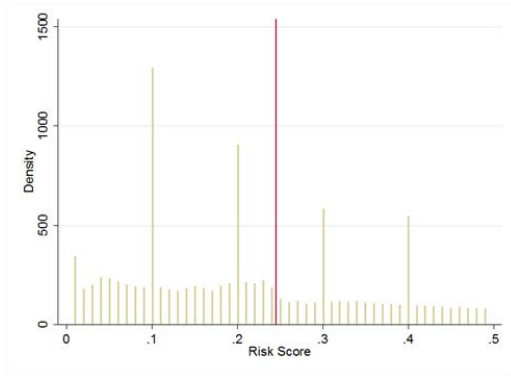
**Panel B: Ratings 1 year after**

|                            | <i>Short Term Banking Debt/Total Assets</i> |                   |                    | <i>Total Banking Debt/Total Assets</i> |                    |                    | <i>Interest rate paid to credit institutions</i> |                    |                     |
|----------------------------|---|-------------------|--------------------|--|--------------------|--------------------|--|--------------------|---------------------|
|                            | (1)   | (2)               | (3)                | (4)                                    | (5)                | (6)                | (7)  | (8)                | (9)                 |
| Rating                     | -0.0301<br>(0.0473)                         |                   |                    | -0.0433<br>(0.127)                     |                    |                    | 0.0197<br>(0.0853)                               |                    |                     |
| Rating<br>1 vs. 2 & 2 vs 3 |   | 0.0108<br>(0.108) | -0.108<br>(0.0848) |  | -0.499*<br>(0.287) | -0.0553<br>(0.220) |  | -0.0142<br>(0.215) | 3.57e-05<br>(0.149) |
| Observations               | 65,966                                      | 41,251            | 48,284             | 113,080                                | 67,632             | 85,815             | 113,004  | 65,235             | 87,300              |
| R-squared                  | 0.772                                       | 0.811             | 0.794              | 0.787                                  | 0.828              | 0.803              | 0.655  | 0.710              | 0.684               |
| Year-Sector FE             | yes   | yes               | yes                | yes                                    | yes                | yes                | yes  | yes                | yes                 |
| Firm FE                    | yes   | yes               | yes                | yes                                    | yes                | yes                | yes  | yes                | yes                 |
| Polynomial                 | yes   | yes               | yes                | yes                                    | yes                | yes                | yes  | yes                | yes                 |

**Panel C: Ratings 2 years after**

|                            | <i>Short Term Banking Debt/Total Assets</i> |                    |                   | <i>Total Banking Debt/Total Assets</i> |                   |                  | <i>Interest rate paid to credit institutions</i> |                  |                   |
|----------------------------|---|--------------------|-------------------|--|-------------------|------------------|--|------------------|-------------------|
|                            | (1)   | (2)                | (3)               | (4)                                    | (5)               | (6)              | (7)  | (8)              | (9)               |
| Rating                     | 0.0455<br>(0.0577)                          |                    |                   | 0.0108<br>(0.147)                      |                   |                  | 0.00422<br>(0.103)                               |                  |                   |
| Rating<br>1 vs. 2 & 2 vs 3 |   | -0.0489<br>(0.121) | 0.0231<br>(0.108) |  | -0.370<br>(0.310) | 0.184<br>(0.270) |  | 0.193<br>(0.235) | -0.186<br>(0.182) |
| Observations               | 46,518                                      | 31,234             | 32,418            | 83,115                                 | 53,054            | 60,785           | 83,678   | 51,675           | 62,400            |
| R-squared                  | 0.787                                       | 0.824              | 0.813             | 0.802                                  | 0.840             | 0.819            | 0.668  | 0.724            | 0.700             |
| Year-Sector FE             | yes   | yes                | yes               | yes                                    | yes               | yes              | yes  | yes              | yes               |
| Firm FE                    | yes   | yes                | yes               | yes                                    | yes               | yes              | yes  | yes              | yes               |
| Polynomial                 | yes   | yes                | yes               | yes                                    | yes               | yes              | yes  | yes              | yes               |

**Figure A1: Firm Density Around Rating Thresholds**



## Appendix 2 - Proofs

### Proof of proposition 1

First, we compute  $\mu_{min}^O$ . From the firing condition of long-tenured workers and

$$\left(\frac{A}{n^{1-\beta}}\mu^O - w\right)\frac{1+r+\lambda}{\delta+r+\lambda} + F = 0 \quad (17)$$

$$\mu_{min}^O = \frac{n^{1-\beta}}{A} \left[ w - \frac{\delta+r+\lambda}{1+r+\lambda} F \right] \quad (18)$$

Given the above definition, we compute  $E[V^O(\mu^O)]$ :

$$E[V^O(\mu^O)] = \left[ \frac{A}{n^{1-\beta}} \frac{1}{2} \left( \phi\mu^H + \frac{n^{1-\beta}}{A} \left[ w - \frac{\delta+r+\lambda}{1+r+\lambda} F \right] \right) - w \right] \frac{1+r+\lambda}{\delta+r+\lambda}$$

Rearranging:

$$E[V^O(\mu^O)] = \frac{1}{2} \left( \frac{A}{n^{1-\beta}} \phi\mu^H - w \right) \frac{1+r+\lambda}{\delta+r+\lambda} - \frac{1}{2} F$$

Therefore an increase in financing frictions  $\lambda$  lowers  $E[V^O(\mu^O)]$  both because it reduces the net present value of worker's surplus (the term  $\frac{1+r+\lambda}{\delta+r+\lambda}$ ) becomes smaller.

Given the value of  $E[V^O(\mu^O)]$ , recall the value of a short-term worker:

$$V^Y(\mu^Y) = \frac{1+r+\lambda}{(r+\lambda+\delta)(1-\eta)} \left\{ \left( \frac{A}{n^{1-\beta}}\mu^Y - w \right) + \frac{(1-\delta)}{1+r+\lambda} \eta \{ E[V^O(\mu^O)] \} \right\} \quad (19)$$

The proof of proposition 1 follows from the fact that an increase in financing frictions  $\lambda$  reduces the value of a short tenured worker  $V^Y(\mu^Y)$  both because it reduces the option value of becoming long-tenured (the second term in curly brackets falls) and because it reduces the net present value of remaining short-tenured (the multiplier in front of the curly brackets also falls). Therefore the term  $E_t[V^Y(\mu^Y)]$  falls, and it needs to be counterbalanced by a reduction in  $n$  in order to increase the productivity of workers and reestablish the equilibrium in the free entry condition  $E_t[V^Y(\mu^Y)] - v = 0$ .

### Proof of proposition 2

From the firing condition for young workers ,  $V^Y(\mu_{min}^Y) = 0$ , we derive the value of  $\mu_{min}^Y$ :

$$\mu_{min}^Y = \frac{n^{1-\beta}}{A} \left\{ w - \frac{(1-\delta)}{1+r+\lambda} \eta E[V^O(\mu^O)] \right\} \quad (20)$$

From the equation above it follows that  $\mu_{min}^Y$  falls as  $\lambda$  increases. Moreover equation **Error! Reference source not found.** implies that  $\mu_{min}^O$  falls, thus proving proposition 2.

### Proof of proposition 3

From equations **Error! Reference source not found.** and **Error! Reference source not found.** it follows that:

$$\frac{\partial \mu_{min}^Y}{\partial A} = -\frac{n^{1-\beta}}{A^2} \left\{ w - \frac{(1-\delta)}{1+r+\lambda} \eta E[V^O(\mu^O)] \right\} \quad (21)$$

And that:

$$\frac{\partial \mu_{min}^O}{\partial A} = -\frac{n^{1-\beta}}{A^2} \left[ w - \frac{\delta+r+\lambda}{1+r+\lambda} F \right] \quad (22)$$

Given that workers are uniformly distributed over productivities, proposition 3 is equivalent to saying that  $\frac{\partial \mu_{min}^Y}{\partial A} - \frac{\partial \mu_{min}^O}{\partial A}$  increases in  $\lambda$ . Therefore the proof follow immediately from the fact that  $\left\{ w - \frac{(1-\delta)}{1+r+\lambda} \eta E[V^O(\mu^O)] \right\}$  increases in  $\lambda$ , while  $\left[ w - \frac{\delta+r+\lambda}{1+r+\lambda} F \right]$  decreases in  $\lambda$ , as argued before.