Credit and Hiring

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VERY PRELIMINARY

Abstract

We study an industry dynamics model where access to credit improves the bargaining position of firms with workers and increases the incentive to hire. The importance of this channel for the hiring decisions of firms is evaluated quantitatively by estimating the model with simulated methods of moments using data from Compustat and Capital IQ.

Introduction

The idea that firms use leverage strategically to improve their bargaining position with workers is not new in the corporate finance literature. For example, Perotti and Spier (1993) constructed a model where debt reduces the surplus upon which wage bargaining takes place and this allows firms to

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reduce the cost of labor. Recent studies by Klasa, Maxwell, and Ortiz-Molina (2009) and Matsa (2010) have tested this hypothesis using firm-level data and found that more unionized firms, that is, firms where workers are likely to have higher bargaining power, are characterized by higher leverages and lower holding of cash. Thus, there is evidence that the bargaining channel is important for the financial decisions of firms.

If the bargaining strength of workers impacts on the financial structure of firms, it is also possible that changes in the financial structure affect the hiring decisions of firms. In fact, if higher leverage allows firms to negotiate more favorable conditions with workers, the ability to issue more debt should increase their incentive to hire more workers. Although there are studies that have investigated the importance of the bargaining channel for the financial decisions of firms (as discussed above), whether this channel is also important for the hiring decisions of firms has not been fully explored in the literature. The goal of this paper is to explore the importance of the bargaining channel for the hiring decisions of firms by estimating a dynamic model with wage bargaining and endogenous choices of financing and hiring.\footnote{Monacelli, Quadrini and Trigari (2011) have studied the macroeconomic implications of the bargaining channel in a general equilibrium model with a representative firm. In this paper we take a micro approach and investigate the mechanism empirically using firm-level data.}

In the model, the compensation of workers is determined at the firm level through bargaining and firms choose the financial structure and employment optimally taking into account that these choices affect the cost of labor. Higher debt allows firms to negotiate lower wages which increases the incentive to hire more workers. Higher debt, however, also increases the probability of financial distress. Therefore, firms face a trade-off in the choice of debt whose resolution determines the optimal financing and employment decisions. When the financial condition of the firm improves, the likelihood of financial distress declines, making the debt more attractive. This, in turn, improves its bargaining position with workers, increasing the incentive to hire. It is trough this mechanism that improved financial market conditions generate a higher demand of labor.

We evaluate the importance of this channel by estimating the structural model through simulated method of moments. The empirical moments are constructed using firm-level data from Compustat and Capital IQ. The first database provides information on typical balance sheet and operation variables including employment. The second database provides firm level data
for unused credit lines which is important for the identification of some key parameter. More specifically, since the likelihood of financial distress increases with leverage, firms tend to borrow less than their credit capacity. We interpret the difference between the maximum debt capacity and the actual borrowing as unused credit. Then, data on unused credit lines provides useful information for the identification of the distress cost parameter.

The remaining sections of the paper are organized as follows. Sections 1 and 2 present the dynamic model and characterizes the key properties. Section 3 describes the data and the structural estimation. Section 4 reports the estimation results. Section 5 concludes.

1 A model of firm dynamics with bargaining

To facilitate the presentation of the model, we first present a simplified version without financial distress. This facilitates the characterization of the key properties of the model and the description of the key mechanism. After that we will extend the model by adding the possibility of financial distress.

Consider a firm with production technology $y_t = \tau_t N_t$, where $\tau_t$ is idiosyncratic productivity and $N_t$ is the number of workers. Employment evolves according to

$$N_{t+1} = (1 - \lambda)N_t + E_t,$$

(1)

where $\lambda$ is the separation rate and $E_t$ denotes the newly hired workers. The hiring cost is $\Upsilon \left( E_t / N_t \right) N_t$, with the function $\Upsilon(.)$ strictly increasing and convex.

The budget constraint of the firm is

$$B_t + D_t + w_t N_t + \Upsilon \left( \frac{E_t}{N_t} \right) N_t = \tau_t N_t + q_t B_{t+1},$$

(2)

where $B_t$ is the stock of bonds issued by the firm at $t - 1$ (liabilities), $D_t$ is the equity payout, $q_t$ is the price of bonds and $w_t$ is the wage.

The issuance of new debt is subject to the enforcement constraint

$$q_t B_{t+1} = \xi_t \beta S_{t+1},$$

(3)

where $S_{t+1}$ is the net surplus of the firm that will be defined below. The variable $\xi_t$ is stochastic and captures the financial conditions of the firm, that is, its access to external credit.
1.1 Firm’s policies and wages

The policies of the firm, including wages, are bargained collectively with its labor force. The labor force can be interpreted broadly, including managers. In this way the model would also capture the agency conflicts between shareholders and managers as in Jensen (1986).

To derive the bargaining outcome, it will be convenient to define few terms starting with the equity value of the firm. This can be written recursively as

\[ V_t(B_t, N_t) = D_t + \beta \mathbb{E}_t V_{t+1}(B_{t+1}, N_{t+1}). \]  

(4)

The equity value of the firm depends on two endogenous states—debt \( B_t \) and employment \( N_t \)—in addition to the exogenous states \( z_t \) and \( \xi_t \). To simplify the notation, the dependence on the exogenous states is not shown explicitly but it is captured by the time subscript \( t \). We will continue to use this convention throughout the paper.

The value of an individual worker employed in a firm with liabilities \( B_t \) and with \( N_t \) employees is

\[ \omega_t(B_t, N_t) = w_t + (1 - \lambda) \beta \mathbb{E}_t \omega_{t+1}(B_{t+1}, N_{t+1}) + \lambda \beta \mathbb{E}_t u_{t+1}, \]  

(5)

while the value of being unemployed is

\[ u_t = a_t + \beta p_t \mathbb{E}_t \omega_{t+1} + (1 - p_t) \beta \mathbb{E}_t u_{t+1}. \]  

(6)

The term \( \omega_{t+1} \) is the value of finding a job and being employed in period \( t+1 \), which happens with probability \( p_t \). An unemployed worker receives the utility flow \( a_t \) in the current period. The terms \( \omega_{t+1}, p_t \) and \( a_t \) are exogenous in the model.

Subtracting equation (6) from equation (5) we obtain

\[ \omega_t(B_t, N_t) - u_t = w_t - a_t + (1 - \lambda) \beta \mathbb{E}_t \left( \omega_{t+1}(B_{t+1}, N_{t+1}) - u_{t+1} \right) - \beta p_t \mathbb{E}_t \left( \omega_{t+1} - u_{t+1} \right) \]  

(7)

The net surplus is defined as the sum of the net value for the firm and the workers, that is,

\[ S_t(B_t, N_t) = V_t(B_t, N_t) + \left( \omega_t(B_t, N_t) - u_t \right) N_t \]  

(8)
We are now ready to define the bargaining problem solved by the firm and the workers. Given \( \eta \) the bargaining power of workers, the policies of the firm are the solution to the maximization problem

\[
\max_{w_t, D_t, E_t, B_{t+1}} \left[ (\omega_t(B_t, N_t) - u_t)N_t \right]^{\eta} \cdot V_t(B_t, N_t)^{1-\eta},
\]

subject to the law of motion for employment, equation (1), the budget constraint, equation (2), and the enforcement constraint, equation (3).

Differentiating with respect to the wage \( w_t \) we obtain the well-known result that workers receive a fraction \( \eta \) of the net surplus while the firm receives the remaining fraction, that is,

\[
\begin{align*}
(\omega_t(B_t, N_t) - u_t)N_t &= \eta S_t(B_t, N_t) \\
V_t(B_t, N_t) &= (1 - \eta) S_t(B_t, N_t).
\end{align*}
\]

By deriving the first order conditions with respect to \( D_t, E_t, B_{t+1} \) and taking into account (9) and (10), we find that the dividend, employment and financial policies maximize the net surplus \( S_t(B_t, N_t) \). This property is intuitive: if the firm and the workers share the net surplus, it is in the interest of both parties to make the net surplus as big as possible. Therefore, in characterizing the hiring and financial policies of the firm we focus on the maximization of the net surplus, that is,

\[
\begin{align*}
S_t(B_t, N_t) &= \max_{e_t, B_{t+1}} \left\{ D_t + (w_t - \bar{a}_t)N_t + \beta \left[ 1 - \eta + \eta(1 - \lambda) \left( \frac{N_t}{N_{t+1}} \right) \right] E_t S_{t+1}(B_{t+1}, N_{t+1}) \right\}
\end{align*}
\]

subject to:

\[
\begin{align*}
D_t + w_t N_t &= z_t N_t - \gamma \left( \frac{E_t}{N_t} \right) N_t + q_t B_{t+1} - B_t \\
q_t B_{t+1} &\leq \xi_t \beta E_t S_{t+1}(B_{t+1}, N_{t+1}) \\
N_{t+1} &= (1 - \lambda) N_t + E_t.
\end{align*}
\]
The recursive formulation of the surplus function is obtained by multiplying equation (7) by $N_t$, summing to (4) and using the sharing rules (9) and (10). The term $\bar{a}_t = a_t + \beta p_t E_t (\bar{w}_{t+1} - u_{t+1})$ is exogenous given the partial equilibrium approach taken in this paper.

We now take advantage of the linearity of the model and normalize by employment $N_t$. This allows us to rewrite the optimization problem with all variables expressed in per-worker terms, that is,

$$s_t(b_t) = \max_{e_t, b_{t+1}} \left\{ d_t + w_t - \bar{a}_t + \beta \left[ (1 - \eta) g_{t+1} + \eta(1 - \lambda) \right] E_t s_{t+1}(b_{t+1}) \right\}$$

subject to:

$$d_t + w_t = z_t - \Upsilon(e_t) + q_t g_{t+1} b_{t+1} - b_t$$

$$\xi_t g_{t+1} \beta E_t s_{t+1}(b_{t+1}) \geq q_t g_{t+1} b_{t+1}$$

$$g_{t+1} = 1 - \lambda + e_t.$$  

The variable $s_t(b_t) = S_t(b_t)/N_t$ is the per-worker surplus, $d_t = d_t/N_t$ is the per-worker dividend, $b_t = B_t/N_t$ is the per-worker liabilities, $e_t = E_t/N_t$ is new hires per existing employment, and $g_{t+1} = N_{t+1}/N_t$ is the gross growth rate of employment in the firm.

### 1.2 First order conditions

The first order conditions with respect to $e_t$ and $b_{t+1}$ are

$$q_t b_{t+1} + \beta(1 - \eta) E_t s_{t+1}(b_{t+1}) = \Upsilon'(e_t), \quad (11)$$

$$q_t g_{t+1} + \beta \left[ (1 - \eta) g_{t+1} + \eta(1 - \lambda) \right] E_t \frac{\partial s_{t+1}(b_{t+1})}{\partial b_{t+1}} + \mu_t g_{t+1} \left[ \xi_t \beta E_t \frac{\partial s_{t+1}(b_{t+1})}{\partial b_{t+1}} - q_t \right] = 0, \quad (12)$$

where $\mu_t$ is the lagrange multiplier associated to the enforcement constraint. The derivative of the surplus is provided by the envelope condition

$$\frac{\partial s_t(b_t)}{\partial b_t} = -1. \quad (13)$$
This condition shows that the normalized surplus function is linear in $b_t$. Thus, we can write the normalized surplus as

$$s_t(b_t) = \bar{s}_t - b_t,$$  \hspace{1cm} (14)

where $\bar{s}_t$ depends only on the exogenous shocks.

Define $g_{t+1}^X = X_{t+1}/X_t$ the gross growth rate of a generic variable $X$. Since $b_{t+1} = B_{t+1}/N_{t+1} = b_t g_{t+1}^B / g_{t+1}^N$, we can rewrite condition (11) as

$$q_t b_t g_{t+1}^B / g_{t+1}^N + \beta (1 - \eta) \mathbb{E}_t s_{t+1} \left( \frac{b_t g_{t+1}^B}{g_{t+1}^N} \right) = \Upsilon'(e_t). \hspace{1cm} (15)$$

Using the envelope condition (13), equation (12) can be rewritten as

$$q_t g_{t+1} = \beta \left[ (1 - \eta) g_{t+1} + \eta (1 - \lambda) \right] + \mu_t g_{t+1} (\beta \xi_t + q_t) \hspace{1cm} (16)$$

### 1.3 Special case with $q_t = \beta$.

Since we are focusing on a partial equilibrium and we abstract from aggregate shocks, it makes sense to assume that the price of a zero coupon bond, $q_t$, is equal to the discount factor $\beta$. Then, the first order condition for debt, equation (16), becomes

$$g_{t+1}^N = (1 - \eta) g_{t+1}^N + \eta (1 - \lambda) + \mu_t g_{t+1}^N (1 + \xi_t). \hspace{1cm} (17)$$

The following proposition establishes an important property about the financial policy of the firm.

**Proposition 1.1** If $\eta > 0$, the firm borrows up to the limit whenever $e_t > 0$. If $\eta = 0$ the debt is undetermined.

**Proof 1.1** If $\eta > 0$, equation (17) implies that the lagrange multiplier $\mu_t$ is strictly positive if $e_t = g_{t+1} - 1 + \lambda > 0$. Therefore, under the condition $e_t > 0$ the enforcement constraint is binding. When $\eta = 0$, instead, equation (17) implies that $\mu_t$ is always equal to zero.

The intuition for this result is simple. Whenever the firm chooses to hire, it adds new workers who are not yet part of the current labor force. Increasing the debt will reduce the compensation of the new hired workers which in
turn increases the current surplus (shared by shareholders and currently employed workers). When the firm does not hire, the debt cannot increase the surplus, since it will only reduce the future compensation of existing workers. In this case there is no value from borrowing. Thus, as long as the firm adds new workers, bargaining introduces a motive to borrow, breaking the irrelevance result of Modigliani and Miller (1958). For this result, however, the bargaining power of workers must be positive, that is, $\eta > 0$. In the limiting case with $\eta = 0$, we go back to Modigliani and Miller (1958).

We now turn attention to the first order condition for hiring, equation (15). Under the assumption $q_t = \beta$, this condition can be rewritten as

$$
\beta \left[ \frac{(1 - \eta) E_t \bar{s}_{t+1} + \eta g_{B_t+1} b_t}{g_{N_t+1}} \right] = \Upsilon'(e_t).
$$

(18)

Together with the normalized law of motion for employment, $g_{N_t+1} = 1 - \lambda + e_t$, this equation establishes a relation between the growth of employment and the growth of debt (which also depends on the initial debt and other factors affecting the surplus of the firm through the term $E_t \bar{s}_{t+1}$). This relation is not linear and depends on the bargaining power of workers $\eta$. However, in the limiting case with $\eta = 0$, employment becomes unrelated to debt as stated in the following proposition.

**Proposition 1.2** If $\eta = 0$, the choice of $e_t$ is independent of $b_t$ and $g_{B_t+1}$.

Thus, when workers do not have any bargaining power, which can be interpreted as representative of a competitive labor market, debt is irrelevant for the hiring decisions of firms. This is a consequence of the fact that the financial structure of firms is no longer relevant as already stated in Proposition 1.1. However, if $\eta > 0$, the employment policy is related to debt. The goal of this paper is to explore this dependence.

## 2 Financial distress cost

So far we have presented the model abstracting from the possibility that the firm could end up in a situation of financial distress. The variable $\xi_t$ captures the financial condition of a firm in terms of access to credit. However, a sudden fall in credit does not generate direct costs for the firm. It only
forces the firm to substitute debt with equity, which can be done without any direct cost. The only cost is indirect, through the impact on wage bargaining. However, the assumption of costless substitution between debt and equity is not very plausible, especially in the short-run. In fact, if the firm is unexpectedly forced to replace debt with equity, this could place the firm in a situation of financial distress, raising its financial cost. To capture this possibility, we now extend the model to formalize this idea.

Define $b^*_t$ as the maximum debt that can be collateralized. This is defined by the condition

$$b^*_t = \xi_t s_t(b^*_t),$$

which is increasing in $\xi_t$.

Since the firm enters the period with a debt $b_t$ that was chosen in the previous period, after the realization of $\xi_t$ the collateral constraint may no longer be satisfied. In other words, the firm may end up in a situation in which $b_t > b^*_t = \xi_t s_t(b^*_t)$, meaning that the debt is bigger than the collateral. In this situation the firm is forced to pay back the difference $b_t - b^*_t$ before it can access the equity market or retain earnings. This forces the firm to access alternative sources of funds that are costly. In particular, we assume that the cost incurred to access alternative sources of funds is $\kappa(b_t - b^*_t)^2$. We call this cost ‘financial distress cost’ since it is paid to raise emergency funds and could also include, in the extreme, bankruptcy costs.

Let $r_t(b_t)$ be the early repayment of the debt, $\varphi_t(b_t)$ the financial cost associated with the early repayment, and $\tilde{b}_t$ the residual debt after the early repayment. Since the firm will make an early repayment and incur the distress cost only if $b_t > b^*_t$, these terms are equal to

$$r_t(b_t) = \max \left\{ b_t - b^*_t, 0 \right\},$$
$$\varphi_t(b_t) = \kappa \cdot r_t(b_t)^2,$$
$$\tilde{b}_t = b_t - r_t(b_t).$$

Using these terms, we can write the problem of the firm, after the early
repayment $r_t(b_t)$, as

$$
\tilde{s}_t(\tilde{b}_t) = \max_{e_t, b_{t+1}} \left\{ d_t + w_t - \pi_t + \gamma(e_t)\mathbb{E}_t s_{t+1}(b_{t+1}) \right\}
$$

subject to:

$$
d_t + w_t = z_t - \Upsilon(e_t) + q_t g_{t+1} b_{t+1} - \tilde{b}_t
$$

$$
\xi_t \gamma(e_t)\mathbb{E}_t s_{t+1}(b_{t+1}) \geq q_t g_{t+1} b_{t+1}
$$

$$
g_{t+1} = 1 - \lambda + e_t,
$$

where $\gamma(e_t) = \beta \left[ (1 - \eta)g_{t+1} + \eta(1 - \lambda) \right]$.

The firm’s problem is defined after the early repayment $r_t(b_t)$ and after the payment of the financial cost $\varphi_t(b_t)$. At this stage the residual debt is $\tilde{b}_t$ and the associated surplus is $\tilde{s}_t(b_t)$. The surplus $s_{t+1}(b_{t+1})$, instead, is the next period surplus before the early repayment, which is defined as

$$
s_{t+1}(b_{t+1}) = \tilde{s}_{t+1}(\tilde{b}_{t+1}) - r_{t+1}(b_{t+1}) - \varphi_{t+1}(b_{t+1}).
$$

### 2.1 First order conditions

The first order conditions with respect to $e_t$ and $b_{t+1}$ are

$$
(1 - \mu_t)q_t g_{t+1} + \beta (1 - \eta) (1 + \mu_t \xi_t) \mathbb{E}_t s_{t+1}(b_{t+1}) = \Upsilon'(e_t), \quad (19)
$$

$$
(1 - \mu_t)q_t g_{t+1} + \gamma(e_t) (1 + \mu_t \xi_t) \mathbb{E}_t \frac{\partial s_{t+1}(b_{t+1})}{\partial b_{t+1}} = 0, \quad (20)
$$

where $\mu_t$ is the lagrange multiplier associated to the enforcement constraint. Notice that the first order conditions do not depend on current debt $b_t$. Therefore, the optimal choice of employment and next period debt is independent of current liabilities. We will see that this feature greatly simplifies the solution of the model.

The envelope condition is

$$
\frac{\partial \tilde{s}_t(\tilde{b}_t)}{\partial \tilde{b}_t} = -1. \quad (21)
$$
Since the derivative of the surplus function after the payment of the distress cost is linear in $\bar{b}_t$, we can write the surplus as

$$\bar{s}_t(\bar{b}_t) = \bar{s}_t - \bar{b}_t,$$  \hfill (22)

where $\bar{s}_t$ depends only on the exogenous shocks.

We can now use the special form of the surplus function to derive expressions for the maximum collateralized debt. Since $s(b_t^*) = \bar{s}(b_t^*)$, we have

$$b_t^* = \xi_t s_t(b_t^*) = \xi_t(\bar{s}_t - b_t^*),$$

We can then solve for $b_t^*$ and obtain

$$b_t^* = \left( \frac{\xi_t}{1 + \xi_t} \right) \bar{s}_t.$$  

Thus, we can rewrite the early repayment as

$$r_t(b_t) = \max \left\{ b_t - \left( \frac{\xi_t}{1 + \xi_t} \right) \bar{s}_t, 0 \right\}.  \hfill (23)$$

Using the linearity of the surplus function, the firm’s problem becomes

$$\bar{s}_t = \max_{e_t, b_{t+1}} \left\{ z_t - \Upsilon(e_t) + q_t g_{t+1} b_{t+1} - \bar{a}_t + \gamma(e_t) \mathbb{E}_t \left[ \bar{s}_{t+1} - b_{t+1} - \varphi_{t+1}(b_{t+1}) \right] \right\}$$

subject to:

$$\xi_t \gamma(e_t) \mathbb{E}_t \left[ \bar{s}_{t+1} - b_{t+1} - \varphi_{t+1}(b_{t+1}) \right] \geq q_t g_{t+1} b_{t+1}$$

$$g_{t+1} = 1 - \lambda + e_t.$$

Therefore, the optimization problem is recursive in the unknown function $\bar{s}_t$, which depends only on the exogenous shocks. We also take advantage of the linearity of the surplus function in the first order conditions. Let’s notice first that

$$\frac{\partial s_{t+1}(b_{t+1})}{\partial b_{t+1}} = -1 - \varphi'_{t+1}(b_{t+1}).$$  \hfill (24)
This term is continuous in the stock of debt \( b_{t+1} \). Because \( \varphi'_{t+1}(b_{t+1}) = 2\kappa r_t(b_{t+1})r_t'(b_{t+1}) \), using (23) we have that the marginal financial cost can be expressed as \( \varphi'_{t+1}(b_{t+1}) = 2\kappa \max \left\{ b_{t+1} - \left( \frac{\xi_{t+1}}{1+\xi_{t+1}} \right) \bar{s}_{t+1}, 0 \right\} \), which is also continuous.

The envelope condition (24) shows that the surplus function is no longer linear in the stock of debt. The distress cost makes the surplus function concave and this introduces a precautionary motive that discourages borrowing.

Substituting (24) in the first order conditions (19) and (20) we obtain

\[
(1 - \mu_t)q_t b_{t+1} + \beta (1 - \eta)(1 + \mu_t \xi_t) E_t \left[ \bar{s}_{t+1} - b_{t+1} - \varphi_{t+1}(b_{t+1}) \right] = \Upsilon'(e_t),
\]

\[ (25) \]

\[
(1 - \mu_t)q_t g_{t+1} - \gamma (e_t)(1 + \mu_t \xi_t) E_t \left[ 1 + \varphi'_{t+1}(b_{t+1}) \right] = 0,
\]

\[ (26) \]

3 Structural estimation

In this section we conduct the structural estimation of the model. We start by describing the data. We then discuss the estimation procedure and the identification strategy.

3.1 Data

With the exception of unused credit lines, all variables used in the estimation are from Compustat annual files except. Data on unused lines of credit is not available in Compustat, and some studies collects information about credit lines from firms’ SEC 10-K files (see, for example, Sufi (2009), Yun (2009)). For this study, we use data from Capital IQ database which contains a large sample of unused lines of credit from 2002 to 2010. In Capital IQ, the variable unused lines of credit also refers to total undrawn credit. See Filippo and Perez (2012) for a detailed description.

Following the literature, we exclude financial firms and utilities with SIC codes inside the intervals 4900-4949 and 6000-6999, and exclude firms with SIC codes greater than 9000. We also exclude firms with a missing value of assets, sales, number of employment, debt, and unused lines of credit. All variables are winsorized at the 2.5% and 97.5% percentiles to limit the influence of outliers. All nominal variables are deflated by the Consumer Price Index. The final sample for the estimation is a balanced panel of 1,508
firms over 9 years from 2002 to 2010. Appendix B provides the definitions variables used in the estimation.

3.2 Simulated method of moments

The model is solved numerically and the model parameters are estimated through the simulated method of moments (SMM). The basic idea of SMM is to choose the model parameters such that the moments generated by the model are as close as possible to the corresponding moments in the data.

The real data we use is a panel of heterogenous firms, but the simulated data is a time series of one representative firm. To keep consistency between the actual data and the simulated data, we estimate the parameters of an average firm in the data. More specifically, given the panel structure of the data, we first calculate the empirical moments for each firm included in the selected sample. We then compute the average of each moment across firms and use it as the target for the model. We use the bootstrap method to calculate the variance-covariance matrix associated with the target moments.

The estimation procedure is as follows.

1. For each firm $i$, we choose moments $h_i(x_{it})$, where $x_{it}$ is a vector representing a variable in the empirical data with subscripts $i$ and $t$ indicating firm and year respectively.

2. For each firm $i$, we calculate the within-firm sample mean of moments as $f_i(x_i) = \frac{1}{T} \sum_{t=1}^{T} h_i(x_{it})$, where $T$ is the number of years in the data.

3. We then compute the average of the within-firm sample mean across firms as $f(x) = \frac{1}{N} \sum_{i=1}^{N} f_i(x_i)$, where $N$ is the number of firms in the data.

4. Correspondingly, we use the model to simulate a panel data of $N$ firms and $S$ periods. We set $S = 100 \cdot T$ to make sure that the representative firm visits all the states in the model.

5. We calculate the average sample mean of moments in the model as $f(y, \theta) = \frac{1}{NS} \sum_{i=1}^{N} \sum_{s=1}^{S} h(y_{is}, \theta)$, where $y_{is}$ is the simulated data from the model, and $\theta$ represents the parameters to be estimated.

6. The estimator $\hat{\theta}$ is the solution to
\[
\min_{\theta} \left[ f(x) - f(y, \theta) \right]^T \cdot \Omega \cdot \left[ f(x) - f(y, \theta) \right].
\]

The weighting matrix \( \Omega \) is defined as \( \hat{\Sigma}^{-1} \), where \( \hat{\Sigma} \) is the variance-covariance matrix associated with the average of sample mean \( f(x) \) in the data. We use the bootstrap method to calculate the variance-covariance matrix \( \hat{\Sigma} \). First, given the population of \( N \) number of firms from the real data, we draw \( J \) random samples with size \( \frac{N}{2} \). Second, for each draw \( j \), we compute the statistics of the drawn sample, denote as \( f(x)^j \). Third, we approximate the variance-covariance matrix by the variance of \( f(x)^j \), i.e.,

\[
\hat{\Sigma} \approx \frac{1}{J} \sum_{j=1}^{J} (f(x)^j - \frac{1}{J} \sum_{j=1}^{J} f(x)^j)^T \cdot (f(x)^j - \frac{1}{J} \sum_{j=1}^{J} f(x)^j).
\]

We set \( J=10,000 \) to have enough accuracy of the bootstrap method.

### 3.3 Parameters and moments

All the model parameters are estimated with the exception of three parameters: the intertemporal discount factor, \( \beta \), the average separation rate, \( \bar{\lambda} \), and the flow utility from unemployment, \( a_t \). The discount factor is set to \( \beta = 0.97 \) such that the implied interest rate is approximately equal to the average of the real interest rate over sample period 2002-2010. The average separation rate is set to \( \bar{\lambda} = 0.1 \). The unemployment benefit is chosen so that the term \( \bar{a}_t = a_t + \beta p_t \mathbb{E}_t (\bar{w}_{t+1} - \bar{u}_{t+1}) \) in the model is half the value of average per-worker production \( \bar{z} \).

The remaining 10 parameters are estimated. They include the persistence and volatility of productivity shock, \( \rho_z \) and \( \sigma_z \), the persistence and volatility of credit shock, \( \rho_\xi \) and \( \sigma_\xi \), the persistence and volatility of separation shock, \( \rho_\lambda \) and \( \sigma_\lambda \), the enforcement parameter, \( \bar{\xi} \), the workers’ bargaining power, \( \eta \), the hiring cost, \( \gamma \), and the financial distress cost, \( \kappa \).

To estimate these parameter we select 14 moments: the means, standard deviations, and autocorrelations of employment growth, total credit growth and sale growth; the ratio of the mean of unused lines of credit to total credit; the ratio of the mean of total credit to total assets; the correlations between employment growth and credit growth, between employment growth and sale growth and between sale growth and credit growth. The values of the moments and the estimated parameters are reported in Table 1.
3.4 Identification

In the estimation, parameters are jointly identified by moments and the number of moments is larger than the number of parameters. Thus, there is no one-to-one mapping between parameters and moments. To grasp a general idea about the identification of the model parameters, we conduct comparative statics exercises to find out the relationship between the target moments and the model parameters. In the comparative statics study, we first use the estimated parameters as benchmark parameters to compute the moments. Then, we adjust the parameters one by one to examine the sensitivity of each moment with respect to the parameter change.

Table 3 reports the results of the comparative statics exercises. Consider first the identification of the three shocks in the model. The two parameters of productivity shock, $\rho_z$ and $\sigma_z$, are mainly identified by two of the moments associated with sale growth: the standard deviation and autocorrelation of sale growth. Similarly, credit shock is identified by two of the moments associated with credit growth: the standard deviation and autocorrelation of credit growth. The separation shock is identified by two of the moments associated employment growth: the standard deviation and autocorrelation of employment growth.

The enforcement parameter $\bar{\xi}$ measures the tightness of the enforcement constraint, and it affects the level of total credit directly. Thus, the enforcement parameter $\bar{\xi}$ is identified mainly by the mean of total credit to assets ratio. The bargaining power of workers $\eta$ is primarily identified by the mean of employment growth. This is because increases in the workers’ bargaining power reduce the firm’s incentives to hire new workers.

The hiring cost parameter $\gamma$ measures the rigidities in adjusting employment and it is mainly identified by the persistence of employment growth and the persistence of sale growth. Finally, the financial distress cost $\kappa$ is mainly identified by the mean of unused lines of credit to total credit ratio. This is because increases in the distress cost induce firms to be more cautious in borrowing and stay away from the borrowing limit.

4 Estimation results

The estimation results are reported in Table 1. The model matches the data quite well, except one moment: the persistence of employment growth.
The reason is because, to match the correlation between employment growth and credit growth (which is a key moment in the model), we need a high persistent separation shock. However, a high persistent separation shock also leads to high persistent employment growth. Thus, there is a trade-off between matching the moment $\rho(\Delta employ_{it})$ and matching the moment $cor(\Delta employ_{it}, \Delta credit_{it})$. As a result, we adjust the weighing matrix to reduce the impacts of the moment $\rho(\Delta employ_{it})$ in the estimation.

The estimated workers’ bargaining power $\eta$ is 0.626. Thus, about 63% of the bargaining surplus goes to workers. The estimated hiring cost $\gamma$ is 2.353, which implies that a 10% increase in total employment would cost the firm about 15% of total production. The estimated financial distress cost is 5.772, which means that the early repayment would be around the firm’s total output if the outstanding debt exceeds the borrowing limit by 50%.

### 4.1 Counterfactual Exercises

Table 2 shows the results of the counterfactual exercises. Productivity shock is important for matching the correlation between employment growth and sale growth. Without the productivity shock, employment growth would be perfectly correlated with sale growth. This is because output is linear in employment: $y_t = z_t N_t$.

Credit shock is important for matching the ratio of unused credit to total credit. The firm uses less of the available credit when the volatility of the credit shock is higher.

Separation shock mainly explains the behavior of employment growth. The higher is the volatility of the separation shock, the higher is the standard deviation of employment growth.

### 5 Conclusion

There is a well-established literature in corporate finance exploring the use of debt as a strategic mechanism to improve the bargaining position of firms with workers. Less attention has been devoted to studying whether this mechanism is also important for the employment decisions of firms. In this paper we have investigated the theoretical and empirical relevance of this mechanism.
Using a firm dynamics model, we have shown that there is a positive relation between debt and employment growth and the strength of this relation increases with the bargaining power of workers. This relation is explored empirical through the estimation of the dynamic model. The estimation results show that this mechanism is especially important for employment growth at the firm level. In particular, greater uncertainty about the firm’s access to credit has large effects on the firm’s employment growth.
A Stochastic separation

So far we have assumed that hiring and separation are deterministic. In reality, however, it is likely that there is significant uncertainty about worker retention and hiring. Therefore, we now extend the model by allowing for firm level shocks to separation. In particular, we assume that employment evolves according to

\[ N_{t+1} = (1 - \lambda_t)N_t + \zeta_tE_t, \]

where now \( \lambda_t \) is stochastic. In addition, the target hiring \( E_t \) is multiplied by the variable \( \zeta_t \) which is also stochastic.

The structure of the problem is similar and can be written as

\[
\begin{align*}
\bar{s}_t &= \max_{e_t,b_t+1} \left\{ z_t - \Upsilon(e_t) + q_tg_{t+1}b_{t+1} - \bar{a}_t + \gamma_t(e_t)\mathbb{E}_t\left[ \bar{s}_{t+1} - b_{t+1} - \varphi_{t+1}(b_{t+1}) \right] \right\} \\
\text{subject to:} & \\
\xi_t\gamma_t(e_t)\mathbb{E}_t\left[ \bar{s}_{t+1} - b_{t+1} - \varphi_{t+1}(b_{t+1}) \right] & \geq q_tg_{t+1}b_{t+1} \\
g_{t+1} &= 1 - \lambda_t + \zeta_te_t,
\end{align*}
\]

where \( \gamma_t(e_t) = \beta[(1 - \eta)g_{t+1} + \eta(1 - \lambda_t)] \). Now, however, there are four shocks that affect the firm: productivity, \( z_t \), credit, \( \xi_t \), separation, \( \lambda_t \), and hiring, \( \zeta_t \).

The first order conditions are also similar,

\[
\begin{align*}
(1 - \mu_t)q_tg_{t+1} + \beta(1 - \eta)(1 + \mu_t\xi_t)\mathbb{E}_t\left[ \bar{s}_{t+1} - b_{t+1} - \varphi_{t+1}(b_{t+1}) \right] &= \frac{\Upsilon'(e_t)}{\zeta_t}, \\
(1 - \mu_t)q_tg_{t+1} - \gamma(e_t)(1 + \mu_t\xi_t)\mathbb{E}_t\left[ 1 + \varphi'_{t+1}(b_{t+1}) \right] &= 0.
\end{align*}
\]

As can be seen from the first equation, the shock \( \zeta_t \) acts as a shock to the cost of hiring.
B Variables: definition and sources

We provide here the definition and sources for the variables used in the estimation:

- $\Delta employ_{it}$: Percentage change in the number of employees from t-1 to t. From Compustat, $emp$.

- $\Delta credit_{it}$: Percentage change in total credit capacity (total debt + unused lines of credit) from t-1 to t. The variable “total debt” is from Compustat, $dlc + dltt$, and the variable “unused lines of credit” is from Capital IQ, total undrawn credit.

- $\Delta sale_{it}$: Percentage change in sales from t-1 to t. From Compustat, $sale$.

- $\frac{unused_{it}}{credit_{it}}$: Ratio of unused lines of credit to total credit capacity (total debt + unused lines of credit) at time t. The variable “total debt” is from Compustat, $dlc + dltt$; and the variable “unused lines of credit” is from Capital IQ, total undrawn credit.

- $\frac{credit_{it}}{asset_{it}}$: Ratio of total credit capacity (total debt + unused lines of credit) to assets at time t. The variable “total debt” is from Compustat, $dlc + dltt$; the variable “assets” is also from Compustat, $at$; and the variable “unused lines of credit” is from Capital IQ, total undrawn credit.
References


Table 1: **Moments and Parameters**

<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Simulated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TARGET MOMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Mean(\Delta employ_{it})$</td>
<td>0.039</td>
<td>0.040</td>
</tr>
<tr>
<td>$Std(\Delta employ_{it})$</td>
<td>0.125</td>
<td>0.118</td>
</tr>
<tr>
<td>$\rho(\Delta employ_{it})$</td>
<td>-0.037</td>
<td>0.666</td>
</tr>
<tr>
<td>$Mean(\Delta credit_{it})$</td>
<td>0.135</td>
<td>0.129</td>
</tr>
<tr>
<td>$Std(\Delta credit_{it})$</td>
<td>0.476</td>
<td>0.501</td>
</tr>
<tr>
<td>$\rho(\Delta credit_{it})$</td>
<td>-0.134</td>
<td>-0.193</td>
</tr>
<tr>
<td>$Mean(\Delta sale_{it})$</td>
<td>0.071</td>
<td>0.054</td>
</tr>
<tr>
<td>$Std(\Delta sale_{it})$</td>
<td>0.157</td>
<td>0.211</td>
</tr>
<tr>
<td>$\rho(\Delta sale_{it})$</td>
<td>0.028</td>
<td>0.017</td>
</tr>
<tr>
<td>$Mean(\Delta unused_{it})$</td>
<td>0.411</td>
<td>0.248</td>
</tr>
<tr>
<td>$Mean(\Delta credit_{it})$</td>
<td>0.344</td>
<td>0.358</td>
</tr>
<tr>
<td>$cor(\Delta employ_{it}, \Delta credit_{it})$</td>
<td>0.266</td>
<td>0.296</td>
</tr>
<tr>
<td>$cor(\Delta employ_{it}, \Delta sale_{it})$</td>
<td>0.493</td>
<td>0.568</td>
</tr>
<tr>
<td>$cor(\Delta sale_{it}, \Delta credit_{it})$</td>
<td>0.210</td>
<td>0.173</td>
</tr>
</tbody>
</table>

|                  |           |           |
| **ESTIMATED PARAMETERS** |          |           |
| Persistence of productivity shock, $\rho_z$ | 0.544    |           |
| Volatility of productivity shock, $\sigma_z$ | 0.178    |           |
| Persistence of credit shock, $\rho_\xi$ | 0.523    |           |
| Volatility of credit shock, $\sigma_\xi$ | 0.206    |           |
| Persistence of separation shock, $\rho_\lambda$ | 0.772    |           |
| Volatility of separation shock, $\sigma_\lambda$ | 0.707    |           |
| Enforcement parameter, $\xi$ | 0.511    |           |
| Workers’ bargaining power, $\eta$ | 0.626    |           |
| Hiring cost, $\gamma$ | 2.353    |           |
| Financial distress cost, $\kappa$ | 5.772    |           |

This table reports the results of the structural estimation. The first panel lists the target moments, and the second panel lists the estimated parameters.
Table 2: Counterfactual Exercises

<table>
<thead>
<tr>
<th></th>
<th>Benchmark Model</th>
<th>Productivity Shock</th>
<th>Credit Shock</th>
<th>Separation Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean($\Delta \text{employ}_{it}$)</td>
<td>0.040</td>
<td>0.098</td>
<td>0.134</td>
<td>0.040</td>
</tr>
<tr>
<td>Std($\Delta \text{employ}_{it}$)</td>
<td>0.118</td>
<td>0.001</td>
<td>0.008</td>
<td>0.123</td>
</tr>
<tr>
<td>$\rho(\Delta \text{employ}_{it})$</td>
<td>0.666</td>
<td>0.404</td>
<td>0.360</td>
<td>0.659</td>
</tr>
<tr>
<td>Mean($\Delta \text{credit}_{it}$)</td>
<td>0.129</td>
<td>0.098</td>
<td>0.214</td>
<td>0.054</td>
</tr>
<tr>
<td>Std($\Delta \text{credit}_{it}$)</td>
<td>0.501</td>
<td>0.012</td>
<td>0.462</td>
<td>0.205</td>
</tr>
<tr>
<td>$\rho(\Delta \text{credit}_{it})$</td>
<td>-0.193</td>
<td>-0.293</td>
<td>-0.290</td>
<td>0.119</td>
</tr>
<tr>
<td>Mean($\Delta \text{sale}_{it}$)</td>
<td>0.054</td>
<td>0.113</td>
<td>0.134</td>
<td>0.040</td>
</tr>
<tr>
<td>Std($\Delta \text{sale}_{it}$)</td>
<td>0.211</td>
<td>0.185</td>
<td>0.008</td>
<td>0.123</td>
</tr>
<tr>
<td>$\rho(\Delta \text{sale}_{it})$</td>
<td>0.017</td>
<td>-0.294</td>
<td>0.360</td>
<td>0.659</td>
</tr>
<tr>
<td>Mean($\text{unused}_{it}$)</td>
<td>0.248</td>
<td>0.000</td>
<td>0.201</td>
<td>0.113</td>
</tr>
<tr>
<td>Mean($\text{credit}_{it}$)</td>
<td>0.358</td>
<td>0.312</td>
<td>0.353</td>
<td>0.340</td>
</tr>
<tr>
<td>$\text{cor}(\Delta \text{employ}<em>{it}, \Delta \text{credit}</em>{it})$</td>
<td>0.296</td>
<td>0.605</td>
<td>0.502</td>
<td>0.595</td>
</tr>
<tr>
<td>$\text{cor}(\Delta \text{employ}<em>{it}, \Delta \text{sale}</em>{it})$</td>
<td>0.568</td>
<td>-0.538</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>$\text{cor}(\Delta \text{sale}<em>{it}, \Delta \text{credit}</em>{it})$</td>
<td>0.173</td>
<td>-0.326</td>
<td>0.502</td>
<td>0.595</td>
</tr>
</tbody>
</table>

This table reports results of counterfactual exercises. The first column summarizes the benchmark moments simulated by the model using the estimated parameters. The second column reports moments simulated by the model with only productivity shock. The third column reports the moments simulated by the model with only credit shock. The fourth column reports the moments simulated by the model with only separation shock.
Table 3: Comparative Statics Exercises

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>$\rho_z$</th>
<th>$\sigma_z$</th>
<th>$\rho_\xi$</th>
<th>$\sigma_\xi$</th>
<th>$\rho_\lambda$</th>
<th>$\sigma_\lambda$</th>
<th>$\xi$</th>
<th>$\eta$</th>
<th>$\gamma$</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean($\Delta employ_{it}$)</td>
<td></td>
<td>0.040</td>
<td>0.035</td>
<td>0.032</td>
<td>0.025</td>
<td>0.058</td>
<td>0.079</td>
<td>0.046</td>
<td>0.009</td>
<td>0.003</td>
<td>0.032</td>
</tr>
<tr>
<td>Std($\Delta employ_{it}$)</td>
<td></td>
<td>0.118</td>
<td>0.121</td>
<td>0.122</td>
<td>0.120</td>
<td>0.082</td>
<td>0.074</td>
<td>0.123</td>
<td>0.116</td>
<td>0.115</td>
<td>0.120</td>
</tr>
<tr>
<td>$\rho$($\Delta employ_{it}$)</td>
<td></td>
<td>0.666</td>
<td>0.652</td>
<td>0.655</td>
<td>0.646</td>
<td>0.404</td>
<td>0.684</td>
<td>0.656</td>
<td>0.633</td>
<td>0.628</td>
<td>0.647</td>
</tr>
<tr>
<td>Mean($\Delta credit_{it}$)</td>
<td></td>
<td>0.129</td>
<td>0.124</td>
<td>0.124</td>
<td>0.125</td>
<td>0.203</td>
<td>0.132</td>
<td>0.160</td>
<td>0.089</td>
<td>0.087</td>
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<tr>
<td>Std($\Delta credit_{it}$)</td>
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<td>0.501</td>
<td>0.499</td>
<td>0.498</td>
<td>0.510</td>
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<td>0.467</td>
<td>0.406</td>
<td>0.458</td>
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<tr>
<td>$\rho$($\Delta credit_{it}$)</td>
<td></td>
<td>-0.193</td>
<td>-0.190</td>
<td>-0.189</td>
<td>-0.145</td>
<td>-0.210</td>
<td>-0.257</td>
<td>-0.245</td>
<td>-0.154</td>
<td>-0.191</td>
<td>-0.192</td>
</tr>
<tr>
<td>Mean($\Delta sale_{it}$)</td>
<td></td>
<td>0.054</td>
<td>0.048</td>
<td>0.060</td>
<td>0.046</td>
<td>0.039</td>
<td>0.072</td>
<td>0.094</td>
<td>0.060</td>
<td>0.022</td>
<td>0.046</td>
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<tr>
<td>Std($\Delta sale_{it}$)</td>
<td></td>
<td>0.211</td>
<td>0.213</td>
<td>0.268</td>
<td>0.212</td>
<td>0.211</td>
<td>0.197</td>
<td>0.197</td>
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<td>0.207</td>
<td>0.214</td>
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<tr>
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<td>0.019</td>
<td>0.015</td>
<td>-0.167</td>
<td>-0.149</td>
<td>0.020</td>
<td>0.009</td>
<td>0.017</td>
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<tr>
<td>Mean($\text{unused}_{it}$)</td>
<td></td>
<td>0.248</td>
<td>0.248</td>
<td>0.250</td>
<td>0.265</td>
<td>0.344</td>
<td>0.203</td>
<td>0.214</td>
<td>0.223</td>
<td>0.203</td>
<td>0.261</td>
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<tr>
<td>Mean($\text{credit}_{it}$)</td>
<td></td>
<td>0.358</td>
<td>0.353</td>
<td>0.354</td>
<td>0.346</td>
<td>0.316</td>
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<td>0.350</td>
<td>0.407</td>
<td>0.364</td>
<td>0.352</td>
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<tr>
<td>Mean($\text{asset}_{it}$)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor($\Delta employ_{it}, \Delta credit_{it}$)</td>
<td></td>
<td>0.296</td>
<td>0.295</td>
<td>0.298</td>
<td>0.285</td>
<td>0.222</td>
<td>0.162</td>
<td>0.226</td>
<td>0.345</td>
<td>0.290</td>
<td>0.285</td>
</tr>
<tr>
<td>cor($\Delta employ_{it}, \Delta sale_{it}$)</td>
<td></td>
<td>0.568</td>
<td>0.568</td>
<td>0.456</td>
<td>0.566</td>
<td>0.413</td>
<td>0.373</td>
<td>0.574</td>
<td>0.566</td>
<td>0.561</td>
<td>0.565</td>
</tr>
<tr>
<td>cor($\Delta sale_{it}, \Delta credit_{it}$)</td>
<td></td>
<td>0.173</td>
<td>0.150</td>
<td>0.125</td>
<td>0.150</td>
<td>0.118</td>
<td>0.052</td>
<td>0.075</td>
<td>0.194</td>
<td>0.157</td>
<td>0.145</td>
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<tr>
<td>cor($\Delta sale_{it}, \Delta asset_{it}$)</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

This table shows the results of comparative statics exercises. The first column lists the moments simulated by the benchmark parameters. The second to the eleventh column shows the results of the sensitivity test by changing the value of one parameter each time. The benchmark parameters are the estimated parameters in Table 1. We increase each parameter by 20% to test the sensitivity, expect that we reduce the persistence and volatility of the separation shock by 20%.