Credit Cycles, Market Liquidity and Heterogeneous Firms

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MASTER THESIS PROPOSAL

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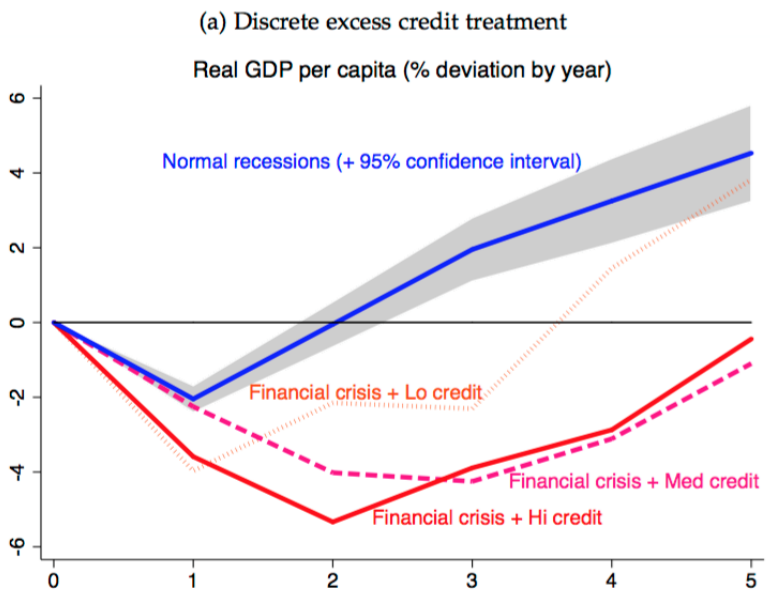
Introduction – Motivation

Figure 2: Unconditional Paths



Importance of credit for recessions – from Jordà, Schularick, and Taylor (2013)

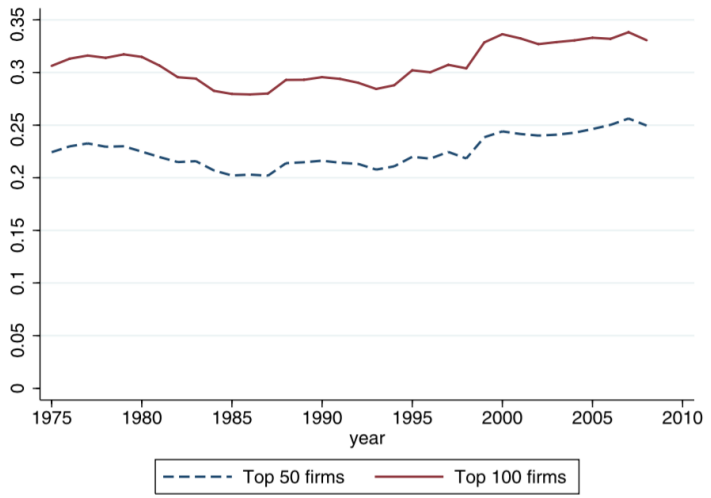


FIGURE 1.—Sum of the sales of the top 50 and 100 non-oil firms in Compustat, as a fraction of GDP. Hulten's theorem (Appendix B) motivates the use of sales rather than value added.

Granularity, top firms matter for aggregates – from Gabaix (2011)

Research question

- What is the influence of firms heterogeneity on credit cycles ?
  - Does granularity of firms amplify or smooth credit-asset prices dynamics ?
  - Does Heterogeneity enhance or exacerbate asset and capital illiquidity

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- Financial liquidity : Two dimensions
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- Firms heterogeneity :
  - Dispersion and power-law distribution
  - Hedging both idiosyncratic and aggregate risk in incomplete market
  - Credit and Collateral constraints

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  - Macro-Finance : both Market and funding illiquidity
    - Financial frictions and credit cycles : BGG (99), Kiyotaki Moore (JPE 1997), Brunnermeier and Sannikov (2014) and many others ...
  - Heterogeneous agents :
    - Households : Aiyagari (94), Kaplan-Moll-Violante (2017),Benhabib, Bisin, and Zhu (2015), Achdou, Han, Lasry, Lions, and Moll (2017)
    - Firms : Moll (2014), Winberry (2016a), Mongey and Williams (2017), Khan and Thomas (2013) [JPE]
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Research question – Empirical exercise

- *Aim :* Study of the three dimensions *together*
  - Propose a theoretical framework with heterogeneous firms, collateral constraints, and market illiquidity, in presence of aggregate risk
- Empirical relevance
  - Micro-level Firms heterogeneity
    - Cross-section data from Compustat
  - Aggregate time series
    - Micro matters for macro

  $\Rightarrow$ Structural estimation (SMM, MCMC)
- Application to Boom and Bust dynamics
  - Great Recession : From credit crunch to economic downturn

Setting

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- Heterogeneous experts :
  - Heterogeneity : Capital k_t subject to income shocks (CRS prod.)

$$dR_t = \bar{R} k_t \, dZ_t \qquad \text{with} \quad Z_t = \xi_t^i \, \zeta_t^c$$

    - Z_t productivity, ξ_t^i idiosyncratic shock : $d\xi_t^i = \mu^i dt + \sigma_t^i dW_t^i$
      ζ_t^c aggregate shock : $d\zeta_t^c = \eta(\mu^c - \zeta_t^c)dt + \sigma_\zeta^c \, \varepsilon_t^c dN_t^c$
  - Two assets portfolio choice (à la Merton 73) :
    - Risk-free Bond b_t at rate r_t vs. Risky Capital k_t at rate R_t
  - Collateral constraints and quality shocks

$$b_t \geq -\theta_t^c \, q_t \, (k_t + \bar{\theta})$$

  - Endogenous asset prices dynamics :

$$\frac{dq_t}{q_t} = \mu_t^e \, dt + \sigma_t^{c,e} \, \varepsilon_t^c \, dN_t^c$$

Setting – Expert control problem

- Reduce to one state-variable : $a_t = b_t + q_t k_t$
- Optimization problem

$$\max_{\{c_t,k_t\}_{t_0}^{\infty}} \mathbb{E}_{t_0} \int_{t_0}^{\infty} e^{-\rho_t t} u(c_t) dt$$

$$da_t = \Big[r_t\, a_t - c_t + q_t k_t \left(\bar{R}\, \mu_t^R - r_t + \mu_t^e + \lambda\, \sigma_\zeta^c\, \sigma_t^{c,e} \right) \Big] dt \qquad \text{(P)}$$
$$+ q_t k_t \bar{R}\, \sigma_t^i dW_t^i + q_t k_t (\bar{R}\, \sigma_\zeta^c + \sigma_t^{c,e})\, \varepsilon_t^c\, dN_t^c$$

$$0 \leq k_t \leq \phi(\theta_t^c, q_t, a_t) \qquad a_t \geq \varphi(\theta_t^c, q_t)$$

- Mean Field Game :
  - (i) Dynamic Programming to get the Hamilton Jacobi Bellman (HJB)
  - (ii) Mean Field Theory to get the Kolmogorov Forward (KF)

Setting – Neoclassical firm and Market illiquidity

- Representative Neoclassical firm
  - Less efficient than Experts firms
  - More patient and unconstrained : will price the asset
- Market illiquidity due to :
  - Decreasing return to scale : $dR_t^n = G'(\underline{k})\, d\zeta_t^c$, with $G' > 0,\ G'' < 0$
  - Lower average return growth $\underline{Z_t} G(\underline{k_t}) = \zeta_t^c\, G(\underline{k_t})$
- The evolution of the prices are thus determined endogenously

$$\frac{dq_t}{q_t} = \underbrace{r_t - G'(\underline{k})\,\eta(\mu^c - \zeta_t^c)}_{=\mu_t^e}\, dt \underbrace{-G'(\underline{k})\sigma_\zeta^c}_{=\sigma_t^{c,e}}\, \varepsilon_t^c dN_t^c$$

- Market for Capital (and for Bonds) clears :

$$\psi \int_{\varphi(\theta_t^c, q_t)} k_t(a) m(da) + (1-\psi)\,\underline{k_t} = \overline{K_t}$$

Mathematical problems and Algorithms

- Heterogeneous agents (HA) :
  - → Usually no analytical solutions : numerics (Bewley-Aiyagari models)
    - Called Mean Field Games in the math literature

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    - Krusell and Smith (1998) (bounded rationality), Reiter (2010) (projection and perturbation methods)
- HA models with aggregate shocks, and non-trivial distribution and non-linear dynamics
  - → ... ?
    - Achdou-Bourany (2018)
    - Ongoing work by other researchers

Result : Stationary equilibrium

- No aggregate shocks : $\sigma_\zeta^c = \sigma_\rho^c = \sigma_\sigma^c = \sigma_\theta^c = 0$
- Stationary MFG system : Competitive Equilibrium
  - HJB (Bellman) :
    $\Rightarrow$ determines controls : consumption $c^\star(a)$ and capital choice $k^\star(a)$

$$-\partial_t v(t,a) + \rho v(t,a) = \max_{\substack{0 \le c \\ 0 \le k_t \le \phi(\theta^c, q, a)}} u(c) + \partial_a v(t,a)\left[r_t a - c + q_t k \bar{R}\,\mu^i\right] + \Delta v(t,a)(q_t k \bar{R}\,\sigma_t^i)^2/2$$

  - KF : $\Rightarrow$ determines the distribution (measure) of agents $m(t,a)$

$$\partial_t m(t,a) = \partial_a\left[m(t,a)\left(r_t a - c^\star(a) + q_t k^\star(a)\,\bar{R}\,\mu^i\right)\right] + \partial_a^2\left[m(t,a)(q_t k^\star(a)\bar{R}\,\sigma_t^i)^2/2\right]$$

Result : Stationary equilibrium

- HJB :
  - Concave value function
  - Choice of capital : almost linear in state, depend on volatility and risk aversion (CRRA)
- KF :
  - Distribution with a Pareto Tail
  - Closed-form solution of the Tail parameter as a function of volatility and risk-aversion

Aggregate shocks – 1

- Productivity shocks (both firms)

$$d\zeta_t^c = \eta(\mu^c - \zeta_t^c)dt + \sigma_\zeta^c \, \varepsilon_t^c dN_t^c$$

  - RBC-style exogenous supply shock
  - Here, affect the exposure of experts to aggregate risk

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- Patience shocks (experts)

$$d\rho_t = \eta(\mu^\rho - \rho_t)dt + \sigma_\rho^c \, \varepsilon_t^c dN_t^c$$

  - NK-style aggregate demand shock
  - Here, affect the patience of experts and their saving motive

Aggregate shocks – 2

- Capital quality shocks (experts)

$$d\theta_t^c = \eta(\mu^\theta - \theta_t^c)dt + \sigma_\theta^c \, \varepsilon_t^c dN_t^c$$

  - Main driver of Great Recession according to Khan and Thomas (2013) and Jermann and Quadrini (2012)
  - Imply credit crunch and deleveraging : causes large drop in investment by leveraged (small) firms

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- Uncertainty shock (experts volatility)

$$d\sigma_t^i = \eta(\mu^\sigma - \sigma_t^i)dt + \sigma_\sigma^c \, \varepsilon_t^c dN_t^c$$

  - The literature initiated by Bloom (2009) and more recently Mongey and Williams (2017).
  - Induce ”wait-and-see” effect (and reduction investment) but more dispersion in firms : ambiguous effects on the distribution of firms

Conclusion

- This paper examine the influence of firm heterogeneity in presence of market illiquidity and financial frictions
- It revisits the persistence and amplification mechanisms of different aggregate shocks that could explain deep recessions

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- THANK YOU FOR YOUR FEEDBACKS !

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