Capital Pledgeability, Inflation and Unemployment*

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Abstract

We study the effects of firm’s credit condition on (1) labor market performance and (2) the inflation and unemployment relationship, in a new monetarist model. Better credit condition has positive impact on labor market as firms save on financing cost, improve profitability, and thus create more vacancies. Inflation increases the financing cost and thus discourages job creation. On the other hand, inflation lowers wage as employed workers carry a lower real balance compared to the unemployed ones. This encourages job creation. The overall effect depends crucially on the credit condition. We show by examples that the Phillips curve can be upward or downward sloping, depending on the credit condition.

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1 Introduction

We study the effect of the firm’s credit condition on labor market performance in a monetary economy. In the presence of limited commitment, agents must use cash or secured credit to trade. When firms cannot commit to pay workers after selling their products, workers demand wage payments on the spot. In order to pay their wage bills, firms must hold cash and/or pledge their capital to acquire secured credit. Similarly, workers must use cash or secured credit to purchase goods from firms. We capture the firm’s credit condition by the pledgeability of their capital.

Our first goal is to understand how pledgeability changes labor market performance given the monetary policy. As long as pledgeability is sufficiently small, the firm faces a binding liquidity constraint and over-accumulates capital. Improvement in pledgeability allows the firm more freedom to substitute capital for money and to save on financing cost of the wage bill. The increase in firm profits encourages job creation and reduces unemployment. In this regard, our work complements the literature on how various credit conditions affect the labor market. For example, Acemoglu (2001) shows that the new firm’s difficulty in accessing loans restricts job creation. Wasmer and Weil (2004) find that the search friction in the credit market leads to higher volatility in unemployment. Bethune et al. (2014) studies the relationship between the availability of unsecured credit to households and unemployment. The credit condition we examine here is the pledgeability of firm’s asset to secure working capital loans.¹

Our second goal is to investigate the effectiveness of the monetary policy on reducing unemployment given the credit condition. In particular, we study how the credit condition changes the slope of the Phillips curve. Empirically, there does not exist a uniform long-term relationship between inflation and unemployment. For example, King and Watson (1994) study the relationship in the U.S., and find that during 1954-1969, there is a strong negative correlation (-.62); from 1970 to

¹The pledge能力ity of the firm’s capital to secure loans has been shown to amplify business cycle volatilities (see Kiyotaki and Moore 1997). Here we focus on the long-term relationship between credit conditions and labor market outcomes.
1987 there is no consistent relation (the sample correlation is .03), and over the entire period from 1954-1987, there is a positive correlation (.50). Berentsen et al (2011) find a positive long-run Phillips curve in the U.S. from 1955 to 2005. Dolado and Jimeno (1997) find that, in Spain, the Phillips curve has a positive slope from 1970 to 1977, and a negative slope from 1977 to 1994. Schreiber and Wolters (2007) identify a negative Phillips curve in Germany in the period 1977-2002. Micro-founded theoretical studies tend to advocate a positive relationship between inflation and unemployment. Berentsen et al. (2011) focus on the search friction in the goods and labor markets. Inflation decreases the demand for the cash goods, reduces the profit of the firms, and thus discourages job creation. Venkateswaran and Wright (2013) study monetary model with consumer credit in which inflation raises capital stock via Mundell-Tobin effect, and consequently labor demand falls.

Our study suggests credit condition as a potential factor to account for the differences in the slope of the Phillips curve. In our model, inflation affects unemployment through two opposing channels. On one hand, when the firm uses cash to pay part of its wage bill, inflation increases the firm’s financing cost, reducing its profits and vacancy postings. Call this channel the cash-financing channel. On the other hand, inflation affects employed and unemployed workers asymmetrically. Employed workers have access to more steady income opportunities and carry a lower real balance than their unemployed counterparts. So inflation hurts unemployed workers more than employed workers. This induces workers to accept a lower wage when inflation is high, and encourages job creation. Call the second channel the wage bargaining channel. We find that the overall effect of inflation on unemployment depends critically on the credit condition. When credit is abundant, firms do not need cash to finance their wage bill. Inflation decreases unemployment as the cash-financing channel shuts down. However, when credit is scarce, the effect is ambiguous, depending on which channel is dominant.

\(^2\)Liu (2008) studies the role of goods and labor market institutions, such as sales taxes, firm’s market power and unemployment benefit, in determining the relationship between inflation and unemployment. Inflation affects unemployed and employed workers differently as the unemployed tend to consume more cash goods.
The paper is organized as follows. Section 2 sets up the baseline model. Section 3 solves the general equilibrium. Section 4 extends the model to include search friction in the goods market. Section 6 concludes.

2 The baseline model

The environment is based on Berentsen et al. (2011), which introduces labor search friction in the spirit of Mortensen and Pissarides (1994) to Lagos and Wright (2005) monetary model. Time is discrete and infinite. In each time period, three markets open sequentially. First a labor market (LM), followed by a decentralized goods market (DM) and finally a centralized goods market (CM). The CM is frictionless. LM and DM are with frictions detailed below.

There are two types of agents, workers and firms. Workers are endowed with one unit of labor. Firms are endowed with a production technology that transforms capital and labor into consumption good valued in the CM according to the production function $F(K,L)$, where $F$ is strictly increasing, strictly concave, twice differentiable, and exhibits constant returns to scale. We assume $F(0,L) = F(K,0) = 0$. The set of the workers is $[0,1]$. The set of the firms is arbitrary large. But not all firms are active at any point of time.

Firms without workers meet with unemployed workers bilaterally in the LM after paying a cost to post the vacancies. Labor is indivisible and each firm can hire at most one worker. An employed worker separates from his job with probability $s$ at the end of the LM, after he produces. An unemployed worker matches with a firm with posted vacancy according to a matching function $M(u,v)$, where $u$ is the measure of unemployed worker and $v$ is the measure of firms that post vacancies. The matching function is increasing, concave, twice differentiable, and homogeneous of degree 1. The labor market tightness is defined as $\tau = v/u$. Firms cannot commit to pay workers after they sell the products, and there is no monitoring device for any unsecured credit extended in the LM. So firms use some payment instruments,
say money or credit secured by capital, to pay workers on the spot.\(^3\)

Firms can transform goods by a linear cost function and sell goods in the DM. Assume the marginal cost to be \(c\). The DM is also subject to commitment problem in the sense that the workers cannot commit to pay back any unsecured credit extended by the firms. So workers need some payment instruments, say cash and/or wage income to make transactions in the DM. In the CM, firms sell any unsold goods, and all agents adjust their money and capital holdings. Worker’s instantaneous utility \(x + v(q)\), where \(x\) is the consumption of the CM good, \(q\) is the consumption of DM good, \(v' > 0, v'' < 0\) and \(v(0) = 0\). If \(x < 0\), workers produce in the CM. Goods are not storable.

Agents discount between periods by \(\beta\). Money supply grows at rate \(\pi\). Changes in \(M\) are accomplished by lump-sum transfers if \(\pi > 0\) and lump-sum taxes if \(\pi < 0\). For convenience, we assume workers pay (receive) the same taxes (transfers) regardless of their labor status. We restrict attention to \(\pi > \beta - 1\), or the limit \(\pi \to \beta - 1\); there is no monetary equilibrium with \(\pi < \beta - 1\).

2.1 Worker’s problem

Let \(W_j^h, U_j^h\) and \(V_j^h, j = 0, 1\), denote the worker’s value function in the CM, LM and DM, respectively, where employed workers are of type \(j = 1\) and the unemployed are \(j = 0\). For simplicity, we assume there is no capital market and the workers do not carry capital. Later we will show this assumption is innocuous. A worker of type \(j\) solves the following problem at the beginning of the CM.

\[
W_j^h (m^h, \omega) = \max_{x, \hat{m}_j^h} \left[ x + \beta U_j^h (\hat{m}_j^h) \right] \\
\text{st} \ x + \phi \hat{m}_j^h + T = \phi m_j^h + \omega
\]

where \(x\) is the consumption of the CM goods, \(T\) is the lump sum tax/transfer to the worker, \(\omega\) is the labor income carried into the CM, \(m_j^h\) denotes worker’s current

\(^3\)Although there is no monitoring device, the worker can punish the firm by quitting the job. So some unsecured credit in the spirit of Kehoe and Levin (1993) is feasible between the worker and the firm. For simplicity, we assume such unsecured credit cannot be used. Alternatively, we can assume that the pledgeability of capital to be larger than 1. So some of the wage payments is received in the CM, which is equivalent to unsecured credit.
money holding, and $\hat{m}_j^h$ is the money carried to the next LM. Note that employed workers may choose different amount of money from the unemployed ones in anticipation of labor income in the LM. Plug the budget equation into the objective function to get

$$W_j^h (m^h, \omega) = \phi m^h + \omega - T + \max_{\hat{m}_j^h} \left[ -\phi \hat{m}_j^h + \beta U_j^h (\hat{m}_j^h) \right]$$

The envelope conditions are

$$\frac{\partial W_j^h}{\partial m^h} = \phi \text{ and } \frac{\partial W_j^h}{\partial \omega} = 1$$

In the LM, an employed worker receives wage $w$, continues to be employed with probability $s$ and gets separated from the job with probability $1 - s$. The value function of an employed worker thus is

$$U_1^h (\hat{m}_1^h) = (1 - s) V_1^h (\hat{m}_1^h, w) + s V_0^h (\hat{m}_1^h, w)$$

An unemployed worker matches with a firm with probability $\lambda_h$. His value function is

$$U_0^h (\hat{m}_0^h) = \lambda_h V_1^h (\hat{m}_0^h, 0) + (1 - \lambda_h) V_0^h (\hat{m}_0^h, 0)$$

Workers cannot use capital directly as means of payment in the DM. But the certificate issued by the firms and secured by the firm’s capital can be used as payment instrument. So workers can use cash and wage to pay for the DM goods. DM is a Walrasian market. As a result of competition, the price of the DM good is $c$.

$$V_j^h (\hat{m}_j^h, \omega) = \max_{q, m', \omega'} \left[ v(q) + W_j^h (\hat{m}_j^h - m', \omega - \omega') \right]$$

st $cq = \hat{m}^h + \omega'$, $m' \leq \hat{m}_j^h$, $\omega' \leq \omega$

where $p$ is the price of the DM good in terms of CM good, $m'$ and $\omega'$ are the transfer of money and wage income to the sellers in exchange for the DM good, $\omega = w$ if the

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4As in Aruoba et al. (2011), buyers in the DM cannot use capital to facilitate DM transactions. The underlying friction is that workers cannot bring physical capital to the goods market and they can counterfeit certificate of the capital costlessly. Whereas the firm’s certificate of capital is recognizable everywhere.
worker is employed, and \( \omega = 0 \) if he is not. By the linearity of \( W_j \), we can write the DM value function as

\[
V_j^h (\hat{m}_j^h, \omega) = \max_q \left[ v(q) - c q + W_j^h (\hat{m}_j^h, \omega) \right]
\]

subject to \( cq \leq \hat{\phi} \hat{m}_j + \omega \)

Use the envelope conditions and combine the value functions to reduce the problem to

\[
\max_{\hat{m}_1^h, q} \left\{ -\hat{\phi} \hat{m}_1^h + \beta \left[ w + v(q) - c q + \hat{\phi} \hat{m}_1^h \right] \right\}
\]

subject to \( cq \leq \hat{\phi} \hat{m}_1^h + w \)

for employed workers, and

\[
\max_{\hat{m}_0^h, q} \left\{ -\hat{\phi} \hat{m}_0^h + \beta \left[ v(q) - c q + \hat{\phi} \hat{m}_0^h \right] \right\}
\]

subject to \( cq \leq \hat{\phi} \hat{m}_0^h \)

for unemployed workers.

For employed workers, the FOC wrt to \( \hat{m}_1^h \) gets us the following:

\[
q_1 = \begin{cases} 
q_i & \text{if } w < c q_i \\
\frac{w}{c} & \text{if } c q_i \leq w < c q^* \\
q^* & \text{if } w \geq c q^* 
\end{cases}
\]

(1)

and

\[
\hat{\phi} \hat{m}_1^h = \begin{cases} 
c q_i - w & \text{if } w < c q_i \\
0 & \text{if } w \geq c q_i 
\end{cases}
\]

(2)

where \( q_i \) solves \( v'(q_i) = (1 + i) c \) and \( q^* \) solves \( u'(q^*) = c \). That is, if \( w \) is low, employed workers acquire additional cash in the CM to pay for the DM goods. Note that \( q_i \) is independent of \( w \) as cash matters at the margin. If \( w \) is higher than \( c q^* \), employed workers is not liquidity constrained as \( w \) is sufficient to pay for optimal \( q \). When \( w \in [c q_i, c q^*) \) employed workers are liquidity constrained. However, acquiring money is too costly compared with the marginal benefit. So employed workers do not demand money.
For unemployed workers, we have

\[ q_0 = q_i \]  

(3)

and

\[ \hat{\phi} \hat{m}_0^h = cq_i \]  

(4)
as they do not have wage income.

Simplify the value functions to get the following in steady state.

\[ W^h_1 (0, 0) = -T + \beta \left\{ w - i \phi m_1^h + v (q_1) - cq_1 + (1 - s) W^h_1 (0, 0) + s W^h_0 (0, 0) \right\} \]  

(5)

and

\[ W^h_0 (0, 0) = -T + \beta \left\{ v (q_i) - (1 + i) cq_i + \lambda h W^h_1 (0, 0) + (1 - \lambda h) W^h_0 (0, 0) \right\} \]  

(6)

Subtract (6) from (5) to get

\[ W^h_1 (0, 0) - W^h_0 (0, 0) = \frac{\beta \left\{ w + v (q_1) - cq_1 - i \phi m_1 - v (q_i) + (1 + i) cq_i \right\}}{1 - \beta (1 - s - \lambda h)} \]  

(7)

Compared with an unemployed worker, an employed worker earns more and gets more trade surplus in the DM as his liquidity constraint is more relaxed.

### 2.2 Firm’s problem

Let \( W^f_j, U^f_j \) and \( V^f_j \) denote the value of the firm of type \( j \) at the beginning of CM, LM and DM, respectively, where firms with workers are type 1 and without workers are type 0. A firm enters the CM with output \( y \), real balance \( \phi m \) and capital \( K \). It adjusts money and capital holdings. Its expected utility is

\[ W^f_j (m^f, K, y) = y + \phi m^f + (1 - \delta) K + \max_{\hat{m}^f, \hat{K}} \left\{ -\phi \hat{m}^f - \hat{K} + \beta U^f_j \left( \hat{m}^f, \hat{K} \right) \right\} \]

where \( \delta \) is the capital depreciation rate. The envelope conditions are

\[ \frac{\partial W^f_j}{\partial m^f} = \phi, \quad \frac{\partial W^f_j}{\partial K} = 1 - \delta, \quad \frac{\partial W^f_j}{\partial y} = 1 \]
In the LM, a firm with a worker pays wage using money and its own capital as collateral. It retains the worker with probability $1 - s$ and loses the worker with probability $s$. Its expected utility is represented by

$$U_f^f(\hat{m}^f, \hat{K}) = \max_{\bar{m}, k} \left[ (1 - s) V_f^f(\bar{m}^f, \bar{K} - k, y) + s V_0^f(\bar{m}^f, \bar{K} - k, y) \right]$$

subject to

$$w = \hat{\phi} \bar{m} + (1 - \delta) k,$$

$$\bar{m} \leq \bar{m}^f, k \leq \chi \hat{K},$$

$$y = F(\hat{K}, 1).$$

where $\bar{m}$ is the money paid to the worker, $k$ is the capital pledged, and $\chi \in [0, 1]$ is the parameter that measures the pledgeability of capital.

For a firm without a worker, carrying money or capital is useless. Therefore, their money and capital holdings are zero. Those firms has probability $\lambda_f$ to meet with an unemployed worker if they pay a cost $\kappa$ to post the vacancy. It does not produce in the current period and does not participate in the following DM. Its expected utility is

$$U_0^f = -\kappa + \lambda_f W_f^f(0, 0, 0) + (1 - \lambda_f) W_0^f(0, 0, 0)$$

In the DM, firms transform some of their products by a linear cost function $cq$. For competitive market, firms do not have profits in the DM. By the envelope condition, the DM value functions are

$$V_f^f(\bar{m}^f, \bar{K}, y) = W_f^f(\bar{m}^f, \bar{K}, y)$$

and

$$V_0^f(\bar{m}^f, \bar{K}, 0) = W_0^f(\bar{m}^f, \bar{K}, 0)$$

Combine the value functions and the envelope conditions to reduce the problem of the firms with workers:

$$\max_{\bar{m}^f, K^f} \left\{ -\phi \bar{m}^f - \bar{K} + \beta \left[ F(\hat{K}, 1) - w + \hat{\phi} \bar{m}^f + (1 - \delta) \hat{K} \right] \right\}$$

subject to

$$w \leq \hat{\phi} \bar{m}^f + \chi (1 - \delta) \hat{K}$$

8
As labor is indivisible, we suppress the labor argument in the production function. The FOCs wrt \( \hat{m} f \) and \( K \), respectively, are

\[
-\phi + \beta \dot{\phi} (1 + \mu) \leq 0 \\
-1 + \beta \left[ F' (\hat{K}) + (1 + \mu \chi)(1 - \delta) \right] = 0
\]

where \( \mu \) is the Lagrangian multipliers on the liquidity constraint in the LM. The steady state is in one of the three regimes.

1. \( \mu = 0 \) and \( m f = 0 \). In this case, \( F'(K) = r^* \), where \( r^* = 1/\beta - 1 + \delta \) and \( \chi (1 - \delta) K > w \).

2. \( \mu \in (0, i) \) and \( m f = 0 \). In this case, \( \mu = \frac{r^* - F'(K)}{\chi (1 - \delta)} \) and \( \chi (1 - \delta) K = w \).

3. \( \mu = i \) and \( m f > 0 \). In this case, \( F'(K) = r^* - i \chi (1 - \delta) \), \( \phi m f = w - \chi (1 - \delta) K > 0 \).

In regime 1, firm’s capital is sufficient to pay the worker. The capital accumulation is at its first best. In regime 2, the liquidity constraint is tight. The firms accumulate more capital to use as payments but they do not use money. In regime 3, the liquidity constraint is tighter and the firms use capital and money to pay workers. In regimes 2 and 3, capital is overly accumulated. Let \( K^* \) solve \( F'(K^*) = r^* \) and let \( \hat{K} \) solve \( F'(\hat{K}) = r^* - i \chi (1 - \delta) \). Given \( w \), the capital stock decreases when the economy moves from regime 3 to 2 then to 1.

Summarizing, given \( w \), firms choose capital and real balances as the follows.

\[
K f = \begin{cases} 
K^* & \text{if } w \leq \chi (1 - \delta) K^* \\
\frac{w}{[\chi (1 - \delta)]} & \text{if } \chi (1 - \delta) K^* < w \leq \chi (1 - \delta) \hat{K} \\
\hat{K} & \text{if } w > \chi (1 - \delta) \hat{K}
\end{cases} 
\tag{10}
\]

and

\[
\phi m f = \begin{cases} 
0 & \text{if } w < \chi (1 - \delta) \hat{K} \\
w - \chi (1 - \delta) \hat{K} & \text{if } w \geq \chi (1 - \delta) \hat{K}
\end{cases} 
\tag{11}
\]

Notice that the capital market will be inactive even if we allow for such a market. Since workers or inactive firms do not use capital, they lend iff \( r = r^* \equiv 1/\beta - 1 + \delta \).
As active firms can pay only \( r \leq r^* \), there is no active lending and borrowing in the capital market. At \( r = r^* \), firms are in regime 1 and are indifferent to borrowing and self financing. So without loss of generality, we assume there is no capital market.

By linearity, the value function for producing firms can be written as

\[
W_f^1 (0, 0, 0) = \beta \{ -\phi m^f + F (K) - r^* K - w + (1 - s) W_f^1 (0, 0, 0) + s W_0^f (0, 0, 0) \} \tag{12}
\]

For firms without workers, the expected value is

\[
W_f^0 (0, 0, 0) = \beta \left[ -\kappa + \lambda_f W_f^1 (0, 0, 0) + (1 - \lambda_f) W_0^f (0, 0, 0) \right] \tag{13}
\]

Subtract (13) from (12) to get

\[
W_f^1 (0, 0, 0) - W_f^0 (0, 0, 0) = \beta \left[ F (K) - r^* K - w + \kappa - i \phi m^f \right] \frac{1}{1 - \beta (1 - s - \lambda_f)} \tag{14}
\]

Let us turn to the wage determination. We assume that the worker and the firm split the production surplus according to Kalai bargaining solution. Let worker have bargaining power \( \rho \). The surplus of the worker and the firm satisfies:

\[
\frac{w + v (q_1) - pq_1 - \phi m_1 - v (q_i) + (1 + i) c q_i}{F (K) - r^* K - w + \kappa - i \phi m^f} = \frac{\rho}{1 - \rho} \tag{15}
\]

To solve for \( \lambda_f \) and \( \lambda_h \), we use the zero-profit condition for firm and the law of motion for unemployment. The zero-profit condition requires that \( W_0^f (0, 0) = 0 \), or

\[
\lambda_f = \frac{\kappa [1 - \beta (1 - s)]}{\beta [F (K) - r^* K - w - i \phi m^f]} \tag{16}
\]

As

\[
\lambda_f = \mathcal{M} (1/\tau, 1) \tag{17}
\]

and

\[
\lambda_h = \mathcal{M} (1, \tau) \tag{18}
\]

From (17) and (18), \( d\lambda_f / d\lambda_h < 0 \) and \( \lambda_h \) is well defined as a function of \( w \) and \( K \).

The law of motion for unemployment is \( u_{t+1} = u_t (1 - \lambda_h) + (1 - u_t) s \). In steady state, the measure of unemployed workers remains constant, which results in

\[
u = \frac{s}{\lambda_h + s} \tag{19}\]

It follows that \( du / d\lambda_h < 0 \).
3 Equilibrium

We look for a list of \((w,K^f,\phi m^f, \phi m_1, \phi m_0, q_1, q_0, \lambda_f, \lambda_0, \tau)\) to solve (1)-(4), (10)-(11), and (15)-(18). To get an more intuitive illustration of the equilibrium, we first assume \(\chi = 0\) and extend the result to \(\chi > 0\).

3.1 Non-Pledgeable Capital

For \(\chi = 0\), the firms are in regime 3, \(K = K^*\) and \(\phi m^f = w\). Equation (16) can be reduced to

\[
\lambda_f = \frac{\kappa [1 - \beta (1 - s)]}{\beta [F(K^*) - r^* K^* - (1 + i) w]}
\]

which is a function of \(w\). It follows that \(\lambda_h\) is also a function of \(w\). Let \(G(w) \equiv \frac{1 - \beta [1 - s - \lambda_f(w)]}{1 - \beta [1 - s - \lambda_h(w)]}\), which is increasing in \(w\). With equations (1)-(4) and (10)-(11), the LHS of (15) can be reduced to

\[
H(w) \equiv \left\{ \begin{array}{ll}
(1 + i) w & \text{if } w < cq_i \\
F(K^*) - r^* K^* - (1 + i) w + \kappa & \text{if } w \in [cq_i, cq^*] \\
\frac{w + v(q^*) - cq^* - [v(q_i) - (1 + i) cq_i] G(w)}{F(K^*) - r^* K^* - (1 + i) w + \kappa} G(w) & \text{if } w \geq cq^*
\end{array} \right.
\]

It can be checked that \(H\) is continuous and strictly increasing in \(w\). To ensure that \(\lambda_f\) is between 0 and 1, we check the upper bound of \(w\). Let \(\hat{w} \equiv \frac{F(K^*) - r^* K^* - \frac{\kappa [1 - \beta (1 - s)]}{\beta}}{1 + i}\).

It is the upper bound of \(w\) under which \(\lambda_f \in [0,1]\). The equilibrium \(w^e\) solves \(H(w^e) = \rho / (1 - \rho)\).

**Proposition 1** If \(H(\hat{w}) \geq \rho / (1 - \rho)\), there exists a unique equilibrium \(w\).

**Proof.** As \(H(0) = 0\) and \(H(\hat{w}) \geq \rho / (1 - \rho)\), there exists a solution to \(H(w) = \rho / (1 - \rho)\) by intermediate value theorem. Since \(H(w)\) is strictly increasing, the solution is unique. 

Notice that the denominator in the first term of \(H(\hat{w})\) is increasing in \(\kappa\). If \(\kappa = 0\), \(H(\hat{w}) = \infty\). Hence, if \(\kappa\) is sufficiently small, the solution exists.

**Corollary 1** There exists a \(\hat{\kappa}\) such that if \(\kappa < \hat{\kappa}\), there exists a unique equilibrium.
For comparative statics, we have the following proposition, proved in the Appendix.

**Proposition 2** As $i$ increases, $w$ decreases.

The intuition is as follows. Given $w$, an employed worker’s surplus in LM increases in $i$ because being unemployed becomes a worse option with higher $i$ as unemployed workers have to acquire all the cash in the CM and bear the higher inflation cost. This lowers the value of the threat point of the worker in the bargaining problem. Given $w$, a producing firm is worse off with higher $i$ because it has to bear higher inflation tax by acquiring cash to pay the worker in the CM. To maintain a constant share of the total surplus, $w$ has to fall.

The ex ante cost of wage can change in either direction. As $i$ goes up, the firm pays more inflation cost but the worker’s threat point falls. So the change in total surplus is ambiguous and the direction of $u$ depends on the parameters. Since the output per producing firm is constant, total output moves in the opposite direction to the unemployment.

We give a numeric example to show how the variables change in response to changes in $i$.

**Example 1** Utility functions and production functions are $v (q) = A_u q^\alpha$, where $A_u = 1.5$ and $\alpha = 0.6$; $F (K, L) = A_f K^\theta L^{1-\theta}$, where $A_f = 1$ and $\theta = 0.3$. The labor market matching function is $M (u, v) = A_m u^\rho v^{1-\rho}$, where $A_m = 0.35$ and $\rho = 0.7$. Other parameters are $\beta = 0.96$, $c = 1$, $\delta = 0.15$, $\kappa = 0.05$, $s = 0.05$, $\chi = 0$, and $\rho = 0.7$. Figure 1 shows the comparative statics. In this example, $u$ increases in $i$. The increase in inflation over weighs the saving on wage, so the firm’s surplus is smaller. Fewer firms post vacancies and the unemployment rate goes up.
3.2 Pledgeable Capital

In this section, we assume $\chi > 0$. From firm’s three regimes of equilibria, we have

$$\lambda_f = \begin{cases} 
\frac{\kappa [1 - \beta (1 - s)]}{\beta [F (K^*) - r^* K^* - w]} & \text{if } w \leq \chi (1 - \delta) K^* \\
\frac{\kappa [1 - \beta (1 - s)]}{\beta [F (w/ [\chi (1 - \delta)]) - r^* w/ [\chi (1 - \delta)] - w]} & \text{if } \chi (1 - \delta) K^* < w \leq \chi (1 - \delta) \bar{K} \\
\frac{\kappa [1 - \beta (1 - s)]}{\beta [F (K^*) - r^* K^* + i \chi (1 - \delta) \bar{K} - (1 + i) w]} & \text{if } w > \chi (1 - \delta) \bar{K}
\end{cases}$$

This implies that $\lambda_f$ and $\lambda_h$ are functions of $(w, K^f)$. We define the second term in the LHS of (15) as follows. Let $G_1 (w) \equiv \frac{1 - \beta (1 - \lambda_f (w, K^*))}{1 - \beta (1 - \lambda_h (w, K^*))}$, $G_2 (w) \equiv \frac{1 - \beta (1 - \lambda_f (w, w/ [\chi (1 - \delta)]))}{1 - \beta (1 - \lambda_h (w, w/ [\chi (1 - \delta)]))}$, and $G_3 (w) \equiv \frac{1 - \beta (1 - \lambda_f (w, K^*))}{1 - \beta (1 - \lambda_h (w, K^*))}$. It is straightforward that $\partial G_i / \partial w > 0$, $i = 1, 2, 3$.

There are three possible cases for $q_1$ and three cases for $K^f$. All together, there are nine cases. We prove that there exists a unique equilibrium. Define the three
branches of the LHS of (15) according to the value of $K$ as

$$
H_1(w) \equiv \begin{cases} 
\frac{(1+i)w}{F(K^*) - r^*K^*-w + \kappa} G_1(w) & \text{if } w < cq_i \\
v \left(\frac{w}{c}\right) - v(q_i) + (1+i) cq_i \cdot G_1(w) & \text{if } w \in [cq_i, cq^*) \\
w + v(q^*) - cq^* - [v(q_i) - (1+i) cq_i] \frac{G_1(w)}{F(K^*) - r^*K^*-w + \kappa} & \text{if } w \geq cq^* 
\end{cases} 
$$

(21)

$$
H_2(w) \equiv \begin{cases} 
\frac{(1+i)w}{F \left( \frac{w}{\chi(1-\delta)} \right) - r^* \frac{w}{\chi(1-\delta)} - w + \kappa} G_2(w) & \text{if } w < cq_i \\
v \left(\frac{w}{c}\right) - v(q_i) + (1+i) cq_i \frac{G_2(w)}{F \left( \frac{w}{\chi(1-\delta)} \right) - r^* \frac{w}{\chi(1-\delta)} - w + \kappa} & \text{if } w \in [cq_i, cq^*) \\
w + v(q^*) - cq^* - [v(q_i) - (1+i) cq_i] \frac{G_2(w)}{F \left( \frac{w}{\chi(1-\delta)} \right) - r^* \frac{w}{\chi(1-\delta)} - w + \kappa} & \text{if } w \geq cq^* 
\end{cases} 
$$

(22)

and

$$
H_3(w) \equiv \begin{cases} 
\frac{(1+i)w}{F(K) - r^*K - (1+i) w + \kappa + i\chi(1-\delta) K} G_3(w) & \text{if } w < cq_i \\
v \left(\frac{w}{c}\right) - v(q_i) + (1+i) cq_i \frac{G_3(w)}{F(K) - r^*K - (1+i) w + \kappa + i\chi(1-\delta) K} & \text{if } w \in [cq_i, cq^*) \\
w + v(q^*) - cq^* - [v(q_i) - (1+i) cq_i] \frac{G_3(w)}{F(K) - r^*K - (1+i) w + \kappa + i\chi(1-\delta) K} & \text{if } w \geq cq^* 
\end{cases} 
$$

(23)

Then

$$
H(w) \equiv \begin{cases} 
H_1(w) & \text{if } w \leq \chi(1-\delta) K^* \\
H_2(w) & \text{if } \chi(1-\delta) K^* \leq w < \chi(1-\delta) K \\
H_3(w) & \text{if } w \geq \chi(1-\delta) K 
\end{cases} 
$$

Note that $H_j, j = 1, 2, 3$, is continuous and increasing in $w$. So each branch of $H$ is increasing in $w$. Note that $H$ is also continuous. Therefore, $H$ is increasing on its domain.
To guarantee that $\lambda_f$ is between 0 and 1 in equilibrium, define three cutoffs of $w$ below which $\lambda_f$ is on $(0, 1)$ for three branches of $H$. Define cutoff $w_j$ in branch $j$ as follows.

$$w_1 = \frac{F(K^*) - r^*K^* - \kappa [1 - \beta (1 - s)]}{\beta}$$

$$w_2 = \frac{F(w_2/ [\chi (1 - \delta)]) - r^*w_2/ [\chi (1 - \delta)] - \kappa [1 - \beta (1 - s)]}{\beta}$$

$$w_3 = \frac{F(\bar{K}) - r^*\bar{K} + i\chi (1 - \delta) \bar{K} - \kappa [1 - \beta (1 - s)] / \beta}{1 + i}$$

and we narrow the domain on which $H(w)$ is defined properly:

First, $H_1$ is defined on $w \in [0, \min \{\chi (1 - \delta) K^*, w_1\}]$. If $w_1 < \chi (1 - \delta) K^*$, then we can check that $w_2$ does not exist on $w \in [\chi (1 - \delta) K^*, \chi (1 - \delta) \bar{K}]$, and $w_3$ does not exist on $w \geq \chi (1 - \delta) \bar{K}$. Similarly, if $w_1 \geq \chi (1 - \delta) K^*$, $H_2$ is defined on $[\chi (1 - \delta) K^*, \min \{\chi (1 - \delta) \bar{K}, w_2\}]$. If $w_2 < \chi (1 - \delta) \bar{K}$, then $w_3$ does not exist on $w \geq \chi (1 - \delta) \bar{K}$. Lastly, if $w_2 \geq \chi (1 - \delta) \bar{K}$, $H_3$ is defined on $[\chi (1 - \delta) \bar{K}, w_3]$. To summarize, the upper bound of the domain, denoted by $\hat{w}$, is
The equilibrium $w^*$ solves $H(w^*) = \rho/(1-\rho)$. We have the following existence and uniqueness proposition.

**Proposition 3** If $H(\hat{w}) > \rho/(1-\rho)$, there exists a unique equilibrium.

**Proof.** As $H(0) = 0$ and $H(\hat{w}) > \rho/(1-\rho)$, by intermediate value theorem, the solution exists. By monotonicity of $H$, the solution is unique. ■

Similar to Proposition 1, we the following corollary.

**Corollary 2** There exists a $\hat{\kappa}$ such that if $\kappa < \hat{\kappa}$, there exists a unique equilibrium.

**Proposition 4** Suppose the economy is in regime 1 when $i = 0$. As $i$ increases, the economy stays in regime 1, $w$ and $u$ decrease.

**Proposition 5** Suppose the economy is in regime 3 when $i = 0$. As $i$ increases, wage decreases, and the economy moves from regime 3 to 2 and may then to 1.

The intuition is similar to the case in which capital is non-pledgeable. When $i$ increases, worker’s threat point drops and the firm’s surplus falls if it uses cash (in regime 3), so $w$ has to increases to keep the shares of surplus constant.

As $w$ decreases, it is straight forward to see that $\lambda_f$ is decreasing in regimes 1 and 2, so is $u$. Intuitively, given $w$, increases in $i$ does not raise firm’s surplus in regimes 1 and 2, but it increases worker’s surplus as the threat point falls. So the total surplus increases and $w$ falls to restore the constant share of the surplus. As production is more profitable, more firms enter and the labor market condition is more favorable to the workers. Consequently, unemployment falls.

If the economy is in regime 3, the effect is ambiguous as $(1+i)w$ can go either way. Therefore, $u$ decreases in regimes 2 and 1, but is ambiguous in regime 3.

An increase in $i$ increases output in regime 1. Though each producing firm produces the same quantity, more firms are operating. In regime 3 and 2, the effect
is ambiguous. In regime 3, firms accumulate more capital as $i$ increases, so unit output increases. But the measure of producing firms can change in either way. In regime 2, unit output decreases as $K^f$ decreases, but more firms are producing.

**Example 2** Continue with example 1. Figures 3a-3c show the effects of $i$, holding $\chi = 0.02$, $\chi = 0.05$, and $\chi = 0.2$, respectively. For these parameter values, the economy lies in regime 3. Unemployment is strictly increasing at low $\chi$, becomes non monotone as $\chi$ gets bigger, and is strictly decreasing at $\chi = 0.2$.

![Figure 3a: Effects of $i$ ($\chi = 0.02$, regime 3, $du/di > 0$)](image)
If we increase \( \chi \) to 0.4, then the economy is in regime 3 for low inflation and switches to regime 2 for high inflation. Unemployment decreases with \( i \) in this case.
Figure 3d: Effects of $i$ ($\chi = 0.4$, regime 3 and 2, $du/di < 0$)

If we increase $\chi$ further to 0.5, the economy stays in regime 1 for all $i$. Though capital does not change and the economy stays in regime 1, wage drops as the worker’s threat point is lowered with higher $i$. Again unemployment decreases.

Figure 3e: Effects of $i$ ($\chi = 0.5$, regime 1, $du/di < 0$)

From these examples, we see that the Phillips curve is sensitive to credit con-
dition. Under good credit condition, the Phillips curve is upward sloping. Under tight credit condition, the slope of the Phillips curve is ambiguous, depending on the parameters.

Regarding the effects of capital pledgeability, we provide the following proposition, proved in the Appendix.

Proposition 6 As $\chi$ increases from 0, $w$ increases, $u$ decreases, and the economy moves from regime 3 to 2 to 1. If the economy is in regime 1, $w$ and $u$ remain constant as $\chi$ increases.

When $\chi$ increases from 0, firms overly accumulate capital and capital increases as it can save more on cash. As $\chi$ increases further, firms no longer need money and the economy moves to regime 2. In regime 2, as capital becomes more pledgeable, firms do not need much capital to pledge for wage. As $\chi$ increases even further, the economy moves to regime 1. Capital alone is sufficient enough to pay the workers and firms do not need to overly accumulate capital.

Given $w$, changes in $\chi$ do not affect worker’s surplus. It increases firm’s surplus in regime 3 as capital can save more cash; it increases firm’s surplus in regime 2 as the firm decreases capital and improves efficiency. Therefore, the total surplus increases and $w$ has to increase to rebalance the shares of surplus. In regime 1, firm’s liquidity constraint does not bind. An increases in pledgeability does not affect firm’s surplus, and wage remains constant.

As $\chi$ increases from 0, capital per firm first increases from $K^*$ (regime 3), then decreases (in regime 2), and finally becomes constant at $K^*$. As unemployment decreases, total output rises in regime 3, may rise or fall in regime 2, and rises in regime 1.

Example 3 We continue with Example 1. We fix $i$ at 0.05, and vary $\chi$. The economy switches regimes where the kinks present.
4 Extension

To compare our results with Berentsen et al. (2011), we consider search friction in the DM. A worker meets a firm with probability $\sigma_h = N(1, 1 - u)$ and a firm meets a worker with probability $\sigma_f = N(\frac{1}{1-u}, 1)$, where $N$ is the matching function in the DM. The DM terms of trade are determined by Kalai bargaining, and the worker’s bargaining power is $\pi$. Let $g(q) = (1 - \pi)u(q) + \pi c(q)$, which is the buyer’s payment in Kalai bargaining. Worker’s DM value function is

$$V_j(\hat{m}^h_j, \omega) = \max_q \{\sigma_h[v(q_j) - g(q_j)] + W_j(\hat{m}^h_j, \omega)\}$$

s.t. $g(q_j) \leq \hat{\phi}\hat{m}^h_j + \omega$

Unemployed workers choose $q_0 = q_i$, where $q_i$ solves $v'(q_i)/g'(q_i) = 1 + i/\sigma_h$, and $m_0^h = g(q_i)$. For unemployed workers, if $w \geq g(q^*)$, $q_1 = q^*$ and $m_1^h = 0$. If $g(q_i) \leq w < g(q^*)$, $q_1 = g^{-1}(w)$ and $m_1^h = 0$. If $w < g(q_i)$, $q_1 = q_i$ and
\[ m^h_i = g(q_i) - w. \]

Worker’s surplus in the LM is

\[ W^h_1(0, 0) - W^h_0(0, 0) = \frac{\beta \{ w + \sigma_h[v(q_1) - g(q_1)] - i \phi m^h_i - \sigma_h [v(q_i) - (1 + i/\sigma_h) g(q_i)] \}}{1 - \beta (1 - s - \lambda^h)} \]  

(24)

The firm’s expected profit in the DM is

\[ A \equiv \sigma_f \{(1 - u)[v(q_1) - g(q_1)] + u[v(q_i) - g(q_i)]\}. \]

Its DM value function is

\[ V^f_j(\bar{m}^f, \bar{K}, y) = A + W^f_j(\bar{m}^f, \bar{K}, y) \]

As in the baseline model, there are three cases regarding firms choice of money and capital. The conditions for each of the cases are the same as in the baseline model. Firm’s surplus in the LM is

\[ W^f_1(0, 0, 0) - W^f_0(0, 0, 0) = \frac{\beta [F(K^f) - r^*K^f - w + A + \kappa - i \phi m^f]}{1 - \beta (1 - s - \lambda^f)} \]

The equilibrium \( w \) solves

\[ \frac{w + \sigma_h [v(q_1) - g(q_1)] - i \phi m_1 - \sigma_h [v(q_i) - (1 + i/\sigma_h) g(q_i)]}{F(K^f) - r^*K^f - w + A + \kappa - i \phi m^f} \frac{1 - \beta (1 - s - \lambda_f)}{1 - \beta (1 - s - \lambda_h)} = \frac{\rho}{1 - \rho} \]

where,

\[ \lambda_f = \frac{\kappa [1 - \beta (1 - s)]}{\beta [F(K^f) - r^*K^f - w + A - i \phi m^f]} \]

and \( \lambda_h \) and \( u \) are determined by the LM matching function and steady state condition as in the baseline model. It can be shown that if \( \kappa \) is sufficiently small, equilibrium exists. There may exist multiple equilibria as in Berentsen et al. (2011), as the unemployment rate changes worker and firm’s matching probabilities in the DM and the surplus may change in either direction.

We continue to use numeric example to illustrate the relationship between credit condition and the Phillips curve under Kalai bargaining. In Appendix 2, we graph how the various variables against the nominal interest rate and capital pledgeability using the same parameters as used in figures 1, 3a – e and 4. All of our main results seem to hold under Kalai bargaining.
5 Conclusion

We provide a search theoretical model to study how firm’s credit condition affects labor market performance and the effectiveness of the monetary policy on combating unemployment. The improvement in the credit condition reduces unemployment given a monetary policy. However, the slope of the Phillips curve is ambiguous and is sensitive to the credit condition. The findings imply that a combination of expansionary monetary and credit policy may be able to achieve higher employment under some circumstances, but not others.

Obviously, other features of credit, labor and goods markets, such as search frictions, tax and unemployment benefit, etc., can matter for the results. Even though our results cannot match all the empirical evidence, we provide a model to sort out the channels through which capital pledgeability affects the macroeconomic variables. Our future research will focus on the empirical side and establish quantitatively the importance of the capital pledgeability.
Appendix 1

Proof of Proposition 2 In each branch of $H$, $H(w;i') \geq H(w;i)$ for $i' > i$, where the equality is strict when $w > 0$. When $i$ increases, $q_i$ decreases, so for $cq_i \leq w < cq_i$, $w$ is in the first branch of $H(w;i)$ and the second branch of $H(w;i')$. Note that for $\hat{i}$ such that $cq_{\hat{i}} = w$,

$$u(w/c) - u(q_{\hat{i}}) + (1 + i) cq_{\hat{i}} = (1 + i) w > (1 + i) w$$

For $i' > i$, note that

$$u(w/c) - u(q_{i'}) + (1 + i') cq_{i'} > (1 + i) w > (1 + i) w$$

as DM trade surplus for the cash-only buyers, $u(q_{i}) - (1 + i) cq_{i}$, is decreasing in $i$. Therefore, for $w \in [cq_{i'}, cq_{i}]$, $H(w;i') > H(w;i)$. This implies that $H$ rotates counter clockwise around 0 when $i$ increases. It follows that $w$ decreases.

Proof of Proposition 4 At $i = 0$, the firm is in regime 1, which implies $H_1(\chi(1-\delta) K^*;i) > \rho/(1-\rho)$. Increasing $i$ to $i'$ rotates $H_1$ counter clockwise, and $H_1(\chi(1-\delta) K^*;i') > H_1(\chi(1-\delta) K^*;i)$). Therefore there exists a solution $w$ on $[0,\chi(1-\delta) K^*)$, and $w$ decreases as $H_1$ rotates up. It can be checked from $\lambda_f$ that $\lambda_f$ decreases in $w$. So $u$ decreases.

Proof of Proposition 5 We will show that an increase in $i$ rotates $H$ function counter clockwise and $H(w;i') \geq H(w;i)$ for $i' > i$, where the inequality is strict if $w > 0$. As there are potentially nine cases of where $w$ fits in the domain of $H$, we will discuss by case. Two things change when $i$ goes up: $q_i$ goes down and $K$ goes up. It is easy to see that if $w$ is in the same branch of $H$, $H(w;i') > H(w;i)$. We check the situation where $w$ moves to a different branch after $i$ increases. The following is the possible cases. We do not discuss $G$ explicitly in the proof it always moves in the same direction of the first term of $H$.

(I) $w \leq \chi(1-\delta) K^*$. In this case, $w$ is in different branches of $H_1$ before and after an increase in $i$ iff $w < aq_i$ and $w \in [aq_{i'},aq^*]$. Suppose $\hat{i}$ is such that $aq_{\hat{i}} = w$, then $u(w/a) - [u(q_{\hat{i}}) - (1 + \hat{i})aq_{\hat{i}}] > (1 + i) w$, which implies $H_1(aq_{\hat{i}};\hat{i}) > H(aq_{\hat{i}};i)$. 

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If \( i' > i \), \( u(q_{i'}) - (1 + i') \, aq_{i'} < u(q_i) - (1 + i) \, aq_i \), so \( H_1(w; i') > H_1(w; i) \) for \( w \in [aq_{i'}, aq^*] \).

(II) \( \chi (1 - \delta) K^* < w \leq \chi (1 - \delta) \bar{K} \). In this case, \( w \) is in different branches of \( H_2 \) before and after an increase in \( i \) iff \( w < aq_i \) and \( w \in [aq_{i'}, aq^*] \). The proof is the same as in (I).

(III) \( w > \chi (1 - \delta) \bar{K} \). Possible cases are (i) \( w > \chi (1 - \delta) \bar{K}' \), \( w < aq_i \) and \( w \in [aq_{i'}, aq^*] \). Then \( w \) are in different branches of \( H_3 \) before and after the increase in \( i \). The proof is the same as in (I). (ii) \( w \leq \chi (1 - \delta) \bar{K}' \). We compare \( H_3 \) at \( i \) and \( H_2 \) at \( i' \). Note first that numerators in \( H_2 \) are greater than that in \( H_3 \) given \( w \) as \( i' > i \). Also note that the denominators in \( H_2 \) and \( H_3 \) are the same at \( w = \chi (1 - \delta) \bar{K} \).

As \( w \) increases above \( \chi (1 - \delta) \bar{K} \), \( d \left[ F \left( \frac{w}{\chi (1 - \delta)} \right) - r^* \left( \frac{w}{\chi (1 - \delta)} \right) - w \right] / dw < - (1 + i) \), whereas \( d \left[ F \left( \bar{K} \right) - r^* \bar{K} - (1 + i) w - i \chi (1 - \delta) \bar{K} \right] / dw = -(1 + i) \). So \( H_2 \) is above \( H_3 \) for \( w > \chi (1 - \delta) \bar{K} \). If \( w < aq_{i'} < aq_i \), we compare the first branch of \( H_3 \) at \( i \) with the first branch of \( H_2 \) at \( i' \). As the denominators in \( H_2 \) is smaller and the numerator is bigger, \( H_2(w; i') > H_3(w; i) \). Similar argument applies to the cases in which \( w > aq_i \). If \( aq_i < w < aq_i \), we compare the second branch of \( H_2 \) at \( i' \) with the first branch of \( H_3 \) at \( i \). By the same argument in (I), the numerator of \( H_2 \) is bigger. As the denominator is smaller, again we have \( H_2(w; i') > H_3(w; i) \).

In all cases, \( H \) rotates counter clockwise when \( i \) increases. It follows immediately that \( w \) decreases as \( i \) increases. As \( \bar{K} \) increases in \( i \) and \( w \) decreases in \( i \), the economy moves from regime 3 to 2 if solution exists. It may move to regime 1 if \( H_1(\chi (1 - \delta) K^*) > \rho / (1 - \rho) \) for some \( i \). But this may fail as \( H_1(\chi (1 - \delta) K^*) \) is bounded above by \( \frac{\chi (1 - \delta) K^* + u(q^*) - cq^*}{F(K^*) - r^* K^* - \chi (1 - \delta) K^* + \kappa} G_1(\chi (1 - \delta) K^*) \) if \( cq^* \geq \chi (1 - \delta) K^* \) and by \( \frac{u(\chi (1 - \delta) K^*)}{F(K^*) - r^* K^* - \chi (1 - \delta) K^* + \kappa} G_1(\chi (1 - \delta) K^*) \) if \( cq^* < \chi (1 - \delta) K^* \). This upper bound may below \( \rho / (1 - \rho) \) and there is no fixed point for \( w \).

**Proof of Proposition 6** First note that \( H_2 > H_1 \) for \( w > \chi (1 - \delta) K^* \) and \( H_2 > H_3 \) for \( w > \chi (1 - \delta) \bar{K} \). Also, \( H_2 \) and \( H_3 \) are decreasing in \( \chi \) for \( w > \chi (1 - \delta) K^* \). When \( \chi \) increases to \( \chi' \), \( H \) does not change for \( w \in [0, \chi (1 - \delta) K^*] \). It stays in regime 1 for \( w \in [\chi (1 - \delta) K^*, \chi' (1 - \delta) K^*] \), which is below the original \( H_2 \).
For \( w \in (\chi' (1 - \delta) K^*, \chi (1 - \delta) \bar{K}] \), it is in regime 2, which is below the original \( H_2 \). For \( w > \chi' (1 - \delta) \bar{K}' \), the economy is in regime 3 and \( H_3 (w; \chi') < H_3 (w; \chi) \).

To show that \( H (w; \chi') < H (w; \chi) \) for \( w \in (\chi (1 - \delta) \bar{K}, \chi' (1 - \delta) \bar{K}'] \), we prove that \( H (w; \chi') \) and \( H (w; \chi) \) do not cross each other on \( (\chi (1 - \delta) \bar{K}, \chi' (1 - \delta) \bar{K}'] \).

Suppose instead they cross. This means \( H_2 (w; \chi') \) has to decrease at some point as \( H_2(\chi (1 - \delta) \bar{K}; \chi') < H_3 (\chi (1 - \delta) \bar{K}; \chi) \) and \( H_2 (\chi' (1 - \delta) \bar{K}'; \chi') < H_3 (\chi' (1 - \delta) \bar{K}'; \chi) \).

But this contradicts the fact that \( H_2 \) is increasing in \( w \). Hence, as \( \chi \) increases, \( H \) rotates down at \( w = \chi (1 - \delta) K^* \). it follows that the fixed point of \( w \) increases and moves from regime 3 to 2 and to 1. Once it is in regime 1, \( \chi \) does not matter and \( w \) becomes a constant.

As \( w \) increases, it is easy to see from \( H \) function that the numerator of the first term increases, which implies the denominator must also increase, so does \( \lambda_f \). Consequently, the unemployment falls. \( \blacksquare \)

Appendix 2

In the Appendix, we show how the variables are affected by inflation and capital pledgeability when the DM trading protocol follows pairwise meetings and Kalai Bargaining. In each graph, there are two lines: the solid lines represent price taking, and the dashed line represents Kalai bargaining. We use the same parameter values in figures 1, 3a – e and 4. The matching function in the DM is given by \( \mathcal{N}(B, S) = 1.5BS/(B + S) \). The buyer’s bargaining power is \( \pi = 0.6 \).
Figure 1k: $\chi = 0$, Kalai

Figure 3a-k: $\chi = 0.02$, Kalai
Figure 3b-k: $\chi = 0.05$, Kalai

Figure 3c-k: $\chi = 0.2$, Kalai
Figure 3d-k: $\chi = 0.4$, Kalai

Figure 3e-k: $\chi = 0.5$, Kalai
Figure 4-k: Effect of $\chi$, Kalai
References


