Firm Heterogeneity and the Transmission of Central Bank Credit Policy

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What is the role of firm heterogeneity for the transmission of central bank credit policy?

What is the role of firm heterogeneity for the transmission of central bank credit policy?

- Firm Heterogeneity: degree to which firms are affected by borrowing constraints; sources of debt financing
- Credit Policy: central bank purchases of corporate debt

- Purchasaes of specific assets affect firms differently, depending on which debt instruments they use
- Credit Policy objective: ease borrowing constraints for firms and stimulate investment
 - Firms affected by borrowing constraints to heterogeneous degree
 - Credit Policy likely to induce heterogeneous response across firms

\Rightarrow Firm distribution potentially affects effectiveness of credit policy

Approach

Theoretical model with limited firm heterogeneity:

- New-Keynesian model à la Bernanke et al. (1999)
- Two ex-ante heterogeneous firm subsectors
 - Calibration: constrained and unconstrained subsector
 - Debt financing from specialised intermediaries
- Credit policy: central bank intermediation as in Gertler and Karadi (2011)

Within this model:

- **Transmission** of credit policy shock
- **②** The role of credit policy **implementation**
- Iffectiveness of credit policy in a financial crisis

Preview of Findings

- Highly differential response to credit policy between subsectors
 - Constrained response positive, unconstrained response negative
 - Rationale: general equilibrium increase in price of capital and financial accelerator
 - \Rightarrow Reduced aggregate effectiveness (-40%) compared to rep. agent setting
 - \Rightarrow Reallocation of capital across subsectors

• Implementation influences effectiveness

- "Unconstrained only" policy most effective
- \Rightarrow Effectiveness determined by financial accelerator

- Credit policy
 - Gertler and Karadi (2011,2013); Curdia and Woodford (2011); Sims and Wu (2020); Caballero and Simsek (2020)
- Firm borrowing constraints
 - Bernanke and Gertler (1989), Carlstrom Fuerst (1997), Lian and Ma (2021), Drechsel (2021)
- Combining costly state verification and costly enforcement friction
 - Kühl (2018), Rannenberg (2016)
- Firm heterogeneity and monetary policy
 - Reiter et al. (2013), Jeenas (2019), Cloyne et al. (2019), Anderson and Cesa-Bianchi (2020); Ottonello and Winberry (2020)

Contribution: firm heterogeneity and credit policy

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Outline

Introduction





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Model Overview

• As in BGG('99); Households, K-Prod., Retailers, MP: standard Details



• New: credit policy, het. firm subsectors, specialised intermediaries Aggregation

Financial Contract and Heterogeneity

- Borrowing subject to friction as in Bernanke et al. (1999)
- Financial contract: Default risk premium increasing in leverage; upward sloping marginal cost of capital curve Friction Illustration

$$\frac{E_t\{R_{i,t+1}^k\}}{R_{i,t+1}^b} = s\left(\frac{Q_tK_{i,t+1}}{N_{i,t+1}}\right)$$

where s'(x) > 0 for x > 1.

- Dimension of subsector heterogeneity: Turnover rate $(1 \gamma_i)$
- Implies heterogeneous steady state levels of net worth, capital and leverage, default risk premium Details Illustration
- Younger firms are smaller and more constrained

Financial Intermediation

Specialised intermediaries modelled in the spirit of Gertler and Karadi (2011):

- Lend exclusively to one of the two subsectors
- Subject to costly enforcement problem: intermediary can divert funds
- Incentive constraint gives rise to endogenous leverage constraint:

$$B_{i,t+1}^b = \phi_{i,t} N_{i,t}^b$$

• Limit on amount of funds that can be intermediated \rightarrow spread btw. (default risk-free) lending and deposit rate not completely closed:

$$\frac{R^b_{i,t+1}}{R_{t+1}} > 1$$

 \Rightarrow "Excess Bond Premium" (Gilchrist and Zakrajsek, 2012)

External Finance Premium

• Total marginal cost of capital determined by external finance premium (EFP)



- Financial contract \rightarrow default risk premium (DRP):
 - Compensation for expected losses from (costly) default
- Costly enforcement problem \rightarrow excess bond premium (EBP):
 - Part of the EFP in excess of compensation for individual default risk
 - Interpretation: intermediation capacity of specialised intermediaries.

As in Gertler and Karadi (2011):

- Financial intermediation by the central bank
 - Not subject to costly enforcement problem
- Relaxation of endogenous leverage constraint and reduction in EBP
 - Increase in "intermediation capacity of the financial system"

Calibration

- Calibrated to the US
- Standard parts (Households, NK block): as in BGG('99)
- Intermediaries: as in Gertler and Karadi (2011)
- Firm parameters: match financial characteristics in BGG('99)
 - Mean annual default rate: 3% p.a.
 - Leverage ratio: 2
- To induce targeted values:
 - Survival probabilities: $\gamma_c = 0.973$, $\gamma_u = 0.986$
 - Variance of idiosyncratic shock: $\sigma^2 = 0.06$
 - Auditing cost: $\mu = 0.45$

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Effects of a Credit Policy Shock



Figure: Dynamic consequences of a simultaneous credit policy shock in both subsectors ("across the board" purchases)

Comparison to Representative Firm Benchmark



- Reduced effectiveness of credit policy under heterogeneity
- Highly differential response and capital reallocation between subsectors



Inspecting the Mechanism



- Decomposition of capital responses according to targeted subsector
 - Impact: Crowding out (role of financial accelerator!)
 - Long-Run: reallocation due to change in relative financial constraints

The Role of Credit Policy Implementation



Figure: Investment response to credit policy shock

- Unconstrained-only policy most effective.
- Why? Financial accelerator dampens crowding out.

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Conclusion

- Analysis of credit policy in a two agent NK model
- Results:
 - ► Role of firm heterogeneity in CP transmission: lower aggregate response
 - Intuition: importance of general equilibrium effects and financial accelerator (crowding out, reallocation)
 - Role of policy implementation
- Complementary project: empirical analysis of whether effects and mechanisms are consistent with the data
 - Look at effects of shocks to the excess bond premium
- More theoretical analysis: welfare

Thank you for your attention!

Appendix

Housholds

• Standard Optimisation problem

$$\max \quad E_t \sum_{k=0}^{\infty} \beta^k \left[\ln(C_{t+k}) + \xi \ln(1 - H_{t+k}) \right]$$

s.t.
$$C_t = W_t H_t + R_t D_t - D_{t+1} + \Theta_t^r + \Theta_t^b$$

• First order conditions

Consumption Euler

$$\frac{1}{C_t} = E_t \left[\beta \frac{1}{C_{t+1}} R_{t+1} \right]$$

Labour supply

$$W_t \frac{1}{C_t} = \frac{\xi}{1 - H_t}$$

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- Combine final goods with existing capital into new capital
- Zero profits, constant returns, capital adjustment costs
- Evolution of capital:

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right)K_t + (1-\delta)K_t$$

Price of capital

$$Q_t = \left[\Phi'\left(\frac{I_t}{K_t}\right)\right]^{-1}$$

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Role: separate price rigidities from investment decision

- One-to-one transformation of homogeneous intermediate into differentiated retail goods
- Final good is a composite of individual retail goods

$$Y_t^f = \left(\int_0^1 Y_t(i)^{\frac{\epsilon-1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}$$

• Price setting á la Calvo (1983)

Taylor rule as in BGG('99)

$$\frac{R_t^n}{R^n} = \left(\frac{R_{t-1}^n}{R^n}\right)^{\rho_m} \left(\frac{\Pi_{t-1}}{Pi}\right)^{\zeta} \exp(\varepsilon_t^m)$$

Intermediate Goods Production and Aggregation

- Continuum of firms divided into two subsectors
- Intermediate good produced in group $i \in \{u, c\}$ according to

$$Y_{it} = A_t K^{\alpha}_{it} L^{(1-\alpha)}_{it}$$

with $L_{it} = H_{it}^{\Omega}(H_i^e)^{(1-\Omega)}$

- Labour H_{it} hired on competitive labour market
- Capital K_{it} purchased from capital producers in t-1 at price Q_{t-1}
- Const. returns to scale: perfect aggregation within subsectors
- Aggregates:
 - Intermediate output: $Y_t = (s_c Y_{c,t}^{\rho} + s_u Y_{u,t}^{\rho})^{1/\rho}$
 - Capital: $K_t = s_c K_{ct} + s_u K_{u,t}$

Financial Friction (1/2)

• Representative subsector *i* firm balance sheet

$$Q_t K_{i,t+1} = N_{i,t+1} + B_{i,t+1}$$

• Borrowing in one period bonds $B_{i,t+1}$ from competitive intermediaries

subj. to costly state verification friction (Townsend, 1979)

- Idiosynrcatic ret. on capital $\omega^j R^k_{i,t+1}$ with $\ln(\omega^j) \sim N(-\frac{1}{2}\sigma^2,\sigma^2)$
- **Optimal contract:** cutoff $\bar{\omega}_{it}$ with default if $\omega^j < \bar{\omega}_{it}$.
 - ▶ Non-default: intermediary receives $\bar{\omega}_i R_{i,t+1}^k Q_t K_{i,t+1} = Z_{i,t+1} B_{i,t+1}$
 - Default: Intermediary recovers $(1 \mu)\omega^j R_{i,t+1}^k Q_t K_{i,t+1}$

<u>Define</u>

• Gross profit share going to the lender: (dropping j superscript)

$$\Gamma(\bar{\omega}_i) \equiv \int_0^{\bar{\omega}_i} \omega^j f(\omega^j) d\omega^j + \bar{\omega}_i \int_{\bar{\omega}_i}^\infty f(\omega^j) d\omega^j$$

• Expected total monitoring costs:

$$\mu G(\bar{\omega}_i) \equiv \mu \int_0^{\bar{\omega}_i} \omega^j f(\omega^j) d\omega^j$$

Firm Profit Maximisation

• Firms maximise profits s.t. zero-profit of intermediary

$$\max_{K_{i,t+1},\bar{\omega}_{i}} (1 - \Gamma(\bar{\omega}_{i}))R_{i,t+1}^{k}Q_{t}K_{i,t+1}$$

s.t. $[\Gamma(\bar{\omega}_{i}) - \mu_{t}^{e}G(\bar{\omega}_{i})]R_{i,t+1}^{k}Q_{t}K_{i,t+1} = R_{t+1}(Q_{t}K_{i,t+1} - N_{i,t+1})$

• FOCs imply:

• External finance premium:
$$\frac{R_{i,t+1}^k}{R_{t+1}} = \rho(\bar{\omega}_i)$$

• Leverage: $\frac{Q_t \kappa_{i,t+1}}{N_{i,t+1}} = \psi(\bar{\omega}_i)$

Finally:

$$\frac{R_{i,t+1}^k}{R_{t+1}} = \rho\left(\psi^{-1}\left(\frac{Q_t K_{i,t+1}}{N_{i,t+1}}\right)\right) = s\left(\frac{Q_t K_{i,t+1}}{N_{i,t+1}}\right)$$

 \Rightarrow Firm's leverage determines cost of funds

Financial Contract - Illustration



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Financial Heterogeneity

- Turnover rate $(1 \gamma_i)$ prevents firms from escaping constraint
- Evolution of net worth in subsector *i*:

$$N_{i,t+1} = \gamma_i V_{it} + H^e_{it} W^e_{it}$$

- Dimension of subsector heterogeneity: γ_i
- Implies heterogeneous steady state levels of:
 - Net worth
 - Capital and leverage
 - Default risk premium
- Younger firms are smaller and more constrained

Illustration

• Assume $\gamma_c < \gamma_u$ with γ_u sufficiently large for subsector u firms to be effectively unconstrained



Note: $\gamma_c = \gamma_u$ implies setting in Bernanke et al. (1999)

External finance premium - Illustration



EBP shifts up the marginal cost of capital curve

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Evolution of Credit Spreads



Source: Gilchrist and Zakrajšek (2021) Back

Parameter	Explanation	Value	Source
ξ	Disutility of labour	10.6	BGG
β	Discount factor	0.99	BGG
ϵ	Elasticity of substitution between retail goods	8	BGG
θ	Fraction of retailers unable to adjust prices	0.75	BGG
δ	Capital depreciation rate	0.025	BGG
η	Elasticity of capital price w.r.t. investment capital ratio	0.25	BGG
à	Capital share in production	0.35	BGG
Ω	Household labour share in total labour	0.99	BGG
ζ	Taylor rule weight on inflation	0.18	-
ρ_m	Taylor rule smoothing parameter	0.9	-
a	Share of constrained firms	0.528	OW
$\rho_{\rm V}$	Elasticity of substitution between intermediate goods	0.8	KuZ
λ_{b}	Fraction of divertible intermediary assets	0.381	GK11
ω_b	Fraction of assets transferred to entering bankers	0.002	GK11
θ^{b}	Survival rate of bankers	0.972	GK11

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Metric/Parameter	Explanation	Value	Source
Targeted values			
$F(\omega)$	Default probability (quarterly)	0.0075	BGG
$\frac{QK}{N}$	Average leverage ratio of firms	2	BGG
$\frac{R_u^k}{R_u^b}$	Def. risk premium of unconstrained firms	1	-
Implied parameter	values		
σ	Parameter governing distribution of ω	0.06	-
γ_c	Survival rate of constrained firms	0.973	-
γ_{u}	Survival rate of unconstrained firms	0.986	-
S _C	Share of constrained firms	0.5	-
μ	Monitoring cost to intermediary	0.45	-

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- Direct effect of credit policy benefits all firms
- Additionally: Financial accelerator for constrained firms
- Crowding out effect induces negative response by unconstrained

Credit Policy Shock - Identical firms

Figure: Dynamic consequences of a credit policy shock - identical firms

Credit Policy Shock - Aggregate responses

Figure: Dynamic consequences of a credit policy shock - model aggregates

Robustness: Different Rep. Agent Benchmark

Figure: CP Investment response - different rep agent benchmarks

• Difference to het agent outcome robust to choice of proxy

Financial Crisis - Stbilisation with Identical firms

Figure: Financial Crisis and Credit Policy - identical firms

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Stabilisation with Heterogeneous Firms

Figure: Financial Crisis and Stabilisation - heterogeneous firms

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