Leverage Restrictions in a Business Cycle Model

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Background

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- Explore some of the dynamic implications of the models.

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- Model
  - first, without leverage restriction
    - observable effort benchmark
    - unobservable case
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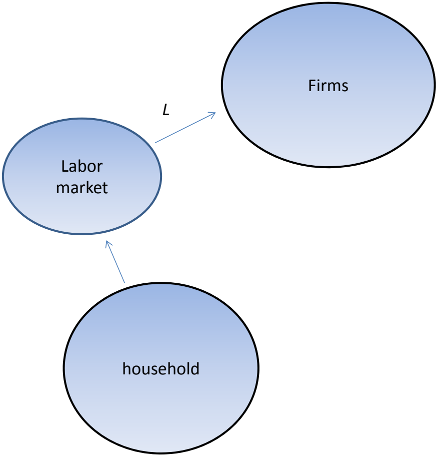
- Steady state properties of leverage restrictions
- Implications for dynamic effects of shocks

Standard Model



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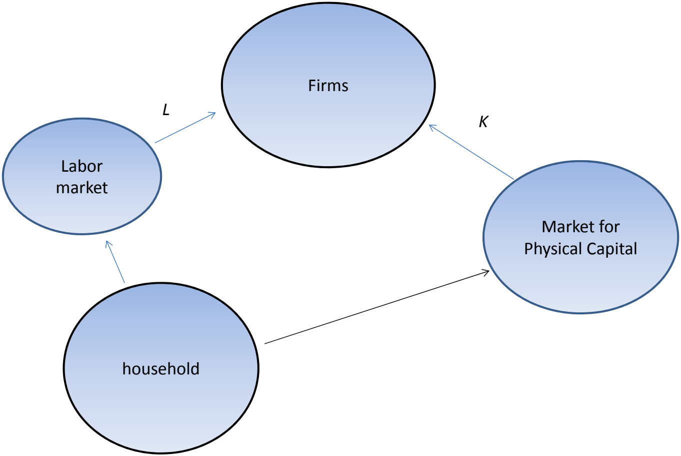

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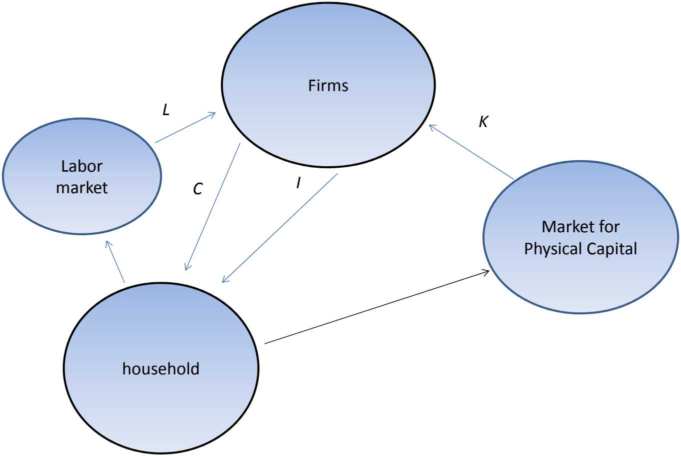

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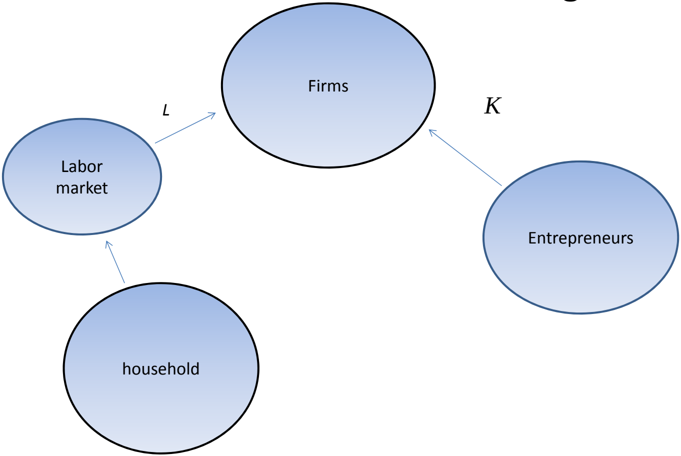

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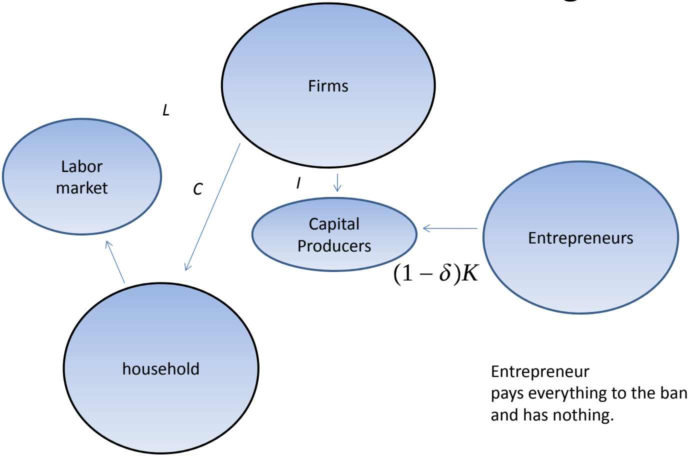

Entrepreneur
pays everything to the bank
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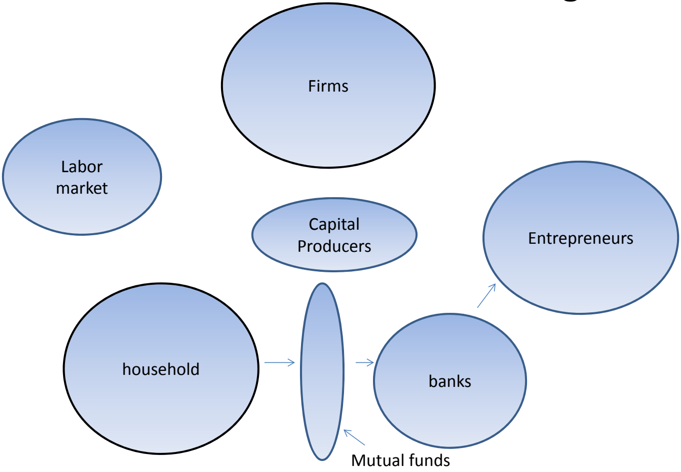

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- In effect, entrepreneurs operate linear investment technologies,

$$R_{t+1}^{g} > R_{t+1}^{b}$$

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- Bankers have a cash constraint:

$$R^b_{t+1}\left(N_t + d_t\right) \geq R^d_{b,t+1}d_t$$

Bankers and their Creditors

- Bankers and Mutual Funds interact in competitive markets for loan contracts:
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Observed Effort Benchmark

- Set of contracts available to bankers is the $\left(d_t, e_t, R^d_{g,t+1}, R^d_{b,t+1}\right)$'s that satisfy

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- Key feature of observed effort equilibrium:

$$e_t = E_t \lambda_{t+1} p_t'\left(e_{t+1}\right)\left(R^g_{t+1} - R^b_{t+1}\right)\left(N_t + d_t\right)$$

Unobserved Effort

- In this case, banker always sets e_t to its privately optimal level, whatever e_t is specified in the loan contract:

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- Two factors can make e_t inefficiently low:
  - $R_{g,t+1}^d > R_{b,t+1}^d$
  - $N_t + d_t$ low.

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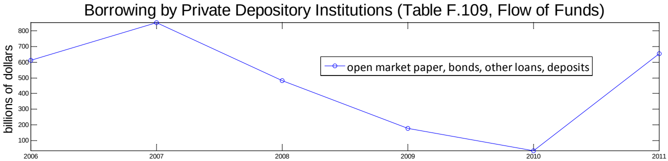

This shows how major debt instruments were used at private depository institutions in the wake of the crisis.

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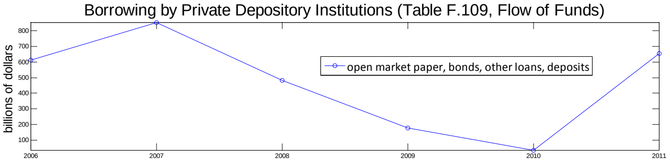

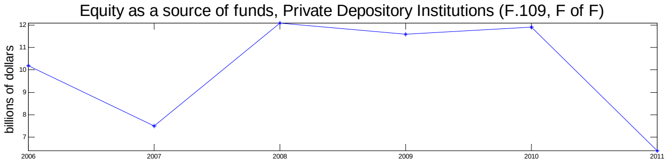

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- Banks get riskier (cross sectional mean return down, standard deviation up).

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    - allows them to behave as monopsonists

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    - allows them to behave as monopsonists
    - make profits on demand deposits....lots of profits:

$$\left[p\left(e_t\right)\left(R_{t+1}^g - R_{g,t+1}^d\right) + \left(1 - p\left(e_t\right)\right)\left(R_{t+1}^b - R_{b,t+1}^d\right)\right] \overbrace{\frac{d_t}{N_t}}^{\text{big}}$$

Leverage Restrictions

- Banks face the following restriction:

$$L_t \geq \frac{N_t + d_t}{N_t}.$$

- What is the consequence of this restriction?
  - With less d_t, banks with bad assets more able to cover losses
    - interest rate spread, $R_b^d - R$, falls, so banker effort rises.
  - Second effect of leverage restriction,
    - leverage restriction in effect implements collusion among bankers
    - allows them to behave as monopsonists
    - make profits on demand deposits....lots of profits:

$$\left[p\left(e_t\right)\left(R_{t+1}^g - R_{g,t+1}^d\right) + \left(1 - p\left(e_t\right)\right)\left(R_{t+1}^b - R_{b,t+1}^d\right)\right] \overbrace{\frac{d_t}{N_t}}^{\text{big}}$$

    - makes N_t grow, offseting incentive effects of decline in d_t.

Macro Model

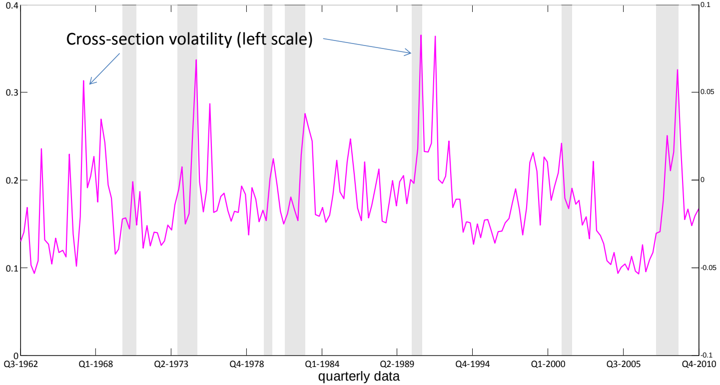
- Sticky wages and prices
- Investment adjustment costs
- Habit persistence in consumption
- Monetary policy rule

Calibration targets

Table 2: Steady state calibration targets for baseline model		
Variable meaning	variable name	magnitude
Cross-sectional standard deviation of quarterly non-financial firm equity returns	s^b	0.20
Fnancial firm interest rate spreads (APR)	$400(R_g^d - R)$	0.60
Financial firm leverage	L	20.00
Allocative efficiency of the banking system	$p(e)e^g + (1 - p(e))e^b$	1

Data behind calibration targets

Figure 1: Cross-section standard deviation financial firm quarterly return on equity, HP-filtered US real GDP



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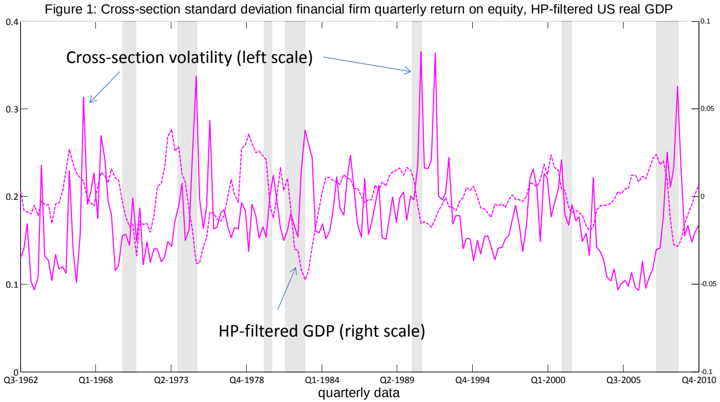

Parameter Values

Table 1: Baseline Model Parameter Values		
Meaning	Name	Value
Panel A: financial parameters		
return parameter, bad entrepreneur	b	-0.09
return parameter, good entrepreneur	g	0.00
constant, effort function	$\bar{a}$	0.83
slope, effort function	$\bar{b}$	0.30
lump-sum transfer from households to bankers	$\tilde{T}$	0.38
fraction of banker net worth that stays with bankers	γ	0.85
Panel B: Parameters that do not affect steady state		
steady state inflation (APR)	$400(\pi - 1)$	2.40
Taylor rule weight on inflation	α_π	1.50
Taylor rule weight on output growth	$\alpha_{\Delta y}$	0.50
smoothing parameter in Taylor rule	ρ_p	0.80
curvature on investment adjustment costs	S''	5.00
Calvo sticky price parameter	ξ_p	0.75
Calvo sticky wage parameter	ξ_w	0.75
Panel C: Nonfinancial parameters		
steady state gdp growth (APR)	μ_{z^*}	1.65
steady state rate of decline in investment good price (APR)	Υ	1.69
capital depreciation rate	δ	0.03
production fixed cost	Φ	0.89
capital share	α	0.40
steady state markup, intermediate good producers	λ_f	1.20
habit parameter	b_u	0.74
household discount rate	$100(\beta^{-4} - 1)$	0.52
steady state markup, workers	λ_w	1.05
Frisch labor supply elasticity	$1/\sigma_L$	1.00
weight on labor disutility	ψ_L	1.00
steady state scaled government spending	$\tilde{g}$	0.89

Steady State Calculations

- Next study steady state impact of leverage
  - Quantify role of hidden effort in the analysis (*essential!*)

Table 3: Steady State Properties of the Model

Variable meaning	Variable name	Unobserved Effort		Observed Effort	
		Leverage Restriction		Leverage Restriction	
		non-binding	binding	non-binding	binding
Spread	$400(R_g^d - R)$	0.600			
scaled consumption	c				
labor	h				
scaled capital stock	k				
bank assets	$N + d$				
bank net worth	N				
bank deposits	d				
bank leverage	$(N + d)/N$	20.00			
bank return on equity (APR)	$400\left(\frac{\left[p(e_t)R_{t+1}^g+(1-p(e_t))R_{t+1}^b\right](N_t+d_t)-R_t d_t}{N_t} - 1\right)$				
fraction of firms with good balance sheets	$p(e)$				
Benefit of leverage (in c units)	100χ				
Benefit of making effort observable (in c units)	100χ				

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Spread	$400(R_g^d - R)$	0.600			
scaled consumption	c	1.84			
labor	h	1.18			
scaled capital stock	k	51.52			
bank assets	$N + d$	51.52			
bank net worth	N	2.58			
bank deposits	d	48.94			
bank leverage	$(N + d)/N$	20.00			
bank return on equity (APR)	$400\left(\frac{\left[p(e_t)R_{t+1}^g+(1-p(e_t))R_{t+1}^b\right](N_t+d_t)-R_t d_t}{N_t} - 1\right)$				
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fraction of firms with good balance sheets	$p(e)$	0.962			
Benefit of leverage (in c units)	100χ	NA			
Benefit of making effort observable (in c units)	100χ	NA			

Table 3: Steady State Properties of the Model					
Variable meaning	Variable name	Unobserved Effort		Observed Effort	
		Leverage Restriction		Leverage Restriction	
		non-binding	binding	non-binding	binding
Spread	$400(R_g^d - R)$	0.600		NA	
scaled consumption	c	1.84		2.01	
labor	h	1.18		1.15	
scaled capital stock	k	51.52		59.75	
bank assets	$N + d$	51.52		59.55	
bank net worth	N	2.58		2.58	
bank deposits	d	48.94		56.98	
bank leverage	$(N + d)/N$	20.00		23.12	
bank return on equity (APR)	$400\left(\frac{\left[p(e_t)R_{t+1}^g+(1-p(e_t))R_{t+1}^b\right](N_t+d_t)-R_t d_t}{N_t} - 1\right)$	4.59		4.59	
fraction of firms with good balance sheets	$p(e)$	0.962		1.000	
Benefit of leverage (in c units)	100χ	NA		NA	
Benefit of making effort observable (in c units)	100χ	NA		6.11	

Making effort observable makes things *a lot* better, equivalent to a 6% permanent jump in consumption!

Table 3: Steady State Properties of the Model					
Variable meaning	Variable name	Unobserved Effort		Observed Effort	
		Leverage Restriction		Leverage Restriction	
		non-binding	binding	non-binding	binding
Spread	$400(R_g^d - R)$	0.600		NA	
scaled consumption	c	1.84		2.01	
labor	h	1.18		1.15	
scaled capital stock	k	51.52		59.75	
bank assets	$N + d$	51.52		59.55	
bank net worth	N	2.58		2.58	
bank deposits	d	48.94		56.98	
bank leverage	$(N + d)/N$	20.00		23.12	
bank return on equity (APR)	$400\left(\frac{\left[p(e_t)R_{t+1}^g+(1-p(e_t))R_{t+1}^b\right](N_t+d_t)-R_td_t}{N_t} - 1\right)$	4.59		4.59	
fraction of firms with good balance sheets	$p(e)$	0.962		1.000	
Benefit of leverage (in c units)	100χ	NA		NA	
Benefit of making effort observable (in c units)	100χ	NA		6.11	

Interestingly, leverage goes up.

Table 3: Steady State Properties of the Model					
Variable meaning	Variable name	Unobserved Effort		Observed Effort	
		Leverage Restriction		Leverage Restriction	
		non-binding	binding	non-binding	binding
Spread	$400(R_g^d - R)$	0.600	0.211	NA	
scaled consumption	c	1.84	1.88	2.01	
labor	h	1.18	1.16	1.15	
scaled capital stock	k	51.52	51.40	59.75	
bank assets	$N + d$	51.52	51.31	59.55	
bank net worth	N	2.58	3.02	2.58	
bank deposits	d	48.94	48.29	56.98	
bank leverage	$(N + d)/N$	20.00	17.00	23.12	
bank return on equity (APR)	$400\left(\frac{\left[p(e_t)R_{t+1}^g+(1-p(e_t))R_{t+1}^b\right](N_t+d_t)-R_t d_t}{N_t} - 1\right)$	4.59	14.96	4.59	
fraction of firms with good balance sheets	$p(e)$	0.962	0.982	1.000	
Benefit of leverage (in c units)	100χ	NA	1.19	NA	
Benefit of making effort observable (in c units)	100χ	NA	NA	6.11	

Cut in leverage in the unobserved effort economy moves things towards observed effort.

Table 3: Steady State Properties of the Model					
Variable meaning	Variable name	Unobserved Effort		Observed Effort	
		Leverage Restriction		Leverage Restriction	
		non-binding	binding	non-binding	binding
Spread	$400(R_g^d - R)$			NA	NA
scaled consumption	c			2.01	1.95
labor	h			1.15	1.14
scaled capital stock	k			59.75	53.86
bank assets	$N + d$			59.55	53.68
bank net worth	N			2.58	3.16
bank deposits	d			56.98	50.52
bank leverage	$(N + d)/N$			23.12	17.00
bank return on equity (APR)	$400\left(\frac{\left[p(e_t)R^g_{t+1}+(1-p(e_t))R^b_{t+1}\right](N_t+d_t)-R_t d_t}{N_t} - 1\right)$			4.59	17.63
fraction of firms with good balance sheets	$p(e)$			1.000	1.000
Benefit of leverage (in c units)	100χ			NA	-2.70
Benefit of making effort observable (in c units)	100χ			6.11	2.03

Hidden effort assumption is *essential*. Otherwise, leverage restriction *reduces* utility.

Dynamics

- Here, we consider the dynamic effects of two shocks
  - shock to monetary policy
  - lump sum shock to net worth

$$R_t = 0.80R_{t-1} + (1 - 0.80)[1.5\pi_{t+1} + 0.5g_{y,t}] + \varepsilon_t^p$$

$$\varepsilon_0^p = +25 \text{ annual basis points}$$

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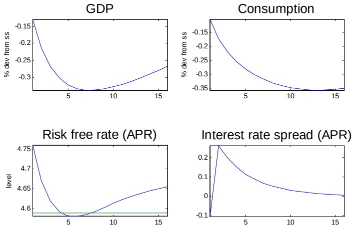

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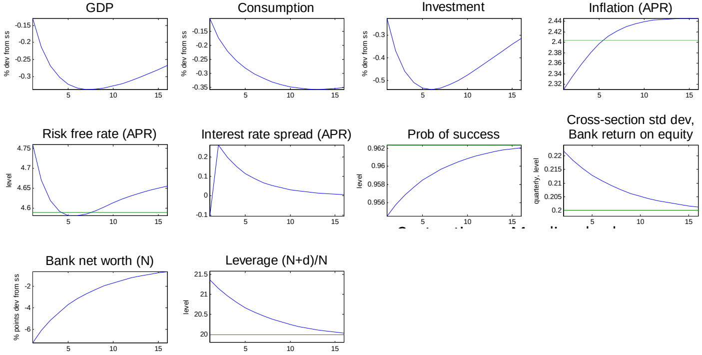

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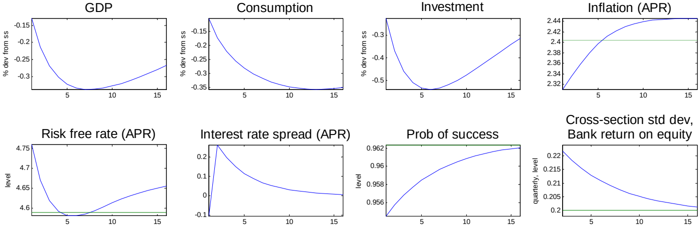

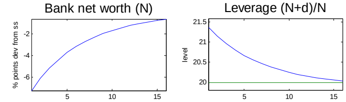

Contractionary M policy shock:

fall in:

- *c, i, y,*
- bank net worth, *N*,
- inflation

Rise in:

- leverage
- cross-sectional dispersion of bank performance

$$\log\left(\frac{T_t}{T}\right) = 0.95\log\left(\frac{T_{t-1}}{T}\right) + \varepsilon_t^T$$

$$\varepsilon_0^T = -0.10$$

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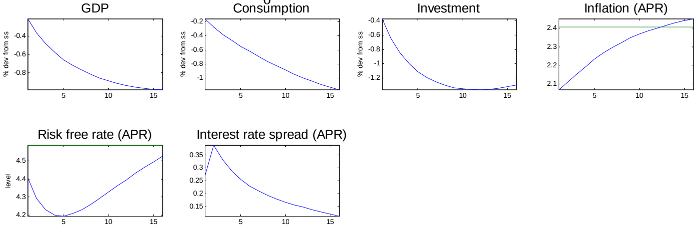

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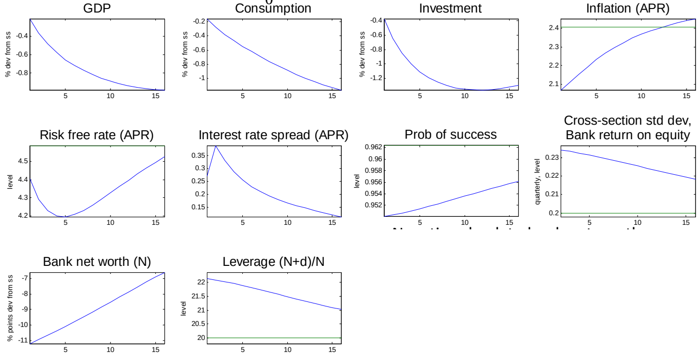

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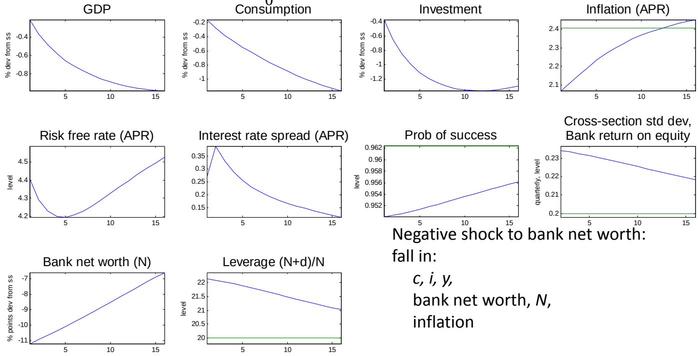

Negative shock to bank net worth:

fall in:

c, i, y,

bank net worth, *N*,

inflation

Rise in:

leverage

cross-sectional dispersion of bank performance

Cyclicality of Leverage

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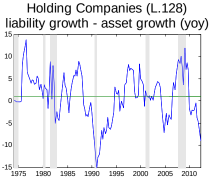
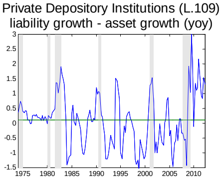
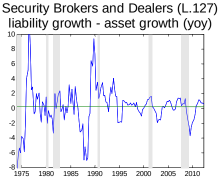
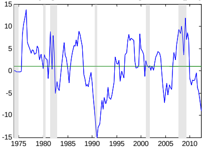
  - This measure of leverage can be negative or gigantic.
- We took measures of L^f for three components of financial business, over a period for which L^f does not behave strangely, the 2000s.


Holding Companies (L.128)
liability growth - asset growth (yoy)
15
10
5
0
-5
-10
-15
1975 1980 1985 1990 1995 2000 2005 2010


Private Depository Institutions (L.109)
liability growth - asset growth (yoy)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
1975 1980 1985 1990 1995 2000 2005 2010


Security Brokers and Dealers (L.127)
liability growth - asset growth (yoy)
10
8
6
4
2
0
-2
-4
-6
-8
1975 1980 1985 1990 1995 2000 2005 2010

Holding Companies (L.128)
liability growth - asset growth (yoy)



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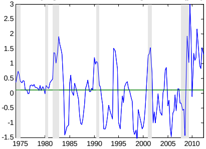

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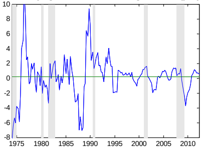
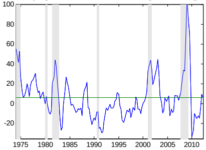
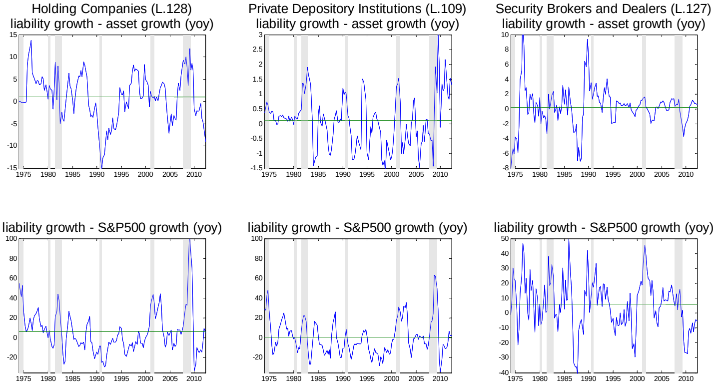


liability growth - S&P500 growth (yoy)

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1975 1980 1985 1990 1995 2000 2005 2010

Conclusion

- Described a model in which there is a problem that is mitigated by the introduction of leverage restrictions.
- Described some loose tests of the model by looking at its dynamic implications.
- Plan to study implications of the model for a broader class of leverage rules.

Bankers and their Creditors

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Assets	Liabilities
Loans and other securities	Deposits, d_t
$N_t + d_t$	Banker net worth, N_t

- No agency problems on asset side of bank balance sheet.

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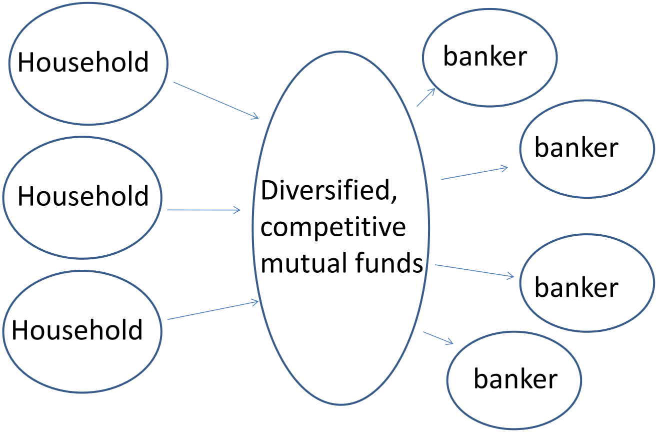
- No agency problems on asset side of bank balance sheet.
- Problems are on liability side.
- Bankers receive credit, d_t, from mutual funds.
  - Mutual funds deal with households.

Risky Bankers Funded By Mutual Funds



$$
\begin{aligned}
L_t^e &= \frac{a_t^f}{a_t^f - l_t^f} \\
dL_t^e &= \frac{da_t^f}{a^f - l^f} - \frac{a_t^f}{\left(a^f - l^f\right)^2}\left(da_t^f - dl_t^f\right) \\
&= \frac{a^f}{a^f - l^f}\hat{a}_t^f - \frac{a_t^f}{\left(a^f - l^f\right)^2}\left(a^f\hat{a}_t^f - l^f\hat{l}_t^f\right) \\
\hat{L}_t^e &= \hat{a}_t^f - \frac{1}{a^f - l^f}\left(a^f\hat{a}_t^f - l^f\hat{l}_t^f\right) \\
&= \frac{l^f}{a^f - l^f}\left(\hat{l}_t^f - \hat{a}_t^f\right)
\end{aligned}
$$

$$
\begin{aligned}
L_t &= \frac{a_t^{nf} + a_t^f}{a_t^{nf} + a_t^f - l_t^f} \\
L\hat{L}_t &= \frac{a^{nf}}{a^{nf} + a^f - l^f}\hat{a}_t^{nf} + \frac{a^f}{a^{nf} + a^f - l^f}\hat{a}_t^f \\
&\quad - \frac{a^{nf} + a^f}{\left(a^{nf} + a^f - l^f\right)^2}\left(a^{nf}\hat{a}_t^{nf} + a^f\hat{a}_t^f - l^f\hat{l}_t^f\right) \\
\hat{L}_t &= \frac{a^{nf}}{a^{nf} + a^f}\hat{a}_t^{nf} + \frac{a^f}{a^{nf} + a^f}\hat{a}_t^f - \frac{1}{a^{nf} + a^f - l^f}\left(a^{nf}\hat{a}_t^{nf} + a^f\hat{a}_t^f - l^f\hat{l}_t^f\right) \\
&= \left[\frac{a^{nf}}{a^{nf} + a^f} - \frac{a^{nf}}{a^{nf} + a^f - l^f}\right]\hat{a}_t^{nf} + \left[\frac{a^f}{a^{nf} + a^f} - \frac{a^f}{a^{nf} + a^f - l^f}\right]\hat{a} \\
&= \left[\frac{a^{nf}}{a^{nf} + a^f} - \frac{a^{nf}}{a^{nf} + a^f - l^f}\right]\hat{a}_t^{nf} - \frac{l^f}{\left(a^{nf} + a^f - l^f\right)\left(a^{nf} + a^f\right)}a^f\hat{a} \\
&= -\frac{l^f a^{nf}}{\left(a^{nf} + a^f\right)\left(a^{nf} + a^f - l^f\right)}\hat{a}_t^{nf} - \frac{l^f a^f}{\left(a^{nf} + a^f\right)\left(a^{nf} + a^f - l^f\right)}\hat{a}_t^f
\end{aligned}
$$