Endogenous Liquidity and Capital Reallocation

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Introduction

A relatively new area for search theory in general and monetary economics in particular: capital reallocation and liquidity.

- Lit. review in the paper
- But we highlight the redistribution channel of firm liquidity and show it is quantitatively significant

Observations:

- Two keys to efficient output and growth: (1) capital accumulation; and (2) capital reallocation.
- Traditional macro focused on (1) but now (2) is in the spotlight.
- As in any asset market, there is feedback from accumulation to reallocation and vice-versa - but the channel in our framework is subtle.

Introduction

- New facts about capital reallocation and liquidity.
  - reallocation Lit. review in the paper
  - but we look at the distributional effect of inflation on reallocation
- New framework with both primary and secondary capital markets.
  - positive or negative relationship depending on bargaining/liquidity positions
- Model both types of reallocation as a result of search and liquidity consideration:
  - acquisition/takeover – i.e., a full sale;
  - purchase of some capital – i.e., a partial sale.
- Study dynamics looking at business cycle statistics.
  - credit shocks necessary for the (volatile) reallocation dynamics
  - both standard RBC statistics and statistics on reallocation
- Study new monetary-fiscal implications.

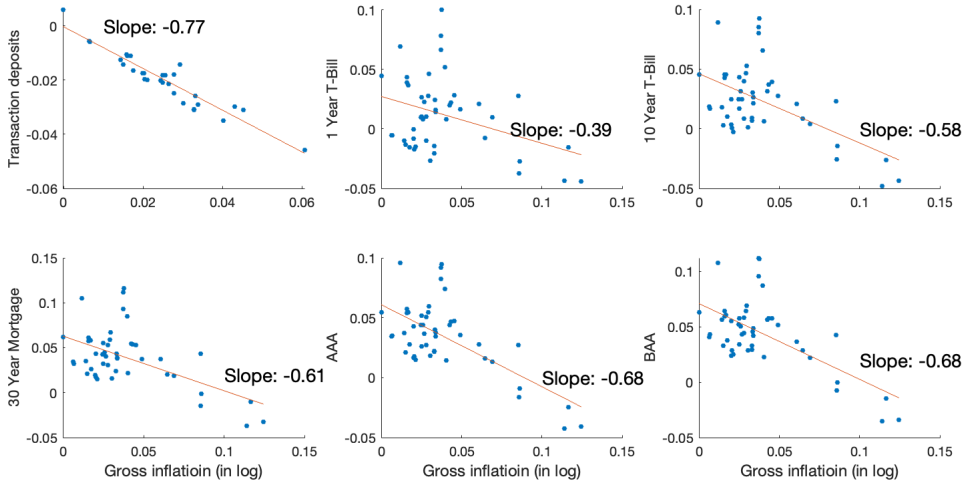
Existing Facts

- Numerous studies find K reallocation is sizeable:
  - used capital 25% to 33% of total K expenditure.
  - these are underestimates, as they ignore small firms, those not publicly traded, mergers, and rentals.
- And document stylized facts we want to match:
  - reallocation is procyclical, K mismatch is countercyclical.
  - productivity dispersion is countercyclical.
  - price of used K is procyclical.
- Many argue secondary capital markets are frictional:
  - price dispersion, long and variable time to trade, etc.
  - suggests financial constraints, search and matching frictions, bargaining problems....

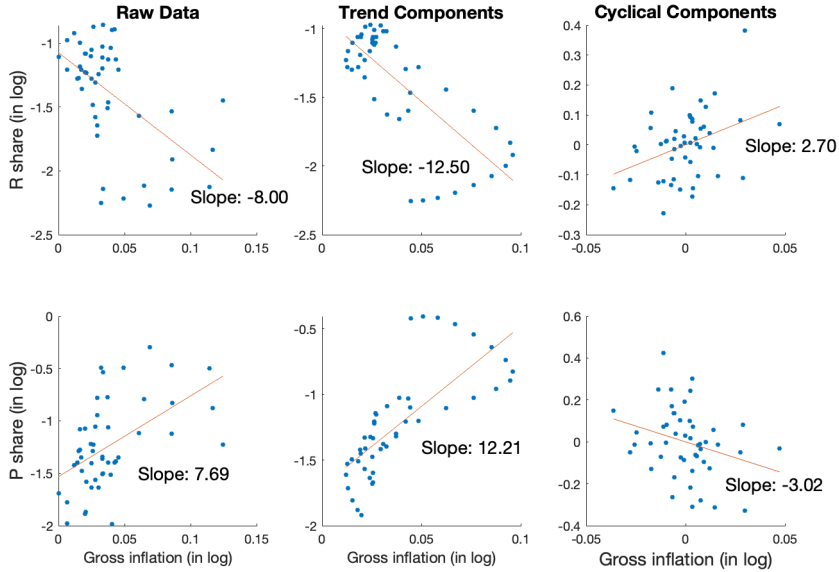
Some New Statistics

- COMPUSTAT 1971-2018 (accounting change since 2019)
  - acquisitions
  - sales of property, plant and equipment
  - total capital expenditures
- R share: reallocation $\div$ capital expenditure $= 28\%$, or 32% after 1984.
- P share partial sales $\div$ reallocation $= 30\%$, or 24% after 1984.
- Slides focus on macro facts (micro facts are in the paper).
- Thomson-Reuters: 42% of full sales use cash/cash equivalent.
  - strongly suggests a role for money and inflation.
  - micro facts from COMPUSTAT show the same picture

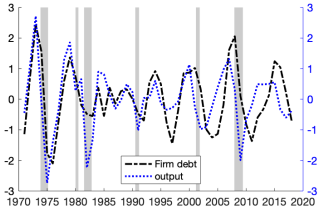
Inflation and the (Real) Returns of Assets

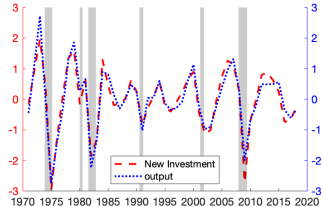


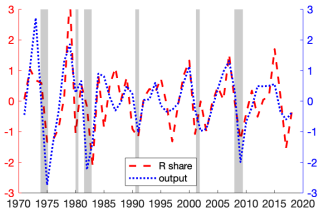
Data: Reallocation and Cost of Liquidity

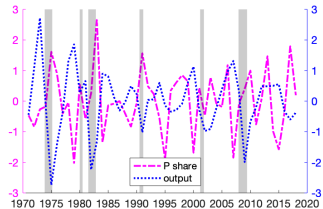


Cyclical Reallocation and Debt







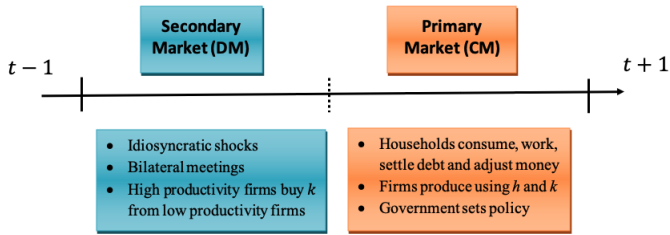


R share procyclical and P share countercyclical

debt positively related to R share, negatively related to P share

Environment

- Firms, owned by households, face idiosyncratic shock ε (ignore agg shocks for now).
- Alternating CM - DM structure from LW:
  - Shocks realized after CM closes $\Rightarrow$ gains from DM trade.
  - Firm meets random counterparty in DM with a prob α, where K could/should flow to one with higher ε.



The CM Problem:

$$W(\Omega,\varepsilon) = \max_{c,h,\hat{k},\hat{z}} \left\{ u(c) - \xi h + \beta \mathbb{E}\left[V_+\left(\hat{k},\hat{z},\hat{\varepsilon}\right) | \varepsilon \right] \right\}$$
$$\text{st } c = \Omega + (1-\tau_h) w h - \left(\phi/\phi_+\right)\hat{z} - \hat{k}$$

where Ω is wealth given (k,ε),

$$\Omega \equiv (1-\tau_k)\Pi(k,\varepsilon) + (1-\delta)k + z - d - T,$$

and with CRS profit Π is linear in εk,

$$\Pi(k,\varepsilon) = B(w)\varepsilon k = \max_{\tilde{h}} \{ (A\varepsilon k)^{1-\eta} \tilde{h}^{\eta} - w\tilde{h} \}.$$

The CM Problem (cont') :

Lemma 1: $W(\Omega, \varepsilon)$ is linear in Ω with slope $\xi/[(1-\tau_h)w]$.

Lemma 2: $(\hat{k}, \hat{z}) \perp (k, z)$, depends on ε only via $\mathbb{E}\left[V_+(\hat{k}, \hat{z}, \hat{\varepsilon})|\varepsilon\right]$.

The DM Problem:

- State: $\Gamma(k, z, \varepsilon)$, dist'n of capital, money and productivity.
- When agent $\mathbf{s} \equiv (k, z, \varepsilon)$ meets agent $\tilde{\mathbf{s}} \equiv (\tilde{k}, \tilde{z}, \tilde{\varepsilon})$ with $\varepsilon > \tilde{\varepsilon}$, former gets $q(\mathbf{s}, \tilde{\mathbf{s}}) \leq \tilde{k}$ and pays $p(\mathbf{s}, \tilde{\mathbf{s}}) \leq z$. Then, DM value

$$V(k, z, \varepsilon) = W(\Omega, \varepsilon) + \alpha \int_{\varepsilon > \tilde{\varepsilon}} S^b(\mathbf{s}, \tilde{\mathbf{s}}) d\Gamma(\tilde{\mathbf{s}}) + \alpha \int_{\varepsilon < \tilde{\varepsilon}} S^s(\tilde{\mathbf{s}}, \mathbf{s}) d\Gamma(\tilde{\mathbf{s}}),$$

  $S^b(\cdot)$ and $S^s(\cdot)$ are buyer and seller surpluses. For example, by Lemma 1

$$S^b(\mathbf{s}, \tilde{\mathbf{s}}) = \frac{\xi \left\{ \left[(1 - \tau_k) \varepsilon B(w) + 1 - \delta \right] q(\mathbf{s}, \tilde{\mathbf{s}}) - p(\mathbf{s}, \tilde{\mathbf{s}}) - d(\mathbf{s}, \tilde{\mathbf{s}}) \right\}}{w(1 - \tau_h)};$$

- In addition to z there is constrained credit:

$$d \leq \chi_0 + \chi_q (1 - \delta) q + \chi_\Pi \Pi + \chi_k (1 - \delta) k.$$

DM Terms of Trade

Lemma 3: DM trade has either:
A *stock out*, or *full sale*, $q = \tilde{k}$ and $p < z$;
A *cash out,* or *partial sale*, $q < \tilde{k}$ and $p = z$.

- Kalai bargaining (can also use Nash, Walras...). θ is a buyer's bargaining power.
- Recall $\Pi = B\varepsilon k$ is profit and define

$$\Delta\left(\varepsilon, \tilde{\varepsilon}; B\right) = (1-\tau_k)B\left[(1-\theta-\chi_\pi)\varepsilon + \theta\tilde{\varepsilon}\right] + (1-\delta)(1-\chi_q).$$

- A stock out:

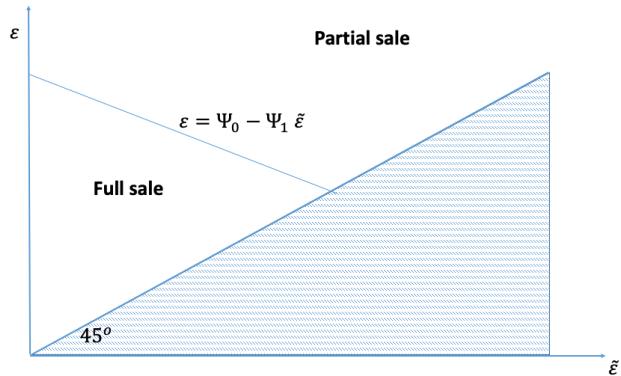
$$q = \tilde{k}, p = \Delta q = \Delta\left(\varepsilon, \tilde{\varepsilon}; B\right)\tilde{k}.$$

- A cash out:

$$q = z/\Delta\left(\varepsilon, \tilde{\varepsilon}; B\right), p = \Delta q = z.$$

Outcomes in Matching Space

$\Psi_1 \equiv \frac{\theta}{1-\theta-\chi_\Pi(1+k/\bar{k})}$; χ_Π determines who are constrained



Note: focus on χ_Π not too big (for a lot of reasons); equil and efficiency at odds as big gains from trade $\Rightarrow$ high price $\Rightarrow$ liquidity binds $\Rightarrow$ small trade.

Equilibrium

- *Equilibrium*: paths for CM variables (as in standard macro model) $\langle K_t, Z_t, C_t, H_t, w_t \rangle$ and DM variables $\langle q(\mathbf{s}, \tilde{\mathbf{s}}), p(\mathbf{s}, \tilde{\mathbf{s}}) \rangle$ satisfying the obvious conditions (see the text) including the Euler equations.
- CM looks like a standard old-time macro model:
  1. investment equation for K;
  2. liquidity preference for Z;
  3. consumption function for C;
  4. labor supply function for H;
  5. market clearing $Y = C + I + G$ solves for w;
  6. quantity equation $\phi_t = Z_t / M_t$.
- DM adds micro foundations: gains from trade due to shocks, random matching, bargaining and liquidity frictions.

IID Case

- Consider ε iid, $\chi_q = 1$, $\chi_0 = \chi_\Pi = \chi_k = 0$ (general case in paper).
- $I_s(k)$: integral of DM surplus from marginal unit of k.
- $I_b(z)$: integral of DM surplus from marginal unit of z.
- Euler equations for k and z:

$$\begin{aligned} u'(C_{-1}) &= \beta u'(C)\left\{(1-\tau_k)B\left[\mathbb{E}\varepsilon + \alpha(1-\theta)I_s(k)\right] + 1 - \delta\right\} \\ u'(C_{-1}) &= \frac{\beta u'(C)}{1+\pi}\left[(1-\tau_k)B\alpha\theta I_b(z) + 1\right], \end{aligned}$$

  where B is return on capital from $\Pi = B\varepsilon K$.
- (K, Z) is degenerate. In SS Euler eqns reduce to two eqns in (B, L); L is threshold productivity with normalized liquidity from

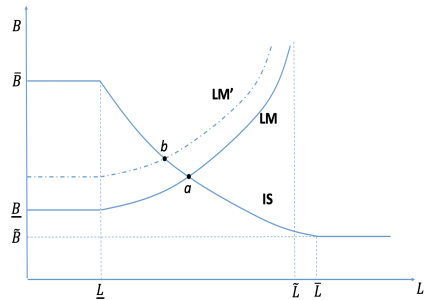
$$L \equiv \frac{Z/K - (1-\chi_q)(1-\delta)}{(1-\tau_k)B}$$

Steady State (SS): "IS - LM"

- Goods market clearing will solve K, then labor, output,...

$$u'^{-1}\left(\frac{\xi}{(1-\tau_h)w}\right) + G = \left[\frac{B(w)J(L,w)}{1-\eta} - \delta\right] K$$

- 3-(or 4-)equation monetary model; ι affects LM but not IS; if $\chi_q = 1$, τ_k affects IS but not LM.



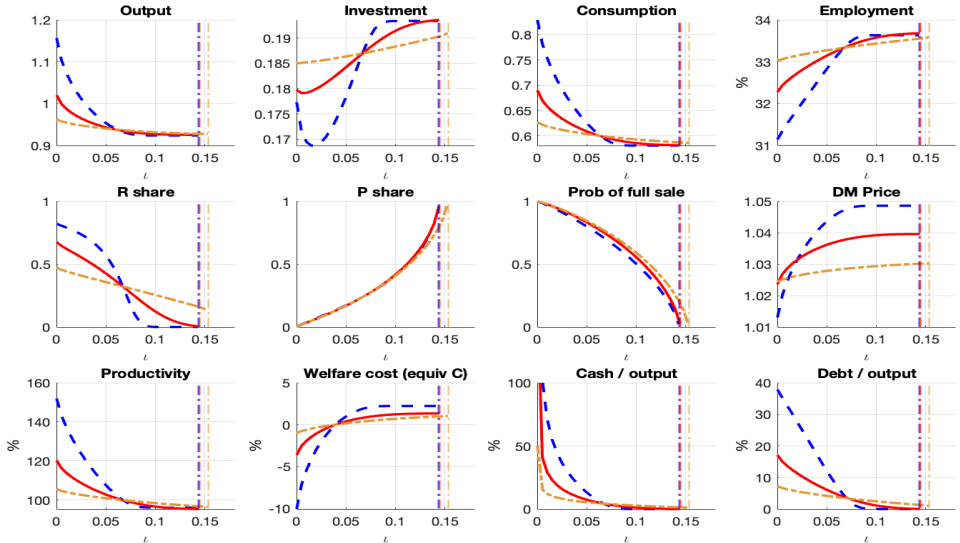
Calibration

- Model nests Hansen (1985), hence some targets are standard.
- Log normal productivity ε calibrated to COMPUSTAT
- To endogenize α, we use endogenous entry with cost following a log normal distribution with mean μ_c and standard deviation σ_c.

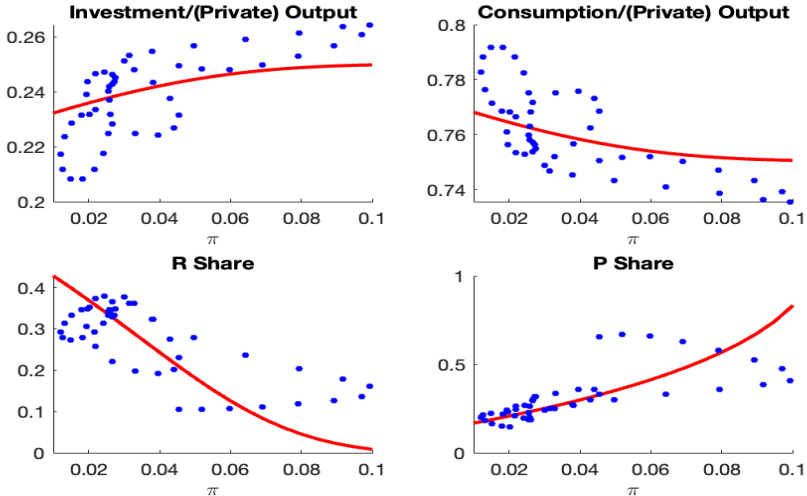
Table: Calibrated Parameter Values

Parameter	Value	Explanation	Parameter	Value	Explanation
ι	0.067	nominal AAA yield	μ_γ	-1.6694	R share
β	0.9619	real AAA yield	χ_q	0.8840	P share
ξ	2.2503	labor hours	χ_Π	0.1034	cash/output
η	0.61	investment/output	τ_k	0.25	capital tax rate
δ	0.1000	depreciation rate	τ_h	0.22	labor tax rate
σ_ε	1.30	COMPUSTAT	G	0.1504	gov't share
σ_γ	0.2846	acquisition elasticity	θ	0.50	symmetry

LR Effects of High Inflation/Interest Rate

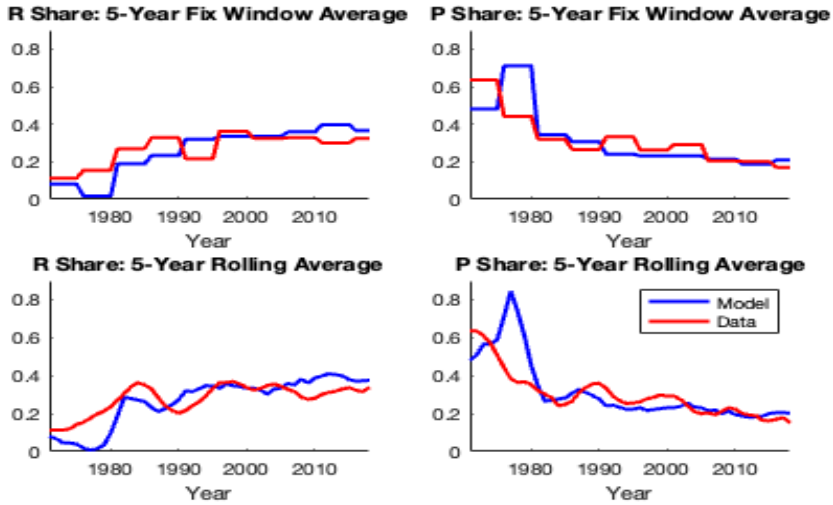


Model's Long-run Prediction



Note: both cash and debt increase when interest rate / inflation falls

Model's Medium-run Prediction



Key Business Cycle Statistics

Table: Business Cycle Statistics

	Standard deviation			Correlation with output		
	Data	A only	A & χ_q	Data	A only	A & χ_q
Output	1.73	1.73	1.73	1.00	1.00	1.00
Consumption	0.67	0.48	0.71	0.96	0.98	0.93
Investment	2.56	2.76	2.30	0.96	0.99	0.92
Employment	0.88	0.47	0.56	0.85	0.96	0.96
TFP	0.69	0.60	0.52	0.76	0.99	0.97
R share	6.45	0.98	6.45	0.61	-0.95	0.50
P share	9.46	1.15	11.83	-0.52	0.91	-0.52
Inflation	0.89	0.10	0.63	0.33	-0.94	0.36

Note: Standard deviation of other variables are relative to output.

Key Business Cycle Statistics

- Model consistent with business cycle statistics. Not trivial because new features may make things worse.
- Both credit and productivity shocks are crucial to match reallocation statistics
- Model matches business cycle facts of reallocation and more
  - procyclical reallocation, countercyclical P share
  - procyclical used capital price, countercyclical productivity dispersion (not in the table)

Key Business Cycle Statistics without Money

Table: Business Cycle Statistics without Money

	SD			Corr with output		
	Data	A only	A and χ_q	Data	A only	A and χ_q
Output	1.73	1.73	1.73	1.00	1.00	1.00
Consumption	0.67	0.43	0.60	0.96	0.96	0.89
Investment	2.56	2.92	2.66	0.96	0.99	0.94
Employment	0.88	0.43	0.49	0.85	0.97	0.95
TFP	0.69	0.63	0.58	0.76	0.99	0.98
R share	6.45	2.38	6.45	0.61	-0.98	0.11
P share	9.46	1.16	5.49	-0.52	0.96	-0.26
Inflation	0.89	-	-	0.33	-	-

Note: SD is standard deviation relative to output, except for output itself.

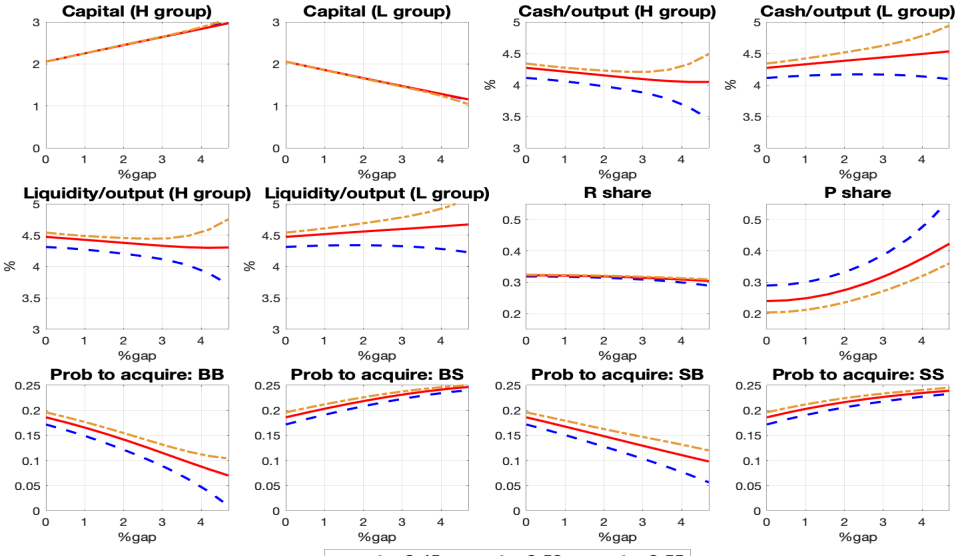
A Quick Summary

- To get both SR and LR facts, we think we need:
- A money-supply story:
  - in LR lower inflation $\Rightarrow$ lower liquidity cost
  - more reallocation, more full sales, fewer partial sales
- A money-demand story:
  - easier credit $\Rightarrow$ higher inflation in SR
  - more reallocation, more full sales, fewer partial sales
- Note: we do *not* say credit shocks are more transitory, but they increase the price level which shows up in data as SR inflation.

Further Exploration: Persistent Idiosyncratic Shocks

- Let $\log \varepsilon = \log a + \log e$ where a is an N state Markov chain and $\log e$ is iid.
- Then we get a N state dist'n of $(\hat{k}, \hat{z})$.
  - For simplicity so far we use $N = 2$ and impose symmetry.
- In general, high a firms hold more k and liquidity (credit + cash), which may depend on θ.
- Larger firms are less likely acquired but more likely to acquire small firms (a feature in the data).
- The results for aggregate variables remains:
  - reminescent of Rios-Rull (1990)
  - of course, it generates more than aggregate statistics – e.g., a cross section of firm liquidity.

An Illustration: Markov Chain with $p = 0.75$



Conclusion

- A framework with primary and secondary markets for capital
  - with search, bargaining, and liquidity frictions.
  - new understanding of different types of reallocation
  - tractable even with heterogeneity and non-degnerate dist'n
- Optimal polices depend on the secondary capital market:
  - may want to deviate from the Friedman rule
  - may want to tax or subsidize capital
- Show the model is quantitative consistent with data
  - fits both standard RBC statistics and facts on reallocation
  - credit plus prod shocks allow us to match the relevant facts.