Chapter 19: Credit Market Frictions

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Outline

1. Introduction and Empirical Motivation
2. Modeling Financial Frictions
3. Financial Frictions in the Neoclassical Model
4. Two-Period Characterization
5. General Model and the Modigliani-Miller Benchmark
6. Numerical Analysis
7. Summary

Introduction and Empirical Motivation

Introduction

Financial frictions entered macroeconomics with Bernanke-Gertler (1989) and Kiyotaki-Moore (1997), yet pre-2008 mainstream models typically abstracted from them, relying on complete-markets frameworks with other frictions (sticky prices, adjustment costs, matching).

This is puzzling: the Great Depression featured widespread bank failures and a credit collapse, yet even the Kehoe-Prescott (2002) volume on the Depression contained no chapter on financial frictions.

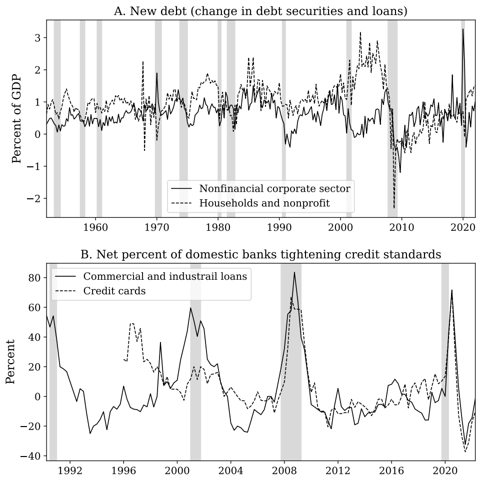
Introduction: The Turning Point

The **Great Recession (2007–2009)** was the turning point: models built on frictionless financial markets were missing essential elements.

This chapter adds a specific friction to the neoclassical growth model; the key properties carry over to a broad class of macro-finance models.

Credit Flows Are Procyclical

New debt (% of GDP) and the index of credit tightening



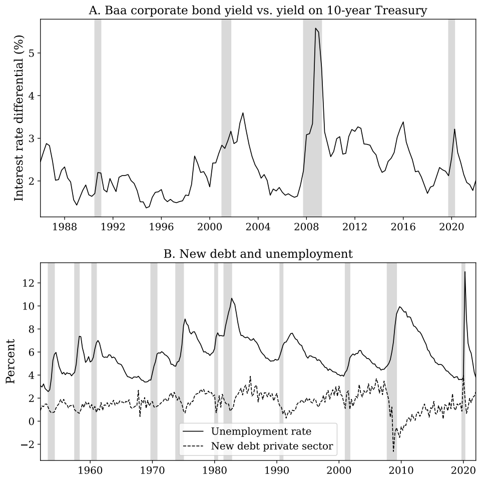
Credit Flows: What the Figure Shows

- Debt growth drops sharply in recessions (especially 2008); corporate debt procyclicality is confirmed in micro data
- Banks tighten credit standards during recessions (countercyclical tightening index)

If markets were complete, there is **no reason** for lenders to change their credit standards over the cycle. The joint dynamics of real and financial variables are hard to square with the complete-market paradigm.

Spreads and New Debt

Baa–Treasury spread; new private-sector debt and unemployment



Spreads and New Debt: What the Figure Shows

- Spreads rise just before recessions; strong negative comovement of new debt and unemployment
- Under complete markets debt could well be **countercyclical** — households borrow to smooth the consumption of the unemployed

Strong comovement between financial and real flows does not by itself establish causality: does lower credit growth cause recessions, or do recessions cause lower credit growth?

Three Causal Scenarios

Comovement does not establish causality. Three possibilities:

1. **Real activity causes financial flows**: borrowers cut debt because they need fewer funds. If this is the only link, modeling finance adds little — the neoclassical assumption.
2. **Propagation**: nonfinancial shocks (e.g., TFP) drive activity, but financial frictions shape the transmission — **amplifying** (falling collateral values tighten credit, deepening the contraction) or **dampening** (credit limits choke an investment boom). The pre-2008 literature focused here.

Three Causal Scenarios (cont.)

3. **Financial shocks**: the disruption originates in the financial sector itself and propagates to the real economy — modeled in reduced form as changes in the parameter governing the friction. Emphasis since 2008.

Modeling Financial Frictions

Two Necessary Ingredients

Financial frictions arise when some claims cannot be traded. Two features are necessary (not sufficient — they must interact):

1. **Missing markets**: markets for certain contingencies are absent
2. **Heterogeneity**: agents differ in a dimension that creates a reason to trade

Modigliani-Miller benchmark: with complete markets, the firm's problem

$$\max_{k,\{\ell_i\}} \left\{ -k + \sum_i p_i \left[F(z_i, k, \ell_i) - \ell_i w_i + (1-\delta)k \right] \right\}$$

is unchanged by splitting funding into debt b and equity $e = k - b$: since $\sum_i p_i R = 1$, the term Rb cancels from the shareholder problem. **Financial structure is indeterminate and irrelevant** for real decisions — for any set of competitively priced instruments.

Missing Markets: Exogenous vs. Endogenous

Exogenous incompleteness: assume by fiat that only non-contingent bonds trade, possibly with an exogenous borrowing limit. Pragmatic approximation: most real-world finance is standard debt.

Endogenous incompleteness: the contract set is restricted by incentives:

- **Information asymmetry**: unobservable effort (moral hazard) or unobservable riskiness (adverse selection)
- **Limited enforcement**: lenders observe but cannot enforce repayment

Missing Markets: Net Worth and the Lucas Critique

Shared property: higher borrower **net worth** $\Rightarrow$ more incentive-compatible external funds. For most applications the source matters little; but endogenous frictions are less vulnerable to the **Lucas critique** (e.g., a higher default penalty endogenously relaxes the borrowing limit). Bernanke-Gertler: information asymmetry; Kiyotaki-Moore: limited enforcement.

Heterogeneity and Preventing Self-Financing

Common approach under aggregate uncertainty: **two permanently different types** (borrowers and lenders), each aggregating linearly into a representative agent of its type.

Preventing Self-Financing

Constrained agents have an incentive to accumulate wealth and outgrow the friction. Assumptions that keep frictions binding in the long run:

- **Finite life span**: OLG or firm entry/exit — newborns hold no wealth
- **Different discounting**: impatient agents borrow; since $R <$ their discount rate, they never escape the constraint
- **Tax benefits of debt**: interest deductibility favors leverage
- **Convenience yield**: debt provides liquidity services/utility, so holders accept low interest rates
- **Wage bargaining**: leverage improves the firm's bargaining position

Financial Frictions in the Neoclassical Model

Setup: Firms and the Stochastic Discount Factor

Representative household; **firms accumulate capital** (a second agent type). Firms maximize the present value of dividends using the household's stochastic discount factor:

$$\mathbb{E}\sum_{t=0}^{\infty} m_t d_t, \qquad m_t = \frac{\beta^t u_1(C_t, L_t)}{u_1(C_0, L_0)}$$

Financing: equity (claims to dividends) and **non-contingent debt**: borrow b_{t+1}/R_t at t, repay b_{t+1} at $t+1$.

Three Assumptions That Make Finance Matter

Without further assumptions, debt is indeterminate and allocations are neoclassical (Modigliani-Miller again — Proposition 19.1 below). Three assumptions make finance matter:

Assumption 19.4.1 (cheap debt): tax advantage $\tau > 0$ so the effective rate is $\tilde{R}_t = R_t/(1+\tau)$.

Assumption 19.4.2 (collateral constraint): $\dfrac{b_{t+1}}{\tilde{R}_t} \leq \xi p_t k_{t+1}$.

Assumption 19.4.3 (costly equity adjustment): dividend cost $\kappa(d_t - \phi)^2$ around target ϕ.

Why All Three Assumptions Are Needed

19.4.1 alone: firms prefer debt (pecking order) and would borrow infinitely $\Rightarrow$ need a borrowing limit.

19.4.1 + 19.4.2: the limit caps debt, but equity is a perfect (if dearer) substitute — dividends can go negative (new issuance) at no cost. The firm retains full financial flexibility; responses to shocks barely change.

19.4.3 restricts the equity margin: deviating from the dividend target is costly (underwriting fees with increasing marginal cost — Altinkilic-Hansen 2000; dividend smoothing — Lintner 1956).

A Note on the Price of Capital

On the price of capital p_t: here it is exogenous (constant at 1 in the numerics). In Bernanke-Gertler-Gilchrist (convex adjustment costs) and Kiyotaki-Moore (fixed asset, like land) the endogenous price of capital is central to amplification.

The Firm's Problem

$$\Omega(S;k,b) = \max_{d,\ell,k',b'} \left\{ d + \mathbb{E}m'\Omega(S';k',b') \right\}$$

subject to

$$F(z,k,\ell) - w\ell + \frac{b'}{\tilde{R}} = b + p\left[k' - (1-\delta)k\right] + \varphi(d), \qquad \xi p k' \geq \frac{b'}{\tilde{R}}$$

where $\varphi(d) = d + \kappa(d-\phi)^2$ is the resource cost of paying dividends d.

The Firm's Problem: Sources and Uses

Sources of funds: operating profits $F - w\ell$ and new debt $b'/\tilde{R}$.
Uses: debt repayment b, investment $p[k' - (1-\delta)k]$, and dividend payments $\varphi(d)$.

The firm is atomistic: it takes the discount factor m' as given, but the aggregation of all firms' policies determines m' in equilibrium.

Firm Optimality Conditions

With $\mu\lambda$ the multiplier on the borrowing limit:

Labor: $F_3(z, k, \ell) = w$ (undistorted)

Capital:

$$\mathbb{E}\left[m' \frac{\varphi'(d)}{\varphi'(d')} \big((1-\delta)p' + F_2(z', k', \ell')\big)\right] = (1 - \mu\xi)p$$

Debt:

$$\mathbb{E}\left[m' \frac{\varphi'(d)}{\varphi'(d')}\right] \tilde{R} = 1 - \mu$$

Firm Optimality: Interpretation

When $\mu > 0$, the effective cost of capital is $(1 - \mu\xi)p < p$: the **collateral premium** — an extra unit of capital expands cheap borrowing capacity, and the benefit rises with ξ. The effective discount factor includes $\varphi'(d)/\varphi'(d')$: a **dividend-smoothing** motive. From the debt FOC, a lower $\tilde{R}$ raises μ: cheap debt makes the constraint more likely to bind.

The Household's Problem

$$V(S;a,b) = \max_{c,\ell,a',b'} \left\{ u(c,\ell) + \beta \mathbb{E} V(S';a',b') \right\}$$

subject to

$$(d+q)a + b + w\ell = c + qa' + \frac{b'}{R} + T$$

where q is the share price and $T = B'/\tilde{R} - B'/R$ are lump-sum taxes funding the interest subsidy ($R > \tilde{R}$).

Household First-Order Conditions

FOCs:

$$u_1(c,\ell)w = -u_2(c,\ell), \qquad \frac{1}{R} = \mathbb{E}\left[\frac{\beta u_1(c',\ell')}{u_1(c,\ell)}\right]$$
$$q = \mathbb{E}\left[\frac{\beta u_1(c',\ell')}{u_1(c,\ell)}(d'+q')\right]$$

Labor supply, bond pricing, and equity pricing; the household's MRS is the discount factor used by firms.

Two-Period Characterization

Two-Period Model

$u(c_t, \ell_t) = \ln(c_t - \ell_t^\nu)$, $F(z_t, k_t, \ell_t) = z_t k_t^\alpha \ell_t^{1-\alpha}$; no uncertainty; terminal conditions $k_2 = b_2 = 0$. Solve backward.

Terminal period: labor supply = MPL gives

$$L' = \left(\frac{1-\alpha}{\nu}\right)^{\frac{1}{\alpha+\nu-1}} (z')^{\frac{1}{\alpha+\nu-1}} (K')^{\frac{\alpha}{\alpha+\nu-1}}$$

and Y', $C' = (1-\delta)K' + Y'$, with $C' - L'^\nu = g(z', K')$ increasing in both arguments.

Two-Period Model: Initial Period

With a binding constraint: six unknowns (K', B', C, D, R, μ) and six conditions — the capital FOC, the borrowing limit $(1+\tau)B'/R = \xi p K'$, the firm budget, the household budget, the firm debt FOC, and the household bond FOC. The key conditions:

$$(1-\mu\xi)p = \beta \frac{C - L^{\nu}}{g(z', K')} \left[1 - \delta + F_k(z', K', L')\right] \left[1 + 2\kappa(D - \phi)\right]$$

$$\frac{(1-\mu)(1+\tau)}{R} = \beta \frac{C - L^{\nu}}{g(z', K')} \left[1 + 2\kappa(D - \phi)\right]$$

$$\frac{1}{R} = \beta \frac{C - L^{\nu}}{g(z', K')}$$

If the constraint does not bind (B small or negative), replace the borrowing limit with $\mu = 0$.

Property 1: Frictions Can Dampen Productivity Shocks

Property 19.5.1: A persistent positive productivity shock raises investment and output, but the responses are **smaller** when the borrowing constraint binds.

Mechanism: higher z' raises $F_k \Rightarrow$ firms want higher K'. Funding: higher current profits help; higher K' relaxes the collateral limit and allows more debt — but with $\xi < 1$ this is not enough. The remainder must come from **lower dividends**, which is costly (φ): the term $1 + 2\kappa(D - \phi)$ falls, discouraging investment.

Property 1: Interpretation

Interpretation: large investments must be partly equity-funded; equity is more expensive, and increasingly so in the amount raised $\Rightarrow$ the effective cost of capital rises and investment responds **less** than without frictions.

$\Rightarrow$ Financial frictions can **dampen**, not amplify — so where does amplification come from?

Property 2: The Price of Capital and Amplification

Property 19.5.2: With a binding constraint and $B > 0$, a higher price of capital p raises capital accumulation, next-period output, and employment.

Net worth $= pK - B$: with leverage, a 1% rise in p raises net worth by **more** than 1%. Eliminating B' from the firm budget using the borrowing limit:

$$K' = \left(\frac{1}{1-\xi}\right)\left[(1-\delta)K + \frac{\alpha F(z,K,L) - B - D - \kappa(D-\phi)^2}{p}\right]$$

Property 2: The Leverage Multiplier

The bracketed flow term is typically negative (debt stock exceeds profits) $\Rightarrow$ higher p raises K'. The factor $1/(1-\xi)$ is a **leverage multiplier**: higher ξ amplifies the net-worth effect.

This net-worth channel is the central amplification mechanism in Bernanke-Gertler (1989), Kiyotaki-Moore (1997), the financial accelerator of Bernanke-Gertler-Gilchrist (1999), and Brunnermeier-Sannikov (2014).

Property 3: Financial Shocks

Changes in ξ — **financial shocks** (Jermann-Quadrini, 2012) — capture securitization, bank balance-sheet stress, changing credit standards.

Property 19.5.3: With a binding constraint, a fall in ξ reduces capital accumulation, next-period output, and employment.

Mechanism: lower ξ forces lower B' (binding limit) $\Rightarrow$ the firm must cut dividends or investment; the multiplier μ rises. Lower D reduces the right-hand side of the capital condition; the left-hand side falls less (the μ effect is scaled by $\xi < 1$) $\Rightarrow$ F_k must rise $\Rightarrow$ K' falls.

Property 3: Asymmetry

Asymmetry (Properties 19.5.4–19.5.5): starting from a **slack** constraint,

- an *increase* in ξ has **no effect** (the limit was not binding)
- a sufficiently large *decrease* in ξ forces deleveraging and a real contraction

Matches the data: credit booms are gradual; busts are sudden and costly.

Working Capital and the Labor Wedge

Frictions so far distort only investment — but labor contributes $\sim$60% of GDP volatility (capital $< 10\%$). For frictions to matter for the cycle, they must hit **labor** directly.

Working capital: wages are paid before revenues arrive; intra-period borrowing $w\ell$ shares the collateral limit:

$$w\ell + \frac{b'}{R} \leq \xi p k'$$

The labor FOC becomes:

$$F_3(z, k, \ell) = (1 + \mu) w$$

Working Capital: Employment and the Wedge

Property 19.5.6: employment falls with the tightness of the constraint:

$$L = \left(\frac{1-\alpha}{(1+\mu)\nu} \right)^{\frac{1}{\alpha+\nu-1}} z^{\frac{1}{\alpha+\nu-1}} K^{\frac{\alpha}{\alpha+\nu-1}}$$

Financial tightening now causes an **immediate** contraction in employment and output — a financial labor wedge. The same logic extends to financing of intermediate inputs.

General Model and the Modigliani-Miller Benchmark

Infinite-Horizon Equilibrium Conditions

Labor: $F_3(z,K,L) = -u_2(C,L)/u_1(C,L)$ (as in the NGM)

Capital:

$$(1-\mu\xi)p = \mathbb{E}\left[\beta \frac{u_1(C',L')}{u_1(C,L)} \frac{\varphi'(D)}{\varphi'(D')} \big((1-\delta)p' + F_2(z',K',L')\big)\right]$$

Two wedges vs. the NGM: the collateral premium $(1-\mu\xi)$ and the dividend-smoothing factor $\varphi'(D)/\varphi'(D')$.

Equilibrium: The Bond Market

Bond market (firm and household FOCs):

$$\frac{(1-\mu)(1+\tau)}{R} = \mathbb{E}\left[\beta \frac{u_1(C',L')}{u_1(C,L)} \frac{\varphi'(D)}{\varphi'(D')}\right]$$
$$\frac{1}{R} = \mathbb{E}\left[\beta \frac{u_1(C',L')}{u_1(C,L)}\right]$$

If $\kappa = 0$: $(1-\mu)(1+\tau) = 1$, so $\tau > 0$ **guarantees** $\mu > 0$ (always binding). With $\kappa > 0$, the constraint is only **occasionally binding** — crises as episodes when it binds.

Proposition 19.1: Back to Modigliani-Miller

Proposition 19.1. If $\tau = 0$ and $\kappa = 0$, the equilibrium debt chosen by firms is indeterminate and the real allocation is the same as in the standard neoclassical growth model.

Proof sketch: with $\tau = \kappa = 0$, $\mu = 0$ and the conditions reduce to

$$p = \beta \mathbb{E}\left[\frac{u_1(C', L')}{u_1(C, L)}\big((1-\delta)p' + F_2(z', K', L')\big)\right]$$
$$\frac{1}{R} = \beta \mathbb{E}\left[\frac{u_1(C', L')}{u_1(C, L)}\right]$$

exactly the NGM conditions. □

Proposition 19.1: Intuition

Intuition: raise Δ in debt to pay dividends today; repay ΔR from dividends tomorrow. The gain is $\Delta(1 - \mathbb{E}m'R) = 0$ by the household's bond FOC. Capital accumulation by firms (rather than households) is irrelevant because firms use the household's discount factor.

Numerical Analysis

Calibration

$u(c,\ell) = c^{\nu}(1-\ell)^{1-\nu}$; quarterly; $p = 1$; global solution (projection on a grid for K and B/K).

Calibration: Parameter Values

Parameter values

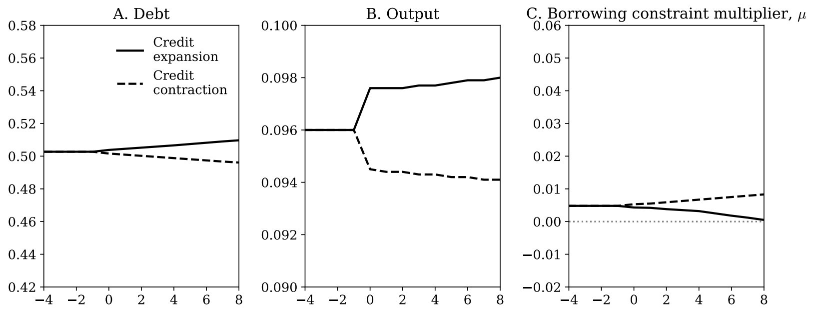
Parameter	Description	Value
β	Discount factor	0.983
ν	Utility parameter	0.412
α	Capital share	0.36
τ	Benefit of debt (corporate tax rate)	0.281
κ	Dividend cost	0.5
p	Price of capital	1
z	3-state Markov: $\{0.183, 0.185, 0.187\}$, persistence 0.9	
ξ	3-state Markov: $\{0.450, 0.500, 0.550\}$, persistence 0.9	

Calibration: Targets

Standard parameters from the RBC literature; z matched to Solow residual moments; ξ process targets the mean, autocorrelation, and volatility of leverage B/K; κ targets the volatility of equity payout (dividends $+$ buybacks $-$ issuance).

Productivity Shocks

Experiment: from the mean state $(z, \xi) = (0.185, 0.500)$, switch z to its highest (boom) or lowest (bust) value, holding ξ fixed.

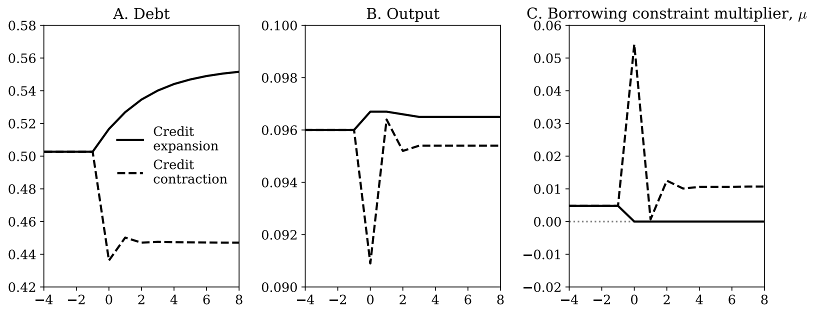


Productivity Shocks: Results

- Debt and output respond positively and **symmetrically**; the constraint binds throughout ($\mu > 0$)
- Procyclical debt, as in the data — though the model's debt response is small relative to output (the data show the opposite)
- The multiplier μ is **countercyclical**: the model counterpart of spreads and loan standards, both countercyclical in Figures 19.1–19.2
- With endogenous p rising in booms, the constraint would loosen further — but generating large movements in p is hard in RBC-type models

Financial Shocks: Asymmetric Booms and Busts

Experiment: from the mean state, switch ξ to 0.550 (credit expansion) or 0.450 (credit contraction), holding z fixed.



Financial Shocks: Results

- **Asymmetry despite symmetric shocks**: a positive shock raises debt **gradually** with a mild output gain; a negative shock causes a **sharp** fall in debt and a **large** (if short-lived) output contraction
- After the expansion the constraint becomes **slack** ($\mu = 0$): firms borrow below the new limit as a **precaution** against reversal, since forced deleveraging is costly
- A negative shock forces cuts in labor, investment, and dividends — the firm picks the least-inefficient mix

Consistent with Reinhart-Rogoff (2009) and Schularick-Taylor (2012): credit booms add little growth; busts bring sharp contractions.

Summary

Key Takeaways (I)

1. **Facts**: credit flows are procyclical; credit standards and spreads are countercyclical (Figures 19.1–19.2). Complete markets struggle with both. Three causal scenarios: real causes finance, propagation, financial shocks.
2. **Necessary ingredients**: missing markets + heterogeneity, interacting. Exogenous (non-contingent debt, ad hoc limits) vs. endogenous (moral hazard, adverse selection, limited enforcement) incompleteness; net worth expands credit in both; endogenous versions resist the Lucas critique.

Key Takeaways (II)

3. **Modigliani-Miller**: with competitively priced instruments, financial structure is irrelevant; Proposition 19.1: with $\tau = \kappa = 0$, debt is indeterminate and allocations are neoclassical.
4. **Three assumptions**: cheap debt ($\tilde{R} = R/(1+\tau)$), collateral limit ($b'/\tilde{R} \leq \xi p k'$), costly dividend deviations ($\kappa(d-\phi)^2$). All three are needed: the limit alone is undone by free equity adjustment.

Key Takeaways (III)

5. **Firm optimality**: collateral premium — effective cost of capital $(1-\mu\xi)p < p$; effective discount factor includes dividend smoothing $\varphi'(D)/\varphi'(D')$; labor undistorted without working capital.
6. **Propagation**: frictions can **dampen** TFP shocks (equity financing margin is costly). **Amplification** requires the net-worth channel: leverage multiplier $1/(1-\xi)$ turns capital-price movements into large net-worth and investment responses (Bernanke-Gertler, Kiyotaki-Moore).

Key Takeaways (IV)

7. **Financial shocks** (ξ): contractions in ξ reduce investment, output, employment; **asymmetric** — expansions from a slack constraint do nothing, contractions force deleveraging. Numerically: gradual booms, sudden busts; precautionary borrowing below the limit; countercyclical μ mirroring spreads and credit standards.
8. **Labor wedge**: with working capital, $F_3 = (1+\mu)w$ — financial tightness directly cuts labor demand, making frictions quantitatively relevant for output (labor is ∼60% of GDP volatility).