Unemployment and Gross Credit Flows in a New Keynesian Framework

David Florian Hoyle[1] Johanna L. Francis[2]

[1]Central Reserve Bank of Peru

[2]Fordham University

Seventh BIS CCA Research Conference
20 May 2016

The views expressed in this paper are those of the authors and do not reflect necessarily the position of the Central Reserve Bank of Peru

Main idea of the paper

- Bank lending has been usually described (studied) in terms of net lending.
- Recent empirical evidence using U.S disaggregated bank-level data by **Contessi and Francis** (2011 and 2013), **Craig and Haubrich** (2006) **Dell'ariccia and Garibaldi** (2005) and **Herrera, Kolar and Minetti** (2011) suggest that sizable gross credit flows coexist at the business cycle frequency.
- Emphasizes the existence of heterogeneous patterns of credit creation, contraction and reallocation at various phases of the business cycle.

Main idea of the paper

- For example, Dell'ariccia and Garibaldi (2005) find that in the United States, gross credit flows are by an order of magnitude more volatile than GDP and investment.
- Reallocation of credit is intense, volatile and has specific business cycle properties.

Main idea of the paper

- In this paper:
  - Model bank lending and gross credit flows as a search and matching friction in an otherwise standard NKM with unemployment.
  - The main propagation mechanism of a financial crisis is through endogenous variation of TFP.
  - Joint dynamics of credit flows, job flows and labor market variables such as unemployment, employment and labor force.

Main idea of the paper

- The main approach of the paper is that lenders and borrowers form **long term relationships**.
- Banking relationships are persistent.
  1. Borrowers do not switch lenders costlessly.
  2. After a credit contract/banking relationship is broken or expires,both parties have to expend time and resources searching for a new partner.

Main idea of the paper

- Our approach focuses on **significant heterogeneity observed in lending across banks** at any phase of the business cycle.
  1. Simultaneous increases and decreases in lending across banks at any point in time.
     - ⋆ Leading to heterogeneous patterns of credit creation and contraction among banks as well as reallocation of credit between firms .
  2. Gross lending flows (credit creation, destruction and reallocation rates) present significant variation.

Main idea of the paper

- Finally, **firm heterogeneity** plays a role in shaping the duration of credit relationships.
  1. Firms have projects that differ in its **productivity**.
  2. Some firms will be able to obtain funding to undertake its project.
  3. In the aggregate, the measure of active credit relationships affects TFP.

Model overview

- We use standard New Keynesian DSGE model with wage and price frictions able to account for movements in GDP, unemployment, and inflation over the business cycle
- Unemployment is generated due to the interaction of sticky wages and a labor market participation condition (Gali 2011)
- Labor is indivisible: A household member works a fixed number of hours or does not work at all.
- Each HH has a continuum of members. Each member is represented by the unit square and indexed by $(i, j) \in (0, 1)^2$.
- i denotes the labor service that HH member is specialized.
- j denotes the dis-utility from work for each HH member: $j^{\overline{\varphi}}$ if employed and zero otherwise.

Model overview

- Participation condition: An individual specialized in type "i" labor will be willing to work in period t if and only if

$$\frac{W_t(i)}{P_t} \geq \frac{\chi_t j^{\overline{\varphi}}}{\lambda_t} = (1+i_t) C_t \chi_t j^{\overline{\varphi}} \tag{1}$$

- Let $L_t(i)$ be the marginal supplier of type i labor. The marginal supplier of type i labor satisfies the following condition

$$\frac{W_t(i)}{P_t} = (1+i_t)\, C_t \chi_t \left(L_t(i)\right)^{\overline{\varphi}} \tag{2}$$

- The labor force is obtained by integrating over all the marginal suppliers, $L_t = \int_0^1 L_t(i)di$.

Model overview

- Two sectors: Final goods and intermediate goods.
  - Firms in the final good sector are subject to price stickiness.
  - Firms in the intermediate good sector have a working capital constraint and face idiosyncratic productivity.

Model overview

- Add a financial/banking sector characterized by search and matching frictions
- Firms must borrow from banks to produce: Firms have to be matched with a bank and hold an active loan contract
- Bank-firm relationships may be broken conditional on firms' idiosyncratic productivity draw (endogenous separation)
- Bank-firm relationships are also subject to exogenous breaks in the match (our financial shock).

Model overview

- The bank-firm relationship generates a surplus to be shared between matched lenders and borrowers.
- Upon a successful match, bilateral Nash bargaining between the parties determines the firm's employment level and the loan interest rate–this is means to share match surplus.
- Banks enter the loan market to search for potential borrowers until the expected cost of extending a loan is equal to its expected benefit.
- Some banks may not end up with loans in their portfolio.
  - Deposit funds with the central bank as excess reserves and receive an interest rate equal to interest rate on deposits.
  - Results in negative profits for bank due to search costs.
  - Transferred to the household at the end of the period.

Model overview

- All uncertainty is revealed before loans are extended:
  - Loans are made and paid back during the same period.
  - Loans are not risky as there is also no default probability.
  - Extension: Possibility of absconding and credit rationing.
- Banks can only form a credit relationship with one firm.

A decentralized loan market

- Matching function:

$$m_t = \mu f_t^{\nu} (b_t^u)^{1-\nu}$$

- Credit market tightness

$$\tau_t = \frac{f_t}{b_t^u} = \frac{p_t^b}{p_t^f}$$

A decentralized loan market

- If an intermediate good producer is matched with a bank, it is endowed with the following technology:

$$y_t\left(\omega_{z,t}\right) = \xi^{pf} A_t \omega_{z,t} N_t\left(\omega_{z,t}\right)^{\alpha}$$

where

  - ξ^{pf} is a scale technology parameter that serve for calibration purposes.
  - A_t is the aggregate productivity level.
  - $\omega_{z,t}$ is a firm-specific idiosyncratic productivity level drawn from a distribution function $G(\omega)$ with support $[\underline{\omega}\ \bar{\omega}]$.
  - $N_t\left(\omega_{z,t}\right)$ is the firm's employment index.

A decentralized loan market

- Optimal reservation policy with respect to $\omega_{z,t}$ is denoted by $\tilde{\omega}_t$.
- The equation for $\tilde{\omega}_t$ is derived by setting the joint surplus of a credit relationship to zero.
- The overall continuation rate of a credit relationship defined to be:

$$\varphi_t\left(\tilde{\omega}_t\right) = (1-\delta_t)(1-\gamma_t\left(\tilde{\omega}_t\right))$$

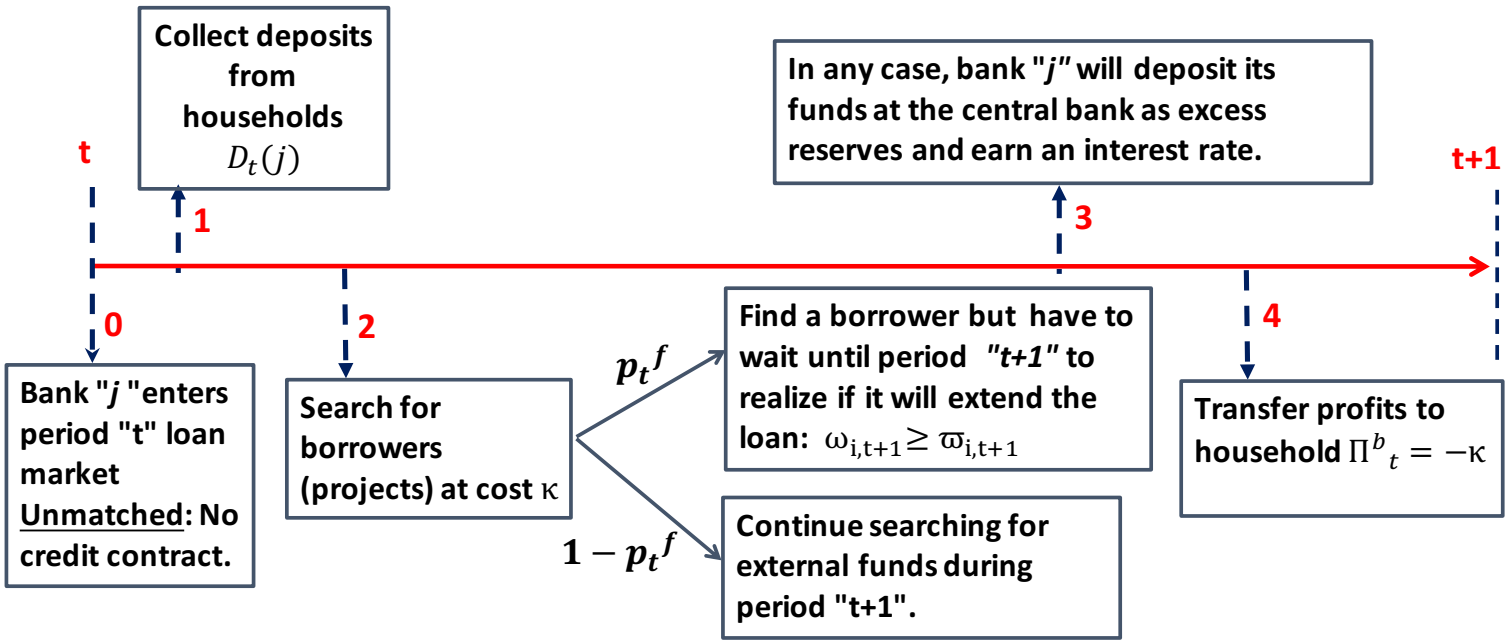
A decentralized loan market

- **Balance sheet:**

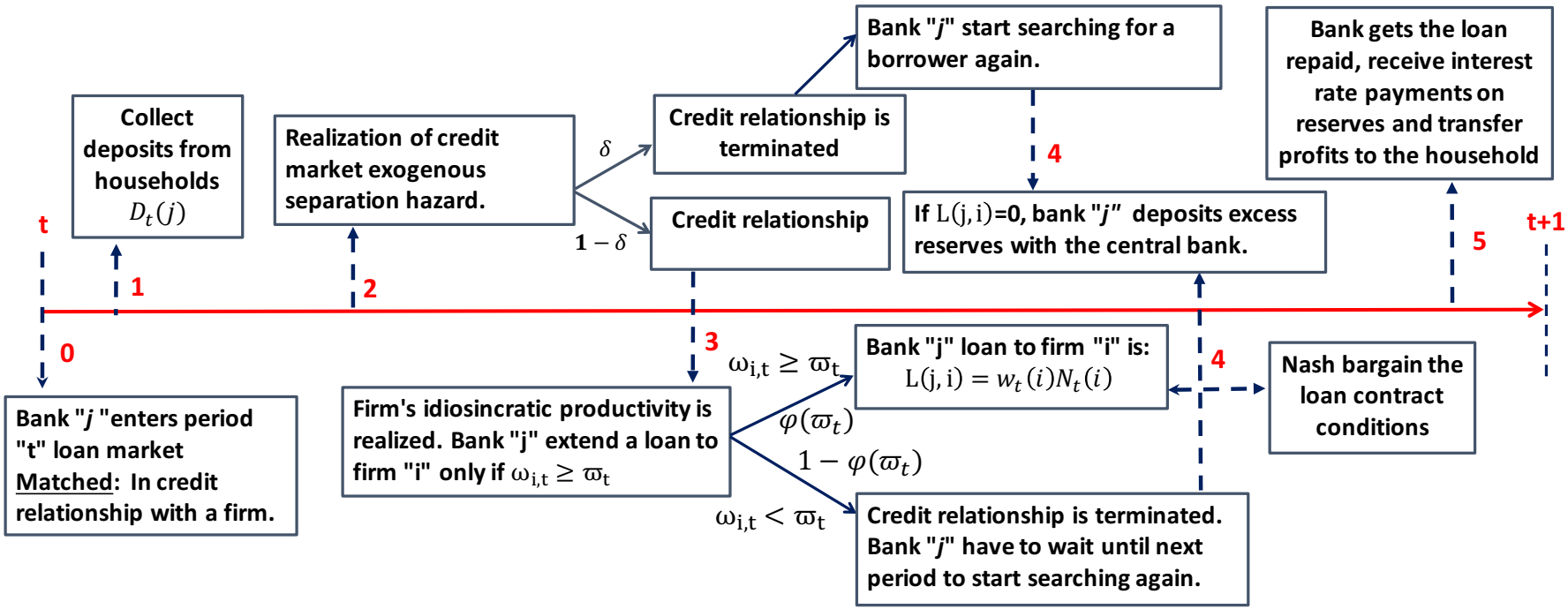
$$\chi_t(j)\, l_t(j, \omega_{z,t}) + (1 - \chi_t(j))\, \frac{ER_t(j)}{P_t} = \frac{D_t(j)}{P_t}$$

- Where $\chi_t(j)$ is an indicator function taking "**1**" if bank j extends a loan to firm z and "**0**" otherwise.

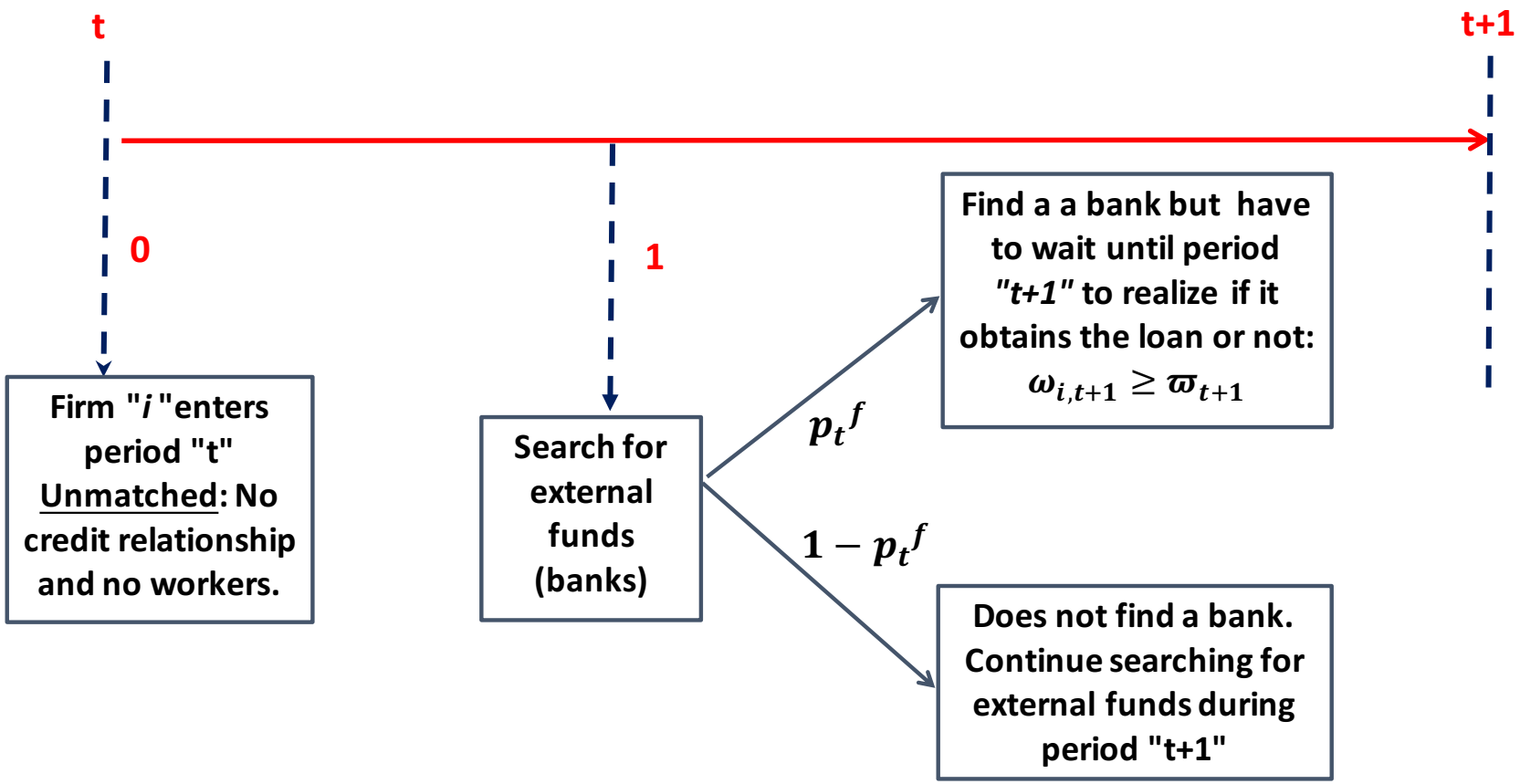
Banks Time Line: Unmatched



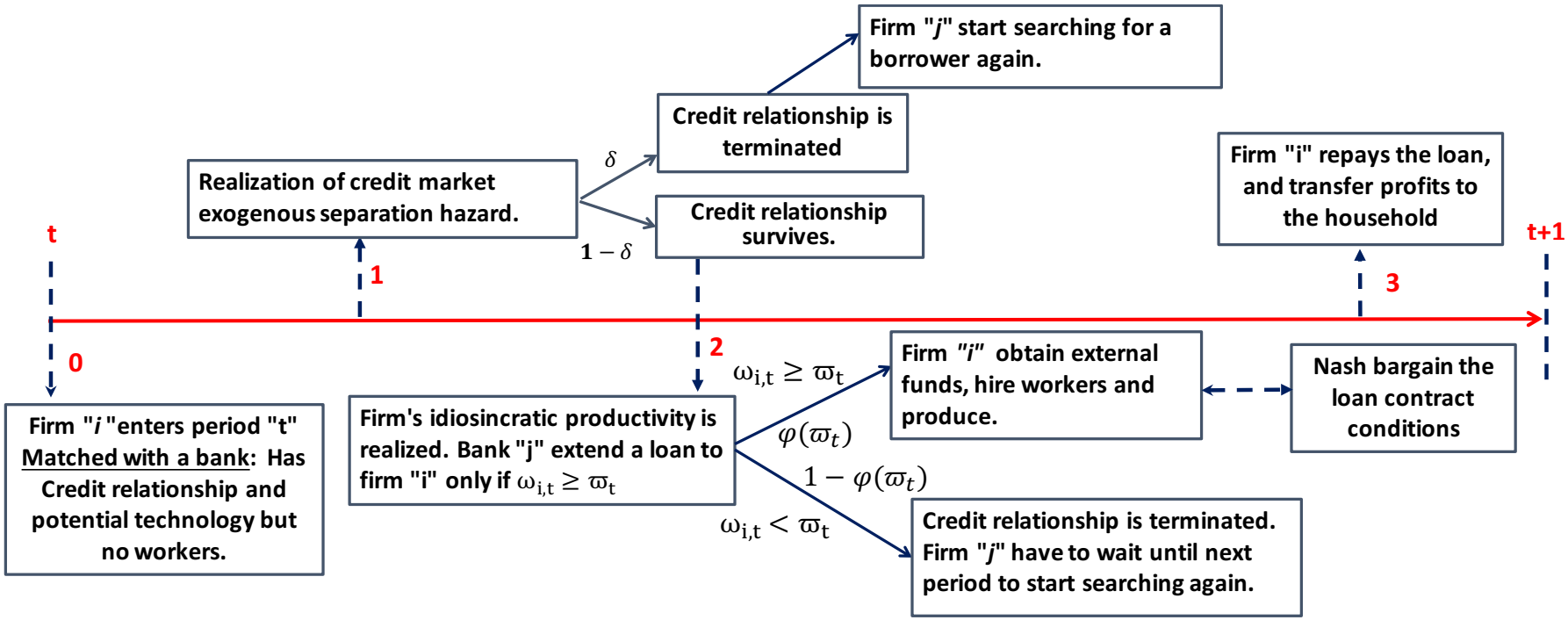
Banks Time Line: Matched



Firms Time Line: Unmatched



Firms Time Line: Matched



Model implications

- The credit contract is obtained via Nash bargaining
- It is characterized by:
  - Optimal hiring rule:

$$\alpha \xi^{pf} A_t \omega_{z,t} N_t^* \left(\omega_t\right)^{\alpha-1} = \mu_t^p w_t R_t, \ \forall \omega_{z,t} > \tilde{\omega}_{z,t}$$

  - Where R_t is the outside opportunity cost of the bank.
  - Loan interest rate:

$$R_t^l\left(j, \omega_{z,t}\right) = \frac{1}{l_t^*\left(j, \omega_{z,t}\right)} \left(\begin{array}{c} (1-\overline{\eta}) \left(\frac{y_t^*(\omega_{z,t}) - x^f}{\mu_t^p} \right) \\ +\overline{\eta} \left(R_t w_t N_t^*(\omega_{z,t}) - \frac{\kappa p_t^f}{\mu_t^p p_t^b} \right) \end{array} \right)$$

  - Where $\overline{\eta}$ is firm's share of the joint surplus (Nash bargaining parameter).

Model implications

- Optimal reservation policy with respect to the idiosyncratic productivity shock:

$$\begin{aligned} \textit{if} \quad & \omega_{i,t} \leq \tilde{\omega}_t \quad \Longrightarrow V_t^{JS}(\omega_{i,t}) \leq 0 \\ \textit{if} \quad & \omega_{i,t} > \tilde{\omega}_t \quad \Longrightarrow V_t^{JS}(\omega_{i,t}) > 0. \end{aligned}$$

- Since the joint surplus is increasing in the firm's idiosyncratic productivity, there exists a unique threshold level $\tilde{\omega}_t$:

$$V_t^{JS}(\tilde{\omega}_t) = 0$$

$$\widetilde{\omega}_t = \left(\frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \frac{\left(\mu_t^p w_t R_t\right)^{\alpha}}{\xi^{pf} A_t} \right) \left[x^f - \left(\frac{1-\overline{\eta} p_t^f}{1-\overline{\eta}} \right) \frac{\kappa}{p_t^b} \right]^{1-\alpha}$$

Model implications

- Production per active firm:

$$y_t^*(\omega_{z,t}) = \left(\xi^{pf} A_t \omega_{z,t}\right)^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{\mu_t^p w_t R_t}\right)^{\frac{\alpha}{1-\alpha}}$$

- Therefore, we can obtain cross-sectional distribution of firms
- And compute gross job flows

Model implications

- We generate a credit **inefficiency wedge** which we can observe in the aggregated output of intermediate good market:

$$Y_t^I = \xi^{pf} A_t F_t^{1-\alpha} \left(\frac{N_t}{\Delta_t^w} \right)^{\alpha} \tag{3}$$

- Wedge is F_t: endogenous component of technology dependent on credit market conditions and the reservation productivity level:

$$F_t = (1-\delta) \left(\frac{(\overline{\omega})^k - (\widetilde{\omega}_t)^k}{k\,(\overline{\omega} - \underline{\omega})} \right) f_{t-1}^m$$

- where $k = \frac{2-\alpha}{1-\alpha}$
- TFP is defined by: $\dfrac{\xi^{pf} A_t F_t^{1-\alpha}}{(\Delta_t^w)^{\alpha}}$

Model implications

- In the absence of credit market frictions, $F_t = 1$

$$Y_t^I = \xi^{pf} A_t \left(\frac{N_t}{\Delta_t^w} \right)^{\alpha} \tag{4}$$

- Remaining inefficiency after aggregation is due to wage rigidities
- Credit frictions impacts both the intensive and extensive margins of employment by impacting the number of firms producing and the productivity of the firms producing

Calibration

Calibrated parameters from data and literature

Parameter	Description	Value
β	Discount rate	0.99
A	Baseline Technology	1.0
$[\underline{\omega}, \overline{\omega}]$	Support for idiosyncratic productivity	[0,1]
θ_p	Calvo parameter for price setting	0.75
θ_w	Calvo parameter for wage setting	0.75
ϵ_p	Elasticity of substitution among final goods	9.0
$\overline{\varphi}$	Inverse of Frisch Elasticity	5
$\overline{\eta}$	**Firm's Nash bargaining share**	0.3
ν	Matching function elasticity	0.7

Table: Parameters taken from the data and conventional values from the literature

Calibration

Steady-state targets

Parameter	Description	Value
U	Unemployment rate	0.05
N	Employment	0.59
Y^f	GDP	1
$\varphi(\tilde{\omega})$	**Overall continuation rate**	0.7
cd	**Credit destruction rate**	0.029
$\frac{\varphi(\tilde{\omega})f^m x^f}{Y^f}$	Fixed cost share of GDP	0.35
$\frac{wN}{Y^f}$	Labor share of GDP	$2/3$
$\frac{l}{d}$	Loan to deposits ratio	0.63
$\frac{er}{d}$	Excess reserves to deposits ratio	0.015

Table: Steady state targets

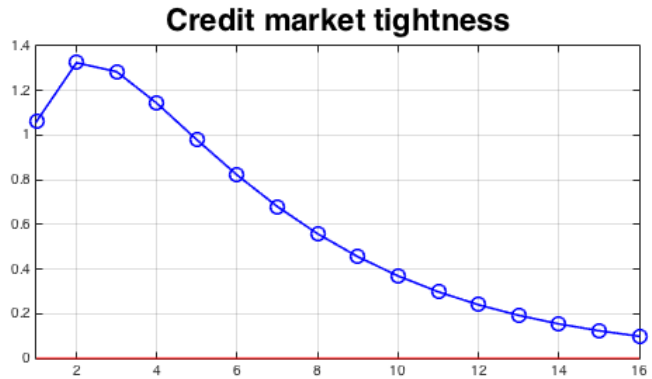
Calibration

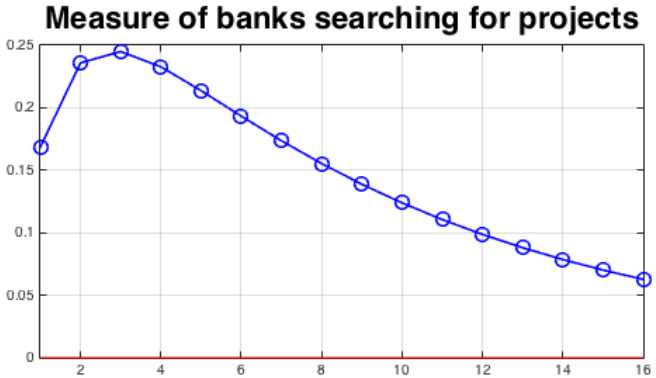
Calibrated parameters consistent with targets

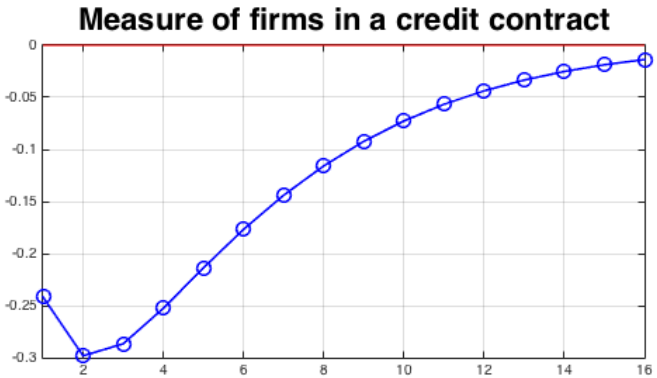
Parameter	Description	Value
κ	Bank's search costs	0.6697
μ	Matching function scale parameter	1.0564
δ	Exogenous probability of separation	0.2029
ξ^{pf}	Production function scale parameter	3.9482
α	Labor elasticity of production function	0.51
ξ^{bs}	Residual term on aggregate bank's balance sheet	0.3550
x^f	Fixed cost of production	0.5556
χ	Preference parameter for dis-utility of labor	12.2297
ϵ_w	Elasticity of substitution among labor types	4.4205

Table: Steady state targets

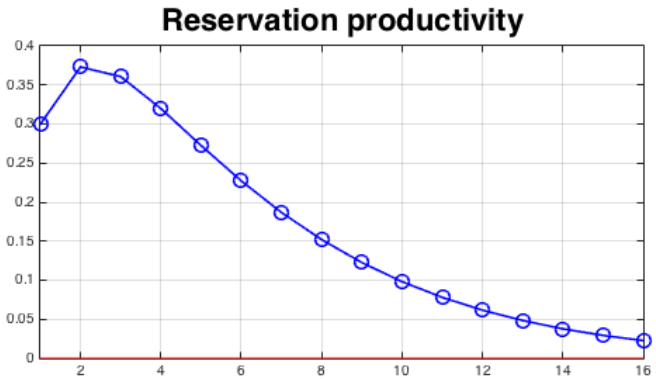
Financial shock

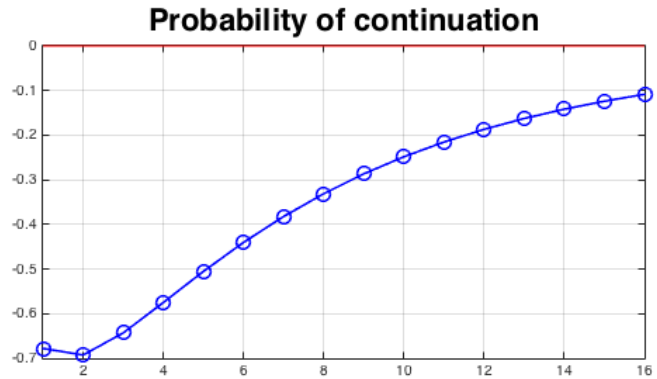


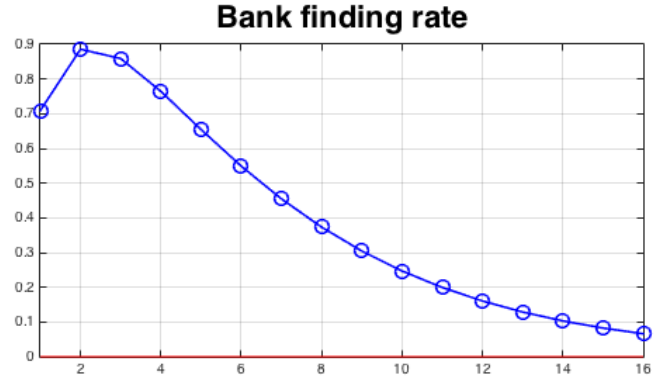


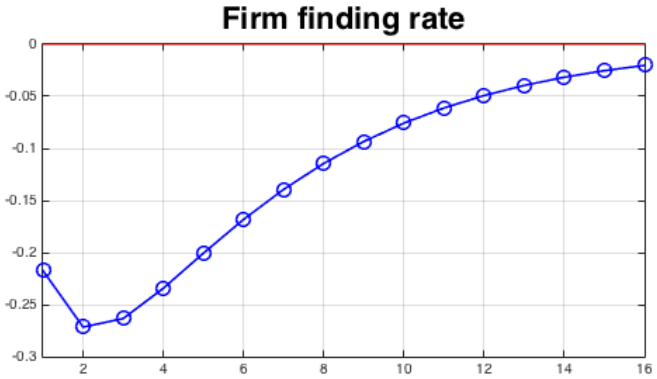


Financial shock

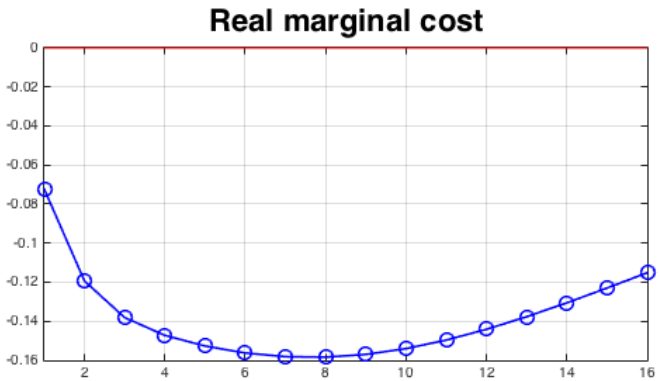


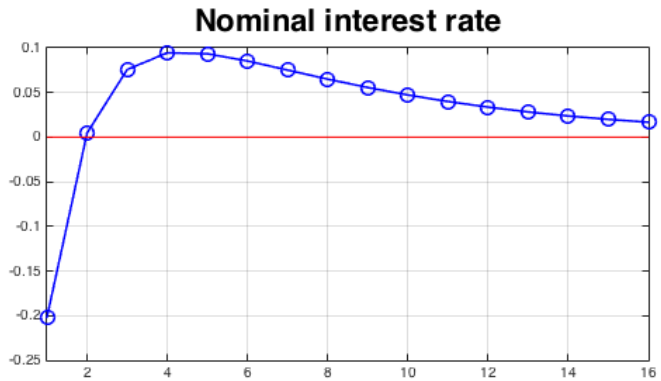


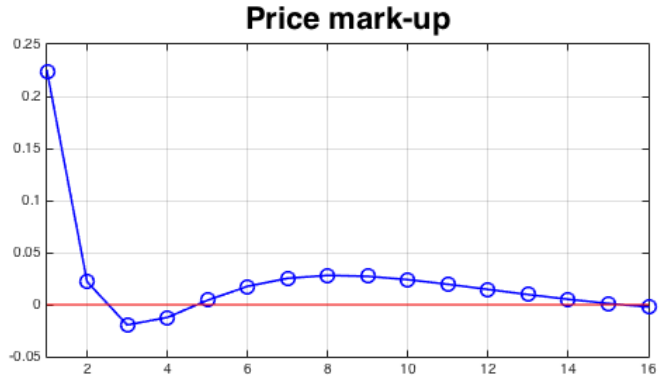




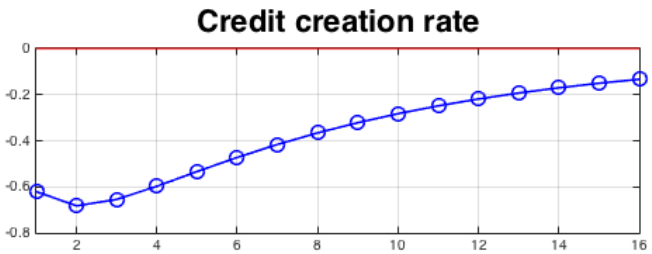
Financial shock

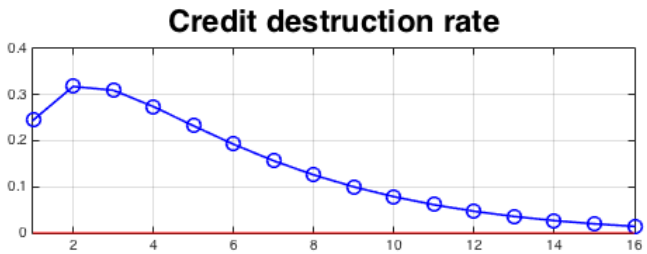


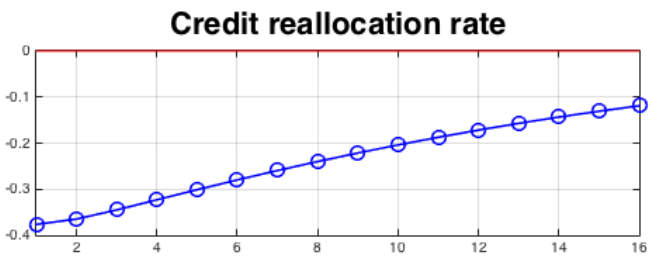


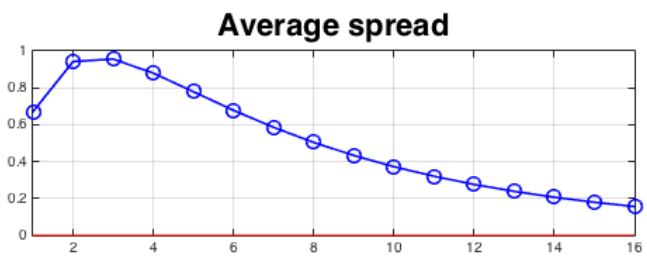


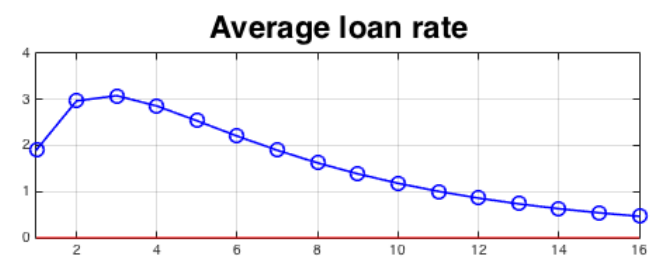
Financial shock



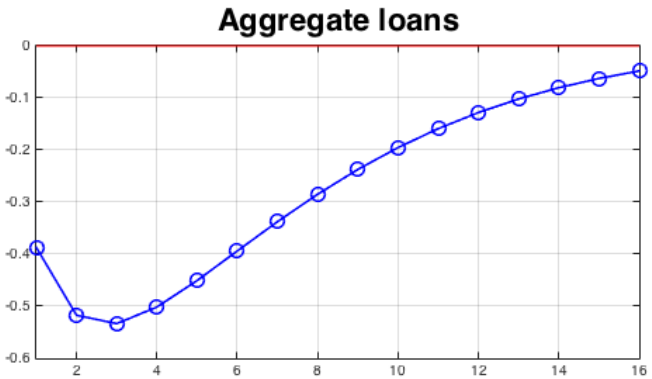


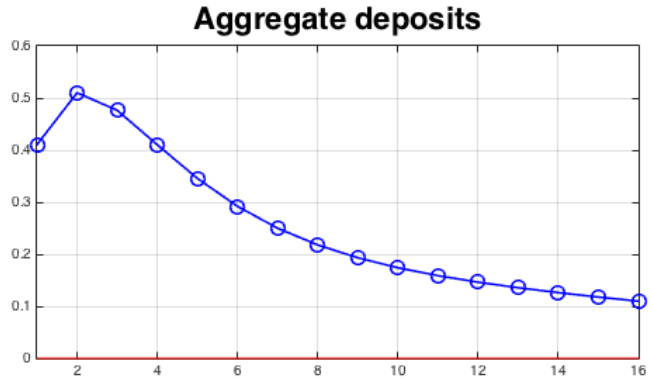


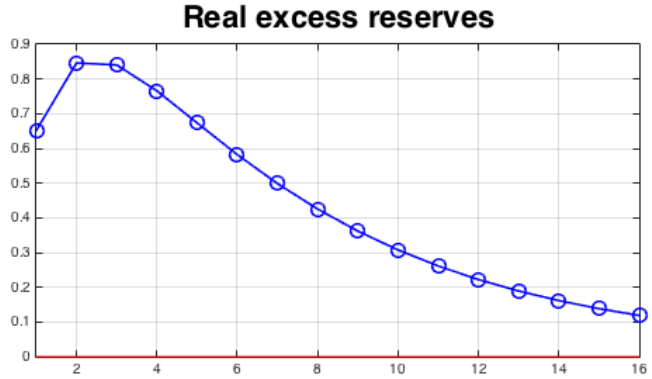


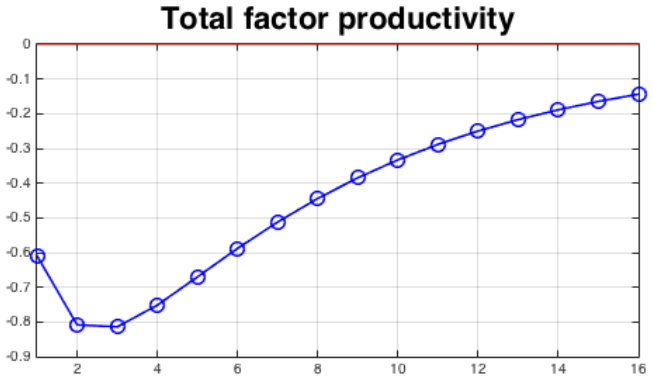


Financial shock

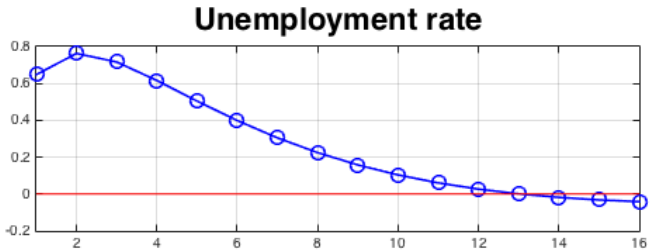


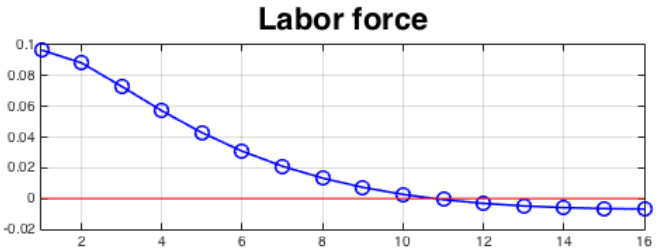


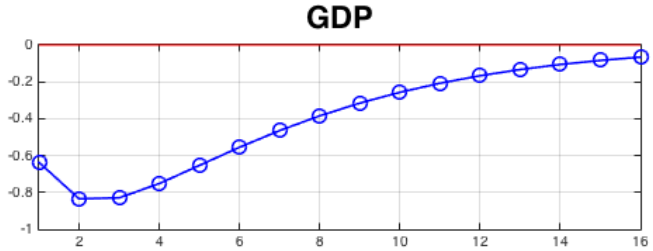


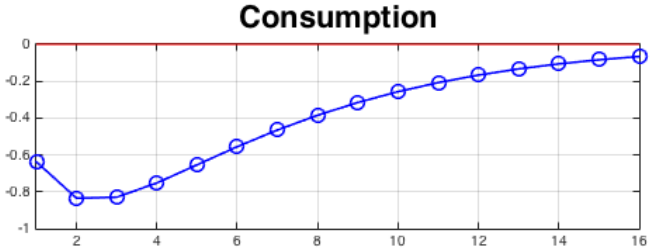


Financial shock









Alternative

Summary of results

- Credit frictions in presence of wage and price rigidities generate an inefficiency wedge (endogenous TFP) impacting the distribution of firms and productivity of those producing
- Credit conditions are amplified through inefficiency wedge (endogenous TFP)
- Generates persistent unemployment following financial shock (14 Q to baseline)
- Large and persistent decline in credit creation and large and persistent increase in credit destruction

Extensions

- Introduce capital: External funds are needed to finance capital vs labor.
- Pareto distribution for idiosyncratic productivity.
- Computation of cross-sectional distributions in equilibrium: Productivity, output, employment, loan interest rates.
  - Compute job flows: Job creation and job destruction.
- Optimal policy: Second order approximation of welfare.
- Possibility of absconding, credit rationing and net worth (possibility of internal funding).

Thanks!