Corporate Finance, Monetary Policy, and Aggregate Demand

Mario Silva

December 8, 2019

Objective

Investigate how heterogeneous financial frictions, over-the-counter credit market, and monopolistic competition influence

- monetary policy: effect of policy rate on
  - lending rate ('pass through')
  - investment ('transmission')
- cash holdings

Cash flows and net interest Margins of publicly traded firms

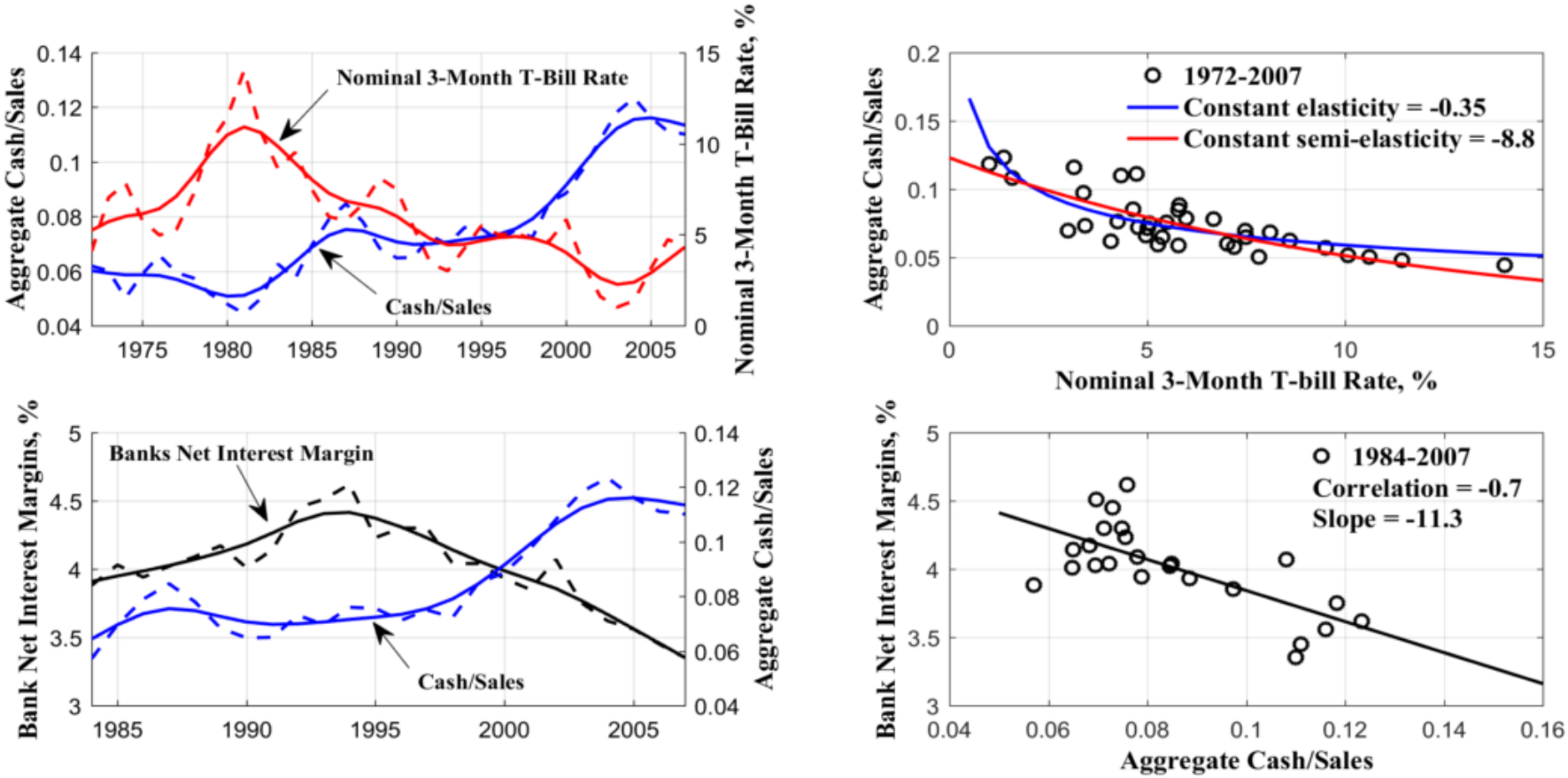


Figure 1: Reprinted from Rocheteau, Wright, and Zhang (2017)

Role of ingredients

- Heterogeneity
  - Interaction with aggregate demand externalities (generates relative price distortions as in NK models)
  - Eliminates artificial kinks in policy
  - Distributional effects of investment and output (mean-preserving spreads of frictions reduce investment and output)
  - Cross-sectional implications (transmission by firm type, financing constraints with cash/sales ratio)
- Search and bank bargaining power $\Rightarrow$ strategic and precautionary motives for holding money
- Monopolistic competition
  - Link between competition and cash holdings
  - Aggregate demand externality and interaction with financial frictions

Closest literature

- Most closely related to Rocheteau, Wright, and Zhang (2017)
- Money, credit, and banking
  - Cavalcanti and Wallace (1999)
- Credit frictions
  - Kiyotaki and Moore (1997)
  - Wasmer and Weil (2004)
  - Bernanke (1996,1999)
- Financial economics literature on cash holdings
  - Opler et al. (1999)
  - Almeida et al. (2004)
- Empirical evidence on heterogeneous monetary policy transmission: Gertler and Gilchrist (1994), Dedola and Lippi (2005), Ehrmann et. al. (2003)
- Empirical evidence on pledgeability: Berger (1996), Almeida and Campello (2007)

Two types of idiosyncratic uncertainty

- Stochastic investment opportunities (Kiyotaki and Moore 1997)
- Stochastic access to bank financing (Wasmer and Weil 2004)

Timing, goods

- Time: $t = 1, 2, \ldots, \infty$
- Two stages each period
  - Investment
  - Production, consumption, settlement
- Goods
  - differentiated goods $y_j, j \in [0, 1]$
  - final consumption good Y
  - capital k

Agents

Four types

- Entrepreneurs (e): $k \to y_j$ (linear)
- Final goods producers (f): $\{y_j\}, j \in [0,1] \to Y$
- Suppliers (s): produce k
- Banks (b): intermediation
  - Partially monitor: enforce payment $\chi_i f(k, Y)$
  - Issue short-term liabilities in Stage 1
  - Can commit to redeem notes in Stage 2

Preferences, technology

- Preferences
  - $U(c, h) = c - h$
  - Discount factor $\beta \in (0, 1)$

Technologies

- Entrepreneur:

$$y_j = \epsilon k \quad \text{for} \quad \epsilon \in \{0, 1\}$$

  where $Pr(\epsilon = 1) = \lambda$

- Supplier

$$k = h$$

- Final goods producer

$$Y = \left[\int_0^1 y_i^{\sigma} di \right]^{\frac{\gamma}{\sigma}} \qquad \sigma < \gamma < 1$$

Timing

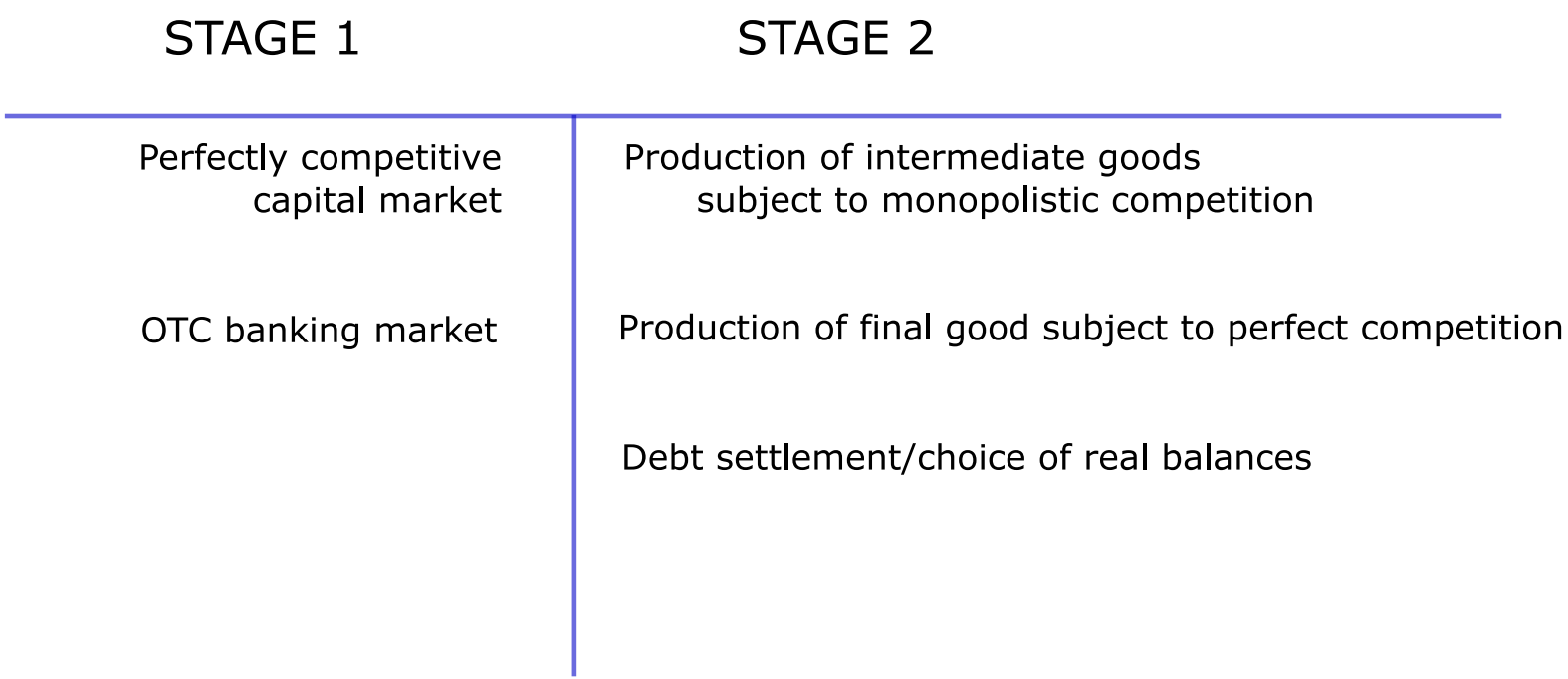


Figure 2: Timing

Production chain

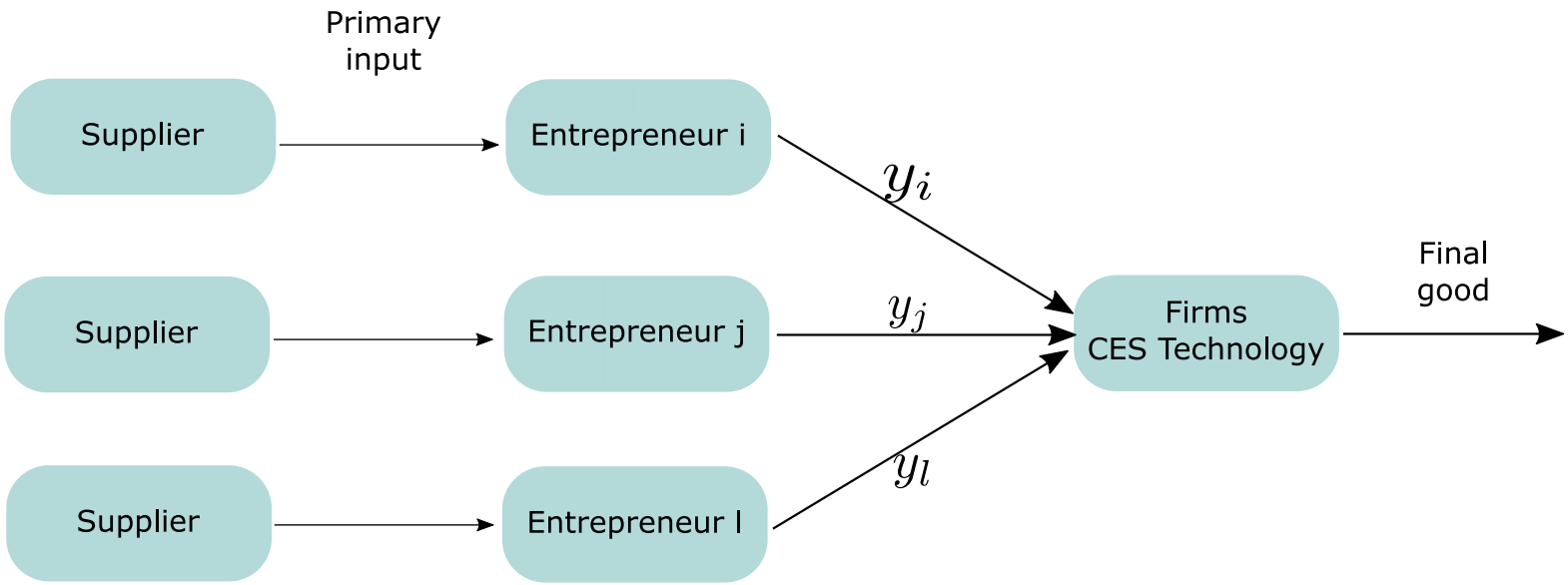


Figure 3: Production chain

Problem of final goods firm

$$\max_{y_i \geq 0} \left(PY - \int_0^1 P_i y_i di \right)$$

- Individual demand curve (normalize $P = 1$)

$$y_i = \left(\frac{\gamma}{P_i} \right)^{\frac{1}{1-\sigma}} Y^{\frac{\gamma-\sigma}{\gamma(1-\sigma)}}$$

- Elasticity of substitution $1/(1-\sigma)$
- Define inverse demand $P_i(k_i, Y)$ using $k_i = y_i$

Revenue function $f(k, Y)$

$$f(k_i, Y) \equiv P_i(k_i, Y)k_i = \gamma Y^{\frac{\gamma-\sigma}{\gamma}} k_i^{\sigma}.$$

- Cobb-Douglas with endogenous total factor productivity $\gamma Y^{(\gamma-\sigma)/\gamma}$
- As $\gamma \to \sigma$, f becomes independent of Y

Adding money

- Investment can be financed with retained earnings
- $M_{t+1} = (1+\pi)M_t$: lump-sum transfer to entrepreneurs
- Disagreement point

$$\Delta_m(a_m^e) = f(k_m, Y) - k_m \quad \text{where} \quad k_m = \min\{a_m^e, k^*\}$$

Bargaining

$$(k, \phi) \in \arg\max [\overbrace{f(k, Y) - k - \phi}^{\text{profits}} - \overbrace{\Delta_m(a_m^e)}^{\text{disagreement}}]^{1-\theta} \phi^{\theta} \quad \text{s.t.}$$

$$\overbrace{k - a_m^e}^{\text{loan size}} + \phi \leq \chi f(k, Y)$$

- Money
  - Raises financing capacity: $\chi f(k, Y) + a_m^e$
  - Affects bargaining position $\Delta_m(a_m^e)$

Characterization of solution

There is an $a^* < k^*$ such that
If $a_m^e \geq a^*$, then

$$k_c = k^*$$

$$\phi^* = \theta \overbrace{[f(k^*, Y) - k^* - \Delta_m(a_m^e)]}^{\text{total surplus}}$$

Otherwise, liquidity constraint binds

Properties

- $\frac{\partial r}{\partial a_m^e} < 0$ for all $a_m^e \in [a^*, k^*]$ and $r \to 0$ as $a_m^e \to k^*$
- $\frac{\partial r}{\partial a_m^e} > 0$ possible if liquidity constraint binds (happens if $\theta = 1$)
- If liquidity constraint binds, then
  - $\frac{\partial k_c}{\partial a_m^e} > 0$
  - $\frac{\partial a_m^e + \chi f(k_c, Y)}{\partial a_m^e} > 1$ (Financial multiplier)
  - $\frac{\partial k_c}{\partial \theta} < 0$

Choice of real balances

Entrepreneur solves

$$\max_{a_m^e \geq 0} \{ -i a_m^e + \underbrace{\lambda(1-\alpha)\Delta_m(a_m^e)}_{\text{internally financed}} + \underbrace{\alpha\lambda\Delta_c(a_m^e)}_{\text{externally financed}} \} \tag{1}$$

for

$$\Delta_c(a_m^e) = \begin{cases} (1-\theta)[f(k^*, Y) - k^*] + \theta\Delta_m(a_m^e) & \text{if} \quad a_m^e \geq a^* \\ (1-\chi)f(k_c, Y) - a_m^e & \text{otherwise} \end{cases}$$

and $1 + i = (1+\rho)(1+\pi)$

- ρ: rate of time preference (natural rate of interest)
- Opportuntity cost of holding money is nominal interest rate on illiquid bond

The real lending rate

- Under perfect enforcement, a first order approximation to lending rate as $i \to 0$, is

$$r = \frac{\theta i}{2\lambda[1 - \alpha(1 - \theta)]}$$

- As $i \to 0, r \to 0$ and, as $i \to \infty$, $r \to \theta(1 - \sigma)/\sigma$, which is the level under only external finance

Coexistence of money and credit

- Monetary equilibrium if either
  - $\lambda(1-\alpha) > 0$ (insurance motive)
  - $\lambda\alpha\theta > 0$ (strategic motive)
- Credit equilibrium if $i > 0$ and $\lambda\alpha > 0$

$\Rightarrow$ robust coexistence

Cases

- $a_m^e > k^*$: entrepreneur finances k^* without bank credit and appropriates full gains from trade
- $a_m^e \in [a^*, k^*]$: finances k^* with bank credit
- $a_m^e < a^*$: liquidity constraint binds; surplus equals non-pledgeable output net of real balances

$\Rightarrow i > 0$ rules out first case by envelope argument

Equilibrium

A monetary equilibrium with internal and external finance is a list (k_m, k_c, r, Y) that solves

- Choice of real balances
- Bargained level of investment and interest rate
- Consistency with aggregate demand

Fit non-standard beta distribution to pledgeability coefficients

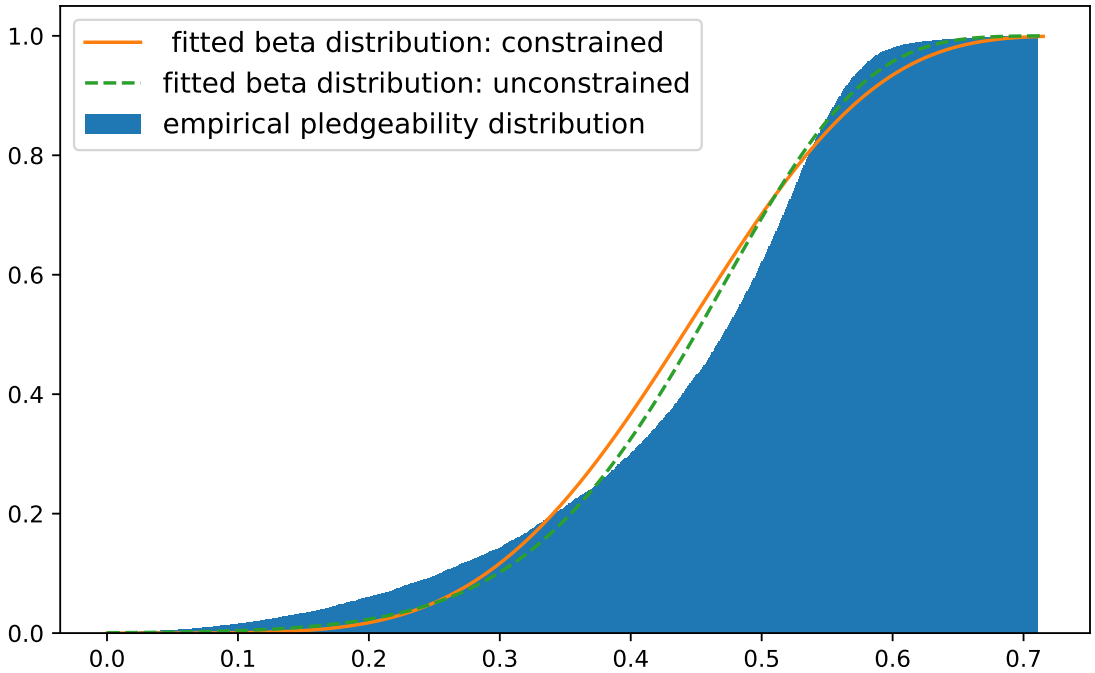


Figure 4: Cumulative distribution function of pledgeability coefficients on universe of Compustat data, 1964-2017. Pledgeability coefficients target expected liquidation value for receivables, inventory, and capital based on estimates from Berger et. al (1996) on discontinued operations of 72%, 55%, and 54%, respectively

Calibration: 1964-2017, annual

Parameter	Values	Calibration Strategy
γ	0.837	Semi-elasticity of output$= -0.7$ (Dedola and Lippi 2005)
α	0.900	Loan application acceptance rate (SSBF 2007)
λ	0.861	Semi-elasticity of money demand$= -7$ (Lucas, 2000)
σ	0.745	Sales-weighted gross markup=1.34
θ	0.583	Real lending rate: 2.4% (RWZ 2017)
i	0.048	3-month T-bill rate (nominal)
μ	0.439	MLE estimation of pledgeability distribution
σ_χ	0.106	MLE estimation of pledgeability distribution
t_0	-46.910	MLE estimation of pledgeability distribution
t_1	0.809	MLE estimation of pledgeability distribution

Table 1: Calibration strategy

Cash holdings, product diversity, and financial constraints

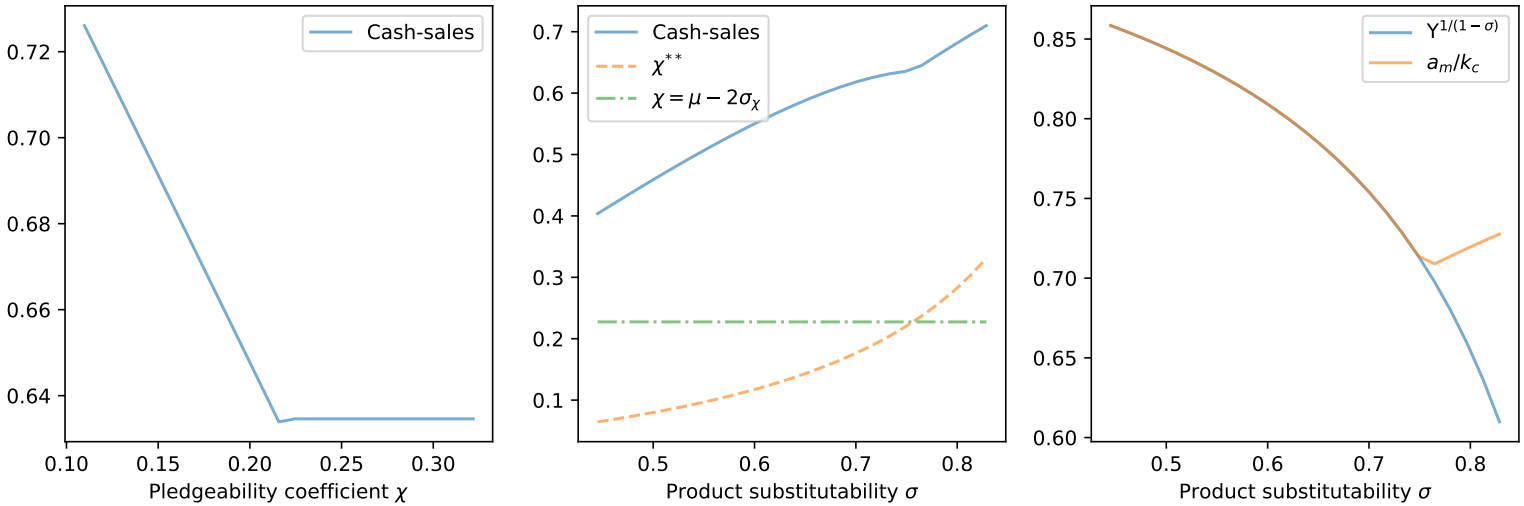


Figure 5: Cash holdings, product diversity, and financial constraints

.

Key interaction: desired investment depends on level of competition and hence affects whether financial constraints bind

Takeaway

- Cash-sales falls with asset pledgeability (rises with financial frictions)
- For unconstrained firms, cash-to-investment falls with competition
- Cash-sales rises with competition, provided firms are financially constrained, and usually rises even if unconstrained
- Tradeoff of higher competition for financially unconstrained firms
  - As firms become more competitive, wish to expand production since marginal revenue approaches price
  - Lower markups reduces cash per unit of investment

The financial multiplier

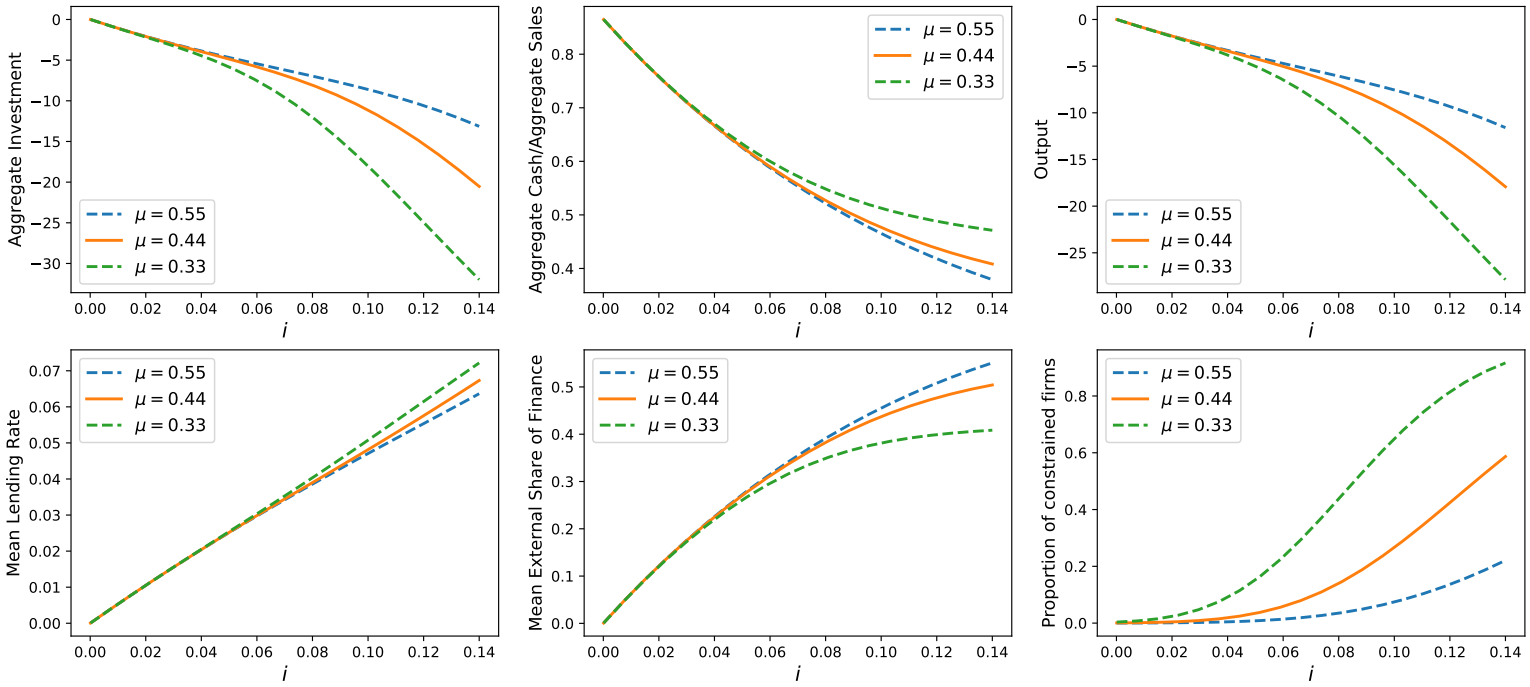


Figure 6: Pass Through of Nominal Interest Rate: different values of μ. The vertical axes in the top panel represent proportional deviations from the initial value. The vertical axes of the bottom panel are in levels.

Interactions between financial frictions and aggregate demand externality

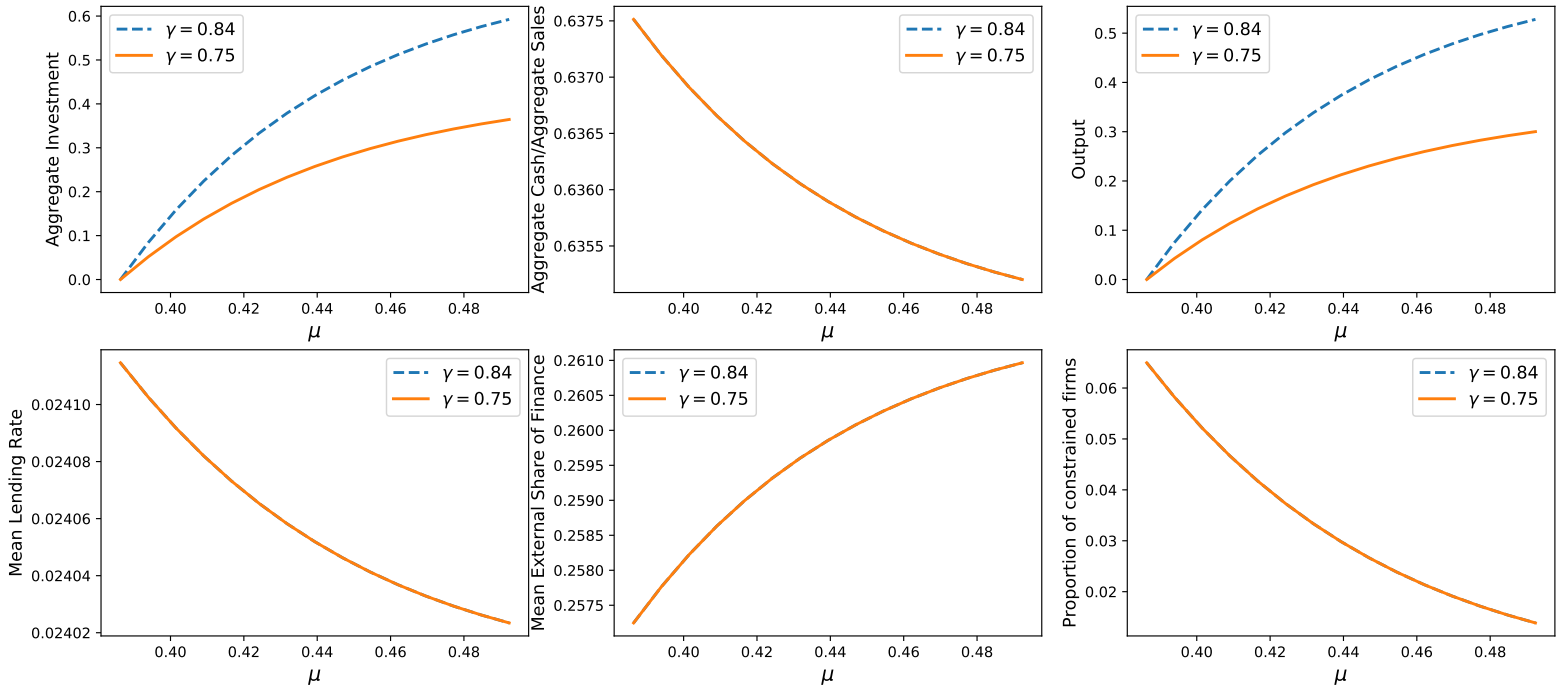


Figure 7: Pass Through of Nominal Interest Rate: different values of μ. The vertical axes in the top panel represent proportional deviations from the initial value. The vertical axes of the bottom panel are in levels.

Cross section of transmission

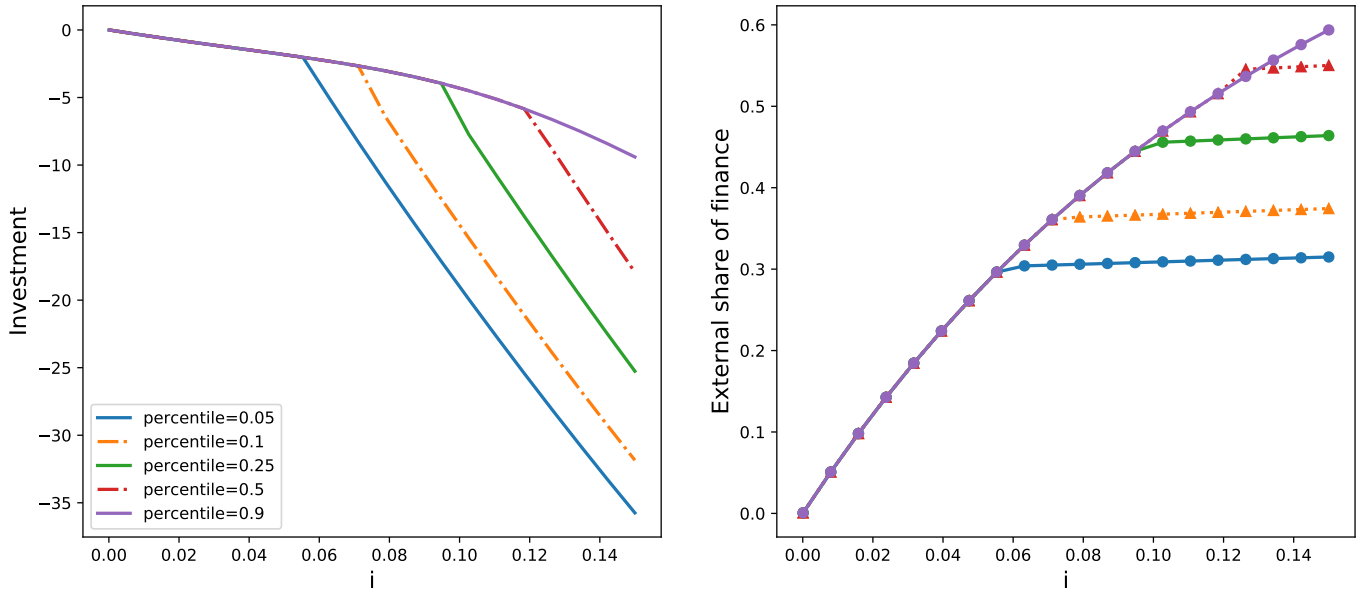


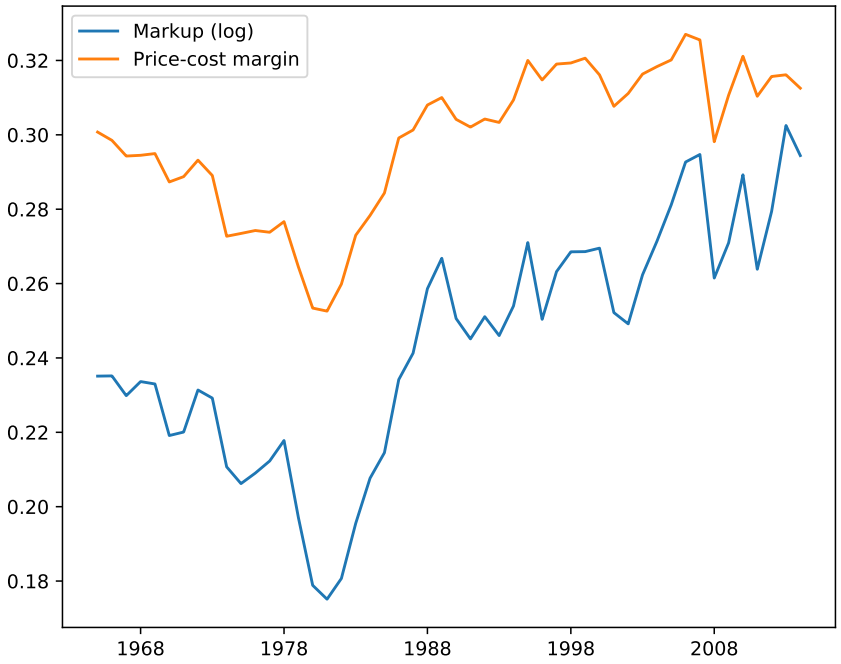
Figure 8: Cross section of transmission by pledgeability coefficient. Investment is expressed in percentage deviations from the initial value and the external share of finance is in levels.

- Supports size as proxy for financial frictions and cross-sectional analysis after controlling for non-financial factors (Gertler and Gilchrist 1994)

Testing link between market power, financial frictions, and cash holdings

- Model predicts that competition and financial frictions raise cash holdings
- Compustat data from 1964-2017 (spans publicly traded firms)
- Publicly traded firms account for about $1/3$ of aggregate employment (Davis et. al 2006) and about 41% of sales (Asker et al. 2014)
- Idea is to estimate markups from production approach and test hypothesis
- Production approach to markup estimation relies on cost minimization (De Loecker and Eeckhout 2017, Ackerberg et al. 2006)

Estimated markup and cash holdings relative to sales



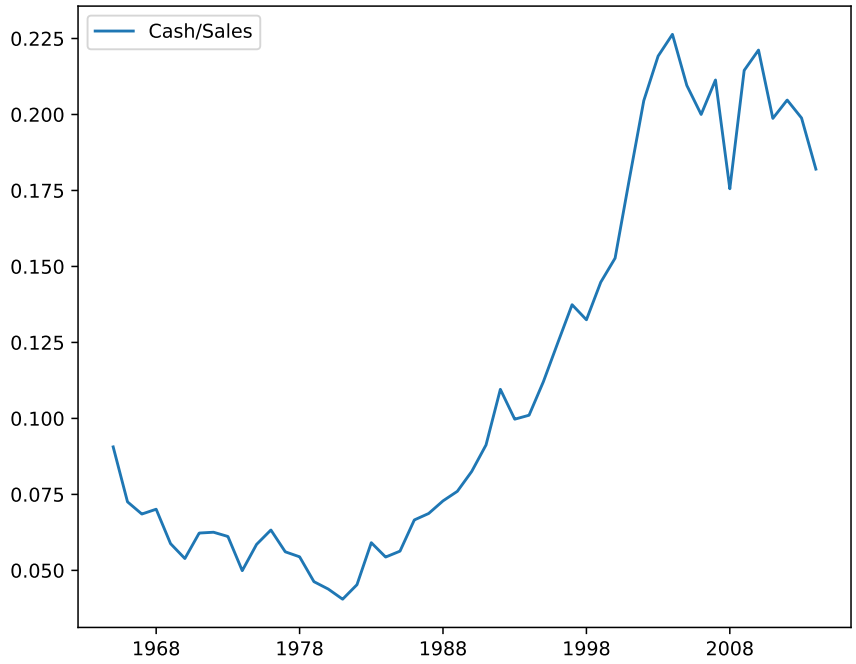


Figure 9: Estimated markup and the price-to-cost margin in the left-hand panel and the cash-sales ratio in the right-hand panel. All four series have been winsorized with a 1% band.

Regression specification

$$cash_{i,t} = \beta_1 \mu_{i,t-1} + \beta_2 \chi_{i,t-1} + \beta_3' \Gamma_{i,t-1} + \alpha_j + \lambda_t + \varepsilon_{i,t}$$

- $cash_{it}$: cash/sales
- μ_{it}: log of estimated markup or price-to-cost margin
- χ_{it}: measure of asset pledgeability
- Γ_{it}: firm-level controls: firm size, market-to-book ratio, cash flow
- Industry fixed effects α_j and time fixed effects λ_t

Regression output

	Constructed markup	Price-to-cost margin
Markup (log)	-0.946***	
	(0.041)	
PCM		−0.718***
		(0.024)
Pledgeability	−1.707***	−1.196***
	(0.106)	(0.096)
Size	−0.166***	−0.117***
	0.007	0.006
Market-to-Book	0.001	0.000
	(0.001)	(0.001)
Cash flow	0.024***	0.037***
	(0.009)	(0.013)

Table 2: The dependent variable is cash/sales. The independent variable is the constructed markup in the first column and the price-to-cost margin in the second column. The time range is 1964-2017. Standard errors, in parentheses below the estimate, are clustered at the firm level.

Demeaned cash/sales and demeaned log markups

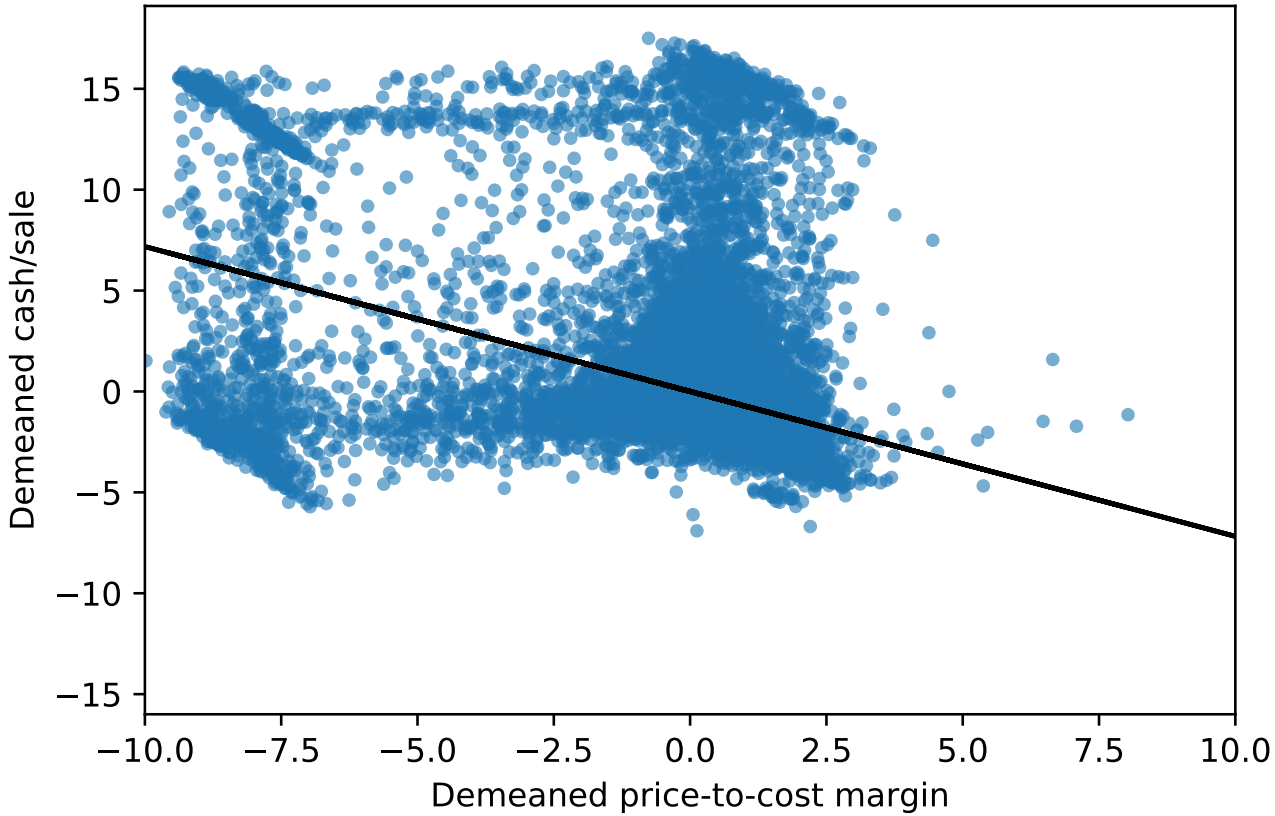


Figure 10: Cash/sales and the price-to-cost margin. Each series is demeaned by industry-and-year fixed effects, pledgeability, and the set of controls $\Gamma_{i,t}$. The two series are winsorized with a 1% band. The dark line is the lest squares regression line.

Conclusion

- Study effects of monetary policy and corporate-finance implications under
  - heterogeneous financial frictions (disciplined according to constructed pledgeability)
  - monopolistic competition
  - OTC market for credit (bank bargaining power, search frictions)
- Aggregate demand externality raises transmission and interacts strongly with financial frictions
- Greater financial frictions and competition induce induce firms to hold more cash
- More financially constrained (and smaller) firms are more greatly affected by monetary policy
- Find empirical support that cash/sales is positively linked to competition and financial frictions

Limitations and extensions

- More evidence on heterogeneity of financial frictions
- Entry margins of firms/banks
- Bank-firm lending relationships
- Dynamics
  - Variable price of capital
  - Dynamic multiplier operating through net worth/asset prices a la Kiyotaki and Moore (1997) and BGG (1999)
  - Challenges with aggregation