Financial markets and unemployment.*

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March 27, 2011

Abstract

We study the importance of financial markets for (un)employment fluctuations in a standard search and matching model where firms issue debt under limited enforcement. Higher debt allows employers to bargain lower wages which in turn increases the incentive to create jobs. The transmission mechanism of ‘credit shocks’ is fundamentally different from the typical credit channel and the model can explain why firms cut hiring after a credit contraction even if there is not need of funds for hiring workers. The theoretical predictions are supported by the estimation of a structural VAR whose identifying restrictions are derived from the theoretical model.

Keywords: Limited enforcement, wage bargaining, unemployment, credit shocks.

JEL classification: E24, E32, E44.

*We thank Wouter Den Haan for insightful comments and seminar participants at Atlanta Fed, University of Bonn, European University Institute, University of Lausanne, New York Fed, Ohio State University, Philadelphia Fed, St. Louis Fed and University of Porto.
1 Introduction

The recent financial turmoil has been associated with a severe increase in unemployment. In the United States the number of unemployed workers jumped from 5.5 percent of the labor force to about 10 percent and continues to stay close 9 percent despite three years have passed since the beginning of the recession. Because the financial sector has been at the center stage of the recent crisis and the volume of credit has dropped significantly, there is a widespread belief that the contraction of credit has been an important driving force of the unemployment hike. The central view is that, since employers faced difficulties raising funds, they were forced to cut investment and employment. Therefore, the typical ‘credit channel’ described in Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) is believed to have played an important role in the recent recession.

Although there is some compelling evidence that the credit channel has been important at the beginning of the crisis when the volume of credit contracted sharply and the liquidity in the business sector dried up, this channel appears less important for explaining the persistence of unemployment after the initial drop. As shown in the top panel of Figure 1, the liquidity held by US businesses contracted sharply in the first stage of the crisis, consistent with the view of a credit crunch. However, after the initial drop, the liquidity of nonfinancial businesses quickly rebounded and shortly after the crisis firms have rebuilt their liquidity. Even if they continue to be unable constrained in the ability to raise debt, the owned liquid funds seem more than adequate to bring employment back to the pre-crisis level. Therefore, there is some doubts that the standard credit channel is the primary explanation for the sluggish dynamics of the labor market after the initial stage of the crisis.

The above considerations raise an important question. If firms do not need external funds to hire workers, is the contraction in business debt irrelevant for the dynamics of employment? In this paper we show that, even if firms have enough internal funds or their hiring decisions do not need financing, a credit contraction can still affects the labor market. The reason lower leverages reduce employment is not because they impair the hiring ability of firms but because it allows workers to bargain higher wages.

The theoretical framework shares the basic ingredients of the models studied in Pissarides (1987) and Mortensen and Pissarides (1994) where firms are created through the random matching of job vacancies and workers. We extend the basic structure of these models in two directions. First, we al-
Figure 1: Liquidity and debt in the US nonfinancial business sector. *Liquidity* is the sum of foreign deposits, checkable deposits and currency, time and savings deposits. *Debt* is defined as credit markets instruments. Data is from the Flows of Funds Accounts.
low firms to issue debt under limited enforcement. Second, we introduce an additional source of business cycle fluctuations which affects directly the enforcement constraint of borrowers and the availability of credit.

Because of the matching frictions and the wage determination process based on bargaining, firms prefer to issue debt even if there is no fixed or working capital that needs to be financed. The preference for debt derives exclusively from the wage determination process, that is, bargaining. Higher debt reduces the net bargaining surplus which in turn reduces the wages paid to workers. This creates an incentive for the employer to borrow until the borrowing limit binds. The goal is to study how exogenous or endogenous changes in this limit affect the dynamics of the labor market.

Central to our mechanism is the firm’s capital structure as a bargaining tool in the wage determination process. Both anecdotal and statistical evidence point to this channel. Consider the anecdotal evidence first. An illustrative example is provided by the case of the New York Metro Transit Authority. In 2004 the company realized an unexpected 1 billion dollars surplus, largely from a real estate boom. The Union, however, claimed rights to the surplus demanding a 24 percent pay raise over three years. Another example comes from Delta Airlines. The company weathered the 9/11 airline crisis but its excess of liquidity allegedly reduced the need to cut costs. This hurt the firm’s bargaining position with workers and three years after 9/11 it faced severe financial challenges.

The idea that debt allows employers to improve their bargaining position is also supported several empirical studies in the corporate finance literature.

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1From The New York Times, Transit Strike Deadline: How extra Money Complicates Transit Pay Negotiations, 12/15/2005: “The unexpected windfall was supposed to be a boom[..] but has instead become a liability[..] How, union leaders have asked, can the authority boast of such a surplus and not offer raises of more than 3 percent a year? Why aren’t wages going up more?” In a similar vein: “The magnitude of the surplus [...] has set this year’s negotiations apart from prior ones, said John E. Zuccotti, a former first deputy mayor. It’s a much weaker position than the position the M.T.A. is normally in: We’re broke and we haven’t gotten any money [...]. The playing field is somewhat different. They haven’t got that defense”.

2From The Wall Street Journal, Cross Winds: How Delta’s Cash Cushion Pushed It Onto Wrong Course, 10/29/2004: “In hindsight, it is clear now that Delta’s pile of cash and position as the strongest carrier after 9/11 lured the company’s pilots and top managers onto a dire course. Delta’s focus on boosting liquidity turned out to be its greatest blessing and curse, helping the company survive 9/11 relatively unscathed but also putting off badly needed overhauls to cut costs”.

3
Bronars and Deere (1991) document a positive correlation between leverage and labor bargaining power, proxied by the degree of unionization. Matsa (2010) finds that firms with greater exposure to (union) bargaining power have a capital structure more skewed towards debt. Atanassov and Kim (2009) find that strong union laws are less effective in preventing large-scale layoffs when firms have higher financial leverage. Gorton and Schmid (2004) study the impact of German co-determination laws on firms’ labor decisions. They show that firms subject to these laws also exhibit greater leverage ratios. In particular, shareholders respond to the allocation of control rights to labor by linking supervisory board compensation to firm performance and by leveraging up the firm. Chen, Chen and Liao (2011) show that labor union strength relates positively to bond yield spreads. Furthermore, the positive effect of the labor union strength on a firm’s credit risk becomes weaker when the firm has higher leverage ratio volatility.

All the aforementioned studies suggest that firms may use financial leverage strategically in order to contrast high bargaining power of labor. Although there are theoretical studies in the micro-corporate literature that investigates this mechanism (see for example Perotti and Spier (1993)), the implications for employment dynamics at the macroeconomic level have not been fully explored. With this paper we provide some new insights along this dimension. In particular, we study the response of the labor market to a shock that affects directly the availability of credit for employers. These shocks resemble the ‘credit shocks’ studied in Jermann and Quadrini (2009). In our model, however, the transmission mechanism of these shocks is not based on the typical credit channel.

A positive credit shock allows firms to increase their debt and pay lower wages to the newly hired workers, which in turn encourages the creation of new jobs. On the other hand, a credit contraction forces firms to cut on borrowing, placing them on a less favorable position in the bargaining of wages. As a result, fewer jobs are created. These shocks can generate sizable employment fluctuations in our model. Furthermore, as long as the credit contraction is persistent—a robust feature of the data—the impact on the labor market is long-lasting. In this vein, the properties of the model are consistent with recent findings that recessions associated with financial crisis are more severe and persistent than recessions not associated with systemic financial difficulties. See IMF (2009), Claessens, Kose, and Terrones (2008), Reinhart and Rogoff (2009).

We also show how the model performs in response to ‘productivity shocks’
which is the dominant source of business cycle fluctuation in the typical matching model. In our model productivity improvements relax the borrowing constraint because the collateral depends on the value of the match which responds positively to a productivity improvement. By borrowing more, employers are able to contain the increase in wages paid to the newly hired workers and, as a result, they create more jobs. In this way the impact of a productivity shock on employment is significantly amplified. This result can be relevant for the recent literature pioneered by Shimer (2005) and Hall (2005) emphasizing the inability of the baseline search-and-matching model to replicate the observed volatility of unemployment.

Chugh (2009) and Petrosky-Nadeau (2009) have also embedded credit market frictions in search and matching models of the labor market. However, the transmission mechanism in these two models is still based on the typical credit channel. More specifically, since firms may be financial constrained, the cost of financing the posting of a vacancy plays a central role in the transmission of shocks. Also related is Wasmer and Weil (2004). They consider an environment in which bargaining is not between workers and firms but between entrepreneurs and financiers. In this model financiers are needed to finance the cost of posting a vacancy and the higher surplus extracted by financiers is similar to a higher cost of financing investments. Thus, the mechanism is still of the credit channel type. In addition to be different in the nature of transmission mechanism, our work differs from Wasmer and Weil in three respects. First, we characterize the equilibrium in which the bargaining is between workers and employers, not between employers and financiers. Also, firms make financing decisions at any point in time, not only when the firm is created. Second, we focus on the business cycle properties of the model rather than steady states. Third, we consider a different source of business cycle fluctuations, that is, credit shocks.

In order to assess the empirical relevance of credit shocks for (un)employed fluctuations, we estimate a structural VAR with both productivity and credit shocks. The two shocks are identified using short-term restrictions derived from the theoretical model. We find that the response of employment (and unemployment) to credit shocks is statistically significant and economically sizable. We also find that TFP shocks generate a credit expansion, which is consistent with the theoretical result that productivity shocks are amplified through the expansion of credit.
2 Model

There is a continuum of agents of total mass 1 with lifetime utility \( E_0 \sum_{t=0}^{\infty} \beta^t c_t \).
At any point in time agents can be employed or unemployed. They save in two types of assets: shares of firms and bonds. Risk neutrality implies that the expected return from both assets is equal to \( 1/\beta - 1 \). Therefore, the net interest rate is constant and equal to:

\[ r = 1/\beta - 1. \] (1)

**Firms:** Firms are created through the matching of a posted vacancy and a worker. Starting from the next period, a new firm produces output \( z_t \) until the match is separated. Separation arises with probability \( \lambda \). To keep the distinction between workers and firms, we assume that a worker cannot be self-employed but needs to search (costlessly) for a job. The number of matches is determined by the typical matching function \( m(v_t, u_t) \), where \( v_t \) is the number of vacancies posted during the period and \( u_t \) is the number of unemployed workers. The probability that a vacancy is filled is \( q_t = m(v_t, u_t)/v_t \) and the probability that an unemployed worker finds a job is \( p_t = m(v_t, u_t)/u_t \).

At any point in time firms are characterized by three states: a productivity \( z_t \), an indicator of the financial conditions \( \phi_t \) that we will describe below, and a stock of debt \( b_t \). The productivity \( z_t \) and the financial state \( \phi_t \) are exogenous stochastic variables, common to all firms (aggregate shocks). The stock of debt \( b_t \) is chosen endogenously. Although firms can choose different levels of debt, in equilibrium they all choose the same \( b_t \).

The dividend paid to the owners of the firm is defined by the budget constraint:

\[ d_t = z_t - w_t - b_t + \frac{b_{t+1}}{R}, \]

where \( R \) is the gross interest rate charged on the debt. As we will see, \( R \) is different from \( 1 + r \) because of the possibility of default when the match is separated.

**Timing:** An incumbent firm starts with a stock of debt \( b_t \) inherited from the previous period. In addition, the firm knows the current productivity \( z_t \) and the financial variable \( \phi_t \). Given the states, the firm bargains the wage \( w_t \) with the worker and output \( z_t \) is produced. The choice of the new debt
$b_{t+1}$ and the payment of dividends arise after wage bargaining. After the payments of dividends and wages, and after contracting the new debt, the firm observes whether the match is separated. It is at this point that the firm chooses whether to default. Therefore, each period can be divided in three sequential steps: (i) wage bargaining, (ii) financial decision, and (iii) default. These sequential steps are illustrated in figure 2.

The timing of decisions for a new firm is very similar except that the initial debt $b_t$ is zero and there is no wage bargaining since production starts in the next period. Still, the newly created firm chooses the debt $b_{t+1}$ and pays the dividend $d_t = b_{t+1}/R_t$. It is further assumed that the newly created match could be separated with probability $\lambda$ before entering the next period. This is without loss of generality and it is immaterial for the results.

**Figure 2: Timing for an incumbent firm**

\begin{center}
\begin{tikzpicture}

\begin{axis}[
    x=0.5cm, y=0.5cm, height=8cm, width=10cm, axis lines=middle,]

\addplot[->,>=stealth] coordinates {(-2,0) (0,0) (2,0)};
\addplot[->,>=stealth] coordinates {(0,0) (0,2) (0,-2)};
\addplot[->,>=stealth] coordinates {(-2,0) (0,0) (2,0)};
\addplot[->,>=stealth] coordinates {(0,0) (0,2) (0,-2)};

\node [below] at (0,-0.5) {Wage bargaining, $w_t$};
\node [below] at (0,0.5) {Payment of dividends, $d_t$};
\node [below] at (2,0) {Choice of new debt, $b_{t+1}$};
\node [below] at (-2,0) {Choice to default};
\node [above] at (0,2) {Separation with probability $\lambda$};
\node [above] at (0,-2) {$z_t, \phi_t, b_t$};
\node [above] at (2,-2) {$z_{t+1}, \phi_{t+1}, b_{t+1}$};
\end{axis}
\end{tikzpicture}
\end{center}

**Value of the firm and borrowing limit:** We assume that lending is done by competitive intermediaries who pool a large number of loans. We refer to these intermediaries as *lenders*. The amount of borrowing is constrained by limited enforcement. As described above, after the payments of dividends and wages, and after contracting the new debt, the firm observes whether the match is separated. It is at this point that the firm chooses whether to default. In the event of default the lender will be able to recover only a fraction $\chi_t$ of the firm’s value.
Denote by $J_t(b_t)$ the equity value of the firm at the beginning of the period, which is equal to the discounted expected value of dividends for the shareholders. This function depends on the individual stock of debt $b_t$. Obviously, higher is the debt and lower is the equity value. It also depends on the aggregate states $s_t = (z_t, \phi_t, B_t)$, where $z_t$ and $\phi_t$ are exogenous aggregate states (see more below), while $B_t$ is the aggregate stock of debt. We distinguish aggregate debt from individual debt since an individual firm has always the option of deviating from the financial policies chosen by other firms. Even though in equilibrium they all choose the same debt, we have to allow for out-of-equilibrium deviations in order to characterize the optimal policies. We use the time subscript $t$ to capture the dependence of the value function from the aggregate states, that is, we write $J_t(b_t)$ instead of writing $J(z_t, \phi_t, B_t, b_t)$. In order to minimize the complexity of the analytical expressions, we will use this notational convention throughout the paper.

We begin by considering the possibility of default in the event in which the match is separated. In this case the value of the firm is zero. Therefore, the lender anticipates that the recovery value is zero and the debt will not be repaid. Therefore, in order to break even, the lender needs to insure that the firm does not default when the match is not separated. It also requires charging a higher interest rate to cover the losses realized when the match is separated.

If the match is not separated, the value of the firm’s equity is $\beta J_{t+1}(b_{t+1})$, that is, the next period expected value of equity discounted to the current period. Adding the present value of debt, $b_{t+1}/(1 + r)$, we obtain the total value of the firm. If the firm defaults, the lender recovers only a fraction $\chi_t$ of the total value of the firm. Therefore, the lender is willing to lend as long as the following constraint is satisfied:

$$\chi_t \left[ \frac{b_{t+1}}{1 + r} + \beta E_t J_{t+1}(b_{t+1}) \right] \geq \frac{b_{t+1}}{1 + r},$$

that is, the recoverable value cannot be smaller than the loan. The variable $\chi_t$ is stochastic and affects the borrowing capacity of the firm. Henceforth, we refer to unexpected changes in $\chi_t$ as ‘credit shocks’.

By collecting the term $b_{t+1}/(1 + r)$, we can rewrite the enforcement constraint more compactly as:

$$\phi_t \beta E_t J_{t+1}(b_{t+1}) \geq \frac{b_{t+1}}{1 + r},$$

(2)
where $\phi_t \equiv \chi_t / (1 - \chi_t)$. We can then think of credit shocks as unexpected innovations to the variable $\phi_t$. This is the exogenous state variable that we included in the set of aggregate states $s_t$.

We now have all the elements to determine the actual interest rate that will be charged to the firm. Since the loan is made before knowing whether the match is separated, the interest rate charged by the lender will take into account that the repayment arises only with probability $1 - \lambda$. Assuming that financial markets are competitive, the zero-profit condition requires that the gross interest rate $R$ satisfies

$$R(1 - \lambda) = (1 + r).$$

The left-hand side of (3) is the lender’s expected income per unit of debt. The right-hand side is the lender’s opportunity cost of finance (per unit of debt). Therefore, the firm receives $b_{t+1}/R$ at time $t$ and, if the match is not separated, it repays $b_{t+1}$ at time $t + 1$. Notice that, due to the assumption of risk neutrality, the interest rate is always constant, and therefore bears no time subscript.

**Firm’s value:** Central to the characterization of the properties of the model is the wage determination process which is based on bargaining. Before describing the wage bargaining, however, we define the value of the firm recursively taking as given the wage bargaining outcome, which we denote by $w_t = g_t(b_t)$. The recursive structure of the problem implies that the wage is fully determined by the states at the beginning of the period. In other words, within the current period, the firm takes the outcome of the wage bargaining as given but it does internalize that its current debt choice affects the future determination of wages.

We can then write the value of the firm as follows:

$$J_t(b_t) = \max_{b_{t+1}} \left\{ z_t - g_t(b_t) - b_t + \frac{b_{t+1}}{R} + \beta(1 - \lambda)E_tJ_{t+1}(b_{t+1}) \right\}$$

subject to

$$\phi_t \beta E_tJ_{t+1}(b_{t+1}) \geq \frac{b_{t+1}}{1 + r}.$$
where the only choice variable is the debt $b_{t+1}$.

We can verify that, given the additive structure of the objective function, the optimal choice of $b_{t+1}$ does not depend neither on the current wage $w_t = g_t(b_t)$ nor on the current liabilities $b_t$. We state this property formally in the following Lemma.

**Lemma 1** The new debt $b_{t+1}$ chosen by the firm depends neither on the current wage $w_t = g_t(b_t)$ nor on the current debt $b_t$.

**Proof 1** Since $w_t$ and $b_t$ enter the objective function additively and they affect neither the next period value of the firm’s equity nor the enforcement constraint, the choice of $b_{t+1}$ is independent of $w_t$ and $b_t$.

As we will see, this property greatly simplifies the wage bargaining problem we will describe below.

**Worker’s values:** In order to set up the bargaining problem for the determination of wages, we define the worker’s values ignoring the capital incomes earned from the ownership of bonds and firms (interests and dividends). Since agents are risk neutral and the change in the dividend of an individual firm is negligible for an individual worker, we can ignore these incomes in the derivation of wages.

When employed, the worker’s value is:

$$H_t(b_t) = g_t(b_t) + \beta \mathbb{E}_t \left[ (1 - \lambda)H_{t+1}(b_{t+1}) + \lambda U_{t+1} \right],$$

which is defined once we know the wage function $w_t = g_t(b_t)$. The function $U_{t+1}$ is the value of being unemployed and is defined recursively as follows:

$$U_t = a + \beta \mathbb{E}_t \left[ p_t H_{t+1}(B_{t+1}) + (1 - p_t)U_{t+1} \right]$$

where $p_t$ is the probability that an unemployed worker finds a job and $a$ is the flow utility for an unemployed worker. While the value of an employed worker depends on the aggregate states and the individual debt $b_t$, the value of being unemployed depends only on the aggregate states since all firms choose the same level of debt in equilibrium. Thus, if an unemployed worker finds a job in the next period, the value of being employed is $H_{t+1}(B_{t+1})$, that is, the value of being matched with a firm that has the average debt.
Bargaining problem: Let’s define the following functions:

\[
\hat{J}_t(b_t, w_t) = \max_{b_{t+1}} \left\{ z_t - w_t - b_t + \frac{b_{t+1}}{R} + \beta(1 - \lambda)E_t J_{t+1}(b_{t+1}) \right\}
\]

(6)

\[
\hat{H}_t(b_t, w_t) = w_t + \beta E_t \left[ (1 - \lambda)H_{t+1}(b_{t+1}) + \lambda U_{t+1} \right]
\]

(7)

These are the values, for the firm and the employed worker respectively, for an arbitrary wage \(w_t\) paid in the current period and with future wages determined by the function \(g_{t+1}(b_{t+1})\). The functions \(J_t(b_t)\) and \(H_t(b_t)\) were defined in (4) and (5) for a particular wage equation \(g_t(b_t)\). Notice that equation (6) explicitly recognizes that the value of the firm depends on the optimal choice of debt \(b_{t+1}\).

For a given bargaining power of workers \(\eta \in (0, 1)\), the current wage is therefore the solution to the following problem:

\[
\max_{w_t} \left\{ \hat{J}_t(b_t, w_t)^{1-\eta} \left[ \hat{H}_t(b_t, w_t) - U_t \right]^{\eta} \right\}.
\]

(8)

Let \(w_t = \psi_t(g; b_t)\) be the solution to (8), where we made explicit the dependence on the wage function \(g\), which determines future wages. The rational expectation solution to the bargaining problem must satisfy the fixed-point condition:

\[
g_t(b_t) = \psi_t(g; b_t).
\]

We can now see the importance of Lemma 1. Since the optimal debt chosen by the firm after the wage bargaining does not depend on the wage, in solving the optimization problem (8) we do not have to consider how the choice of \(w_t\) affects \(b_{t+1}\).

Therefore, in deriving the first order condition we take \(b_{t+1}\) as given. After some re-arrangement, the first order conditions of problem (8) can be written as follows:

\[
J_t(b_t) = (1 - \eta)S_t(b_t),
\]

(9)

\[
H_t(b_t) - U_t = \eta S_t(b_t),
\]

(10)

where \(S_t(b_t) = J_t(b_t) + H_t(b_t) - U_t\) is the bargaining surplus. As it is typical in search models with Nash bargaining, the bargaining surplus is split between the contractual parties proportionally to their bargaining power.
Choice of debt: Let’s first rewrite the bargained surplus as follows:

\[
S_t(b_t) = z_t - a - b_t + \frac{b_{t+1}}{R} + \beta \mathbb{E}_t \left[ (1 - \lambda - p_t \eta)S_{t+1}(b_{t+1}) \right]
\] (11)

Since the choice of the new debt, \( b_{t+1} \), does not depend on the existing debt, \( b_t \) (see Lemma 1), we have that:

\[
\frac{\partial S_t(b_t)}{\partial b_t} = -1.
\] (12)

We will use this property below.

Using (9), the firm’s problem (4) can be re-written as:

\[
J_t = \max_{b_{t+1}} \left\{ z_t - g_t(b_t) - b_t + \frac{b_{t+1}}{R} + \beta(1 - \lambda)(1 - \eta)\mathbb{E}_t S_{t+1}(b_{t+1}) \right\}
\] (13)

subject to

\[
\phi_t \beta \mathbb{E}_t S_{t+1}(b_{t+1}) \geq \frac{b_{t+1}}{1 + r}
\]

Let \( \mu_t \) be the Lagrange multiplier associated with the enforcement constraint. The first order condition of problem is:

\[
\beta(1 - \lambda)R(1 - \eta)(1 + \phi_t \mu_t) = 1 - \mu_t,
\] (14)

where we have used \( \partial S_t(b_t)/\partial b_t = -1 \).

From condition (14) we can establish that the enforcement constraint is always binding to the extent that workers have some bargaining power. We express this point in the following lemma:

**Lemma 2**. The enforcement constraint is binding \( (\mu_t > 0) \) if and only if \( \eta \in (0, 1) \).

**Proof 2**. Equation (14) implies \( (1 - \eta) = (1 - \mu_t)/\beta(1 - \lambda)R(1 + \phi_t \mu_t) \).

To show that \( \mu_t > 0 \) requires \( \eta \in (0, 1) \), suppose \( \mu_t = 0 \). Using the zero profit condition (3) and condition (1), this would lead to \( 1 - \eta = 1 \), which is satisfied only if \( \eta = 0 \). Conversely, suppose \( \eta \in (0, 1) \). Then using (3) and (1), equation (14) can be written \( \mu_t = \eta/ [1 + (1 - \eta)\phi_t] \), which implies \( \mu_t > 0 \).
A key implication of Lemma 2 is that, to the extent that workers have some bargaining power, the firm always chooses to maximize the debt until the borrowing limit binds. To gather some intuition about the economic interpretation of the multiplier $\mu_t$, it will be convenient to re-arrange the first order condition as follows:

$$\mu_t = \left[ \frac{1 + r}{1 + \beta(1 + r)(1 - \eta)\phi_t} \right] \left[ \frac{1}{R} - \beta(1 - \lambda)(1 - \eta) \right],$$

which is the product of two terms. The first term is the change in next period liabilities $b_{t+1}$ allowed by a marginal relaxation of the enforcement constraint, that is, $b_{t+1}/(1 + r) - \phi_t\beta(1 - \eta)\mathbb{E}_tS(z_{t+1}, B_{t+1}, b_{t+1}) \leq \bar{a}$, where $\bar{a} = 0$ is a constant. This is obtained by marginally changing $\bar{a}$. In fact, using the implicit function theorem, we have

$$\frac{\partial b_{t+1}}{\partial \bar{a}} = \frac{1 + r}{1 + \beta(1 + r)(1 - \eta)\phi_t},$$

which is the first term in brackets.

The second term in brackets is the net gain from increasing the next period liabilities $b_{t+1}$ by one unit. If the firm increases $b_{t+1}$ by one unit, it receives $1/R$ units of consumption goods today, which can be paid as dividends. Next period this unit has to be repaid. The effective cost, however, is lower than 1, for two reasons. First, the repayment is made only with probability $1 - \lambda$, that is, only if the match is not separated. Second, a higher level of debt allows the firm to reduce the next period wage by $\eta$, that is, the part of the surplus going to the worker. This implies that the expected discounted cost for the firm is $\beta(1 - \lambda)(1 - \eta)$. Therefore, the multiplier $\mu_t$ is the total gain from the increase in debt allowed by a marginal relaxation of the enforcement constraint. It is equal to the total change in debt (first term in brackets) multiplied by the marginal gain from additional borrowing (second term in brackets),

It is interesting to observe that the effective cost of the debt decreases with $\eta$: the higher the bargaining power of workers, the higher is the firm’s incentive to borrow. When the bargaining power is zero, the firm does not gain from borrowing and $\mu_t = 0$ (since $\beta(1 + r) = 1$).
2.1 Firm entry and general equilibrium

So far we have defined the problem solved by incumbent firms. We now consider more explicitly the problem solved by new firms. In this setup, new firms are created when a posted vacancy is filled by a searching worker. Because of the matching frictions, a posted vacancy will be filled only with probability $q_t = m(v_t, u_t)/v_t$. Since posting a vacancy requires a fixed cost $\kappa$, vacancies will be posted only if the value of a filled vacancy (new firm) is not smaller than the cost.

We start with the definition of the value of a filled vacancy. When a vacancy is filled, the newly created firm starts producing and paying wages in the next period. The only decision made in the current period is the debt $b_{t+1}$. The funds raised by borrowing are distributed to shareholders. Therefore, the value of a vacancy that has been filled with a worker is defined as:

$$Q_t = \max_{b_{t+1}} \left\{ \frac{b_{t+1}}{R} + \beta(1 - \lambda)(1 - \eta)\mathbb{E}_t S_{t+1}(b_{t+1}) \right\}$$

subject to

$$\phi_t \beta(1 - \eta)\mathbb{E}_t S_{t+1}(b_{t+1}) \geq \frac{b_{t+1}}{1 + r}$$

Since the new firm becomes an incumbent firm starting in the next period, $S_{t+1}(b_{t+1})$ is the surplus of an incumbent firm as defined earlier.

As far as the choice of $b_{t+1}$ is concerned, a new firm faces the same problem as incumbent firms (see problem (13)). Even if the new firm has no debt and it does not pay wages, the choice of $b_{t+1}$ is not affected by the existing pair of debt and wage (see Lemma 1). Therefore, new firms choose the same debt as incumbent firms, which allows us work with a representative firm. Of course, this is possible because all firms also have the same $z_t$ and $\phi_t$.

We are now ready to define the value of a vacancy. Let $\kappa$ be the cost of posting a vacancy and $q_t$ the probability that the vacancy is filled. The value of posting a vacancy is given by:

$$V_t = q_t Q_t - \kappa$$

In a general equilibrium, all firms choose the same level of debt. Therefore, $b_t = B_t$. Furthermore, assuming that the bargaining power of workers
is positive, firms always borrow up to the limit. Therefore, the enforcement constraint is always binding, that is, $b_{t+1}/(1 + r) = \phi_t \beta (1 - \eta) \mathbb{E}_t S_{t+1} (B_{t+1})$.

Another general equilibrium condition derives from the assumption of free entry. As long as the value of posting a vacancy is positive, more vacancies will be posted until $V_t = q_t Q_t - \kappa = 0$. Using the binding enforcement constraint and the free entry condition, Appendix A derives the following expression for the wage:

$$w_t = (1 - \eta) a + \eta (z_t - b_t) + \frac{[(1 - \eta) \beta p_t + \phi_t A] \eta \kappa}{q_t (1 + \phi_t) A},$$

(16)

where $A \equiv \beta (1 - \lambda) (1 - \eta) > 0$.

This expression makes clear that the initial debt $b_t$ acts like a reduction in productivity in the wage equation. Instead of getting a fraction $\eta$ of the output, the worker gets a fraction $\eta$ of the output ‘net of debt’. Thus, for a given bargaining power $\eta$, the larger is the debt the lower is the wage received by the worker.

### 3 Response to shocks

In this section we investigate how the value of a filled vacancy, $Q_t$, responds to a credit shock (change in $\phi_t$) and to a productivity shock (change in $z_t$). Through the free entry condition $q_t Q_t = \kappa$ we can then infer the impact on job creation. More specifically, if the value of a filled vacancy $Q_t$ increases, the probability of filling a vacancy $q_t = m(v_t, u_t)/v_t$ must decline. Since the number of searching workers $u_t$ is given in the current period, this requires an increase in the number of posted vacancies. Thus, more jobs will be created.

#### 3.1 Credit

To derive some intuition we consider a temporary shock that affects only a single firm. In this way we can abstract from general equilibrium effects.

Starting from a steady state equilibrium, let’s assume that there is one firm with a newly filled vacancy for which the value of $\phi_t$ increases. The increase is purely temporary and it reverts back to the steady state value starting in the next period.
The derivative of $Q_t$ with respect to $\phi_t$ is:

$$\frac{\partial Q_t}{\partial \phi_t} = \left[ \frac{1}{R} + A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial b_{t+1}} \right] \frac{\partial b_{t+1}}{\partial \phi_t}$$

Applying the implicit function theorem to the enforcement constraint holding with equality, $b_{t+1}/R = \phi_t AES_{t+1}(b_{t+1})$, we can write:

$$\frac{\partial b_{t+1}}{\partial \phi_t} = \frac{RAE_t S_{t+1}(b_{t+1})}{1 - \phi_t RA \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial b_{t+1}}}$$

Recalling that $\frac{\partial E_t S_{t+1}(b_{t+1})}{\partial b_{t+1}} = -1$ (see equation (12)), we can substitute this expression in $\frac{\partial Q_t}{\partial \phi_t}$ and obtain:

$$\frac{\partial Q_t}{\partial \phi_t} = (1 - RA) \left( \frac{AE_t S_{t+1}(b_{t+1})}{1 + \phi_t RA} \right) \quad (17)$$

The expression in (17) allows us to assess the effect of a credit shock on the value of a newly created firm. Formally, we have the following proposition:

**Proposition 1** Consider a positive credit shock for a newly created firm. If $\eta \in (0, 1)$, the rise in $\phi_t$ increases the value of the firm $Q_t$.

**Proof 3** Using (1) we have that $RA = 1 - \eta < 1$. Hence the derivative in (17) is positive if $\eta \in (0, 1)$.

Therefore, an increase in $\phi_t$ increases the value of a newly filled vacancy $Q_t$, provided that the worker has some bargaining power. The intuition for the above proposition is straightforward. If the new firm can increase its debt in the current period, the firm can pay more dividends now and less dividends in the future. However, the reduction in future dividends is smaller than the increase in the current dividends because the higher debt allows the firm to reduce the next period wages. Effectively, part of the debt will be repaid by the worker, and therefore, the value of the firm increases if the firm can borrow more.

In deriving this result we assumed that the change in $\phi_t$ was only for one firm. By doing so we did not have to consider the possible general equilibrium effects of this change. However, since $\phi_t$ is an aggregate variable, the change affects all new firms. Therefore, the value of posting a vacancy increases and more vacancies will be posted. The higher job creation will have some general equilibrium effects that cannot be characterized analytically. Therefore, the general equilibrium effects will be studied quantitatively using numerical tools.
3.2 Productivity

In general, productivity shocks generate an employment expansion because the value of a filled vacancy increases. This would arise even if the level of debt were constant, and, for instance, normalized to zero. What we want to show here is that the endogeneity of debt amplifies the employment impact of a productivity shock. To derive some intuition about the amplification mechanism, we consider a productivity shock that affects only one newly created firm. As in the case of a credit shock, this allows us to abstract from general equilibrium effects.

Starting from a steady state equilibrium, let’s assume that there is one newly created firm, that is, a firm with a vacancy filled in the current period, for which the value of $z_t$ increases. We further assume that the productivity shock is persistent. For example, it could follow a first order autoregressive process. The persistence implies that the firm will be more productive also in the next period when it starts producing. Of course, if the increase in $z_t$ were purely temporary, it would not have any effect since the new firm does not produce in the current period.

The derivative of $Q_t$ with respect to $z_t$ is:

$$\frac{\partial Q_t}{\partial z_t} = A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial z_t} + \left[ \frac{1}{R} + A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial b_{t+1}} \right] \frac{\partial b_{t+1}}{\partial z_t}$$

Applying the implicit function theorem to the enforcement constraint $b_{t+1}/R = \phi_t A E_t S_{t+1}(b_{t+1})$, we obtain

$$\frac{\partial b_{t+1}}{\partial z_t} = \frac{\phi_t R A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial z_t}}{1 - \phi_t R A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial b_{t+1}}}$$

Since $\frac{\partial E_t S_{t+1}(b_{t+1})}{\partial b_{t+1}} = -1$ (see equation (12)), substituting in the derivative of the firm’s value $Q_t$ we get:

$$\frac{\partial Q_t}{\partial z_t} = A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial z_t} + (1 - RA) \left( \frac{\phi_t R A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial z_t}}{1 + \phi_t R A} \right)$$

We can now compare the above expression to the equivalent expression when the borrowing constraint is exogenous. More specifically, we replace the enforcement constraint (2) with the borrowing limit $b_{t+1} \leq \bar{b}$ where $\bar{b}$ is
constant. Under this constraint we have that \( \partial b_{t+1}/\partial z_t = 0 \). Therefore,

\[
\frac{\partial Q_t}{\partial z_t} = A \frac{\partial E_t S_{t+1}(b_{t+1})}{\partial z_t}
\]

Comparing (18) to (19), we can see that when the borrowing limit is endogenous, there is an extra term in the derivative of \( Q_t \) with respect to \( z_t \). Under the assumption that \( \eta > 0 \), we have that \( 1 - RA = \eta > 0 \). Therefore, the change in the value of a filled vacancy in response to a productivity improvement is bigger when the borrowing limit is endogenous. Intuitively, the increase in productivity raises the value of the firm. This allows for more debt which in turn increases the value of a filled vacancy \( Q_t \). The additional term we have in the right-hand-side of equation (18) captures the amplification generated by the endogeneity of the borrowing limit.

The amplification result has been derived under the assumption that only one firm is affected by the productivity improvement. When the change in \( z_t \) arises in aggregate, the value of any filled vacancy increases. Given the free entry condition \( q_t Q_t = \kappa \), this will generate an increase in the number of posted vacancies and more jobs will be created. As in the case of a credit shock, there will be general equilibrium effects that cannot be characterized analytically. We thus turn to the quantitative exercise where the general equilibrium is characterized numerically.

### 4 Dynamic simulations

In this section we present a series of quantitative experiments where we solve the model numerically. We first discuss our calibration of the relevant parameters.

**Calibration** The parameters of the model are as follows. We think of a period in the model to be a quarter and set the discount factor to \( \beta = 0.99 \). The matching function takes the typical Cobb-Douglas form \( m(v, u) = \xi v^\alpha u^{1-\alpha} \) where \( \xi \) is a constant. We set the parameter \( \alpha \) and the bargaining power \( \eta \) both to 0.5.

After normalizing the steady state value of productivity to 1, we have five parameters that can be pinned down using steady state conditions: the steady state value of the enforcement variable, \( \bar{\phi} \), the utility flow for unemployed workers, \( a \), the separation rate, \( \lambda \), the cost to create a vacancy, \( \kappa \), and
the constant in front of the matching function, $x_i$. These five parameters are calibrated using the following conditions: (i) the steady state debt-to-output ratio is 1; (ii) the utility flow for unemployed workers $a$ is 95% the steady-state value of wages; (iii) the steady state unemployment rate is 5 percent; (iv) the probability of filling a vacancy is 0.7; (v) the probability of finding a job is 0.93.

At this point we are only left with the parameters determining the stochastic process for the two shocks. Assuming that they both follow independent first order autoregressive processes, we need to assign the persistence parameters, $\rho_\phi$ and $\rho_z$, and standard deviations, $\sigma_\phi$ and $\sigma_z$. For the productivity shock we set $\rho_z = 0.95$ and $\sigma_z = 0.01$, which are relatively standard values in the literature. For the parametrization of the credit shock there is not a well established literature. We assign $\rho_\phi = 0.95$ and the standard deviation is chosen to have a response of employment of similar magnitude as the response to a productivity shock. This is obtained by setting $\sigma_\phi = 0.01$.

**Responses to a productivity shock** The top panel of Figure 1 plots the impulse response of employment to a productivity shock. The bottom panel plots the response to a credit shock. The numbers are percent deviation from the steady state. To show the importance of issuing debt, we compare those responses to the ones that would obtain in the case in which the stock of debt is not allowed to deviate from its steady-state value. We refer to this case as *exogenous debt limit*. More specifically, we impose the borrowing constraint $b_{t+1} \leq \bar{b}$, where $\bar{b}$ is the steady state debt in the model with endogenous borrowing limit.

As can be seen from the top panel, the response of employment to a productivity shock is greatly amplified when the borrowing limit is endogenous. After the increase in productivity, the firm’s value increases. Because of the nature of the enforcement constraint, the increase in the firm’s value relaxes the borrowing limit. Thanks to the higher debt, the wage paid by new firms increases less and this leads to more job creation.

The dynamics of debt and wages are shown in the next two figures. The top panel of Figure 2 shows that the debt increases in response to the productivity improvement and returns to the original steady state gradually. The pattern of wages is shown in Figure 3. At impact wages increase significantly. This is because workers anticipate that the firm is taking more debt and, starting from the next period, their wages will be reduced. However,
what matters for job creation is not the current wage but the wage that new firms will pay starting in the next period. As can be seen from Figure 3, the wage paid starting in the next period is homogeneously lower than the wage paid when the borrowing limit is exogenous. This is the key factor that generates amplification.

We would like to point out that the amplification mechanism derives from the change in the value of the match for the firm, which is an asset price. In this vein our mechanism shares some similarities with the amplification channel emphasized by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997). In our model, however, the change in the asset price generates an economic expansion not because it allows for greater financing of investment and employment (standard credit channel) but because it improves the bargaining position of firms.

**Responses to a credit shock**  The bottom panel of Figure 1 plots the response of employment to a temporary credit shock. The response is qualitatively similar to the response to a productivity shock. Of course, in the case of a credit shock, imposing an exogenous borrowing limit is equivalent to eliminating the credit shock, which explains why employment does not move. The responses of debt and wages are plotted in the lower sections of Figures 2 and 3. Especially important is the dynamics of the wage starting from the period that follows the shock. After raising at impact, the wage falls below the steady state level. Since the value of a new firm depends on future wages, the incentive to create jobs increases.

The final exercise simulates the economy in response to a permanent decline in $\phi_t$. Suppose that starting from a steady state equilibrium, the economy experiences a sequence of $\phi_t = \{\bar{\phi} - \Delta\}$ Here $\Delta$ is a positive number that denotes the deviation from the steady state value. Notice that the sequence of $\phi_t$ is not anticipated. Agents continue to form expectations based on the AR process. As can be seen in Figure 4, employment falls below the steady state and remains at this lower level for the whole simulation period. This exercise shows how persistent problems in financial markets can generate a long lasting increase in unemployment. A feature that characterizes the recent dynamics of the labor market in the US.
5 Empirical analysis

The theoretical analysis suggests that shocks to the ability of borrowing could be important for employment fluctuations. In this section we investigate this mechanism empirically using a structural VAR where the identifying restrictions are derived from the theoretical model studied in the previous sections.

We use a three dimensional VAR in the growth rates of TFP, Credit to the Private Sector, Employment. The inclusion of the TFP series is motivated by the need to separate the credit expansion induced by productivity shocks from credit expansions driven by other shocks. As we have seen in the theoretical model, productivity shocks have two effects on employment. In addition to the direct impact, productivity shocks are amplified through the expansion of credit that is made possible by the endogeneity of the borrowing limit. The explicit inclusion of the TFP series should separate the credit expansion induced by productivity shocks from the credit expansion induced by other perturbations. We refer to these other perturbations as ‘credit shocks’.

The identification of the structural shocks is done through the imposition of zero short-term restrictions. To illustrate the identification assumptions it will be convenient to write down explicitly the VAR system:

\[(I - A_1L - A_2L^2 - ... - A_nL^n) \begin{pmatrix} z_t \\ b_t \\ e_t \end{pmatrix} = \begin{pmatrix} \epsilon_{z,t} \\ \epsilon_{b,t} \\ \epsilon_{e,t} \end{pmatrix}\]

where \(L\) is the lag operator and \(n\) is the number of lags included in the VAR.

The vector \((z_t, b_t, e_t)\) is the observed data. It includes the growth rate of TFP, \(z_t\), the growth rate of private credit, \(b_t\), and the growth rate of employment, \(e_t\). A more detailed description of the data is provided below.

The vector \((\epsilon_{z,t}, \epsilon_{b,t}, \epsilon_{e,t})\) are the orthogonalized disturbances. In order to assign a particular economic interpretation to these shocks, we impose that some of the elements of the matrix \(P\) are equal to zero. To be more specific, let’s write the matrix in extensive form:

\[P = \begin{pmatrix} p_{zz} & p_{zb} & p_{ze} \\ p_{bz} & p_{bb} & p_{be} \\ p_{ez} & p_{eb} & p_{ee} \end{pmatrix}\]

By imposing that some of the elements of \(P\) are zero, we are assuming that some of the orthogonalized disturbances cannot have an immediate impact
on some of the variables included in the system. For example, if we set $p_{eb} = 0$, the shock $\epsilon_{b,t}$ cannot have an immediate impact on employment $e_t$. Since the identification of a three dimensional system requires at least three restrictions, we have to impose that at least three elements of the matrix $P$ are zero. Thus, we start with the following restrictions:

1. Since TFP evolves exogenously in the model, credit shocks cannot affect TFP. Therefore, we set $p_{zb} = 0$.

2. Since in the model an improvement in productivity affects employment with one period lag (due to the matching frictions), innovations to productivity cannot affect employment at impact. Therefore, we set $p_{ez} = 0$.

3. The same logic applies to credit shocks, that is, they also affect employment with one period lag. Therefore, innovations to availability of credit cannot affect employment at impact, which implies $p_{eb} = 0$.

With these restrictions, we can interpret $\epsilon_{z,t}$ as innovations to TFP, $\epsilon_{b,t}$ as innovations to the availability of credit and $\epsilon_{e,t}$ as residual disturbances.\(^3\)

**Data:** The estimation uses quarterly data over the period 1984.1-2009.3. The TFP growth is constructed using the utilization-adjusted TFP series constructed by John Fernald (2009). The growth in private credit is constructed using data from the Flow of Funds. Specifically, we use new borrowing (financial market instruments) for households and nonfinancial businesses dividend by the stock of debt (again, financial market instruments). For employment we have three series. The first series includes all civilian employment from the BLS. The second series includes all employees in private industries, also from the BLS. The third series includes all employees in the nonfarm sector, from the Current Employment Statistics survey.

**Impulse responses:** We first estimate the VAR system with $e_t$ measured by ‘employment in the private sector’ and five lags ($n = 5$). Results using the other two definitions of employment (not reported) are similar.

\(^3\)An alternative way to generate a just-identified system is to assume (i) $p_{zb} = 0$, (ii) $p_{ze} = 0$, and (iii) $p_{eb} = 0$. Results based on this alternative identification scheme are similar, and are available upon request.
The impulse response functions of Private Credit and Employment to credit and TFP shocks are plotted in Figure 5. As far as the credit shock is concerned, we see that this generates an expansion in the growth rate of private credit that lasts for many quarters. Therefore, these shocks tend to generate long credit cycles. Credit shocks generate an expansion in the growth rate of employment that is statistically significant for four quarters.

TFP shocks also generate an expansion in the growth rate of private credit but the impact is much less persistent. The growth rate of employment goes up but the overall impact is smaller than the impact of credit shocks.

Overall, the results presented in Figure 4 are consistent with the properties of the theoretical model. In particular, we see that credit shocks have a statistical significant impact on employment and TFP shocks lead to a credit expansion. As long as a credit expansion allows for more job creation, the financial mechanism allows for an amplification of productivity shocks.

As an alternative to using employment as a measure of labor market performance, we could use the rate of unemployment. We re-estimate the VAR with the growth rate of TFP, Private Credit and Unemployment. For unemployment we use the measure provided by the BLS. The impulse responses to financial and productivity shocks are plotted in Figure 6. Also in this case we find that productivity shocks have a statistically significant impact on the growth rate of private credit and unemployment.

**Alternative identification:** In the identification scheme adopted above, we have imposed that financial shocks do not impact TFP, at least in the current period. This is consistent with the exogenous nature of productivity which we assumed in the theoretical model. However, we have not imposed that the residual shock $\epsilon_{e,t}$ also cannot have an impact on TFP. Therefore, we now repeat the estimation imposing this additional restriction, that is, $p_{ze} = 0$. By doing so we have a total of four restrictions. This implies that the structural VAR is over-identified. The impulse responses, plotted in Figure 7, confirm the results obtained with the identification strategy adopted above.

**6 Conclusion**

In this paper we have studied the importance of financial flows for employment (and unemployment) fluctuations. We have extended the basic matching model by allowing firms to issue debt under limited enforcement
of financial contracts. Our approach goes beyond a mere cumulation of frictions, respectively in financial and labor markets. Firms have an incentive to borrow in order to affect the wage-bargaining process as emphasized in the corporate finance literature. Our paper embeds this mechanism in a general equilibrium environment and investigates its role for the dynamics of aggregate employment.

In our model the ability to borrow can change exogenously in response to credit shocks or endogenously in response to productivity shocks. Independently of the sources of credit expansion, higher debt allows firms to bargain lower wages. Through this mechanism, credit shocks can generate large employment fluctuations and the impact of productivity shocks is greatly amplified. The determination of wages based on bargaining is central to these results.

The paper has also investigated the empirical relevance of credit shocks using a structural VAR where the shocks are identified with zero short-term restrictions derived from the theoretical model. The estimation of the VAR shows that the impact of credit shocks on employment is statistically significant and productivity shocks lead to a credit expansion. These findings confirm the importance of the financial mechanism for the performance of the labor market.
Appendix

A Wage equation

Consider the value of a filled vacancy defined in (15). Using the binding enforcement constraint, \( b_{t+1}/(1 + r) = \phi_t \beta (1 - \eta) E_t S_{t+1}(B_{t+1}) \), to eliminate \( b_{t+1} \), the value of a filled vacancy becomes:

\[
Q_t = (1 + \phi_t) A E_t S_{t+1}(B_{t+1}),
\]

where \( A = \beta (1 - \lambda) (1 - \eta) \).

Next we use the free entry condition \( V_t = q_t Q_t - \kappa = 0 \). Substituting the above expression for \( Q \) we get an expression for the expected value of the surplus:

\[
E_t S_{t+1}(B_{t+1}) = \kappa \frac{q_t (1 + \phi_t) A}{(1 + \phi_t) A}
\]

Substituting into the definition of the surplus—equation (11)—and taking into account that \( b_{t+1}/R = \phi_t A E_t S_{t+1}(B_{t+1}) \), we get:

\[
S_t(B_t) = z_t - a - b_t + \frac{[\beta (1 - \lambda - p_t \eta) + \phi_t A] \kappa}{q_t (1 + \phi_t) A}
\]  

(20)

Now consider the net value for a worker:

\[
W_t(B_t) - U_t = w_t - a + \eta (1 - \lambda - p_t) \beta E_t S_{t+1}(B_{t+1})
\]

Eliminating the expected value of the surplus and remembering that \( W_t(B_t) - U_t = \eta S_t(B_t) \) we get:

\[
\eta S_t(B_t) = w_t - a + \frac{\eta (1 - \lambda - p_t) \beta \kappa}{q_t (1 + \phi_t) A}
\]  

(21)

Finally, combining (20) and (21) we get the expression for the wage:

\[
w_t = (1 - \eta) a + \eta (z_t - b_t) + \frac{[(1 - \eta) \beta p_t + \phi_t A] \eta \kappa}{q_t (1 + \phi_t) A}
\]
References


International Monetary Fund (2009). World Economic Outlook, Chapter 3, April.


Figure 1: Model simulation - Employment.

**EMPLOYMENT RESPONSE TO PRODUCTIVITY**

**EMPLOYMENT RESPONSE TO CREDIT SHOCK**
Figure 2: Model simulation - Debt.

DEBT RESPONSE TO PRODUCTIVITY

DEBT RESPONSE TO CREDIT SHOCK
Figure 3: Model simulation - Wage.

**WAGE RESPONSE TO PRODUCTIVITY**

**WAGE RESPONSE TO CREDIT SHOCK**
Figure 4: Response to a permanent negative credit shock.
Figure 5: Exactly identified structural VAR.
Figure 6: Exactly identified structural VAR.
Figure 7: Over-identified structural VAR.