Chapter 6
Financial Multipliers and Business Cycles

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Outline

1. The equilibrium dynamics of the CL model
2. A financial multiplier and the amplification of business cycles
3. Quantitative properties
4. Introducing shocks in financial markets

The equilibrium dynamics of the CL model

Projects and creditors: asset values

- Creditor must be searched for in the financial market at a flow cost κ_I
- Search is successful with a probability $p(\phi_t)$
- Ratio of projects searching in the market, $\mathcal{N}_{ct}$
- amount of creditors $\mathcal{B}_{ct}$
- κ_B expenditure in resources searching for investment projects

Projects and creditors: asset values

- Assume constant returns to scale matching function in the credit market $\mathcal{M}_C(\mathcal{N}_{ct}, \mathcal{B}_{ct})$
- Project-creditor pair can dissolve with probability s^C
- Worker-firm pair dissolves with probability s^L
- Effective discount factor denoted by β^C

Projects and creditors: asset values

- The effective discount factor:

$$\beta^C = \frac{1 - s^C}{1 + r}$$

- The asset values of the project are:

$$E_{ct} = -\kappa_I + p(\phi_t)E_{vt} + \frac{1 - p(\phi_t)}{1 + r}\mathbb{E}_t E_{ct+1} \tag{1}$$

$$E_{vt} = \beta^C \mathbb{E}_t \left[q(\theta_t)E_{\pi t+1} + (1 - q(\theta_t))\, E_{vt+1}\right] + \frac{s^C}{1 + r}\mathbb{E}_t E_{ct+1} \tag{2}$$

$$E_{\pi t} = x_t - w_t - \psi_t + \beta^C \mathbb{E}_t \left[\left(1 - s^L\right) E_{\pi t+1} + s^L E_{vt+1}\right] + \frac{s^C}{1 + r}\mathbb{E}_t E_{ct+1} \tag{3}$$

Projects and creditors: asset values

- The asset values of the creditor in each stage are:

$$B_{ct} = -\kappa_B + \check{p}(\phi_t) B_{vt} + \frac{1 - \check{p}(\phi_t)}{1 + r} \mathbb{E}_t B_{ct+1} \tag{4}$$

$$B_{vt} = -\gamma + \beta^C \mathbb{E}_t \left[q(\theta_t) B_{\pi t+1} + (1 - q(\theta_t)) B_{vt+1} \right] + \frac{s^C}{1 + r} \mathbb{E}_t B_{ct+1} \tag{5}$$

$$B_{\pi t} = \psi_t + \beta^C \mathbb{E}_t \left[\left(1 - s^L \right) B_{\pi t+1} + s^L B_{vt+1} \right] + \frac{s^C}{1 + r} \mathbb{E}_t B_{ct+1} \tag{6}$$

Bargaining and equilibrium in the financial market

- There is free entry in the financial market at all dates t
- Projects and creditors enter until exhaustion of profit opportunities implies: $E_{ct} = 0$ and $B_{ct} = 0$ at all dates

Bargaining and equilibrium in the financial market

- Value of being in the labor market stage v for the creditor and project:

$$B_{vt} = \frac{\kappa_B}{\phi_t p(\phi_t)}; \text{ and } E_{vt} = \frac{\kappa_I}{p(\phi_t)} \tag{7}$$

- Creditor and project determine at the time of contact a repayment rule in expectation that solves the Nash problem:

$$\mathbb{E}_t \psi_{t+1} = \mathit{argmax} \left(E_{vt} - E_{ct}\right)^{1-\alpha_C} \left(B_{vt} - B_{ct}\right)^{\alpha_C}$$

- Solution to the negotiation problem:

$$\alpha_C \left(E_{vt} - E_{ct}\right) = \left(1 - \alpha_C\right)\left(B_{vt} - B_{ct}\right) \tag{8}$$

Bargaining and equilibrium in the financial market

- Time-invariant equilibrium credit market tightness:

$$\phi_t^* \equiv \phi^* = \frac{\kappa_B}{\kappa_I}\frac{1-\alpha_C}{\alpha_C}. \quad \forall t \tag{9}$$

- The expected repayment rule that solves the Nash bargaining problem is:

$$\mathbb{E}_t\psi_{t+1} = \alpha_C \mathbb{E}_t\left[x_{t+1} - w_{t+1}\right] + (1-\alpha_C)\left[\beta^C \frac{\gamma}{q(\theta_t)} - \left(1 - s^L\right)\mathbb{E}_t \frac{\gamma}{q(\theta_{t+1})}\right]$$

Job Creation

- The asset values of the joint project-creditor pair are the sum of the value to the creditor and the project of the labor search (v) and profit (π) stages:

$$J_{vt} = -\gamma + \beta^C \mathbb{E}_t \left[q(\theta_t) J_{\pi t+1} + (1 - q(\theta_t)) J_{vt+1} \right]$$
$$J_{\pi t} = x_t - w_t + \beta^C \mathbb{E}_t \left[\left(1 - s^L\right) J_{\pi t+1} + s^L J_{vt+1} \right]$$

Job Creation

- Value of a job vacancy to the firm, the project-creditor pair, is equal to the total search costs in the credit market involved in the creation of a job opening, $K(\phi)$:

$$J_{vt} = E_{vt} + B_{vt} = \frac{\kappa_I}{p(\phi)} + \frac{\kappa_B}{\phi p(\phi)} = K(\phi)$$

Job Creation

- The first equation, the asset value of a vacant job to the firm, can be re-expressed as:

$$\underbrace{K(\phi^*)(1+o_t)}_{\text{Cost of credit frictions}} \underbrace{+\frac{\gamma}{q(\theta_t)}}_{\text{Cost of labor frictions}} \underbrace{= \beta^C \mathbb{E}_t J_{\pi t+1}}_{\text{Expected profits}} \tag{10}$$

- where $o_t \equiv \frac{(1-q_t)(r+s^C)}{q_t(1+r)} = \frac{1-q_t}{q_t}\left(1-\beta^C\right)$

Job Creation

- Define the discrete time annuity value of $K(\phi)$ as:

$$k(\phi) = (1 - \beta^C)K(\phi)$$

- Discrete time job creation condition in the CL model:

$$\frac{\gamma_k}{q_t} = \beta^C \mathbb{E}_t \left[x_{t+1}^{CL} - w_{t+1} + \left(1 - s^L\right) \frac{\gamma_k}{q_{t+1}} \right] \qquad (11)$$

Wage Bargaining

- Block-bargained wage in the discrete time CL model

$$w_t = (1 - \alpha_L)\, z + \alpha_L \left[x_t + \theta_t \left(\frac{\gamma + k(\phi)}{1 - s^C} \right) \right] - \alpha_L k(\phi)$$

or

$$w_t = (1 - \alpha_L)\, z + \alpha_L \left[x_t^{CL} + \theta_t \left(\frac{\gamma_k}{1 - s^C} \right) \right]$$

A financial multiplier and the amplification of business cycles

Understanding Amplification

- Assume that wages are exogenously fixed at $w_t = \overline{w}$
- Log-linearization around the steady state in the CL model:

$$\widehat{\theta}_t = \frac{1}{\eta_L} \times \frac{x}{x - \bar{w} - k(\phi)} \times \left(1 - \beta^{CL}\right) \mathbb{E}_t \sum_{i=0} \left(\beta^{CL}\right)^i \widehat{x}_{t+1+i} \tag{12}$$

- where $\beta^{CL} = \left(1 - s^L\right) \beta^C$

Understanding Amplification

- ρ_x is the auto-correlation of productivity innovations
- Elasticity of labor market tightness to a productivity shock ϵ_t in the discrete time CL model, after a log-linear approximation and with a fixed wage, is given by:

$$\varsigma^{CL} = \frac{\partial \widehat{\theta}_t^{CL}}{\partial \epsilon_t} = \frac{1}{\eta_L} \times \frac{q(\theta^{CL})}{\gamma_k} \times \frac{\beta^C \rho_x}{1 - \beta^{CL} \rho_x} \tag{13}$$

- In the standard model ς^{CL} would be given by:

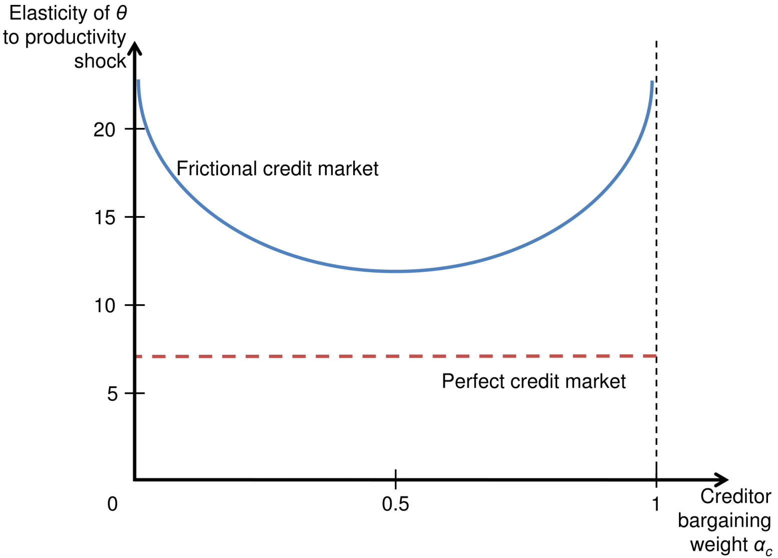
$$\varsigma^{L} = \frac{\partial \widehat{\theta}_t^{L}}{\partial \epsilon_t} = \frac{1}{\eta_L} \times \frac{q(\theta^{L})}{\gamma} \times \frac{\beta \rho_x}{1 - (1 - s^L)\, \beta \rho_x} \tag{14}$$

Understanding Amplification

- Financial frictions multiplier in the CL model:

$$\Lambda_C \equiv \frac{\varsigma^{CL}}{\varsigma^{L}} = \frac{q(\theta^{CL})}{q(\theta^{L})} \frac{\gamma}{\gamma_k} = \frac{x - \bar{w}}{x - \bar{w} - k(\phi)} \tag{15}$$

Hosios in the financial market and the financial multiplier for an elasticity of the credit matching function η_C of 0.5



Quantitative Properties

Calibration Strategy

- Month is the basic unit of time
- Assume process for productivity as an AR91) in logs with persistence of $\rho_x = 0.95^{1/3}$
- Conditional volatility, $\sigma_x = 0.00625$

A Calibration of Labor and Credit Markets: Parameter Values

	Parameter	Value		Reference or Target:
Technology:				
persistence parameter	ρ_x	$0.95^{1/3}$	$\rightarrow$	BLS labor productivity
standard deviation	σ_x	0.00625	$\rightarrow$	BLS labor productivity
Labor market:				
job-separation rate	s^L	0.032	$\rightarrow$	JOLTS
matching curvature	ν_L	1.25	$\rightarrow$	DenHannRameyWatsonAER2000
vacancy cost	γ	0.15	$\rightarrow$	Unemployment rate
worker bargaining weight	α_L	0.15	$\rightarrow$	Wage elasticity
nonemploymentnon-employment value	z	0.71	$\rightarrow$	Chapter **??**
Credit market:				
separation rate	s^C	0.01/3	$\rightarrow$	BernankeEtAl1996
creditor bargaining weight	α_C	0.12	$\rightarrow$	Spread on returns
project search costs	κ_I	0.33	$\rightarrow$	Volatility of unemployment
creditor search costs	κ_B	0.47	$\rightarrow$	Financial sector's share of GDP
matching curvature	ν_C	1.35	$\rightarrow$	Credit market transition rate
risk-free rate	r	0.01/3	$\rightarrow$	3- month USU.S. T-bill

Calibration Strategy

- Calibration Targets:
  - Returns to loans in the credit market

$$R_t = \frac{\mathbb{E}_t\left(\psi_{t+1}\right)}{\gamma/q_t} - s^T \tag{16}$$

  - Share of the financial sector in aggregate value added

$$\Sigma_B = \frac{\psi(1-\mathcal{U}) - \gamma\mathcal{V} - \kappa_B\mathcal{B}_c}{x\left(1-\mathcal{U}\right)} \tag{17}$$

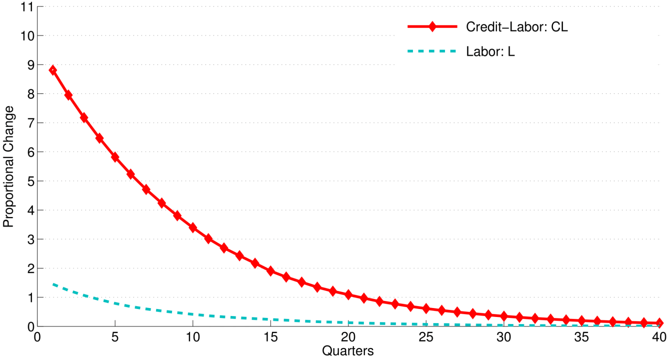
Labor Market Moments: Model with Credit and Labor Market Frictions

	$\mathcal{U}$	$\mathcal{V}$	θ		$\mathcal{U}$	$\mathcal{V}$	θ
	Panel A: Credit and Labor Frictions				Panel B: Removing Credit Frictions		
Standard deviation	0.127	0.147	0.272		0.042	0.061	0.098
Autocorrelation	0.336	—-0.09	0.165		0.341	—-0.098	0.174
Correlation matrix		—-0.721	—-0.896	$\mathcal{U}$		—-0.772	—-0.912
			0.950	$\mathcal{V}$			0.946
				θ			

Quantitative Moments and Dynamics

- Table obtained by taking quarterly averages of monthly $\mathcal{U}, \mathcal{V}$, and x to convert to quarterly series
- All variables in HP-filtered proportional deviations from the mean with a smoothing parameter of 1,600

IRF of Labor Market Tightness to a Positive Productivity Shock, CL and L models

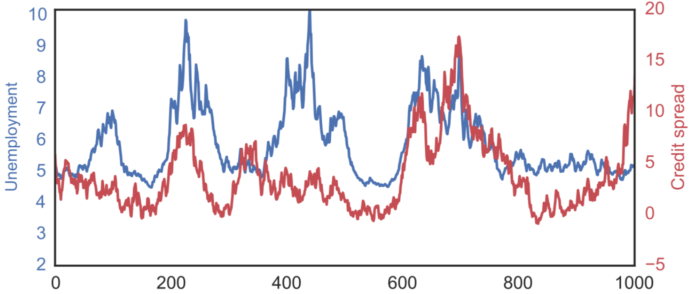


Introducing Shocks in the financial market

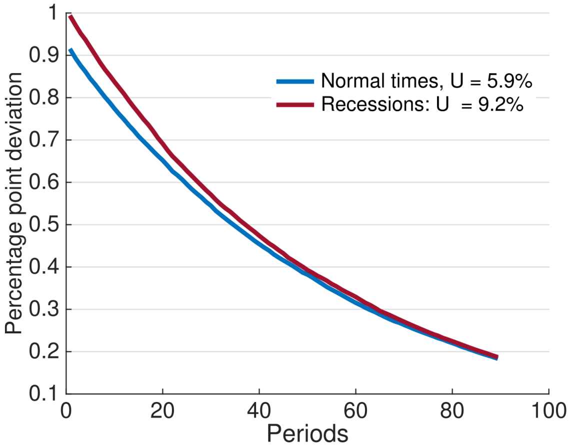
Parameterization and Calibration

- Search costs in the financial market κ_B are assumed to follow an AR(1) in logs: $\log \kappa_{Bt} = (1 - \rho_{\kappa_B}) \log \kappa_{Bt-1} + \sigma_{\kappa B} \epsilon_t^{\kappa_B}$
- Persistence parameter, ρ_{κ_B}, is set to the same value as for productivity shocks
- conditional volatility, σ_{κ_B}, is such that the model credit spread matches the volatility of the credit spread in the data
- $\sigma_{\kappa_B} = 0.018$

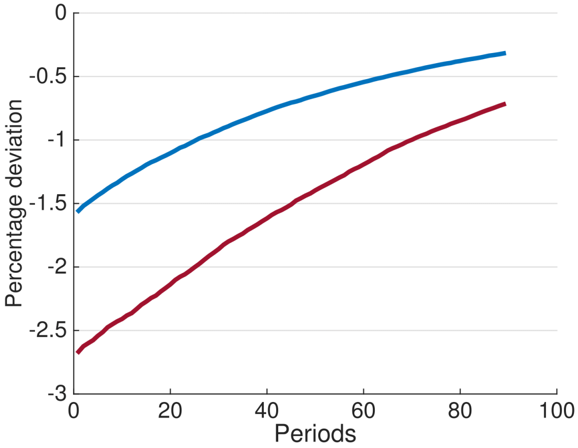
Model Simulated Paths for unemployment Rate and Credit Market Spread



Credit Spread



Labor Market Tightness



Unemployment Rate