Dry Firms, Deep Recessions: Corporate Payouts and Aggregate Dynamics

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† Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank or the Eurosystem.

Motivation

- Corporate cash increased over the past 40 years to more than 10% of GDP
- A large literature thinks about the causes of the increase in cash holdings...
  Opler et al. ('99), Acharya et al. ('07), Bates et al. ('09), Riddick and Whited ('09), Chen et al. ('17)
- ...but macroeconomic implications of corporate cash holdings remain understudied.
- **Key question:** How does ample liquidity alter the nature of the business cycle?
- **Main finding:** Corporate cash affects consumption response to shocks via dividend income.

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This paper

- **Model:** Business-cycle, heterogeneous firm with financial frictions.
- **Mechanism:** firms hold precautionary cash but exhibit a satiation point.
- **State dependence:**
  - High corporate cash smooths dividends...
  - ...and dampens consumption losses after adverse TFP shocks.
- **Sufficient statistic:** the Marginal Propensity to Pay Out (MPPO):
  - Is U-shaped in cash holdings.
  - Measures the pass-through of firm liquidity to households.
- **Micro evidence** in support of cash distribution and mechanism.

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Literature

- Financial frictions and aggregate dynamics
  Bernanke et al. (‘99), Gertler & Kiyotaki (‘10), Begenau & Salomao (‘18), Ottonello & Winberry (‘20), Cloyne et al. (‘23)
  ⇒ Financial frictions affect consumption **through the dividend channel**

- Increase in corporate cash hoarding
  Opler et al. (‘99), Almeida et al (‘05), Acharya et al (‘07), Bates et al (‘09), Riddick & Whited (‘09), Bolton et al (‘11), Chen et al. (‘17), Bolton et al (‘19)
  ⇒ **Macro implications** of cash hoarding

- Business-cycle heterogeneous-agent models
  Aiyagari (‘94), Krusell & Smith (‘98), Khan and Thomas (‘08, ‘13), Gilchrist & Zakrajsek (‘12), Jermann & Quadrini (‘12), Alfaro et al (‘24)
  ⇒ **Nonlinearity** from cash hoarding survives aggregation

Quantitative model

Baseline Model Features

- Heterogeneous firms with idiosyncratic and aggregate shocks:
  - Firms choose labor, dividends, and cash (non-negative) each period.
  - Cobb-Douglas production function with D.R.S. with single input labor.
  - Firms pay a fixed operating cost ξ.
  - Firms can issue equity subject to: $C(d) = \frac{\mu}{2} d^2 \mathbb{I}(d < 0)$.
  - Two-state Markov process for aggregate TFP: $A_t \in \{A_B, A_G\}$
- Cash holdings:
  - Evolve according to $n_{it+1} = n_{it} + q_t^n h_{it}$.
  - Price is set such that $q_t^n = \kappa m_t$. Alfaro et al. ('24) and Cooley and Quadrini ('01).
  - Supply of cash follows $N_{i+1}^S = \mathcal{H}(q_t^n)^{\frac{1}{\xi}}$ Alfaro et al. ('24)
- Households consume, supply labor, hold bonds and firms' equity. Household's problem

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Recursive firm problem

$$J(n, z; X) = \max_{n', d} \quad d - C(d) + \mathbb{E}\left[m(X; X')J(n', z'; X')\right]$$

s.t.:

$$d = \pi(z; X) + n - q^n n', \qquad \text{[Dividend]}$$

$$\pi(z; X) \equiv \max_{l} zAl^\gamma - w(X)l - \xi, \qquad \text{[Profits]}$$

$$C(d) = \frac{\mu}{2}\mathbb{I}(d < 0)d^2, \qquad \text{[Equity issuance cost]}$$

$$n' \geq 0, \qquad \text{[Cash constraint]}$$

$$X \equiv \{\Phi, A\}, \qquad \text{[Aggregate state]}$$

$$\text{and} \quad \Phi' = G(\Phi, A) \qquad \text{[Aggregate law of motion]}$$

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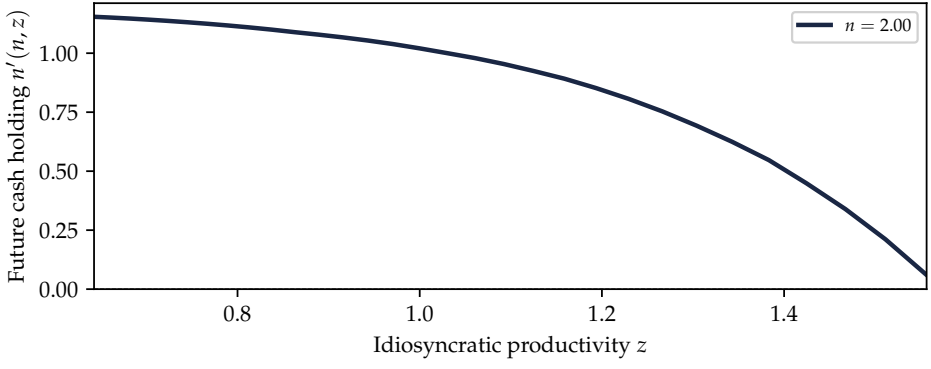
Role of market incompleteness

Cash holdings



- Firms exhibit a cash holdings satiation point.
- Cash policy hump-shaped in z.
- Satiation point contrasts sharply with household's patterns. Aiyagari comparison

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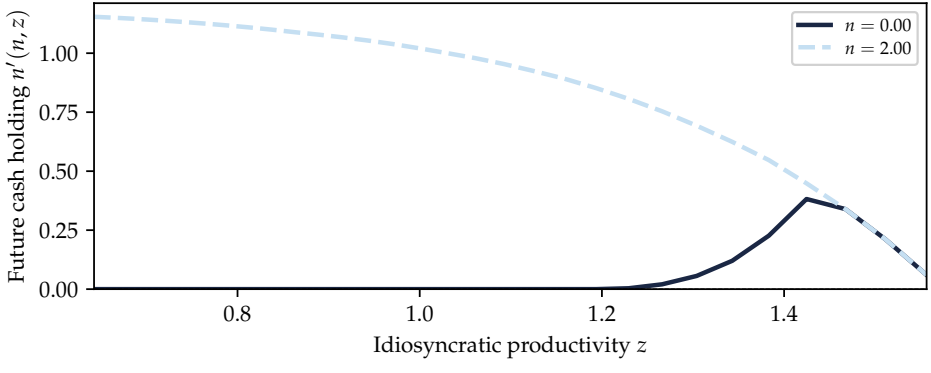

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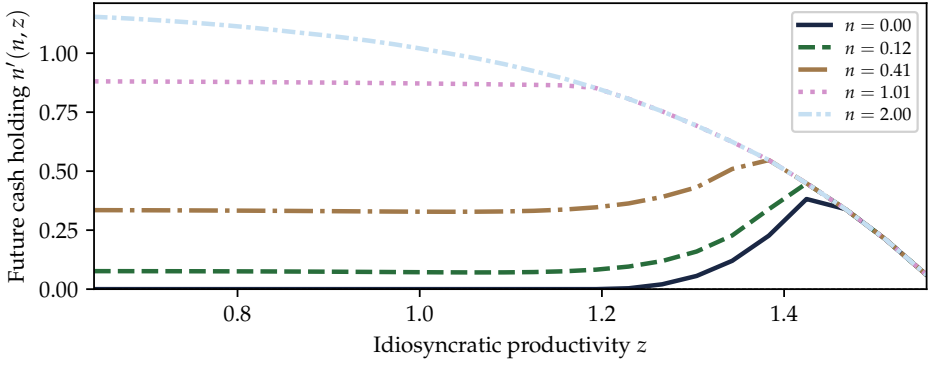

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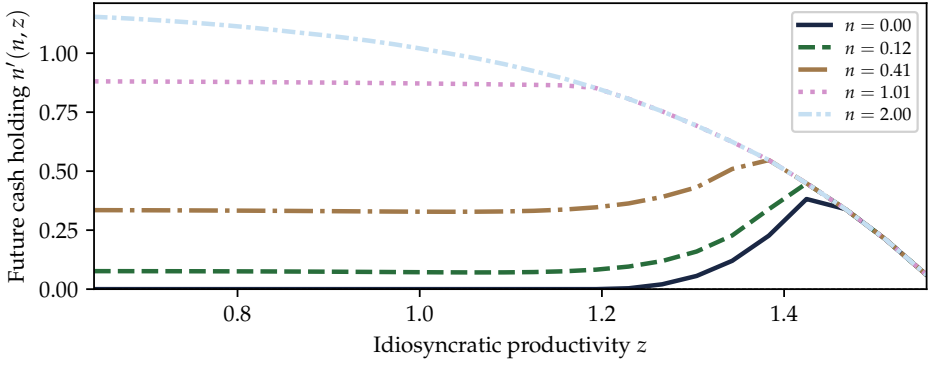

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Marginal Propensity to Pay Out (MPPO)

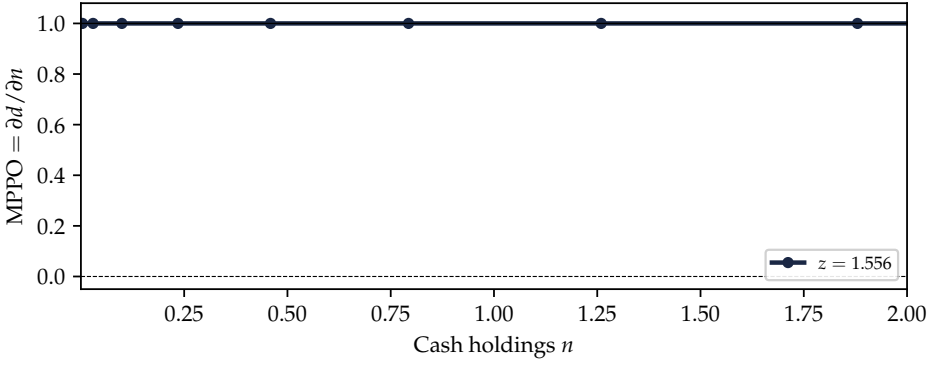
Definition (MPPO)

$$MPPO(n, A) = \frac{\partial d(n, A)}{\partial n} = 1 - q^n \frac{\partial n'(n, A)}{\partial n}.$$

- MPPO always 1 for most productive firms.
- MPPO U-shaped in n for lower productivity levels.

Proposition

Marginal Propensity to Pay Out (MPPO)



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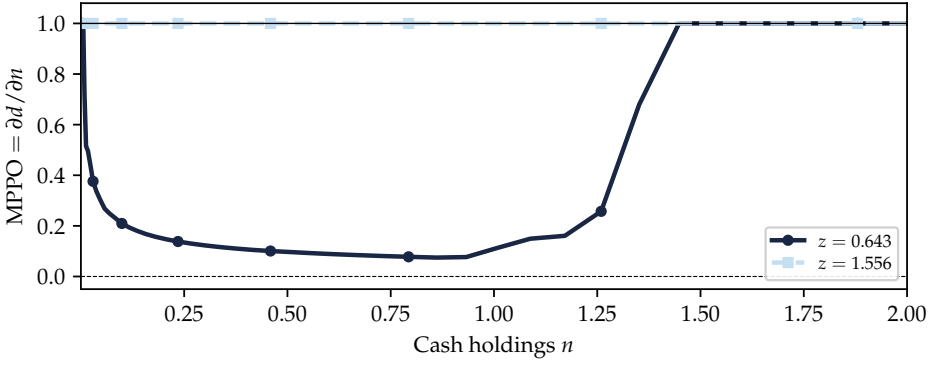

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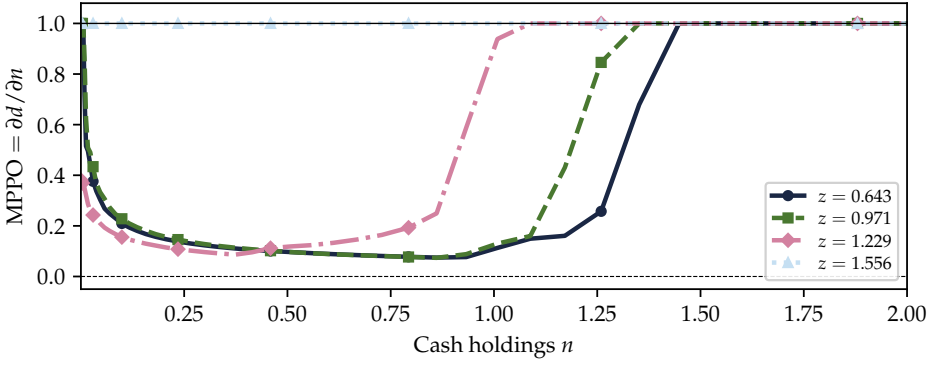

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Sufficient statistic: MPPO

Three simplifying assumptions:

- Assume only two periods.
- Normalize labor supply to 1.
- Representative firm

Proposition

The MPPO coincides with how the consumption response to TFP shock depends on firm liquidity:

$$\frac{\partial(c_1(n_1^L + \Delta_n, \bar{A} - \Delta_A) - c_1(n_1^L, \bar{A} - \Delta_A))}{\partial \Delta_n} = MPPO(A_1, n_1).$$

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Business cycle

Calibration

- A model period is a quarter.
- 7 parameters are taken from the literature
- 4 parameters are used to match 4 moments

Parameters	Description	Data	Model	Calibrated parameter
Targeted moments				
μ	Corporate cash holdings to output (%)	10.00	10.12	0.08
ξ	Consumption relative to output (%)	66.00	62.85	0.15
η	Hours worked relative to time available (%)	33.00	33.00	13.50
Δ_A	Output volatility (% *p.q.*)	1.45	1.74	0.04
Untargeted moments				
	Dividend to output (%)	1.91	1.98	

Micro fit

- Model calibrated to macro moments.
- How does it perform at the micro level?
- We use Compustat data

Description	Data	Model
$\mathrm{Corr}(n/y, y)$	-0.293***	-0.078***
$\mathrm{Corr}(\mathrm{std}(n/y)_p, \bar{y}_p)$	-0.972***	-0.393***
Dividend-drop mitigation from 1 s.d. higher cash/assets	50%	50%
$MPPO_{Q1} - MPPO_{Q4}$	0.62	0.39

Cash distribution | Cash standard deviation | Dividend smoothing | Dividend smoothing model | MPPO

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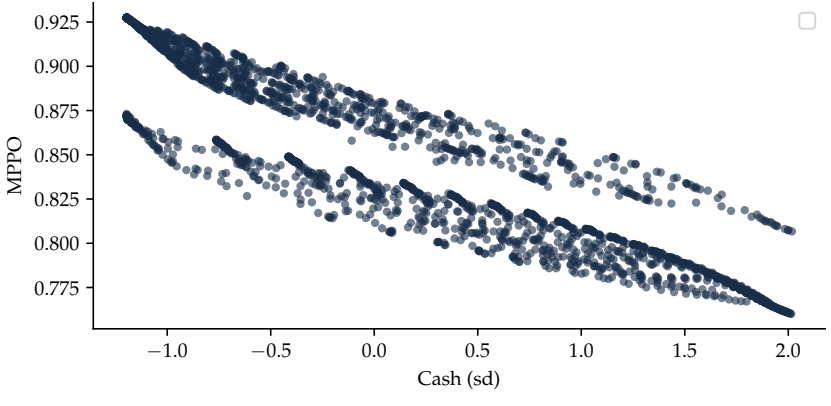
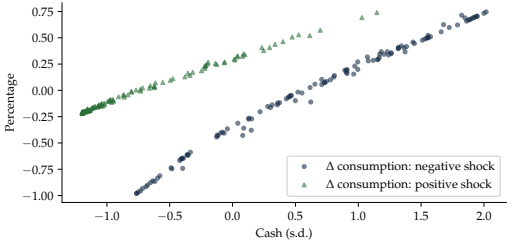
Aggregate MPPO and cash holdings

Business-cycle cash levels lie mostly on the declining part of the firm-level U.

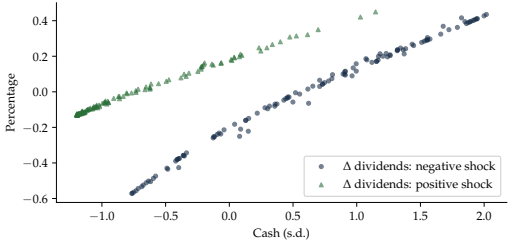


Takeaway. Higher cash lowers aggregate *MPPO*; TFP states generate dispersion.

State dependent consumption response



(a) Consumption



(b) Dividends

Takeaway. For bad TFP shocks, 1 s.d. higher cash raises consumption outcome by 0.60p.p.

Regression coefficient | Fiscal policy | GIRF | Heterogeneity | Social optimum

Empirical evidence

Mechanisms to test

- **Consumption responds to dividends** Results
  - PSID data on expenditures and dividend income.
  - Are increases in dividend income associated with increases in expenditures?
  - $1 increase in dividends is associated with 7.9¢ increase in expenditures. Baker et al ('06), Di Maggio et al ('20) and Brauer et al ('22)
- **Macro suggestive evidence** Results
  - Aggregate cash holdings and consumption volatility.
  - Model prediction: higher cash lowers consumption volatility.
  - Cash-to-output ratio doubled while consumption growth volatility decreased by 50%.

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Conclusion

- How do corporate cash holdings affect the business cycle?
- Higher cash holdings reduce consumption volatility over the cycle.
  - Cash holdings smooth dividends...
  - ...which in turn smooths consumption.
- MPPO emerges as a sufficient statistic summarizing these effects.
- The mechanism is visible in the data.

Appendix

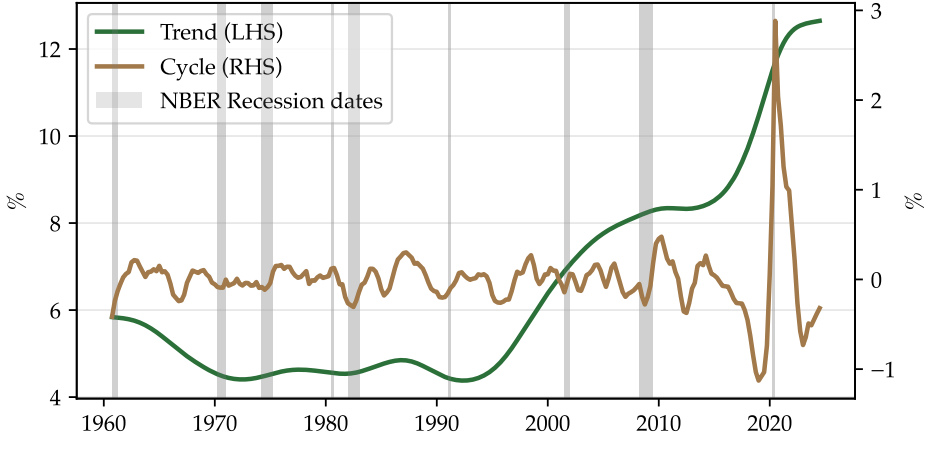
Cash definition

Cash is defined as the sum of:

- Private foreign deposits (FL103091003.Q).
- Checkable deposits and currency (FL103020005.Q).
- Total time and savings deposits (FL103030003.Q).
- Money market fund shares (FL103034000.Q)

Back

Cash evolution



Corporate cash (Flow of Funds) cyclical and trend components (HP filter).

Back

General equity issuance cost

- Results hold for a more general form of equity issuance cost.

$$C(d) = \begin{cases} \mu_0 + \mu_1 d + \frac{1}{2}\mu_2 d^2 & \text{if } d < 0 \\ 0 & \text{if } d \geq 0 \end{cases}$$

Back

Household's problem

$$V^H(b,s;X) = \max_{c,s',b',l^H} \left[\log(c) - \frac{\eta}{1+\frac{1}{\chi}}(l^H)^{1+\frac{1}{\chi}} + \beta \mathbb{E}\left[V^H(b',s';X')\right] \right]$$

subject to:

$$c + q(X)b' + \sum_{A'} \Gamma_{A,A'} \int m(X;X')s' d\Phi' = w(X)l^H + s + b + T(X)$$

$$X \equiv \{\Phi, A\}$$

Back

Recursive competitive equilibrium

Definition

A recursive competitive equilibrium is a set of functions

$$\left(q, q^n, m, w, T, J, N, D, L, V^H, C, L^H, S, B, N^S, \Phi\right)$$

that solve the firm problem, household problem, government budget constraint, and clear the markets for liquid assets, labor, output and household bond holdings, as described by the following conditions:

1. Taking q^n, m and w as given, J solves the firm problem, and (N, D, L) are the associated policy functions for firms.
2. V^H solves the household problem and (C, B, L^H, S) are the associated policy functions for households.
3. T satisfies the government budget constraint.
4. The goods market clears.

Competitive equilibrium

Definition

5. The market for shares clears $s(X) = \int [J(n, z; X) + C(D(n, z; X))] d\Phi$ as the external financing costs and aggregate firm values jointly determine the supply of equity.
6. The labor market clears $L^H(X) = \int L(n, z; X) d\Phi$
7. The liquid asset market clears $(N^S(X))' = \int N(n, z; X) d\Phi$
8. The evolution of the distribution is consistent with policy functions.
9. The bond market-clearing condition, $B(X) = 0$ is satisfied by Walras's law.

Back

Linear LoM

$$\log(N_{t+1}) = -0.5473 + 0.8899 * \log(N_t), \quad \text{if } A_t = A_B, \text{ and } R^2 = 0.9977,\ MSE = 0.0006$$

$$\log(N_{t+1}) = -0.7437 + 0.7331 * \log(N_t), \quad \text{if } A_t = A_G, \text{ and } R^2 = 0.9914,\ MSE = 0.0011$$

$$\log(p_t) = 1.3545 - 0.0093 * \log(N_t), \quad \text{if } A_t = A_B, \text{ and } R^2 = 0.9332,\ MSE = 0.0000$$

$$\log(p_t) = 1.3284 - 0.0073 * \log(N_t), \quad \text{if } A_t = A_G, \text{ and } R^2 = 0.9573,\ MSE = 0.0000$$

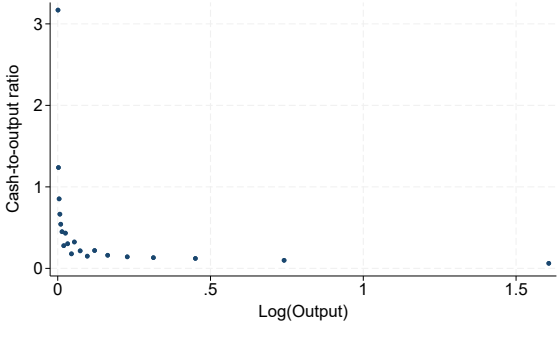
Back

Parameters

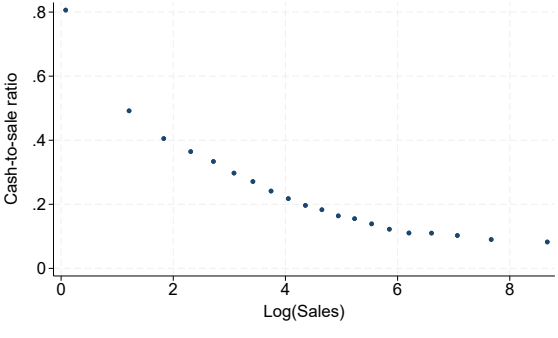
Parameter	Description	Value	Source
Households			
β	Discount factor	0.995	Chen et al '17
χ	Frisch labor supply elasticity	1.000	Kaplan et al '18
Production			
γ	Span of control	0.930	Standard calibration
κ	Cash return wedge	0.870	Cooley & Quadrini '01
ρ_z	Idiosyncratic shock persistence	0.861	Bachmann et al '13
σ_z	Idiosyncratic shock volatility	0.075	Bachmann et al '13
Aggregate			
$p(A_B\|A_B)$	Persistence of low aggregate TFP	0.875	Krusell & Smith '98
$p(A_G\|A_G)$	Persistence of high aggregate TFP	0.875	Krusell & Smith '98

Back

Model fit to the data - Cash holdings distribution



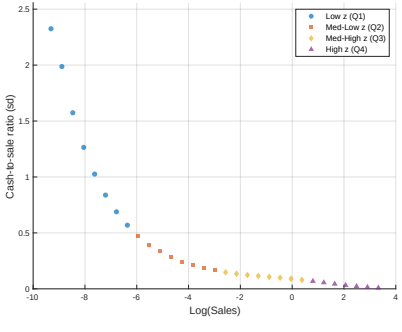
(a) Model



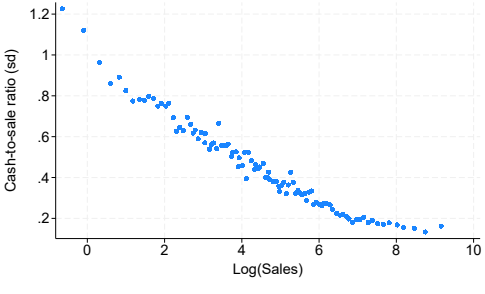
(b) Data

Back

Standard deviation of cash to output ratio



(a) Cash-to-output model



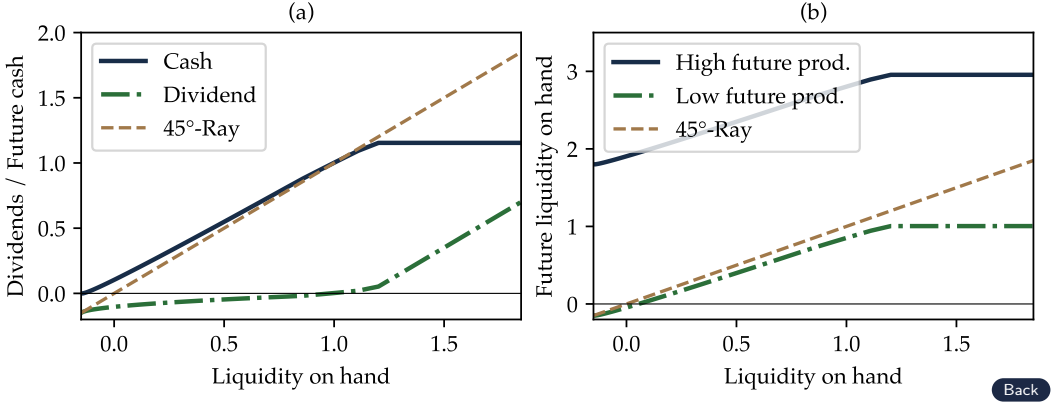
(b) Cash-to-sales data

Back

Comparison with Aiyagari ('94)

- Define liquidity on hand as:

$$\text{Liquidity on hand}_t := \underbrace{\pi_t}_{\text{Liquidity from operating profit}} + \underbrace{n_t}_{\text{Cash}}.$$



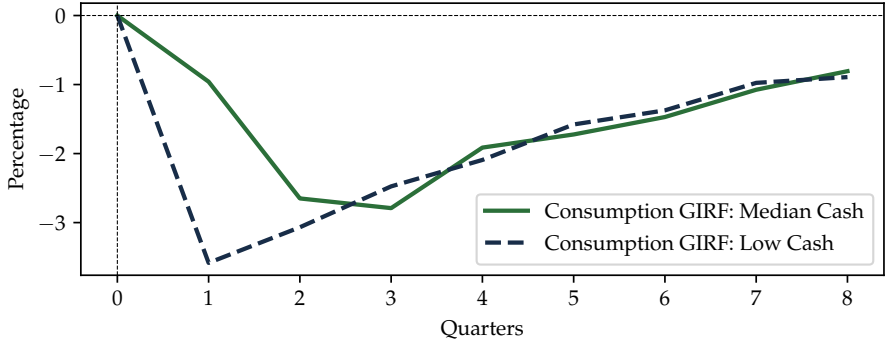
Back

State dependent consumption response

	Dep. Var.: $log(c_t)$ $(p.p.)$	
	Neg. (1)	Pos. (2)
$Cash_t(s.d.)$	0.605	0.419
	(0.006)	(0.002)
Constant	Yes	Yes
Observations	119	119
R^2	0.988	0.996

Back

GIRF to negative shock



- ΔC_t 2p.p. lower for cash 1std below the average.

Back

Heterogeneous vs. Representative: State dependence

- Role of heterogeneity in driving the state dependence?
- Mass of firms at the two flat parts of policy function important driver.
  - **At satiation point**: Firms fully pass positive shock but smooth negative one.
  - **At constraint**: Firms fully pass negative shock but smooth positive one.
- Shut down heterogeneity to highlight its importance

Back

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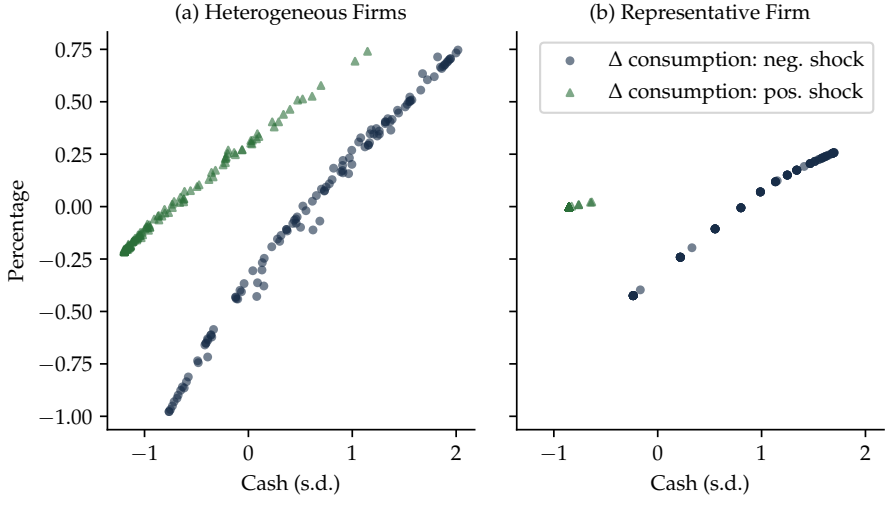
State dependent consumption response



- State dependence twice as strong in heterogeneous firms model. GIRF

Fiscal Policy

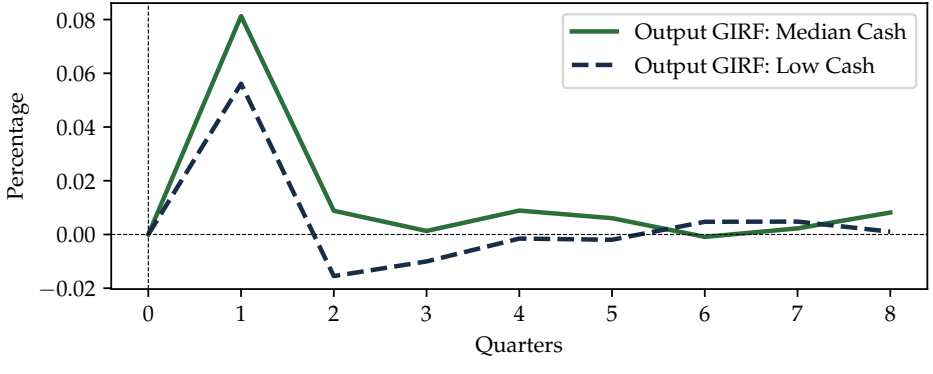
- **Transfer process** T_t two-state Markov
- $T_t \in \{T_B = 0, T_G = 2.4\% Y_{ss}\}$ to match *TARP* with

$$p(T_{t+1} = T_B \mid T_t = T_B) = 0.98, \qquad p(T_{t+1} = T_G \mid T_t = T_G) = 0.$$

- Subsidy financed with lumpsum tax on HH.
- GIRF to positive subsidy shock across high and low cash.

Back

Fiscal Policy

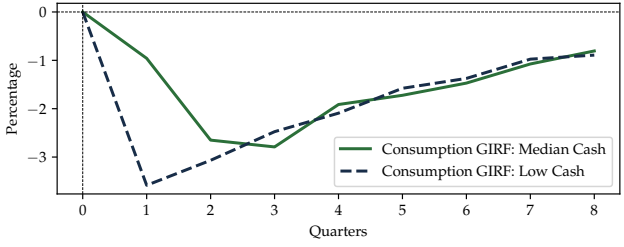


- Low cash → high MPPO → lower labor supply response → higher multiplier.

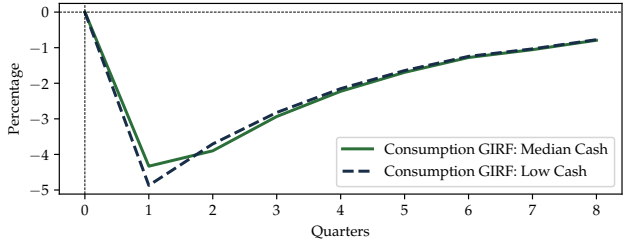
Takeaway. Subsidy multiplier larger when MPPO lower.

Back

Heterogeneous vs Representative: State dependence



(a) Heterogeneous firms (Baseline)



(b) Representative firm

Back

Method

- As the model is highly nonlinear, we use the repeated transition method

  Lee. ('25)

- The method relies on the similarity of the aggregate states across the periods and the recursive nature of RCE: history repeats itself.

- In each period t we need the conditional expectation:

$$\mathbb{E}J = \Gamma_{A_t,A_G} J(\cdot;\phi_{t+1},A_G) + \Gamma_{A_t,A_B} J(\cdot;\phi_{t+1},A_B).$$

- Assume $S_{t+1} = G$. If path long enough, there exists a $\widetilde{t}+1$ such that:
  1. $\phi_{t+1} = \phi_{\widetilde{t}+1}$.
  2. $S_{\widetilde{t}+1} = B$

- We can use $J_{\widetilde{t}+1}$ to fill in for the missing counterfactual at t+1, $J(\cdot;\phi,A_B)$.

Back

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Back

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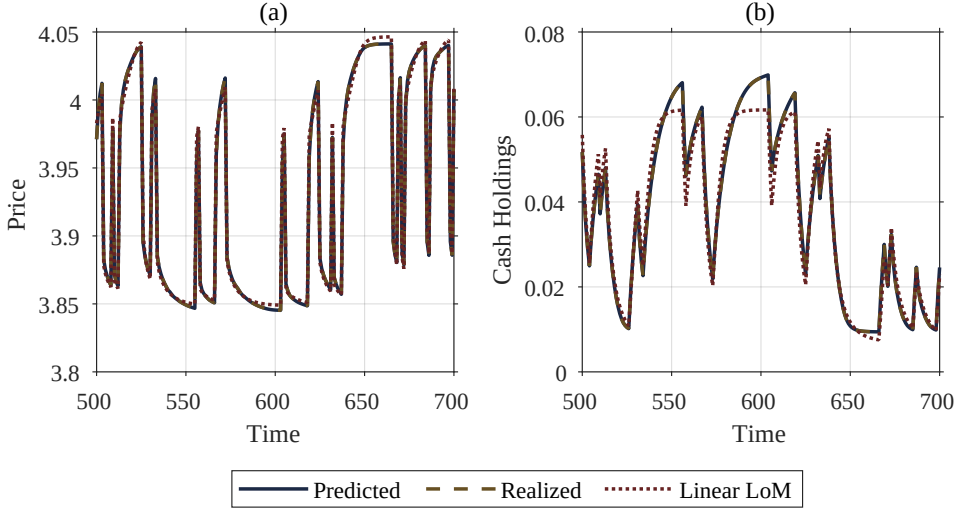


- Assuming linear LoM would generate wrong results. Linear LoM

State dependent consumption response

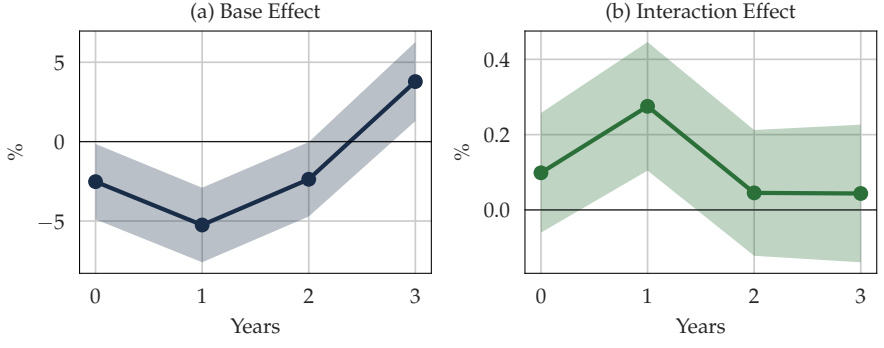
- Does consumption response to TFP shocks depend on cash holdings?
  - Positive TFP shock: $A_B \to A_G$
  - Negative TFP shock: $A_G \to A_B$
- **Key mechanism:** Dividend response to shock being state dependent.
- Firms with more cash don't reduce dividend as much in response to negative shock.
- This leads to a lower drop in consumption.

Cash holdings and dividend smoothing

- Regress log dividends, on a recession ind. and interact with cash.

$$d_{it+h} = \beta \text{rec}_t + \delta n_{it-1} + \gamma \text{rec}_t \times n_{it-1} + \Gamma_h \mathbf{X}_{it-1} + \alpha_i + \epsilon_{it}$$

- 1% increase in cash reduces dividend responsiveness by 0.05 p.p.



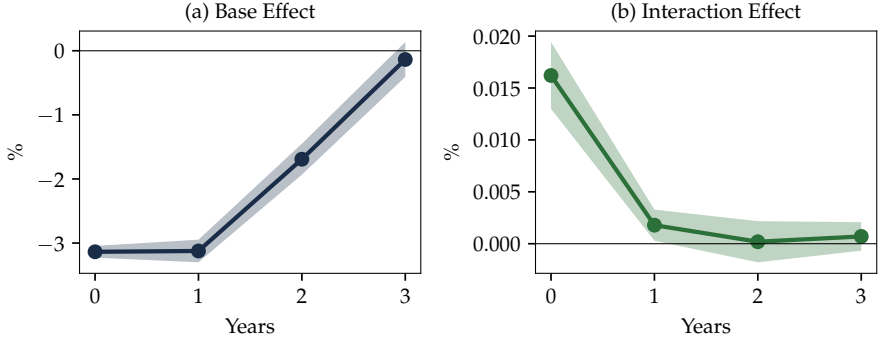
Back

Cash holdings and dividend smoothing - Model

- Regress log dividends, on a recession ind. and interact with cash.

$$d_{it+h} = \beta \text{rec}_t + \delta n_{it-1} + \gamma \text{rec}_t \times n_{it-1} + \Gamma_h \mathbf{X}_{it-1} + \alpha_i + \epsilon_{it}$$

- 1% increase in cash reduces dividend responsiveness by 0.0016 p.p.



Back

Household consumption and dividend income

- Regress consumption on dividend income.

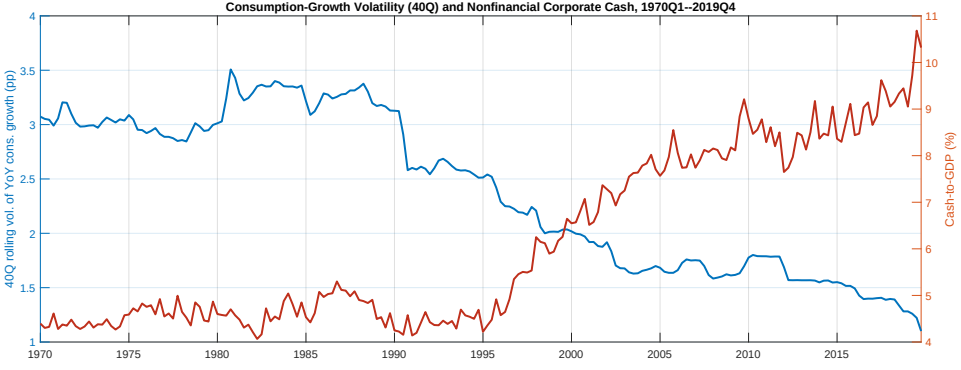
$$c_{it} = \beta d_{it-1} + \Gamma X_{it-1} + \mu_i + \mu_t + \epsilon_{it},$$

- $1 increase in dividends is associated with a $0.079 increase in C.

	Real Expenditure	Real Expenditure	Real Expenditure	Real Expenditure
Real dividend income	0.157^{***}	0.0886^{**}	0.0814^{*}	0.0785^{*}
	(0.0338)	(0.0416)	(0.0428)	(0.0412)
HH covariates		✓	✓	✓
HH FE			✓	✓
Year FE				✓
Observations	46 419	23 138	21 223	21 223

Back

Macro evidence



Corporate cash (Flow of Funds).

Cash definition | Cash cyclicality

Back

Social optimum

- Cash holdings reduce consumption volatility over the cycle.
- But is the cash buffer optimal?
- We compare baseline model to social planner's solution.
  - Planner's problem matches the RBC.
  - Planner cannot change the cost of cash.

Back

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Back

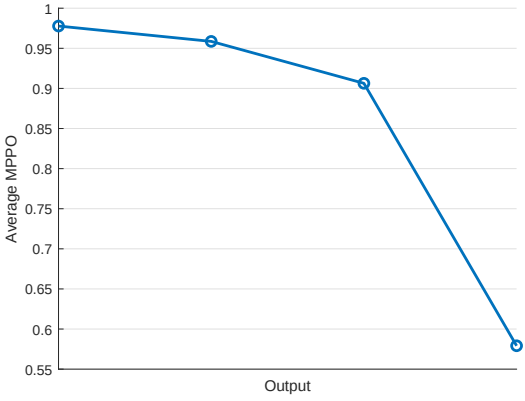
MPPO estimate

- 2002 reform: 5-year carryback for losses in 2001 and 2002.
- 2009 reform: 5-year carryback for losses in either 2008 or 2009.
- Firms recover taxes paid in previous profitable years.
- Liquidity shock: extra refund relative to the old 2-year carryback rule.
- We estimate payout responses by lagged profit bins.

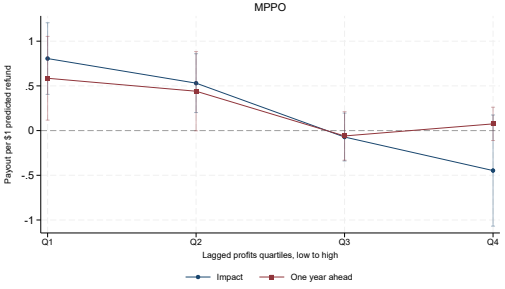
$$\frac{Payout_{i,t+h}}{A_{i,t-1}} = \sum_q \beta_{q,h} \left(\frac{\widehat{Refund}_{it}}{A_{i,t-1}} \times \mathbf{1}\{ProfitsBin_{i,t-1} = q\} \right) + \Gamma X_{i,t-1} + \alpha_j + \tau_t + \varepsilon_{it+h}$$

Back

MPPO estimates



(a) Model MPPO



(b) Empirical MPPO

Takeaway. MPPO is lower for more productive/profitable firms.

Back

Inefficient consumption smoothing

	Baseline	Social planner	Rep. firm
std$(\log(C))$	0.0133	0.0188	0.0184
std$(\log(Y))$	0.0172	0.0119	0.0124
corr$(\log(C), \log(Y))$	0.9335	1.0000	0.9803
$\mathbb{E}(N)$	0.0333	0.0000	0.0018
std(N)	0.0198	0.0000	0.0021

- Social planner prefers a zero cash economy...
- ...despite the increase in consumption volatility.
- Cash externality stronger than decrease in consumption volatility. Theory
- True cost of business cycle is not volatility but consumption level.

Back

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Back

State dependent consumption

Proposition (The state-dependent consumption response)

The consumption response to a negative TFP shock weakly decreases in the firm's initial cash holdings n_1. In particular, the pass-through of an incremental increase in initial cash into consumption, conditional on a negative TFP realization, lies in the unit interval:

$$1 \geq \frac{\partial(c_1(n_1^L + \Delta_n, \bar{A} - \Delta_A) - c_1(n_1^L, \bar{A} - \Delta_A))}{\partial \Delta_n} > 0$$

Moreover, this pass-through is state-dependent and piecewise determined by the firm's optimal cash policy.

Back

Cash holdings

Proposition (Non-monotone cross-sectional cash policy)

Fix an initial cash position $n > 0$ at which the firm's policy is interior (i.e., $n'(n, z) > 0$ and $d(n, z) > 0$ for some z). Define $\underline{z}(n) := \inf\{z : n'(n, z) > 0\}$. Then there exists a productivity level $z^*(n) > \underline{z}(n)$ such that:

(i) For $z \in (\underline{z}(n),\ z^*(n))$: $\partial n'(n, z)/\partial z > 0$.

(ii) For $z > z^*(n)$: $\partial n'(n, z)/\partial z \leq 0$, with strict inequality whenever $n'(n, z) = \bar{n}(z)$.

Consequently, $n'(n, z)$ is hump-shaped in z, reaching a maximum at $z^*(n)$.

Back

Corollary (U-shaped cross-sectional MPPO)

The MPPO is U-shaped in productivity. For $z < \underline{z}(n)$, $n'(n,z) = 0$ *is independent of* n, *so* $MPPO(n,z) = 1$. *For* $z > z^*(n)$ *with* $n'(n,z) = \bar{n}(z)$, n' *is again independent of* n, *so* $MPPO(n,z) = 1$. *For* $z \in (\underline{z}(n),\, z^*(n))$, $\partial n'(n,z)/\partial n > 0$ *and* $MPPO(n,z) < 1$.

Back

Social planner

- Maximizes present discounted value of HH utility.
- $\mathcal{C}(d)$ does not show up as it is rebated back to the HH.

$$
\begin{aligned}
\max_{c_1, c_2} \quad & log(c_1) + \beta \mathbb{E} log(\widetilde{c}_2), \\
\text{s.t.} \quad & c_1 = A_1 - n_1 q^n + n_0, \\
& \widetilde{c}_2 = \widetilde{A}_2 + n_1, \\
& n_t \geq 0
\end{aligned}
$$

Socially optimal savings

Proposition (Inefficiency of the decentralized cash holdings)

Socially optimal cash holdings are equal to zero.

- This happens due to the cash externality.
- Higher cash depresses household's wealth by reallocating resources toward lower-return assets.
- Firm over-saving holds for any n_0 and for any $q^n - SDF > 0$.

Back