

# Asset Quality Dynamics

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- ▶ ... and use it to quantify the impact of safe corporate debt markets on the US business cycle
- ▶ ... and the impact of greater appetite for US safe assets (the “saving glut”)



## Methodological approach

- ▶ We lay out a macroeconomic model that is standard on the real side but where the security space responds endogenously to changes in fundamentals
- ▶ We do so by embedding Allen and Gale's 1988 "Optimal Security Design" model into a dynamic environment

# Methodological approach

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- ▶ Fixed point problem:
  1. Taking the contingent path of financial structures as given, agents choose an optimal consumption policy
  2. This consumption path, in turn, determines agents' willingness to pay for different securities
  3. Taking this willingness to pay as given, producers issue menus of securities that maximize their profits
  4. The resulting financial structure must coincide with the guess agents made in the first place

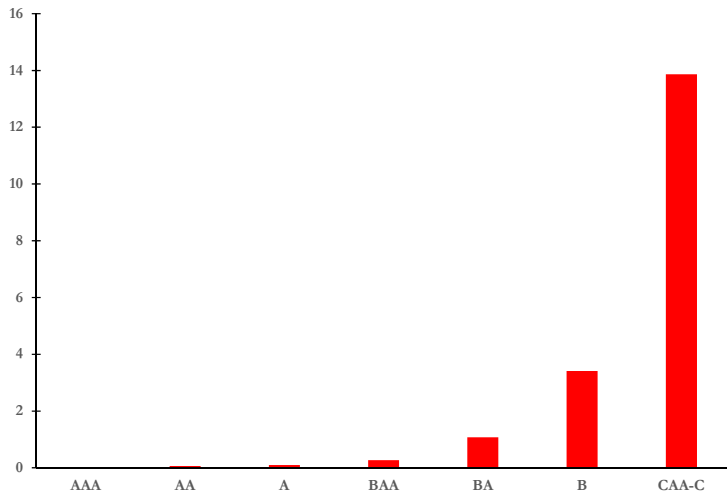
# Data

- ▶ Firms in Compustat, 1985-2016 (394,682 firm-year)
- ▶ Exclude foreign, utility and financial firms (197,629)
- ▶ Exclude missing or bad data (96,994)

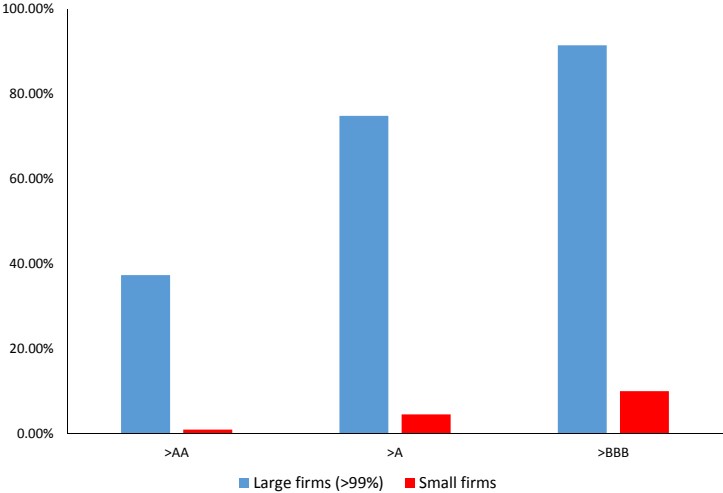
# Firm count details

	AAA	AA	A	BBB	<BBB	No rating
1986	13	64	159	108	258	2,040
1987	13	59	137	117	316	2,023
1988	13	60	136	100	291	1,996
1989	14	51	140	102	230	1,980
1990	14	54	129	107	255	2,098
1991	13	55	130	114	222	2,292
1992	13	55	131	117	225	2,526
1993	13	54	134	132	270	2,697
1994	13	49	136	141	283	2,863
1995	12	48	135	155	289	3,251
1996	12	45	146	176	331	3,282
1997	12	43	149	186	336	3,175
1998	10	35	158	208	387	3,244
1999	9	32	144	218	383	3,065
2000	9	27	136	223	406	2,739
2001	8	22	124	223	425	2,522
2002	7	20	115	219	465	2,516
2003	6	15	113	220	482	2,531
2004	6	13	115	210	504	2,466
2005	6	12	113	205	509	2,466
2006	6	11	113	201	495	2,399
2007	6	11	101	203	478	2,287
2008	6	12	93	200	454	2,226
2009	6	13	86	194	461	2,190
2010	5	14	83	197	448	2,166
2011	4	13	89	209	441	2,131
2012	4	13	87	205	453	2,198
2013	4	13	88	212	472	2,232
2014	4	15	90	211	488	2,095
2015	3	19	87	208	467	2,046
2016	3	20	76	209	456	1,942

# Frequency of default by rating, 1920-2010



# Rating by size



# Cyclicality of safe corporate debt

Firm rating	$\geq$ AA	$\geq$ A	$\geq$ BBB	$<$ BBB	All
$\rho(D, Y)$	0.03	0.28*	0.28*	0.67**	0.56**

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$\rho(D + E, Y)$	0.31*	0.33*	0.37*	0.65**	0.60**

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# Cyclicality of safe corporate yields

	1985-2006	1985-2016	1947-2016
$\rho(\text{AAA yield}, Y)$	-0.0439	-0.2114	-0.3060
$\rho(\text{BAA-AAA spread}, Y)$	-0.2991	-0.3774	-0.6028

## Related work

1. Allen and Gale (1988, 1991)
2. Quadrini and Jerman (2011), Covas and Den Haan (2011), Karabarbounis, Macnamara and McCord (2014), Eler et. al (2012), Khale and Stulz (2011), Crouzet (2018), Nikolov, Schmid and Steri (forthcoming), ...
3. Bernanke et. al. (2011)
4. Brunnermeier and Sannikov (2012)

# The model

- ▶ Time is discrete and infinite, one good
- ▶ Mass 1 of households who value consumption only, time-separable CRRA preferences
- ▶ Large mass of producers characterized by talent/productivity  $z \sim \mu$

# Producers

- ▶ Can activate a project by investing 1 unit of capital at the start of the period
- ▶ Gross output is

$$A_t z^{1-\alpha} n_t^\alpha + (1 - \delta)$$

- ▶  $A_t$  is aggregate TFP and  $n_t$  is labor input
- ▶ TFP follows a first-order markov process with transition  $G_A$

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- ▶ TFP follows a first-order markov process with transition  $G_A$
- ▶ Net operating income is:

$$\Pi(A_t, w_t; z) \equiv \max_{n>0} A_t z^{1-\alpha} n^\alpha - n w_t$$

- ▶ Labor demand is:

$$n^*(A_t, w_t; z) \equiv \arg \max_{n>0} A_t z^{1-\alpha} n^\alpha - n w_t$$

# Security markets

- ▶ Producers sell claims to households and to world markets
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- ▶ Claims sold to world markets must be risk-free
- ▶ Participation in that market costs  $\kappa > 0$  per period
- ▶ World markets pay  $q_t^W$  per unit of risk-free claims at date  $t$

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- ▶ World markets pay  $q_t^W$  per unit of risk-free claims at date  $t$
- ▶  $q^W$  is measurable with respect to the history of aggregate shocks

# Producer problem

$$MV_t(z) \equiv \max_{b^s \geq 0} \quad b^s q_t^W + \int_{\mathcal{A}} q_t^H(A) \left[ (\Pi(A, w_t; z) + 1 - \delta) - b^s \right] dA \\ - (1 + 1_{\{b^s > 0\}} \kappa),$$

subject to:

$$b^s \leq \Pi(\underline{A}_t, w; z)$$

▶ Debt vs. EBITDA

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► Debt vs. EBITDA

Producers issue risk-free debt if:

$$\left( q_t^W - \int_{\mathcal{A}} q_t^H(A) dA \right) \Pi(\underline{A}_t, w_t; z) \geq \kappa.$$

## Comments on maturity and external finance

1. Long-term contracts play no role in our model, short-term contracts suffice
2. At the same time, one can think of financial policies as long-term, history-contingent financial contracts
3. Under that understanding, there is no need to raise new external finance for most producers in each period
4. Instead of paying households and then raising new capital, keep what you need
5. In our calibration, only new entrants need to raise new finance, and they do not issue debt

# Risky security prices and returns

- ▶ Securities sold by producers of type  $z$  pay

$$\Pi(A, w_t; z) + 1 - \delta - b_t^s(z)$$

and sell for:

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- ▶ Stochastic return on the same security is

$$r_t(A; z) = \frac{\Pi(A, w_t; z) + 1 - \delta - b_t^S(z)}{\int_{\mathcal{A}} q_t^H(A) \left[ (\Pi(A, w_t; z) + 1 - \delta) - b_t^S(z) \right] dA}.$$

# Household problem

- ▶  $\mathcal{H}_t$ : possible histories of aggregate TFP shocks up to date  $t$
- ▶ Households assume a mapping

$$S_t : \mathcal{H}_t \mapsto \mathcal{S}$$

- ▶ ...where  $S_t(h_t) = \{q_t^W, r_t(\bullet, z) : z \geq 0\}$



# Household problem

$$\max_{b^d \geq 0, e^d \geq 0} E \sum_{t=0}^{+\infty} \beta^t U(c_t)$$

subject to:

$$q_t^W b_t^d + \int e_t^d(z) d\mu(z) + c_t = a_t(h_t) + \int \max\{MV_t(z), 0\} d\mu(z),$$

$$\begin{aligned} a_{t+1}(h_t, A) &= \int e_t^d(z) r_t(A, z) d\mu(z) \\ &+ b_t^d + w_t(h_t, A), \text{ for all } A \in \mathcal{A} \end{aligned}$$

where:

$$\{q_t^W, r_t(\bullet, z) : z \geq 0\} = S_t(h_t),$$

# Equilibrium

Prices, security menus and and decisions such that:

1. Decision plans are optimal given prices;
2.  $\int_{\{z: MV_t(z) \geq 0\}} n^*(A, w_t; z) = 1$  for all  $A \in \mathcal{A}$ ;
3.  $\int_{\{z: MV_t(z) \geq 0\}} b_t^s(z) d\mu \geq b_t^d$ ;
4.  $e_t^d(z) r_t(A, z) = \Pi(A, w_t; z) + 1 - \delta - b^s(z)$  for all  $A \in \mathcal{A}$ ;
5.  $MV_t(z) = b_t^s(z) q_t^W + \int_{\mathcal{A}} q_t^H(A) \left[ (\Pi(A, w_t; z) + 1 - \delta) - b_t^s(z) \right] dA - \left( 1 + 1_{\{b_t^s > 0\}} \kappa \right)$ .

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6.  $q_t^H(A_t) = \frac{\beta G_A(A_t | A_{t-1}) U'(c_{t+1}(h_t, A_t))}{U'(c_t)}$ ;

# Aggregation

Given capital  $K$ , labor  $N$  and exogenous TFP  $A$ , aggregate output is:

$$F(A, K, N) = AE [z|z \geq \underline{z}(K)]^{1-\alpha} K^{1-\alpha} N^\alpha.$$

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GDP accounting:

$$c_{t+1} + K_{t+1} - (1-\delta)K_t + \int_{b_t^s > 0} \kappa d\mu + b_t^W - q_{t+1}^W b_{t+1}^W = F(A_t, K_t, N_t).$$

▶ Return

# Security markets

## Proposition

*The solution to the producer security design problem at a given date  $t$  is fully described by two thresholds  $0 \leq \underline{z}_t \leq \bar{z}_t$  such that:*

1. *Producers issue securities if and only if  $z \geq \underline{z}_t$ ;*
2.  *$b_t^s(z) = 0$  if  $z < \bar{z}_t$ ;*
3.  *$b_t^s(z) = \Pi(\underline{A}_t, w_t; z)$  if  $z > \bar{z}_t$ .*

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**Proof:** Producers issue risk-free debt if:

$$\left( q_t^W - \int_A q_t^H(A) dA \right) \Pi(\underline{A}_t, w_t; z) \geq \kappa.$$

## Security markets (qualitative remarks)

1. The cyclicality of overall producer liabilities is driven by the lower threshold
2. The cyclicality of safe debt use is governed by the upper threshold (extensive margin) and the borrowing constraint (intensive margin)
3. Participation and financial policies are highly persistent
4. "New" external finance need only be raised by new entrants



# Household portfolio

Effectively, households invest in one security/portfolio whose stochastic payoff is

$$F(A_t, K_t, 1) + (1 - \delta)K_t - b_t^W,$$

and whose price at the start of the period is

$$\int_{\mathcal{A}} q_t^H(A) \left[ F(A_t, K_t, 1) + (1 - \delta)K_t - b_t^W \right] dA,$$

hence whose return, for all possible values of  $A_t$  is

$$r^H(A_t) = \frac{F(A_t, K_t, 1) + (1 - \delta)K_t - b_t^W}{\int_{\mathcal{A}} q_t^H(A) \left[ F(A_t, K_t, 1) + (1 - \delta)K_t - b_t^W \right] dA}.$$

# Recursive equilibrium

- ▶ Aggregate state is:  $\theta = (\bar{a}, A_{-1}) \in R_+ \times \mathcal{A}$ ,
- ▶ An equilibrium consists of the following objects:
  1.  $g : \Theta \times \mathcal{A} \mapsto \Theta$
  2.  $K : \Theta \mapsto R_+$
  3.  $\underline{z} \times \bar{z} : \Theta \mapsto R_+^2$
  4.  $q^H : \Theta \times \mathcal{A} \mapsto R_+$
  5.  $r^H : \Theta \times \mathcal{A} \mapsto R_+$
  6.  $e^H : \Theta \times R_+ \mapsto R_+$
  7.  $c : \Theta \times R_+ \mapsto R_+$
  8.  $w : \Theta \times \mathcal{A} \mapsto R_+$
  9.  $b^W : \Theta \mapsto R_+$
  10.  $MV : \Theta \times R_+ \mapsto R_+$
  11.  $V^H : \Theta \times R_+ \mapsto R$

# Household value function

$$V^H(\theta, a) = \max_{e^H > 0, b > 0} U\left(a + \int_{z \geq \underline{z}} MV(z) dz - e^H - q^W b\right) + \beta \int_{\mathcal{A}} V^H(g(\theta, A), a'(A)) dG(A|A_{-1})$$

where, for all  $A \in \mathcal{A}$

$$a'(A) = b + e^H r^H(\theta, A) + w(\theta, A).$$

# Allen-Gale condition

## Proposition

*The household value function  $V^H$  is concave and differentiable in assets. Furthermore, for all possible values  $\theta \in \Theta$  of the aggregate state,*

$$\frac{\partial V(\theta, a)}{\partial a} = U'(c(\theta, a)).$$

# RCE conditions

1.  $K(\theta) = \int_{z \geq \underline{z}} d\mu$
2.  $e^H(\theta, a) = \int_{\mathcal{A}} q^H(\theta, A) \left[ F(A, K(\theta), 1) + (1 - \delta)K(\theta) - b^W(\theta) \right] dA$
3.  $\int_{z \geq \underline{z}} MV(\theta, z) dz = q^W(\theta) b^W(\theta) + \int_{\mathcal{A}} q_t^H(A) \left[ (\Pi(A, w(\theta); z) + 1 - \delta) - b^S(\theta, z) \right] dA$
4.  $c(\theta, a) = a + \int_{z \geq \underline{z}} MV(\theta, z) dz - e^H(\theta, a)$
5.  $a'(\theta, A) = e^H(\theta, A) r^H(\theta, A) + w(\theta, A)$
6.  $q^H(\theta, A) = \frac{\beta G(A|A_{-1}) U'(c^i(g(\theta, A), a'(\theta, A)))}{U'(c(\theta, a))}$  for  $A \in \mathcal{A}$
7. Financial structure solves producer problems

# Mapping from model to data

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1.  $\int \max \{MV_t(z), 0\} d\mu(z) \Rightarrow$  Income of top managers and proprietors
2.  $Y \equiv F(A, K, N) \Rightarrow$  Value added by the private sector

## Parameters set to standard values

Parameter	Description	Value
$\beta$	Discount rate	0.95
$\sigma$	Utility curvature	2.00
$\delta$	Depreciation rate	0.10
$\alpha$	Labor share	0.60

# Calibration

Parameter	Value	Target	Data	Model
TFP ( $A$ )	$\{0.97, 1.00, 1.03\}$	$\sigma(\log(Y))$	2.75%	2.51%

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Transition matrix for TFP:

$$G_A = \begin{bmatrix} 0.47 & 0.53 & 0.00 \\ 0.28 & 0.44 & 0.28 \\ \mathbf{0.00} & 0.53 & 0.47 \end{bmatrix}$$

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Risk-free process:

$$q^W = \{0.972, 0.968, 0.976\} \Rightarrow \rho \left( \frac{1}{q^W} - 1, Y \right) = -0.31$$

## Basic horse race

Recall that producers issue risk-free debt if

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Two sources of procyclicality for safe debt use:

1.  $\underline{A}_t$  is procyclical (Jerman-Quadrini effect)
2.  $q^W$  is procyclical

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Recall that producers issue risk-free debt if

$$\left( q_t^W - \sum_A q_t^H(A) \right) \Pi(\underline{A}_t, w_t; z) \geq \kappa.$$

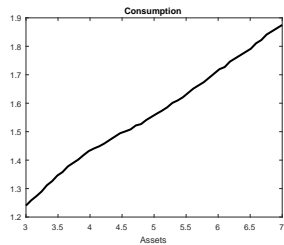
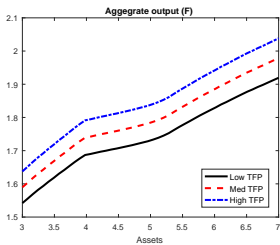
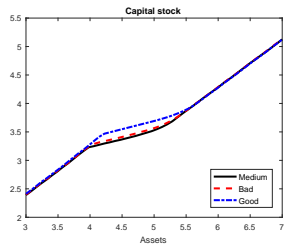
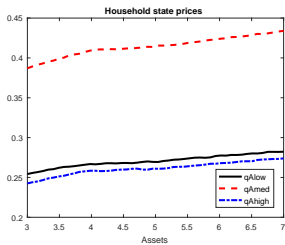
Two sources of procyclicality for safe debt use:

1.  $\underline{A}_t$  is procyclical (Jerman-Quadrini effect)
2.  $q^W$  is procyclical

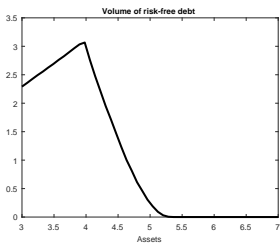
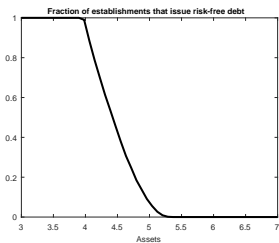
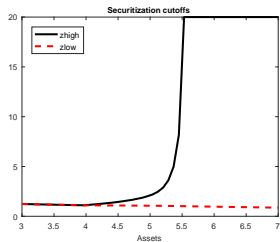
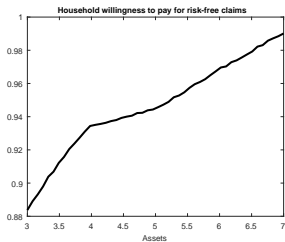
Two sources of countercyclicality:

1.  $q^H$  is procyclical
2.  $w_t$  is procyclical

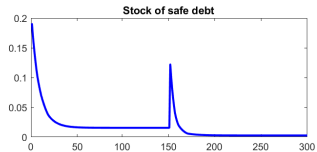
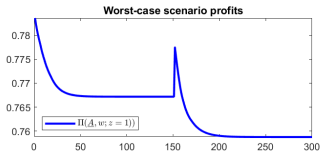
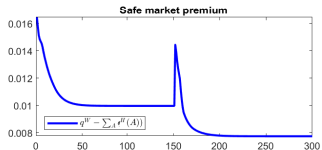
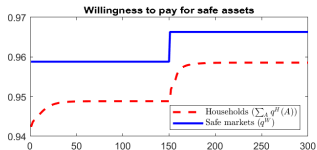
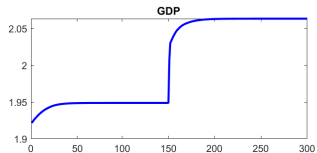
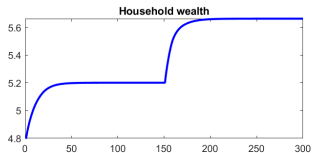
# RCE (1)



# RCE (2)



# Sample paths



# Cyclical properties of key model variables

Moment	Data	Model
$\rho(D^S, Y)$	0.03	-0.06



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# Cyclical properties of key model variables

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$\rho(D + E, Y)$	0.60	0.57

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$\rho(D + E, Y)$	0.60	0.57
$\rho(E(r^H) - r_F, Y)$	-0.25	-0.04

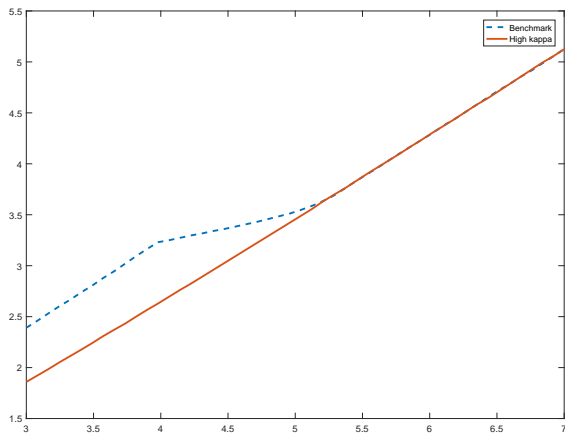
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$\rho(E(r^H) - r_F, Y)$	-0.25	-0.04
$\rho(E(r^H) - r_F, I)$	-0.37	-0.27

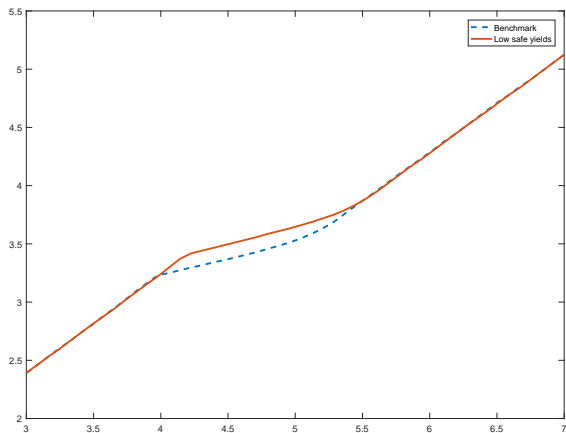
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$\rho(E(r^H) - r_F, I)$	-0.37	-0.27
$\rho(E(r^H) - r_F, C)$		-0.54

# Tranching cost and capital formation



# Low safe yields and capital formation





# Safe debt markets and the business cycle

	Benchmark	High $\kappa$
Mean $\frac{D^s}{Y}$	3.47%	0.00%
Mean $Y$	1.9540	-0.01%
$std(\log(Y))$	0.0250	-1.60%
Mean Cons	1.5840	+0.23%
$std(\log(C))$	0.0148	+6.48%
Mean Assets	5.1825	+1.40%
$std(\log(a))$	0.0275	-16.73%
Mean $K$	3.6656	+0.05%
$std(\log(K))$	0.0271	-2.21%

▶ Analytical argument

## Safe debt markets and the business cycle

	Benchmark	High $\kappa$	Low $\kappa$
Mean $\frac{D^s}{Y}$	3.47%	0.00%	8.26%
Mean Y	1.9540	-0.01%	+0.01%
$std(\log(Y))$	0.0250	-1.60%	+0.80%
Mean Cons	1.5840	+0.23%	-0.30%
$std(\log(C))$	0.0148	+6.48%	-0.72%
Mean Assets	5.1825	+1.40%	-1.87%
$std(\log(a))$	0.0275	-16.73%	+14.18%
Mean K	3.6656	+0.05%	+0.02%
$std(\log(K))$	0.0271	-2.21%	+1.48%

## Safe debt markets and the business cycle

	Benchmark	High $\kappa$	Low $\kappa$	Low yields
Mean $\frac{D^s}{Y}$	3.47%	0.00%	8.26%	17.55%
Mean Y	1.9540	-0.01%	+0.01%	-0.03%
<i>std(log(Y))</i>	0.0250	-1.60%	+0.80%	-0.40%
Mean Cons	1.5840	+0.23%	-0.30%	-0.81%
<i>std(log(C))</i>	0.0148	+6.48%	-0.72%	+0.00%
Mean Assets	5.1825	+1.40%	-1.87%	-5.53%
<i>std(log(a))</i>	0.0275	-16.73%	+14.18%	+17.09%
Mean K	3.6656	+0.05%	+0.02%	-0.05%
<i>std(log(K))</i>	0.0271	-2.21%	+1.48 %	-7.75%

# Summary

1. A dynamic model of costly security creation can account for the acyclicity of safe corporate debt issues
2. Access to safe debt markets has little effect on the level and cyclicity of output but helps reduce consumption volatility
3. Exogenous, permanent reductions in safe yields also have limited effects on the level of GDP because the reduction in interest rates depresses household wealth accumulation
4. But they reduce aggregate consumption

## Cyclicality of safe corporate debt (HP filter)

Firm rating	$\geq$ AA	$\geq$ A	$\geq$ BBB	$<$ BBB	All
$\rho(D, Y)$	0.22	0.23	0.28	0.67***	0.47***
$\rho(E, Y)$	0.07	-0.16	0.09	0.31	0.31

▶ Back

