

# Financial Engineering and the Macroeconomy

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# Definition

**Financial Engineering:** Transformation of cash-flows to create securities that cater to the needs of heterogenous investors (Allen and Gale, 1988)

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- ▶ We shock both to cause changes in the quantity of costly security creation . . .
- ▶ . . . and quantify the impact on output, capital formation, TFP, and welfare

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- ▶ TFP and output tend to move in opposite direction
- ▶ When increases in financial engineering are caused by changes in the distribution of investor types, the impact on output is even more likely to be negative

# Literature

- ▶ King and Levine (1993), Rajan and Zingales (1998) ...
- ▶ Amaral and Quintin (2010), Midrigan and Xu (2014), Moll (2014) ...
- ▶ Berkes, Panizza and Arcand (2012), Gennaioli, Shleifer and Vishny (2012)
- ▶ Allen and Gale (1989, 1991), Corbae and Quintin (2016)

▶ Other related papers

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- ▶ Mass  $\theta_A$  of households are type  $A$ ,  $\theta_N$  are type  $N$
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- ▶ Households supply one unit of labor when young
- ▶ Large mass of two-period lived producers

# Producers

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- ▶ Types are public information
- ▶ Can activate a project in the first period of their life by installing a unit of capital
- ▶ Aggregate conditions are drawn
- ▶ An active producer of talent  $z \in \{z_B, z_G\}$  transforms labor  $n$  into the consumption good according to

$$z^{1-\alpha} n^\alpha$$

where  $\alpha \in (0, 1)$

- ▶ Define:

$$\Pi(w; z) \equiv \max_{n>0} z^{1-\alpha} n^\alpha - nw$$

# Producer preferences

- ▶ Producers consume at the start of either period of their life
- ▶ They order consumption plans  $(c_{1,t}^P, c_{2,t}^P(B), c_{2,t}^P(G))$  according to:

$$c_{1,t}^P + \epsilon E \left( c_{2,t}^P(\eta) | \eta_{t-1} \right),$$

where  $\epsilon$  is a small but positive number

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- ▶ Producers finance their investment by selling claims to households
- ▶ Selling securities to one household type is free
- ▶ Selling securities to both types carries a fixed cost  $\zeta$
- ▶ They take the market value of securities as given

# Producer problem

Active producers of type  $(z_B, z_G)$  maximize:

$$q_{A,t}(x_{A,t}(B), x_{A,t}(G)) + q_{N,t}(x_{N,t}(B), x_{N,t}(G)) + \epsilon E (c_{2,t}^P(\eta) | \eta_{t-1}) \\ - 1 - \zeta \mathbf{1}_{\{x_{A,t} \neq 0, x_{N,t} \neq 0\}}$$

subject to:

$$x_{A,t}(B) + x_{N,t}(B) + c_{2,t}^P(B) \leq \Pi(w_t(B); z_B),$$

$$x_{A,t}(G) + x_{N,t}(G) + c_{2,t}^P(G) \leq \Pi(w_t(G); z_G),$$

$$q_{A,t}(x_{A,t}(B), x_{A,t}(G)) + q_{N,t}(x_{N,t}(B), x_{N,t}(G)) \geq 1 + \zeta \mathbf{1}_{\{x_{A,t} \neq 0, x_{N,t} \neq 0\}},$$

$$x_A, x_N, c_2^P \geq 0$$

# Security menus

From the point of view of households, the security menu is a set of available returns

$$R_{i,t}(z, \eta) = \frac{x_{i,t}(\eta)}{q_{i,t}(x_{i,t}(B), x_{i,t}(G))}$$

on the securities issued by producers of type  $z = (z_B, z_G) \in \mathbb{R}_+^2$  for household type  $i \in \{A, N\}$



# Type N households

$$\max_{a_t^N(z), c_{y,t}^N, c_{o,t}^N \geq 0} \log(c_{y,t}^N) + \beta \log \left\{ E \left( c_{o,t+1}^N(\eta) | \eta_t \right) \right\}$$

subject to:

$$\begin{aligned} w_t &= \int a_t(z) d\mu + c_{y,t-1}^N, \\ c_{o,t}^N(B) &= \int a_t^N(z) R_{N,t}(z, B) d\mu, \\ c_{o,t}^N(G) &= \int a_t^N(z) R_{N,t}(z, G) d\mu, \end{aligned}$$

# Pricing kernel for type $N$ securities

Letting

$$\bar{R}_{N,t} = \max_z T(B|\eta_{t-1}) R_{N,t}(z, B) + T(G|\eta_{t-1}) R_{N,t}(z, G),$$

old risk-neutral agents are willing to pay:

$$q_{N,t}(x(B), x(G)) = \frac{T(B|\eta_{t-1}) x(B) + T(G|\eta_{t-1}) x(G)}{\bar{R}_{N,t}}$$

for a marginal investment in a security with payoff  $(x(B), x(G))$  at date  $t$ .

# Type A households

$$\max_{a_t^A(z), c_{y,t}^A, c_{o,t}^A \geq 0} \log(c_{y,t}^A) + \beta \log \left\{ \min \left\{ c_{o,t+1}^A(B), c_{o,t+1}^A(G) \right\} \right\}$$

subject to:

$$\begin{aligned} w_t &= \int a_t(z) d\mu + c_{y,t-1}^A, \\ c_{o,t}^A(B) &= \int a_t^A(z) R_{A,t}(z, B) d\mu, \\ c_{o,t}^A(G) &= \int a_t^A(z) R_{A,t}(z, G) d\mu. \end{aligned}$$

# Pricing kernel for type A securities

Letting

$$\bar{R}_{A,t} = \frac{\min\{c_{0,t}^A(B), c_{0,t}^A(G)\}}{a_{A,t}},$$

1.  $q_{A,t}(x(B), x(G)) = \frac{\min(x(B), x(G))}{\bar{R}_{A,t}}$  if  $c_{0,t}^A(B) = c_{0,t}^A(G)$ ,
2.  $q_{A,t}(x(B), x(G)) = \frac{x(G)}{\bar{R}_{A,t}}$  if  $c_{0,t}^A(B) > c_{0,t}^A(G)$ ,
3.  $q_{A,t}(x(B), x(G)) = \frac{x(B)}{\bar{R}_{A,t}}$  if  $c_{0,t}^A(B) < c_{0,t}^A(G)$

# Equilibrium

An equilibrium consists of wage rates, security menus and returns, pricing kernels, and policies for all agents such that, at all dates and histories:

1. All agents optimize given prices
2. The market for labor clears
3. The market for each security clears
4. Pricing kernels assumed by producers are consistent with household decisions given the resulting securities menu

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## Proposition

*An equilibrium exists.*

# Financial policies (1)

## Lemma

*In any equilibrium, risk-averse households only purchase risk-free securities. Furthermore,  $\bar{R}_{N,t} \geq \bar{R}_{A,t}$ .*

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So producers maximize:

$$\frac{x_A}{\bar{R}_{A,t}} + \frac{T(G|\eta_{t-1})x_N(G) + T(B|\eta_{t-1})x_N(B)}{\bar{R}_{1,t}} - 1 - \zeta 1_{\{x_A > 0 \text{ and } x_N > 0\}} + \epsilon E(c_2^P | \eta_{t-1}),$$

where:

$$\begin{aligned} x_A &\leq \min \{ \Pi(w(B); z_B), \Pi(w(B); z_G) \}, \\ x_A + x_N(B) + c_2^P(B) &\leq \Pi(w(B); z_B), \\ x_A + x_N(G) + c_2^P(G) &\leq \Pi(w(G); z_G). \end{aligned}$$



# Financial policies (2)

## Proposition

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### Proposition

Among active projects and  $\mu$ -almost surely:

1. Either  $x_A = 0$  or  $x_A = \underline{\Pi}(z)$ ;
2. Producers pay  $\zeta$  to sell securities in two markets when:

$$\frac{T(G|\eta_{t-1}) (\bar{\Pi}(z) - \underline{\Pi}(z))}{\bar{R}_{N,t}} + \frac{\underline{\Pi}(z)}{\bar{R}_{A,t}} - \zeta > \epsilon (\bar{\Pi}(z) - \underline{\Pi}(z)) + \frac{\underline{\Pi}(z)}{\bar{R}_{A,t}}, \text{ and,}$$
$$\frac{T(G|\eta_{t-1}) (\bar{\Pi}(z) - \underline{\Pi}(z))}{\bar{R}_{N,t}} + \frac{\underline{\Pi}(z)}{\bar{R}_{A,t}} - \zeta > \frac{T(G|\eta_{t-1})\bar{\Pi}(z) + T(B|\eta_{t-1})\underline{\Pi}(z)}{\bar{R}_{N,t}}.$$

# Aggregation

Let  $K$  be the aggregate quantity of capital used to operate active projects. Then:

$$K = \int_{Z_{\Theta}} d\mu.$$

Furthermore,

$$F(\eta, K, N) = \bar{z}(\eta)^{1-\alpha} K^{1-\alpha} N^{\alpha},$$

where  $\bar{z}$  is the average productivity of active projects.

## A simple case (constant $\frac{z_G}{z_B}$ )

Assume that

$$z_G = zA_G$$

while

$$z_B = zA_B$$

where  $z > 0$  is the producer's idiosyncratic skill level. Then,

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2. Output, capital formation and TFP are only a function of  $\underline{z}_t$
3. A change in  $\zeta$ , holding prices constant, only affects the upper-threshold
4. It takes general equilibrium effects to move the lower threshold



# The quantity of financial engineering

Three measures:

1. The mass of producers that bear the security creation cost
2. The market value of those producers
3. The resources spent on security creation:

$$\int_{Z_{\Theta}} \zeta \mathbf{1}_{\{x_A > 0 \text{ and } x_N > 0\}} d\mu$$

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Two shocks to the environment that move these quantities:

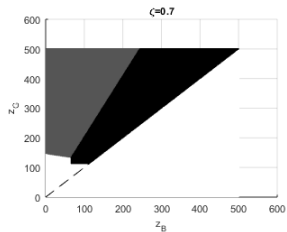
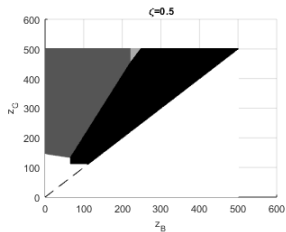
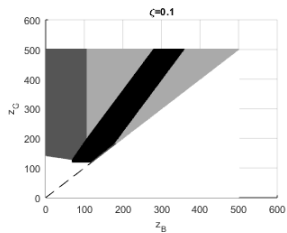
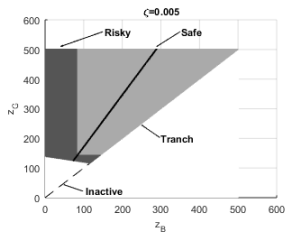
1. A drop in  $\zeta$
2. A increase in  $\theta_A$

# Parametrization

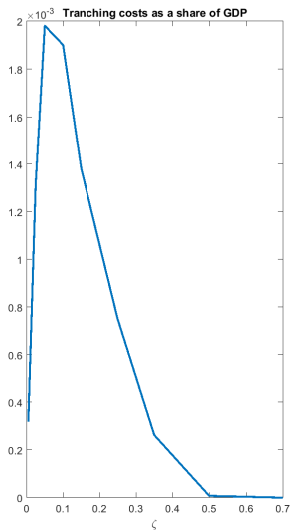
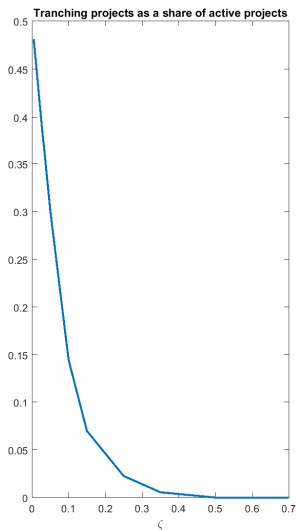
- ▶ One period= 25 years
- ▶  $\theta_A = \theta_N = 0.5$
- ▶  $\beta = \frac{1}{1.03^{25}}$
- ▶  $\alpha = 0.7$
- ▶  $T_{BB} = .2, T_{GG} = .9$
- ▶  $\mu$  is bivariate normal truncated to  $z_G \geq z_B$  and is specified to imply:
  1. Average output difference of 25% between good and bad times
  2. A ratio of producer rents to value added of around 10%

▶ Algorithm

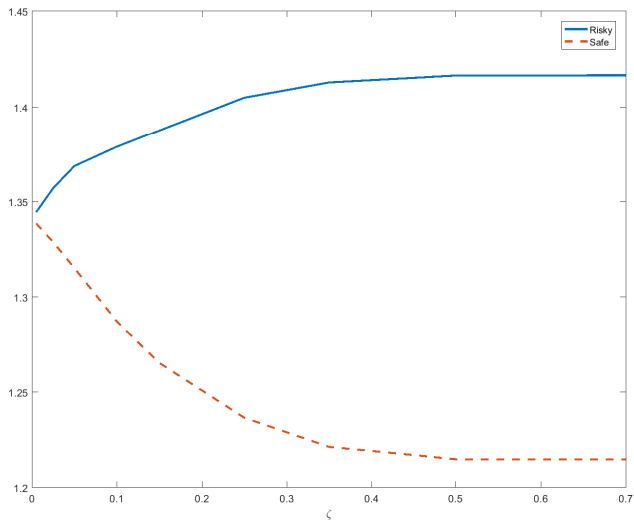
# Producer policies



# Measures of financial engineering



# Rates of return



# Comparative statics for capital formation

$$\Delta \text{ capital formation} = \Delta \text{ spending on securities}$$

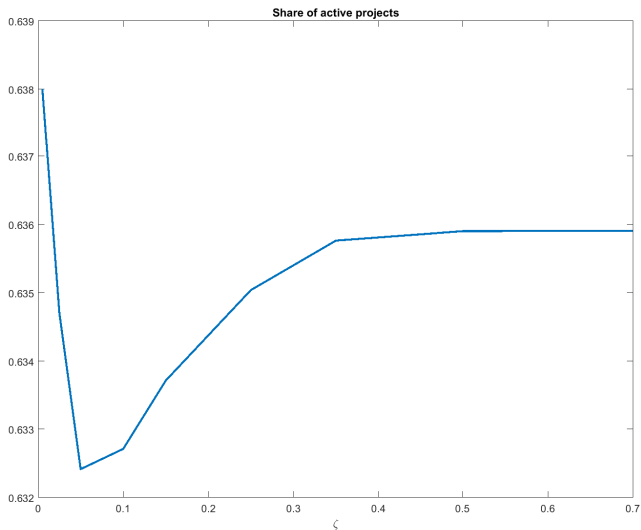
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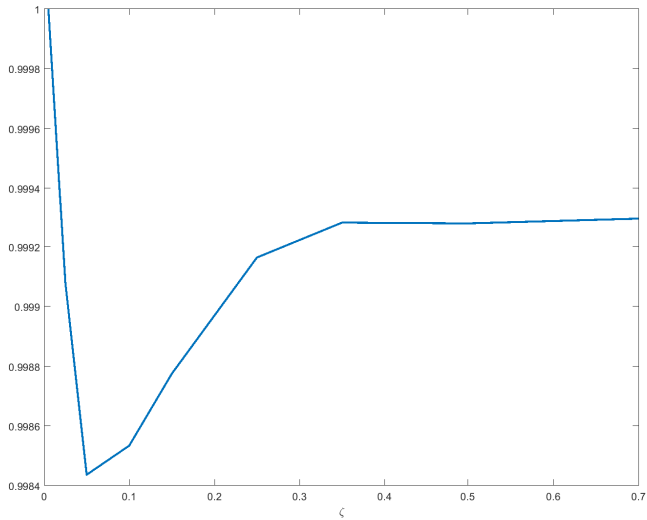
- $\Delta$  security creation expenditures
- $\Delta$  producer rents.

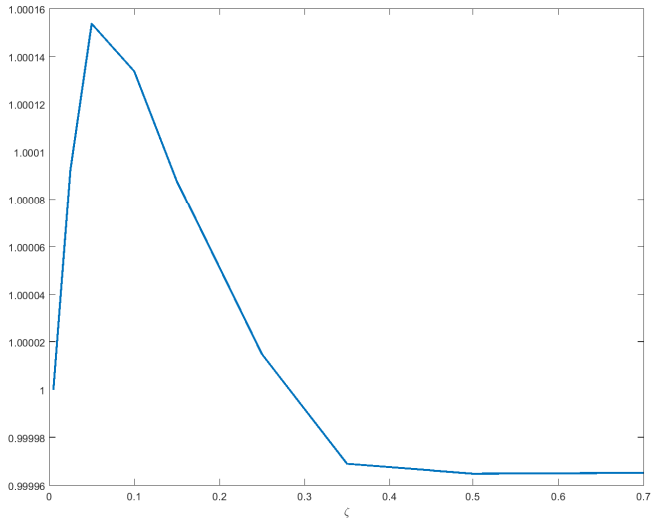


# Capital formation



# GDP

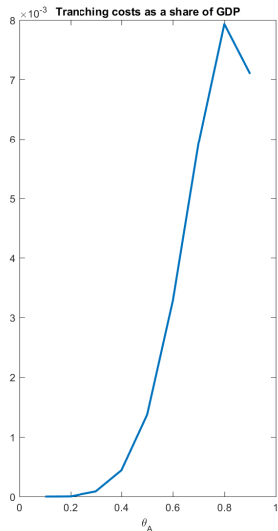
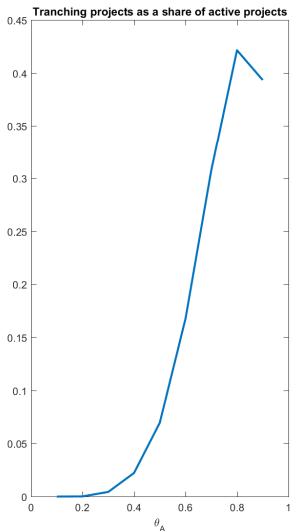




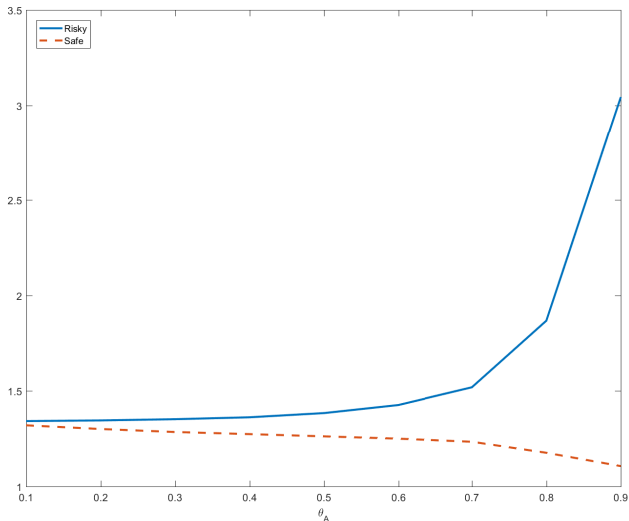
## Varying $\theta_A$

*"Given the strength of demand for safe U.S. assets, it would have been surprising had there not been a corresponding increase in their supply." Ben Bernanke*

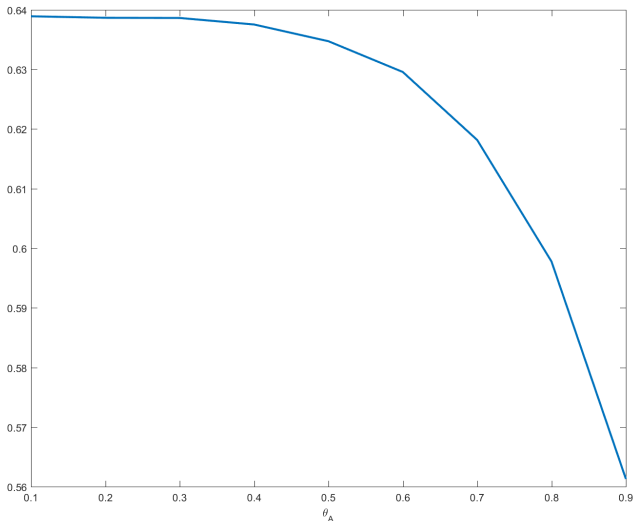
# Measures of financial engineering



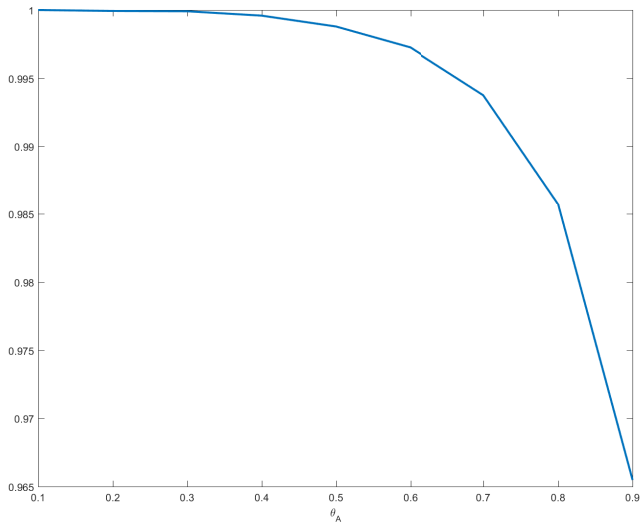
# Rates of return



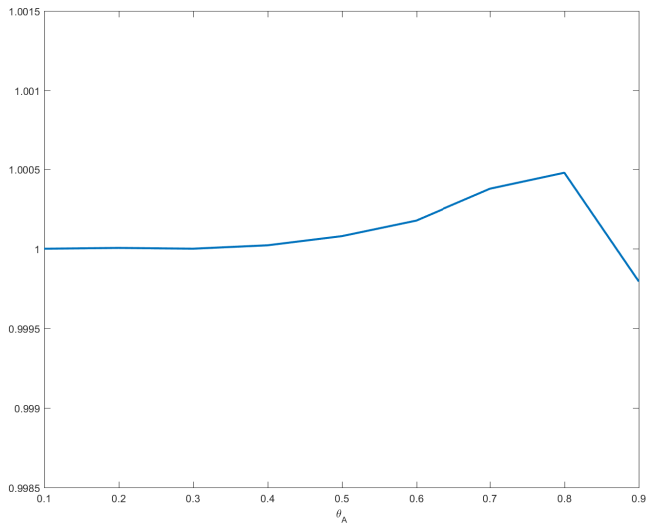
# Capital formation



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We look at two proxies for financial complexity:

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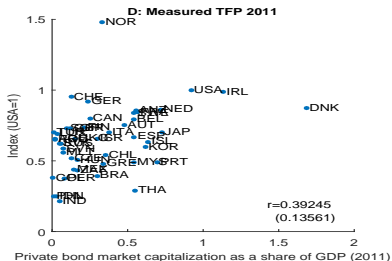
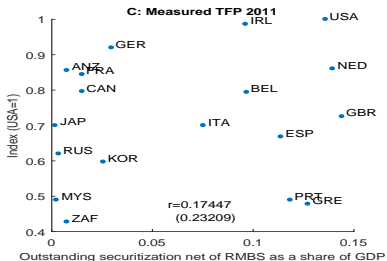
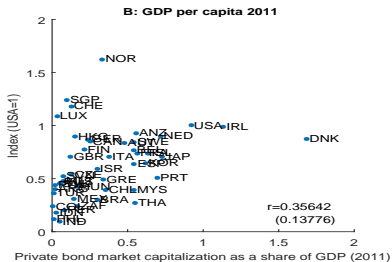
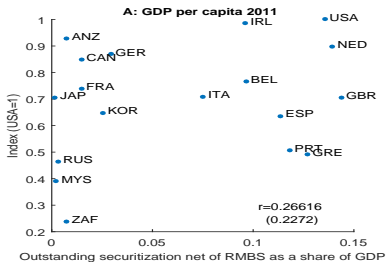
We look at two proxies for financial complexity:

- ▶ Securitization activity
- ▶ Private bond market capitalization

Unconditionally, financial complexity and economic development are positively correlated

Conditionally on income they are not

# Data II



# Conclusion

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- ▶ Probably best to think of financial development as consisting of two distinct phases
  1. Initially, institutional gains enable constrained producers to become active and/or operate more effectively.
  2. In economies with already well functioning markets, financial innovation tends to take the form of repackaging

# Conclusion

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- ▶ Probably best to think of financial development as consisting of two distinct phases
  1. Initially, institutional gains enable constrained producers to become active and/or operate more effectively.
  2. In economies with already well functioning markets, financial innovation tends to take the form of repackaging
- ▶ First phase delivers potentially high output and TFP gains



# Conclusion

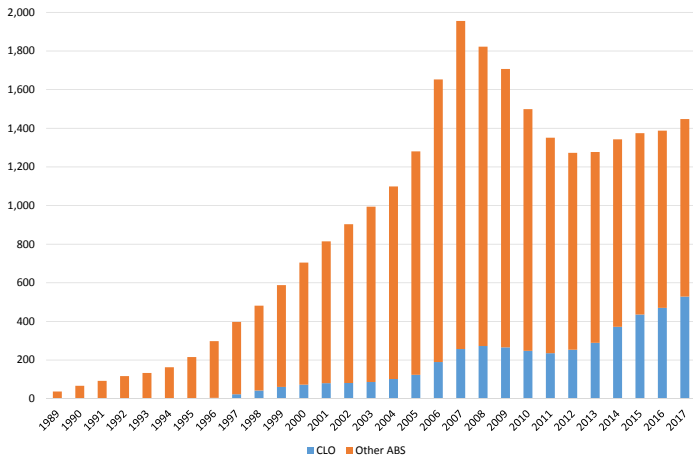
- ▶ Shocks that boost costly security creation have a small impact on output and capital formation
- ▶ It may even be negative
- ▶ Probably best to think of financial development as consisting of two distinct phases
  1. Initially, institutional gains enable constrained producers to become active and/or operate more effectively.
  2. In economies with already well functioning markets, financial innovation tends to take the form of repackaging
- ▶ First phase delivers potentially high output and TFP gains
- ▶ Second phase probably not so much, if any

## More papers

- ▶ Goldsmith (1969), McKinnon (1973) and Shaw (1973)
- ▶ Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), Banerjee and Newman (1993), Khan (2001), Amaral and Quintin (2006)
- ▶ Erosa (2001), Jeong and Townsend (2007), Erosa and Cabrillana (2008), Quintin (2008), Buera, Kaboski, and Shin (2011), Buera and Shin (2013), Caselli and Gennaioli (2013)

▶ Go back

# US Asset-Backed Securities Outstanding

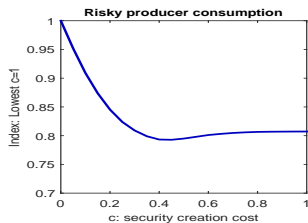
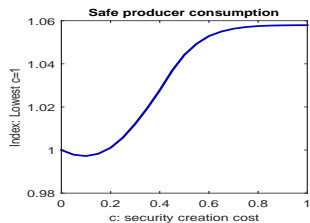
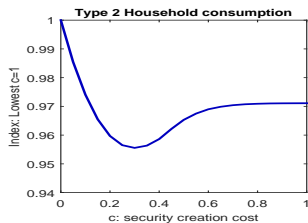
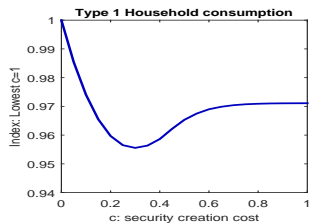


# Algorithm

1. Given parameters, solve for household and intermediary policy functions for every possible aggregate state of the economy;
2. Draw a 1000-period sequence of aggregate shocks  $\{\eta_t\}_{t=1}^{1000}$  using the Markov transition matrix  $T$  and record the value of all endogenous variables starting from an arbitrary value of aggregate wealth;
3. After dropping the first 100 periods, so that assumed initial conditions have at most a negligible effect on the value of endogenous variables, compute average values for all endogenous variables.

▶ Go back

# Welfare



Go back

