Risk Aversion, Uninsurable Idiosyncratic Risk, and the Financial Accelerator

Giacomo Candian
HEC Montréal

Mikhail Dmitriev
FSU

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Entrepreneurship Risk and the Business Cycle

- Entrepreneurs are inevitably exposed to **non-diversified risk** and face extreme dispersion in equity returns
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  - Assume no idiosyncratic risk (Kiyotaki and Moore, 1997)

  - Assume borrower risk neutrality (Bernanke,Gertler and Gilchirst, 1999)

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When borrowers can't fully insure idiosyncratic risk, do financial frictions still amplify business cycles?

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Our contribution

- Develop tractable model to study macro effects of risk aversion and uninsurable risk in the presence of agency frictions.
  - Extend results from contract theory (Tamayo, 2014)
  - Embed in BGG-style NK framework
- Show that presence of uninsurable risk stabilizes the business cycle

Findings

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- Financial shocks have substantially smaller effects (60% smaller effect on output)
- Firm-level evidence is consistent with our model:
  - firms with higher risk aversion display higher responsiveness of investment to future capital returns

Relation to the Literature

- Incomplete markets and investment risk
  - Angeletos and Calvet (2005), and Angeletos (2007), Covas (2006), Meh and Quadrini (2006)
  - These authors focus on steady state and/or abstract from aggregate shocks
- Aggregate risk sharing between lenders and borrowers
  - Dmitriev and Hoddenbagh(2017) and Carstrom, Fuerst and Paustian (2016)
  - Amplification decreases when lenders and borrowers are able to share aggregate risk
- We study the implications of uninsurable risk for the transmission of shocks over the cycle
- We show that self-insurance motive arising from uninsurable idiosyncratic risk also decreases amplification

Outline

Lenders and Borrowers

- Borrower invests QK
- Project returns $QKR^k\omega$, $\ln(\omega) \sim \mathcal{N}(-\frac{1}{2}\sigma^2, \sigma^2)$ and $E(\omega) = 1$.

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- Borrower reports $s(\omega)$, which is verified by the lender if $\omega \in \Omega^V$.
- We guess and verify that reports are truthful everywhere

The Contracting Problem

Definition

A contract under CSV is an amount of borrowed money B, a repayment function $R(\omega)$ in the state of nature ω and a verification set Ω^V, where the lender chooses to verify the state of the world.

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- Optimal contract solves

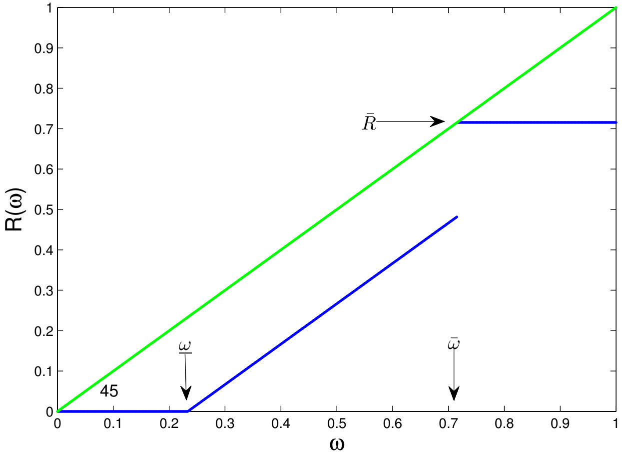
$$\max_{K,R(\omega)} \frac{1}{1-\rho}\int_0^\infty [QKR^k(\omega - R(\omega))]^{1-\rho} dF(\omega) \tag{1}$$

$$QKR^k \int_0^\infty R(\omega)dF(\omega) - \mu QKR^k \int_{\omega\in\Omega^V} \omega dF(\omega) \geq BR \tag{PC}$$

$$QK = B + N \tag{CB}$$

$$0 \leq R(\omega) \leq \omega \tag{RC}$$

The Static Financial Contract



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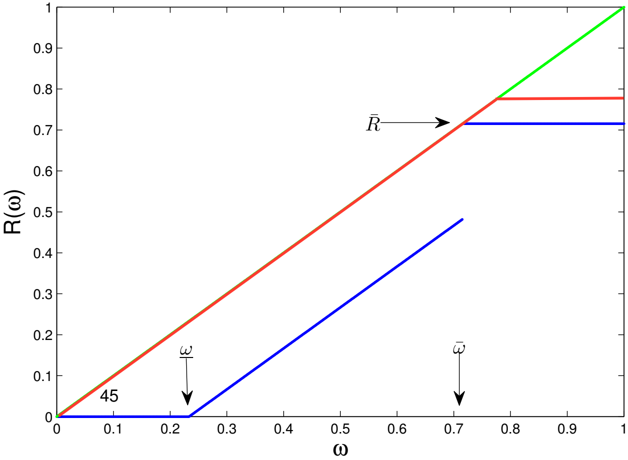

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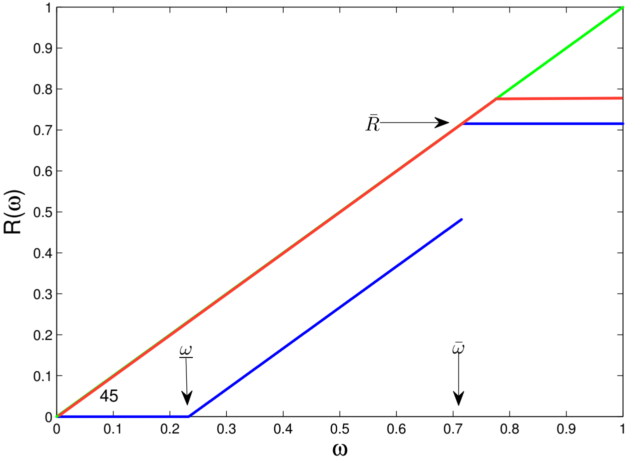
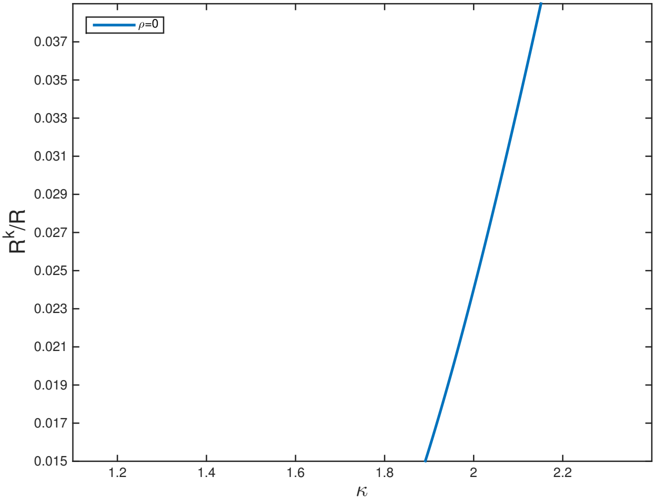
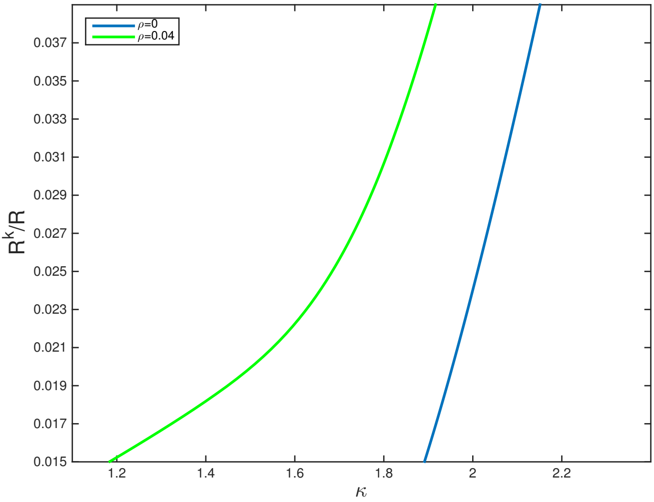


- Optimal contract features a self-insurance component in low states
- Borrowers optimally transfer risk to lenders in low states of the world

Contract Curve



Increase in Risk Aversion



▸ Leverage, Risk Aversion, and Vol

Dynamic Problem with Aggregate Risk

- Entrepreneurs buy K in period t, returns R^k realized in $t+1$
- Entrepreneurs survive with probability γ. They maximize

$$(1-\gamma)\sum_{s=1}^{\infty}\gamma^s\mathbb{E}_t\left\{\frac{(C^e_{t+s})^{1-\rho}}{1-\rho}\right\}$$

- Challenge: how do we aggregate? We assume:
  - Entrepreneurs consume when they die
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- Challenge: how do we aggregate? We assume:
  - Entrepreneurs consume when they die
  - Entrepreneur work only in the first period of their lives
- Lenders are competitive, diversify loans, and pay a predetermined interest rate to the household (as in BGG)
- Household's participation constraint is:

$$\beta\mathbb{E}_t\left\{\frac{U_{c,t+1}}{U_{c,t}}\right\}R_t = 1$$

The Financial Contract with Aggregate Risk

Proposition

The log-linearized solution to the contract yields

$$\hat{\kappa}_t = \nu_p(\mathbb{E}_t \hat{R}^k_{t+1} - \hat{R}_t) + \nu_\sigma \hat{\sigma}_{\omega,t}$$

- Same equation as in financial accelerator model with risk shocks
- Risk aversion changes ν_p and ν_σ
- In our contract simulations we find that

$$\frac{\partial \nu_p}{\partial \rho} > 0 \qquad \left|\frac{\partial \nu_\sigma}{\partial \rho}\right| > 0.$$

$\rightarrow$ leverage is more sensitive to changes in expected returns and changes in idiosyncratic volatility when entrepreneurs are risk averse!

The heart of the Financial Accelerator

- There are three forces determining the strength of the financial accelerator:
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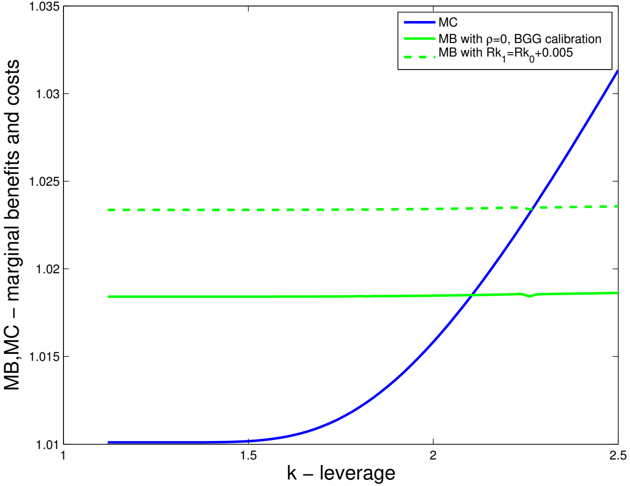
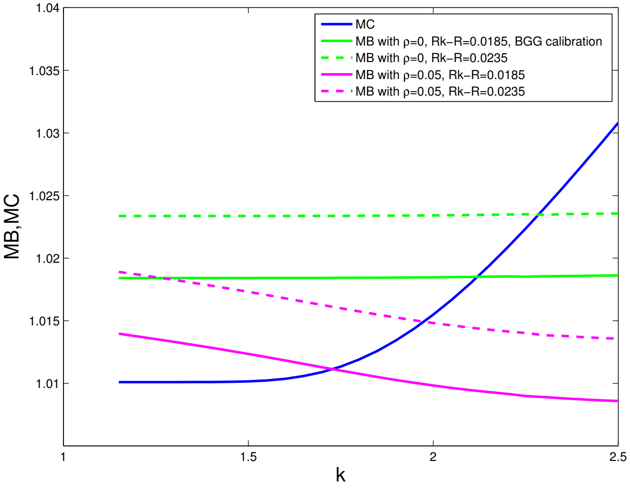
  through ν_p
- In a frictionless economy $\nu_p = \infty \implies \mathbb{E}_t \hat{R}^k_{t+1} = \hat{R}_t$ and leverage is irrelevant
- With agency frictions . . .

Start from risk-neutral case . . .



- demand for funds is infinitely elastic because of CRS and because entrepreneurs care only about average returns
- ν_p depends only on the elasticity of supply of funds

. . . and increase risk-aversion



When risk aversion rises

1. **leverage effect**: Entrepreneurs borrow less ex ante, dampening net worth fluctuations $\implies$ more stabilization
2. **supply-elasticity effect**: with lower leverage there are fewer agency frictions, and the supply of funds is more elastic $\implies$ more stabilization
3. **demand-elasticity effect**: entrepreneurs are reluctant to increase leverage ex post, because this would increase the volatility of their returns $\implies$ more amplification

Which forces dominate?

General Equilibrium NK model

- Entrepreneurs rent capital to perfectly-competitive wholesalers
- Wholesalers combine capital and labor in production
- Monopolistically competitive retailers buy goods from wholesalers, differentiate them and apply a mark-up
- The household maximizes $\mathbb{E}_t \left\{ \sum_{s=0}^{\infty} \beta^s \left[\frac{C_{t+s}^{1-\sigma}}{1-\sigma} - \chi \frac{H_{t+s}^{1+\eta}}{1+\eta} \right] \right\}$
- Capital adjustment costs
- Nominal rigidities
- Taylor rule for monetary policy

▸ Equations

Calibration - Case 1

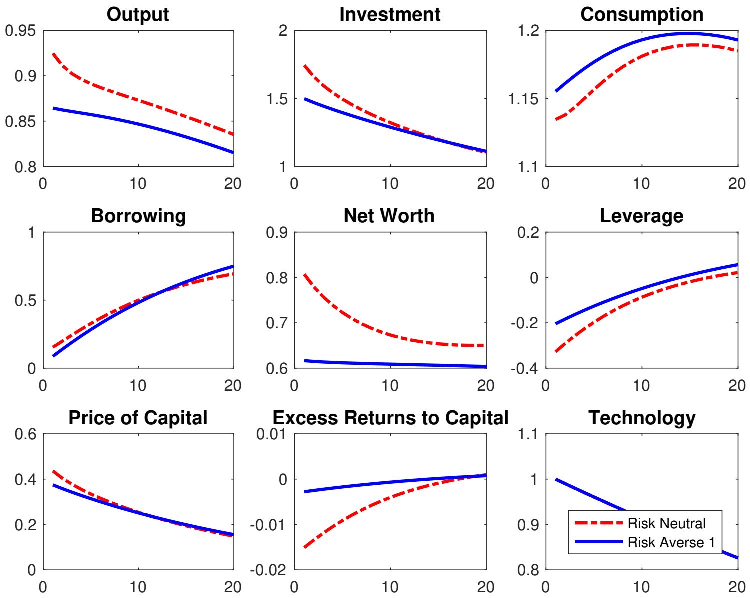
We first explore quantitatively a pure increase in risk aversion

Symbol	Description	Neutral	Averse 1
A. Calibrated parameters			
ρ	Risk aversion	0.0	0.05
σ_ω	Std. id. productivity	0.28	0.28
γ	Survival probability	0.977	0.977
μ	Monitoring costs	0.120	0.120
B. Implied steady-state values			
κ	Leverage	2.00	1.63
$\log(R^k/R)$	Premium (%)	2.5	2.8
$\Phi(\bar{\omega})$	Default rate (%)	3.8	0.2
C. Implied elasticities			
ν_p	Sensitivity to returns	21.7	73.4
ν_σ	Sensitivity to id. risk	-0.69	-1.27

$$\hat{\kappa}_t = \nu_p(\mathbb{E}_t \hat{R}^k_{t+1} - \hat{R}_t) + \nu_\sigma \hat{\sigma}_{\omega,t}$$

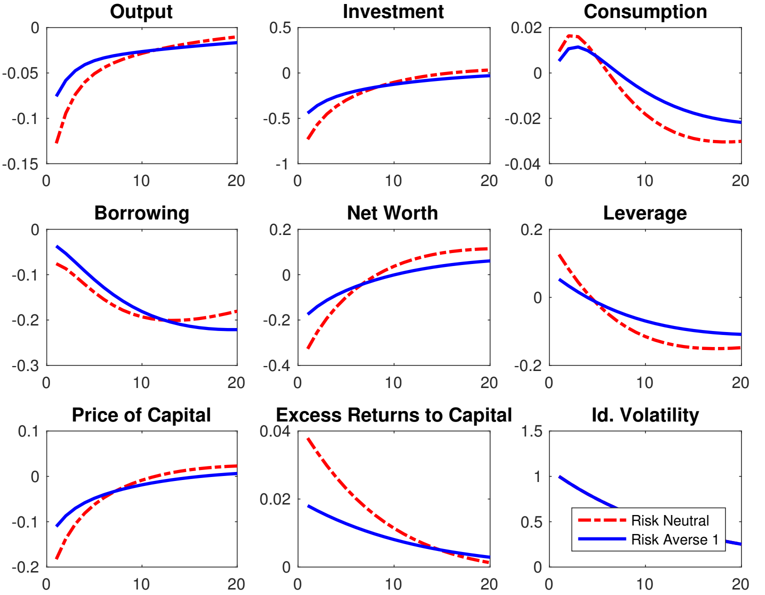
More

Impulse Responses - Technology Shock



More IRFs

Impulse Responses - Risk Shocks



More IRFs

Calibration - Case 2

- Risk-neutrality: γ, σ_ω, μ calibrated to match ss defaults, leverage, and risk premium.
- Risk-aversion: we have an extra parameter (ρ) so we target an additional moment: **firm-specific volatility**.
- Firm-specific volatility of TFP: estimates between 0.04 - 0.12
  Castro, Clementi and Lee (2010)
- Volatility of annual growth of sales: between 0.24 - 0.3
  Comin and Mulani (2006), Davis et al. (2006), Veirman and Levin (2014)
- From our model simulations, these numbers correspond to $\sigma_\omega \in (0.08, 0.1)$
- We pick $\sigma_\omega = 0.08$ and $\rho = 0.5$
- Results are robust to different choices of σ_ω as long as ρ is chosen to obtain a leverage of 2.

Calibration - Case 2

Symbol	Description	Neutral	Averse 2
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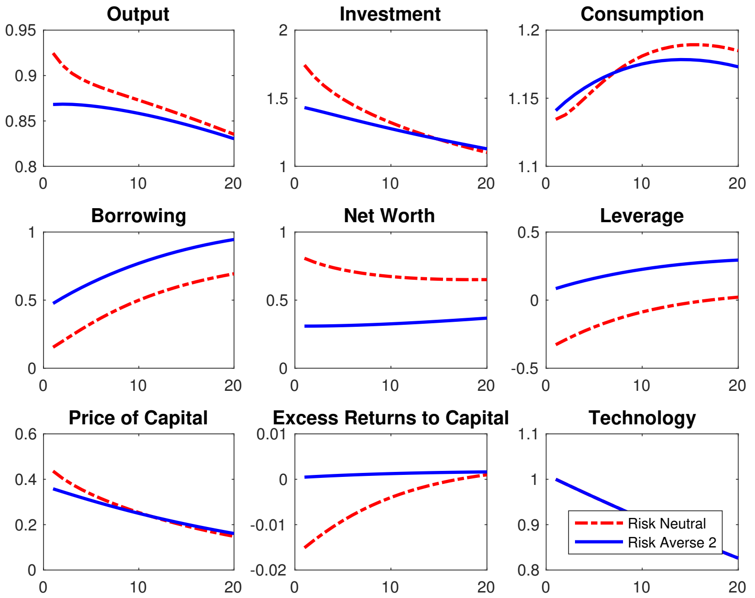
ρ	Risk aversion	0.0	0.5
σ_ω	Std. id. productivity	0.28	0.08
γ	Survival probability	0.977	0.976
μ	Monitoring costs	0.120	0.021
B. Implied steady-state values			
κ	Leverage	2.00	2.03
$\log(R^k/R)$	Premium (%)	2.5	2.5
$\Phi(\bar{\omega})$	Default rate (%)	3.8	3.8
C. Implied elasticities			
ν_p	Sensitivity to returns	21.7	181.8
ν_σ	Sensitivity to id. risk	-0.69	-1.99

$$\hat{\kappa}_t = \nu_p(\mathbb{E}_t \hat{R}^k_{t+1} - \hat{R}_t) + \nu_\sigma \hat{\sigma}_{\omega,t}$$

▸ More

Impulse Responses - Technology Shock



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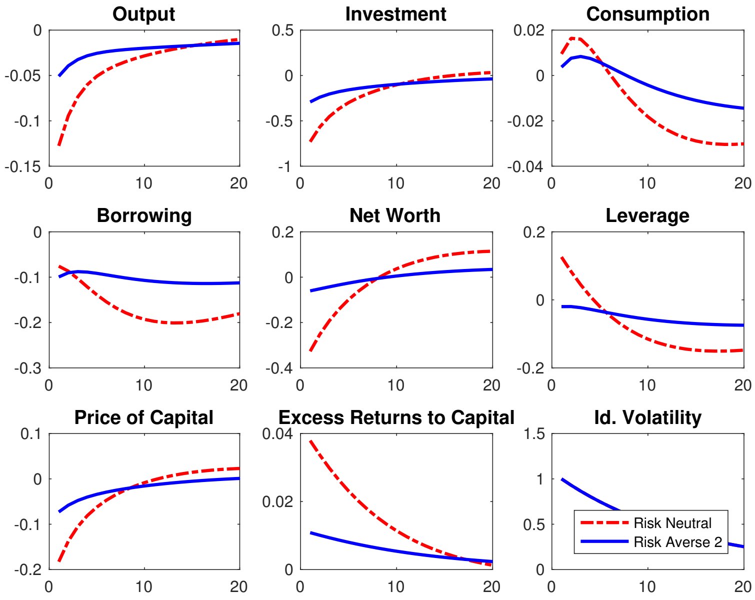
Impulse Responses - Risk Shocks



▸ More IRFs

A Test Using Firm-Level Data

- **Key theoretical result:** leverage/investment of more risk-averse entreprenuers is more responsive to expected returns to capital
- We test this on Compustat data using a variant of standard investment regressions (Gilchrist, Sim, and Zakrajsek,2014)
- **Challenge**: how do we measure risk aversion?
- Follow Panousi and Papanikolaou (2012, JF) and proxy it with managerial insider ownership (Thomson Financial)
  - Yearly holdings of a firm's shares held by firm officers (as fraction of shares outstanding).

$$(I/K)_{i,t} = \beta_0 + \beta_1 X_{i,t} + \sum_{j \in \{2,3,4,5\}} \beta_j X_{i,t} \times INSD_{i,j,t} + Z_{i,t}\gamma' + \eta_i + g_t + v_{i,t}$$

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Dependent variable: $(I/K)_{i,t}$	(1)	(2)	(3)	(4)
$\log(Y/K)_{i,t}$	***0.162	***0.154	***0.115	***0.086
	(9.72)	(9.74)	(8.15)	(6.94)
$\log(Y/K)_{i,t} \times INSD_2$	0.011	0.010	0.016	0.017
	(0.50)	(0.47)	(0.75)	(0.90)
$\log(Y/K)_{i,t} \times INSD_3$	*0.049	*0.044	0.040	0.022
	(1.85)	(1.72)	(1.60)	(0.94)
$\log(Y/K)_{i,t} \times INSD_4$	***0.114	***0.109	***0.095	***0.075
	(3.87)	(3.70)	(3.24)	(2.72)
$\log(Y/K)_{i,t} \times INSD_5$	***0.104	***0.096	***0.085	**0.046
	(3.83)	(3.57)	(3.22)	(1.99)
Observations	32,444	32,444	32,444	32,444
R^2	0.77	0.77	0.78	0.79
Fixed effects	F	F, T	F, T	F, T
Controls	No	No	Q	Q, K

Conclusions

- We study the propagation of aggregate shocks in a model of agency frictions and uninsurable idiosyncratic risk
- Self-insurance make leverage of risk-averse borrowers more responsive to changes in capital returns
- In GE, higher responsiveness significantly dampens the effect of financial shocks on key macro variables
- Our results suggest that risk-sharing across borrowers, by stripping away self-insurance motive, may undesirably increase economy's vulnerability to aggregate disturbances

Thank you!

$$-\sigma\left(\mathbb{E}_t\hat{C}_{t+1}-\hat{C}_t\right)+\mathbb{E}_t\hat{R}_{t+1}=0, \tag{2}$$

$$\hat{R}^n_t=\mathbb{E}_t\hat{R}_{t+1}+\mathbb{E}_t\hat{\pi}_{t+1} \tag{3}$$

$$\hat{Y}_t-\hat{H}_t-\hat{\mathcal{X}}_t-\sigma\hat{C}_t=\eta\hat{H}_t, \tag{4}$$

$$\hat{\pi}_t=-\frac{(1-\theta)(1-\theta\beta)}{\theta}\hat{\mathcal{X}}_t+\beta\mathbb{E}_t\hat{\pi}_{t+1}. \tag{5}$$

$$\hat{Y}_t=\hat{A}_t+\alpha\hat{K}_{t-1}+(1-\alpha)(1-\Omega)\hat{H}_t. \tag{6}$$

$$\hat{K}_t=\delta\hat{I}_t+(1-\delta)\hat{K}_{t-1}, \tag{7}$$

$$\hat{Q}_t=\delta\phi_K(\hat{I}_t-\hat{K}_{t-1}), \tag{8}$$

$$\hat{R}^k_{t+1}=(1-\epsilon)(\hat{Y}_{t+1}-\hat{K}_t-\hat{\mathcal{X}}_{t+1})+\epsilon\hat{Q}_{t+1}-\hat{Q}_t \tag{9}$$

$$Y\hat{Y}_t=C\hat{C}_t+I\hat{I}_t+G\hat{G}_t+C^e\hat{C}^e_t, \tag{10}$$

Go back

$$\hat{N}_{t+1} = \epsilon_N(\hat{N}_t + \hat{R}_{t+1} + \kappa(\hat{R}^k_{t+1} - \hat{R}_{t+1}) + \nu_\Psi \hat{\sigma}_{\omega,t}) + (1 - \epsilon_N)(\hat{Y}_t - \hat{\mathcal{X}}_t), \tag{11}$$

$$\hat{\kappa}_t = \hat{K}_t + \hat{Q}_t - \hat{N}_t \tag{12}$$

$$\hat{C}^e_{t+1} = \hat{N}_t + \hat{R}_{t+1} + \kappa(\hat{R}^k_{t+1} - \hat{R}_{t+1}) + \nu_\Psi \hat{\sigma}_{\omega,t} \tag{13}$$

$$\mathbb{E}_t \hat{R}^k_{t+1} - \mathbb{E}_t \hat{R}_{t+1} = \nu_\kappa \hat{\kappa}_t + \nu_\sigma \hat{\sigma}_{\omega,t} \tag{14}$$

$$\hat{A} = \rho^A \hat{A}_{t-1} + \epsilon^A_t \tag{15}$$

$$\hat{R}^n_t = \rho^{R^n} \hat{R}^n_{t-1} + \xi \hat{\pi}_t + \rho^Y \hat{Y}_t + \epsilon^{R^n}_t \tag{16}$$

$$\hat{G}_t = \rho^G \hat{G}_{t-1} + \epsilon^G_t \tag{17}$$

$$\hat{\sigma}_{\omega,t} = \rho^{\sigma_\omega} \hat{\sigma}_{\omega,t-1} + \epsilon^{\sigma_\omega}_t \tag{18}$$

Go back

The Financial Contract with No Aggregate Risk

- Theorem 1 allows us to reformulate the problem as

$$\mathcal{L} = \max_{\bar{\omega},\underline{\omega},\bar{R},\kappa,\lambda} \frac{(\kappa R^k)^{1-\rho} g(\bar{\omega},\underline{\omega},\bar{R})}{1-\rho} + \lambda\Big(\kappa R^k h(\bar{\omega},\underline{\omega},\bar{R}) - (\kappa-1)R\Big)$$

where $g(\bar{\omega},\underline{\omega},\bar{R})$ and $h(\bar{\omega},\underline{\omega},\bar{R})$ are correspondingly:

$$g(\bar{\omega},\underline{\omega},\bar{R}) \equiv \int_0^{\underline{\omega}} \omega^{1-\rho} dF(\omega) + \underline{\omega}^{1-\rho} \int_{\underline{\omega}}^{\bar{\omega}} dF(\omega) + \int_{\bar{\omega}}^{\infty} (\omega - \bar{R})^{1-\rho} dF(\omega)$$

$$\begin{aligned} h(\bar{\omega},\underline{\omega},\bar{R}) \equiv & (1-\mu) \int_{\underline{\omega}}^{\bar{\omega}} \omega dF(\omega) - \underline{\omega} \int_{\underline{\omega}}^{\bar{\omega}} dF(\omega) + \bar{R}[1 - F(\bar{\omega})] \\ & - \mu \int_0^{\underline{\omega}} \omega dF(\omega) \end{aligned}$$

Go back

Technical Optimization Problem for Entrepreneurs

Entrepreneurs maximize

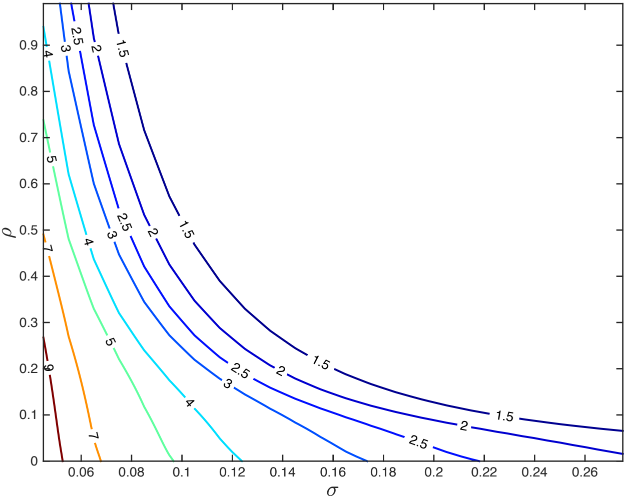
$$\max_{\kappa_t, \bar{\omega}_{t+1}, \bar{\omega}_{t+1}, \bar{R}_{t+1}} \frac{1-\gamma}{1-\rho} \kappa_t^{1-\rho} \sum_{s=1}^{\infty} \gamma^s \mathbb{E}_t \left\{ (R_{t+1}^k)^{1-\rho} g(\bar{\omega}_{t+1}, \underline{\omega}_{t+1}, \bar{R}_{t+1}) \right\} \tag{19}$$

s.t.

$$\mathbb{E}_t \left(\beta U_{c,t+1} \kappa_t R_{t+1}^k h(\bar{\omega}_{t+1}, \underline{\omega}_{t+1}, \bar{R}_{t+1}) \right) = (\kappa_t - 1) U_{c,t} \tag{20}$$

Go back

Leverage, Risk Aversion and Volatility



▸ Back

Calibrating σ_ω From Cross-Sectional Data

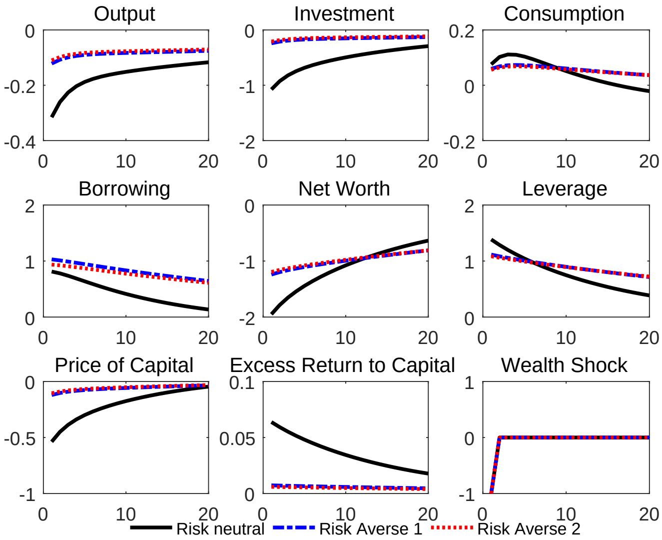
- Castro, Clementi and Lee (2010) obtain a value firm specific volatility of TFP between 0.04 and 0.12
- Comin and Mulani (2006), Davis, Haltiwanger, Jarmin and Miranda (2006), Veirman and Levin (2014) report the volatility for the annual growth of sales between 0.24 and 0.3
- From our model simulations, these numbers correspond to $\sigma_\omega = 0.08$ and $\sigma_\omega = 0.1$
- So we pick $\sigma_\omega = 0.085$ and $\rho = 0.5$
- Results are robust to different choices of σ_ω as long as ρ is chosen to obtain a leverage of 2. Back

Calibration

Parameter	Value	Description
β	0.99	Household Discount Factor
σ	1	Household Risk Aversion Parameter
η	1/3	Inverse Elasticity of Labor Supply
α	0.35	Share of Capital in Cobb-Douglas Production
ϕ_K	10	Investment Adjustment Costs
δ	0.025	Quarterly Capital Depreciation
Ω	0.99	Share of Household Labor in Production
θ	0.75	Calvo Pricing Parameter
ξ	1.1	Taylor Rule Inflation Response
ρ^{R^n}	0.9	Interest Rate Smoothing
ρ_A	0.99	Persistence of Technology Shock
ρ_{σ_ω}	0.93	Persistence of Risk Shock

Back

Impulse Responses - Wealth Shock



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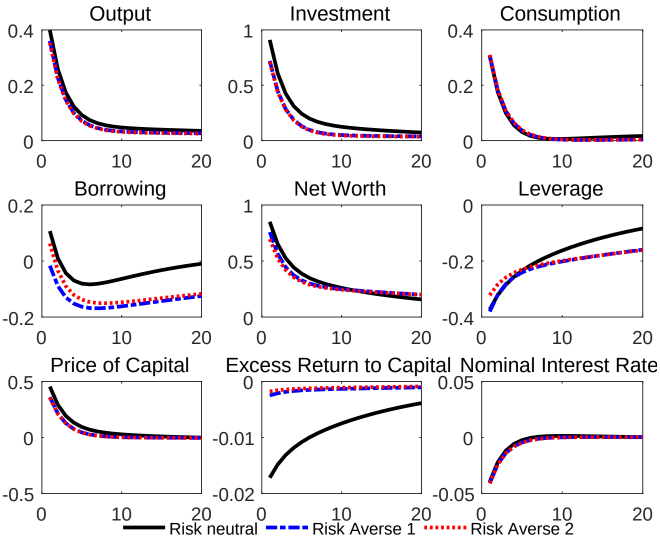
Impulse Responses - Monetary Shock



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