Firing the Wrong Workers:

Financing Constraints and Labor Misallocation

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Abstract

This paper studies the effect of firms' financing constraints on the decision of which workers are fired. Firms need to consider wages and productivity (current and expected) 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 show empirical evidence of this distortion using matched employer-employee data from the whole active population of Sweden 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 using 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.

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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.[1] More generally, 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.[2] This type of trade-off is 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 which types of workers 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. A firm needs to consider several factors in order to decide which workers to fire such as the current and future expected productivity of a worker, wages, or firing and hiring costs. For example, a firm may 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

[1] Note: 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).

[2] 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. 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. 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 affect not only the overall level of firm employment, but also the optimal mix of short-tenure and long-tenure workers. More financially constrained firms have a higher opportunity cost of money, and discount the option value of short-tenure workers more heavily, placing a larger weight on short-term returns. Moreover, long-tenure 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-tenure workers. As a consequence, the model implies the following three testable hypotheses: First, everything else equal, the more financially constrained is a firm, the more likely it will fire a short-tenure worker, and the less likely it will fire a long-tenure worker. Second, the more financially constrained is a firm, the younger is the tenure profile of its labour force. Third, after an exogenous shock which requires a reduction in employment, a more financially constrained firm fires relatively more short-tenure workers than a less constrained firm.

In order to understand the empirical relevance of these distortions, we need to analyze the average firing policies of firms, the tenure profile of the labor force, and 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 between 1990 and 2010. We match worker information with employer information, for which we have extensive balance sheet and credit scoring data. The exceptional quantity and quality of information available in this dataset makes it optimal for our objective. We identify financing constraints in three different ways. First, we use three discrete rating categories 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. Finally, we run within firm-year regressions. This specification absorbs any time-varying characteristics that affect both types of workers, so the identification comes from comparing high and low-tenure workers within a firm on a given year.

We identify exogenous changes in firing needs using exogenous shocks to the exchange rate of a firm-specific basket of currencies, based on the export composition of the firm at the beginning of the sample.

Our analysis concentrates on the firing of short-tenure workers, which are on average younger, with steeper productivity profiles and lower firing costs, vs. long-tenure workers. The results show first, that financially constrained firms employ more short-tenure workers on average. Second, after suffering an exchange rate appreciation shock, both constrained and unconstrained firms are more likely to fire workers. Importantly, while there are no substantial differences in their overall firing rates, we find significant different in the types of workers fired. The shock causes relatively more firing of short-tenured workers than long-tenure ones in more financially constrained firms, but relatively less firing of short-tenure workers in less constrained firms.

Quantitatively we find that small exogenous changes in financing friction generate potentially large distortions in the form of excessive firings of short term 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-tenure workers increase by around 20%. These results are consistent with our analytical predictions and show a, so far, relatively unexplored form of misallocation: financially constrained firms fire low-tenured workers that have positive growth prospects and would be retained by less constrained firms.

The main effects identified in the paper are generally applicable to most labor markets. In dual labor markets with fixed-term and permanent workers or in those with severance payments that are increasing in tenure, the studied effects are likely to be 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. Therefore, the results of the article can be extrapolated to other labour markets. If anything, given Sweden's labour market characteristics, the results have to be seen as a lower bound to the effect in other European countries, given that both financing constraints and labour frictions are, in relative terms, low in Sweden.

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 US and Bentolila, Jansen, Jiménez and Ruano (2013) for Spain.[3] 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 the above two 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 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

[3] For a more comprehensive review of the literature on labour and finance, see Pagano and Pica, 2012.

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, 2013) 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, 2015).

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-tenure workers. Third, firing costs increase with workers tenure in the firm.

For simplicity, the model considers the trade-off between firing short-tenure workers vs. long-tenure workers regardless of their age. However, the assumption that short-tenure workers have steeper productivity profiles than long-tenure 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, μ 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 ouptut to total labour input n_t.

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

Conditional on becoming long-tenure the worker draws a new productivity value μ^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.[4]

Firms can fire short-tenure workers without cost and long-tenure workers by paying a fixed firing cost *F>0,* and they can hire new short-tenure 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, $n_t = n$. Without loss of generality we then fix the wage w, and the associated division of surplus between firm and workers, at an arbitrary value. Nonetheless it would be straightforward to microfound it as the outcome of a bargaining process. The assumption of fixed wage simplifies the analysis considerably, however all the qualitative results derived in this section would hold if we relax it, as long as wages do not fully adjust to compensate fluctuations in the productivity of workers.[5]

The timing of the problem is the following: at the beginning of each period with probability δ workers leave the firm exogenosly, and the firm decides whether or not to fire those that stay.[6] Among continuing workers a fraction η of the short-tenure workers become long-tenured, while some new short-tenure workers are hired. Then all workers produce and are paid a wage $w > 0$.

[4] This assumption implies that the distribution of productivities is more dispersed among long-tenured workers. However this feature is not essential and it could be eliminated by assuming that the productivity of long tenured workers is drawn from a less dispersed distribution.
[5] Sweden is one of the countries with highest wage compression in the world, so the assumption that wages under-react to workers' productivity is particularly relevant in our empirical setting.
[6] 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. This assumption simplifies the analysis, but it is not essential for the results of this model.

Value of long-tenure workers:

We define $V^O(\mu_t^O)$ as the value of a long-tenure 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 λ 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 bankrtuptcy 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-tenure worker with current productivity μ^Y who has not been fired in the current period has the following value:

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

Which can be simplied 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 μ_{min}^O is the minimum productivity of continuing long-tenure 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:

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

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

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

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

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

The proof of Proposition 1 is straighforward since V^Y is inversely related to λ, 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-tenure workers who reveal too low productivity, and have a negative value for the firm, will be fired an replaced by a new worker, so that the minimum productivity μ^Y_{min} satisfies:

$$V^Y(\mu^Y_{min}) = 0, \tag{8}$$

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

$$V^O(\mu^O_{min}) = -F \tag{9}$$

The relation between μ^O_{min} and μ^Y_{min} is affected by two counteracting forces. On the one hand, the value of a short-tenure 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 μ_{min}^O a short-tenure worker is more valuable than a long-tenure one. The difference $V^Y(\mu_{min}^O) - V^O(\mu_{min}^O)$ increases in the value of the parameter ϕ, which measures the growth opportunities of short-tenure 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-tenure than a short-tenure workers conditional on a given productivity level μ, despite the long-tenure workers are more costly to fire.

An higher value of financing frictions λ reduces the value of long-tenure workers relative to the opportunity cost of firing F, and reduces μ_{min}^O, meaning that a more financially constrained firm will fire less frequently long-tenure workers. Moreover it reduces the net present value of the future productivity of short tenured workers, thereby reducing their option value, and increasing μ_{min}^Y. Therefore both effects imply that μ_{min}^Y increases relative to μ_{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 then unconstrained firms, because financial frictions reduce the option value of these workers. Moreover, the higher firing hazard of short-tenure workers implies that a smaller fraction of them become long-tenure 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-tenure 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 μ^{Y}_{min} and μ^{O}_{min} increase and the firm fires both some short tenured and long-tenure workers. What is the effect of financing frictions on the mix of short tenured and long-tenure workers that are fired?

In the previous section, we have shown that the more a firm is constrained (higher value of λ), the more it discounts the option value of short tenured workers, and only keeps those with relatively high current productivity μ^{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-tenure relative to the long-tenure 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-tenure 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-tenure 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-tenure 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.*

4 Data and Descriptive Statistics

4.1 Firm Data

We test our hypotheses using a matched firm-employees 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 labour 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 will make use of 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 129,193firm-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. 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-tenure workers (0-2 years with the firm) are fired every year but only about 3% of the long-tenure 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).[7] These discrete ratings are based on a continuous measure "Risk Forecast" of the annual probability of default of the firm. Discrete

[7] 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.

thresholds of the continuous measure determine the 5 discrete ratings.[8] 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.

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.[9] 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 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

[8] The thresholds on the risk score are 0.245%, 0.745%, 3.045%, and 8.045% and are determined by UC AB.

[9] The three categories correspond to a *gold badge* for *"highest creditworthiness"* a *silver badge* for "*high creditworthiness"* and a *bronze badge* for *"creditworthy"*.

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 treated as coming 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) 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.[10]

[10] 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.

In Figure A1 we show the density of firms around the discontinuity for the two boundaries analyzed.[11] 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.[12] The results in Panel B show, firms at the threshold are indistinguishable in terms of their characteristics the previous year (thus supporting the first assumption). However, Panel A shows that they differ in their contemporaneous and future leverage variables (lending support to the second assumption). In particular, firms seem to have lower leverage once they become constrained (Columns 1 to 3) and higher bank interest rates (Columns 4-6). The effect on the interest rate of total debt ranges from positive and not statistically significant (Columns 7 and 8), to negative and statistically significant (Column 9). 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.

[11] There are some probability mass points at round numbers. These correspond to the risk forecasts pre 2006 that are reported in round 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.
[12] More specifically, we follow the specification in expression (14) as shown in the next section.

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-tenure 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.[13] 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 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. 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

[13] Related identification strategies can be found in Revenga (1992), Bertrand (2004), or Cuñat and Guadalupe (2009).

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 $Shock_{ft}$ 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, 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 a FX 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-tenure* that takes the value one if the worker has been less than two full years working for the company.[14]

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

[14] The results are robust to other thresholds such as 1 year or 3 year.

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), 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, and in both case 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%.

5.4 Specifications

5.4.1 Firm level regressions

Consider the following firm-level specification:

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

In which the dependent variable is the fraction of short-tenure workers employed at the firm, or other outcome variables related to employment or firm characteristics. 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

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

where y_{ft} 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:

$$y_{ift} = \alpha + \beta_1 Shock_{ft-1} + \beta_2 Short\_tenured_{it} + \beta_3 C_{ft} \quad (12)$$

$$+\beta_4 (C_{j,f} * Shock_{ft-1}) + \beta_5 (Short\_tenured_{it} * Shock_{ft-1}$$

$$+ \beta_6 C_{ft} Short\_tenured_{it} * Shock_{ft-1} + \varepsilon_{it}$$

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.

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

where δ_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.

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

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

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

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:

$$y_{ift} = \alpha + \delta_{ft} + \beta_1 Short\_tenured_{it} + \beta_2(Short\_tenured_{it} * Shock_{st-1} + \beta_3 C_{ft} Short\_tenured_{it} * Shock_{ft-1} + \varepsilon_{it} \tag{16}$$

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-tenure and short-tenure workers.

However, the within-firm estimator is nested with and RDD specification in which one single time-varying polynomial on the running variable is used to absorb the continuous effect of the risk forecst 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 negative export 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 have on average between 1.4% and 4.7% more low tenure 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-tenure 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-tenure workers on average and, conditional on firing workers, they fire relatively more short-tenure than long-tenure 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 does not contain the shock variable or its interactions. The results are quite consistent across specifications. Short-tenure workers are more likely to leave the firm at any point in time. The size of the effect is large, between 6% and 7% higher probability where the average probability of being fired across all workers is 6%. Constrained firms show ambiguous results with respect to firing a long-tenure worker. In particular, the specification in Column (2) shows that they are less likely to fire them, while the RDD specification in Column (3) shows that they are more likely to fire them. The size of both effects is small. The final result of the first three columns is that short-tenure 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-tenure workers. The shock variable is associated with a positive and significant coefficient. These two results explain the ambiguity of the 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. This partially explains the result of the firm regressions, showing that tenure decreases when firms are exposed to a shock. The effect of the shock for 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, long-tenure workers are protected by a larger fraction of short-tenure workers being present and fired in constrained firms. Finally, the interaction between low-tenure, constrained and a negative shock has a clear positive coefficient across all specifications. That is, financially constrained firms fire an abnormally large fraction of low-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. It is also quite a sizeable effect once put in perspective with 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, the results in Table A3 show increases in average interest rates paid between 0.14% and 0.28%. 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 across the gold-silver ratings should be 0.16% and 0.54% across the 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.

Recall that 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).

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 were categorized as gold (rating 1) for two years in a row and we focus on the boundary between gold and silver badges. The rationale for this specification is the firms that transition from gold to silver rating for the first time are the ones who least expect to be in the silver category. Therefore, it is for these firms that it is precisely hardest for to try to affect their rating in the short run. The results on the table are qualitatively in line with the results in Table 3. However, they are quantitatively much more sizeable and statistically significant. In other words, the firms for which a change in 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.

7 Conclusions

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

We illustrate the main forces in 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 which types of workers are fired across firms, and have potentially important distortionary effects on the optimal allocation of employees even when they have little effect on the total employment level.

We estimate firing decisions at the firm and worker level using a very 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-tenure workers as a fraction of their labour force. ii) Tend to fire more sort-tenure workers. iii) The effect in ii) is emphasized when financially constrained firms experience negative shocks. This results in long-tenure workers being relatively 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-tenure 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-tenure worker, 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.

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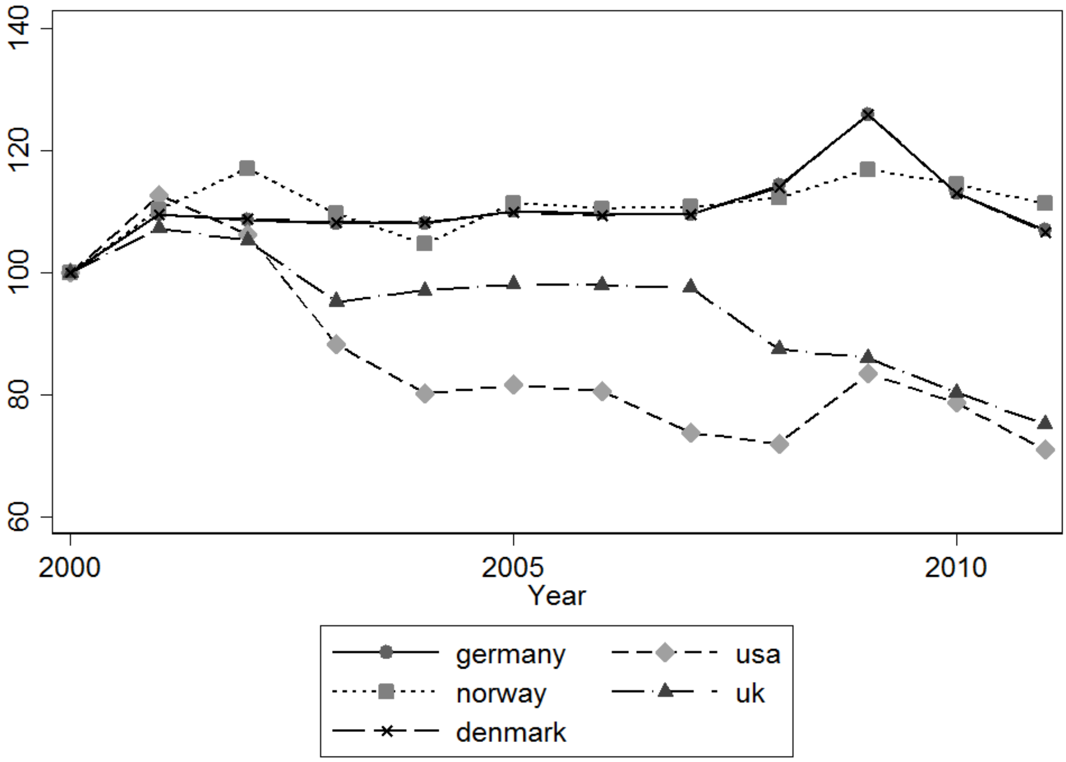
9 Figures

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.



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. FX Shock is an exchange rate shock. In “FX small” the exchange rate shock is equal to one for the 25% highest appreciation quantile within a year, and zero otherwise. Otherwise we denote with “FX big” the regressions where we qualify as shocks larger appreciations, within the 25% 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…5 (1=best rating, 5=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

	mean	**p25**	**p50**	**p75**	**N**
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
FX Shock (small)	0.199	0.000	0.000	0.000	129206
FX 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 low tenure (0-2 years) and high tenure (3 and more years). Age is the age of the worker in years Female is a variable that takes the value of 1 for men and 2 for women. Sources: SCB LISA.

Panel B: Worker Characteristics

	mean	**p25**	**p50**	**p75**	**N**
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-tenure	0.104	0.000	0.000	0.000	3256913
Fired | Long-tenure	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…5 (1=best rating, 5=worst rating). 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".

*** p<0.01 ** p<0.05 * p<0.1

	Fraction of workers with tenure 0-2 years					
	(1)	(2)	(3)	(4)	(5)	(6)
Negative export shock	0.017***	0.008**	0.008**			
	(0.004)	(0.004)	(0.004)			
Constrained	0.047***	0.014***	-0.003	0.046***	0.014***	-0.004*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Negative export shock X Constrained	-0.014***	-0.006***	-0.006***			
	(0.002)	(0.002)	(0.002)			
Observations	129029	129029	129029	129029	129029	129029
Polynomial on Credit Risk	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 is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 25% 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,…,5 (1=best rating, 5=worst rating). Low tenure 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".
*** p<0.01 ** p<0.05 * p<0.1

	Fired Next Year							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short-tenure	0.058***	0.060***	0.074***	0.066***	0.065***	0.064***	0.057***	0.070***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.007)	(0.001)
Shock (large)	-	-	-	-	0.002***	0.009***	0.002***	-
	-	-	-	-	(0.001)	(0.001)	(0.001)	-
Short-tenure X Shock (large)	-	-	-	-	-0.034***	-0.024***	-0.031***	-0.024***
	-	-	-	-	(0.001)	(0.001)	(0.001)	(0.001)
Rating	0.007***	-0.003***	0.001***	-	0.007***	-0.002***	-0.005*	-
	(0.000)	(0.000)	(0.000)	-	(0.000)	(0.000)	(0.002)	-
Short-tenure X Rating	0.009***	0.007***	0.002***	0.007***	0.007***	0.006***	0.016***	0.006***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)
Shock (large)=1 X Rating	-	-	-	-	-0.000	-0.002***	-0.000	-
	-	-	-	-	(0.000)	(0.000)	(0.000)	-
Short-tenure X Shock (large)=1 X Rating	-	-	-	-	0.008***	0.006***	0.007***	0.006***
	-	-	-	-	(0.001)	(0.001)	(0.001)	(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 is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 25% 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. Low tenure 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”.
*** p<0.01 ** p<0.05 * p<0.1

	Fired Next Year			
	(1)	(2)	(3)	(4)
Short-tenure	0.070***	0.069***	0.064***	0.054***
	(0.000)	(0.000)	(0.002)	(0.003)
Shock (large)	0.002***	0.007***	0.007***	-
	(0.000)	(0.000)	(0.000)	-
Short-tenure X Shock (large)	-0.025***	-0.020***	-0.020***	-0.018***
	(0.001)	(0.001)	(0.001)	(0.001)
Rating 1 vs. 2	0.009***	-0.006***	-0.009***	-
	(0.000)	(0.000)	(0.002)	-
Short-tenure X Rating 1 vs. 2	0.017***	0.014***	0.021***	0.029***
	(0.001)	(0.001)	(0.003)	(0.004)
Shock (large)=1 X Rating 1 vs. 2	-0.005***	-0.001	-0.001	-
	(0.001)	(0.001)	(0.001)	-
Short-tenure X Shock (large)=1 X Rating 1 vs. 2	0.015***	0.013***	0.013***	0.006***
	(0.001)	(0.001)	(0.001)	(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 is an exchange rate shock. "Large" refers to shocks of larger appreciations, within the 25% 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. Low tenure 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".
*** p<0.01 ** p<0.05 * p<0.1

	Fired Next Year			
	(1)	(2)	(3)	(4)
Short-tenure	0.087***	0.084***	0.315***	0.277***
	(0.000)	(0.001)	(0.046)	(0.052)
Shock (large)	-0.004***	0.004***	0.004***	-
	(0.001)	(0.001)	(0.001)	-
Short-tenure X Shock (large)	-0.010***	-0.008***	-0.008***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.001)
Rating 2 vs. 3	0.004***	0.002***	-0.001	-
	(0.000)	(0.000)	(0.001)	-
Short-tenure X Rating 2 vs. 3	-0.003***	-0.004***	-0.003	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)
Shock (large)=1 X Rating 2 vs. 3	0.007***	-0.003**	-0.003**	-
	(0.001)	(0.001)	(0.001)	-
Short-tenure X Shock (large)=1 X Rating 2 vs. 3	-0.004**	0.003	0.003*	0.006***
	(0.002)	(0.002)	(0.002)	(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 is an exchange rate shock. "Shock (small)" is equal to one for the 25% highest appreciation quantile within a year, and zero otherwise. Rating is a categorical variable equal to 1,…,5 (1=best rating, 5=worst rating). Low tenure 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".
*** p<0.01 ** p<0.05 * p<0.1

	Fired Next Year			
	(1)	(2)	(3)	(4)
Short-tenure	0.066***	0.066***	0.082***	0.087***
	(0.000)	(0.001)	(0.002)	(0.002)
Shock (small)	0.002***	0.010***	0.009***	-
	(0.000)	(0.001)	(0.001)	-
Short-tenure X Shock (large)	-0.027***	-0.022***	-0.022***	-0.021***
	(0.001)	(0.001)	(0.001)	(0.001)
Rating	0.007***	-0.002***	0.002***	-
	(0.000)	(0.000)	(0.001)	-
Short-tenure X Rating	0.007***	0.005***	0.000	-0.002
	(0.000)	(0.000)	(0.001)	(0.001)
Shock (large)=1 X Rating	-0.001***	-0.003***	-0.003***	-
	(0.000)	(0.000)	(0.000)	-
Short-tenure X Shock (small)=1 X Rating	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(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 is an exchange rate shock. "Shock (small)" is equal to one for the 25% highest appreciation quantile within a year, and zero otherwise. Rating is a categorical variable equal to 1,…,5 (1=best rating, 5=worst rating). Low tenure 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”.
*** p<0.01 ** p<0.05 * p<0.1

	Fired Next Year			
	(1)	(2)	(3)	(4)
Short-tenure	0.070***	0.069***	0.097***	0.073***
	(0.001)	(0.001)	(0.003)	(0.001)
Shock (large)	0.009***	0.022***	0.022***	
	(0.001)	(0.002)	(0.002)	
Short-tenure X Shock (large)	-0.058***	-0.046***	-0.044***	-0.033***
	(0.002)	(0.003)	(0.003)	(0.003)
Rating 1 vs. 2	0.006***	0.002***	0.011***	
	(0.000)	(0.001)	(0.002)	
Short-tenure X Rating 1 vs. 2	-0.002**	-0.000	-0.007***	-0.002**
	(0.001)	(0.001)	(0.003)	(0.001)
Shock (large)=1 X Rating 1 vs. 2	-0.007***	-0.012***	-0.013***	
	(0.001)	(0.001)	(0.001)	
Short-tenure X Shock (large)=1 X Rating 1 vs. 2	0.026***	0.021***	0.019***	0.013***
	(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

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
Risk forecast, annual absolute deviation on a 5% neighborhood		
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.

		This year's rating		
		Gold	Silver	Bronze
Last year's rating	Gold	78%	18%	4%
	Silver	28%	54%	18%
	Bronze	8%	36%	56%

Table A3

The dependent variable in columns (1)-(3) is the debt to equity ratio. The dependent variable in columns (4)-(6) is the interest rate paid to credit institutions. The dependen variable in columns (7)-(9) is the total interest rate. Rating is a categorical variable equal to 1…5 (1=best rating, 5=worst rating) and is used in (1), (4), and (7). 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 and used in specifications (2), (5), and (8). 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 and used in specifications (3), (6), and (9). Polynomial indicates a polynomial of order 12 of the running variable "risk forecast". All variables are constructed as %. *** p<0.01 ** p<0.05 * p<0.1

Panel A: Contemporaneous

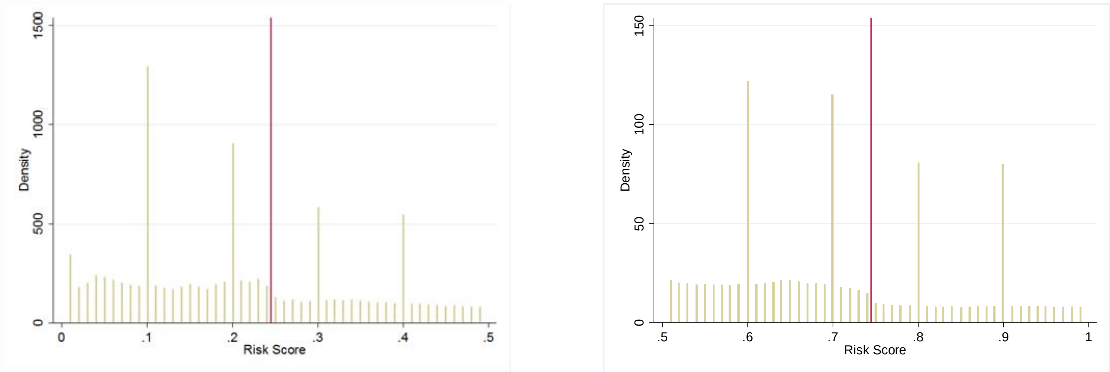
	Debt / equity			***Interest rate paid to credit institutions***			***Total debt interest rate***		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rating	-2.21*			0.141*			0.000939		
	(1.19)			(0.0831)			(0.008)		
Threshold		-0.427	-2.75		0.0713	0.282**		0.0074	-0.0286**
1 vs. 2 & 2 vs 3		(2.29)	(2.40)		(0.216)	(0.138)		(0.0197)	(0.014)
Observations	379,077	241,392	252,051	185,675	94,949	147,832	357,157	217,436	246,726
R-squared	0.76	0.812	0.753	0.614	0.683	0.641	0.732	0.738	0.774
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 B: 1 Year before

Panel B: Previous Year's Differences

	Debt / equity			*Interest rate paid to credit institutions*			*Total debt interest rate*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rating	-0.561			0.027			0.002		
	(1.239)			(0.0818)			(0.00908)		
Threshold		-4.077*	2.706		-0.045	0.044		0.005	-0.008
1 vs. 2 & 2 vs 3		(2.102)	(2.592)		(0.203)	(0.144)		(0.020)	(0.016)
Observations	279,417	200,643	169,395	120,584	70,813	91,777	248,791	170,753	159,653
R-squared	0.797	0.837	0.790	0.648	0.701	0.679	0.768	0.775	0.807
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 μ_{min}^{O}. From the firing condition of long-tenure workers and

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

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

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 fricions λ 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:

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

The proof of proposition 1 follows from the fact that an increse in financing fricions λ reduces the value of a short tenured worker $V^{Y}(\mu^{Y})$ both because it reduces the option value of becoming long-tenure (the second term is curly brakets falls) and because it reduces the net present value of remaining short-tenure (the multiplier in front of the curly brakets 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 increse 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 , $V^Y(\mu^Y_{min}) = 0$, we derive the value of μ^Y_{min}:

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

From the equation above it follows that μ^Y_{min} falls as λ increases. Moreover equation 18 implies that μ^O_{min} falls, thus proving proposition 2.

Proof of proposition 3

From equations 18 and 20 it follows that:

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

And that:

$$\frac{\partial \mu^O_{min}}{\partial A} = -\frac{n^{1-\beta}}{A^2}\left[w - \frac{\delta+r+\lambda}{1+r+\lambda}F\right] \tag{22}$$

Given that workers are uniformly distributed over productivities, proposition 3 is equivalent to saying that $\frac{\partial \mu^Y_{min}}{\partial A} - \frac{\partial \mu^O_{min}}{\partial A}$ increases in λ. 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 λ, while $\left[w - \frac{\delta+r+\lambda}{1+r+\lambda}F\right]$ decreases in λ, as argued before.