Dry Firms, Deep Recessions: Corporate Payouts and Aggregate Dynamics*

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Abstract

This paper studies the macroeconomic implications of corporate cash holdings over the business cycle. Developing a heterogeneous-firm business-cycle model with precautionary savings, we show that firm-level nonlinear cash holdings drive state dependence in aggregate real dynamics. Specifically, low corporate liquidity triggers sharp dividend cuts, doubling the consumption drop in response to adverse productivity shocks relative to liquid periods. We identify the corporate *marginal propensity to pay out* (MPPO) as a crucial determinant of fiscal policy effectiveness during downturns: government transfers stimulate output most effectively when firms are liquid with low MPPO. Despite this stabilizing role, we find that equilibrium cash holdings are inefficiently high due to a negative pecuniary externality.

Keywords: Business cycle, corporate cash holdings, state dependence, fiscal policy, pencuniary externality.

JEL codes: E32, E44, G35.

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1 Introduction

U.S. corporations are holding a historic stockpile of liquidity. As shown in Figure 1, the ratio of aggregate corporate liquid assets to nominal GDP has surged over the past three decades, growing significantly faster than output. While the microeconomic incentives driving this ”corporate saving glut” are increasingly documented, a fundamental macroeconomic question remains: How does this vast liquidity buffer alter the nature of the business cycle? Does it act as a shield that insulates the real economy from shocks, or does it introduce new forms of aggregate instability? This paper fills that gap. We develop a heterogeneous-firm business cycle model with precautionary savings to quantify how these liquidity buffers shape the transmission of aggregate fluctuations.

Our analysis yields three main contributions to the study of business cycles. First, we show that corporate financial frictions generate endogenous state dependence in aggregate dynamics. Unlike standard heterogeneous agent models where micro-frictions often wash out in the aggregate, we find that the non-tradability of corporate cash preserves firm-level nonlinearities at the macro level. Specifically, the economy reacts asymmetrically to productivity shocks depending on the pre-existing distribution of liquidity. When firms are cash-poor, adverse productivity shocks force sharp dividend cuts to preserve survival buffers. This amplifies the recession, doubling the drop in household consumption compared to liquid periods. Conversely, high aggregate cash holdings dampen the transmission of shocks by allowing firms to smooth payouts.

Second, we uncover the *corporate marginal propensity to pay out* (MPPO)—defined as the fraction of an additional unit of liquidity that is immediately distributed to shareholders—as a crucial determinant of fiscal policy effectiveness during downturns. We find that the effectiveness of government transfers depends critically on the cross-sectional distribution of corporate liquidity. Counter-intuitively, fiscal multipliers on output are largest when firms are unconstrained (liquid). In this state, firms have a low MPPO and retain fiscal transfers on their balance sheets rather than passing them through to households immediately. This intertemporal retention generates a negative wealth effect that stimulates household labor supply and output. In contrast, when firms are constrained (high MPPO), transfers are immediately paid out as dividends, neutralizing the real effects on output.

Third, we demonstrate a volatility-efficiency paradox in corporate liquidity. While high cash holdings successfully reduce aggregate consumption volatility, we show that the decentralized equilibrium level of cash is inefficiently high. This inefficiency arises from a negative pecuniary externality: when firms accumulate cash to hedge against

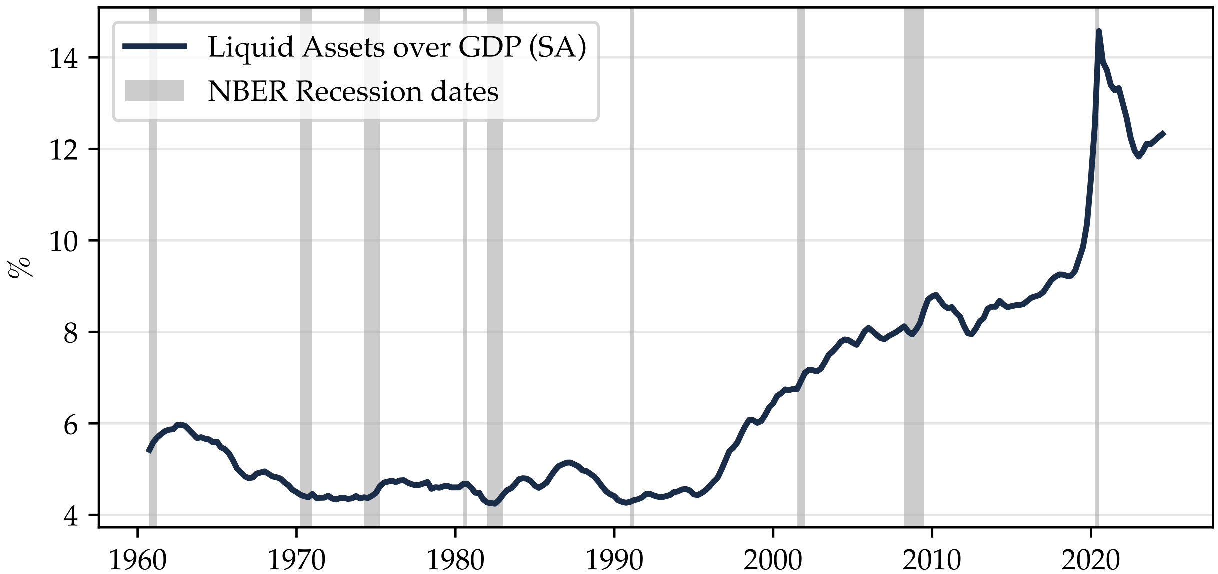


Figure 1: US nonfinancial corporate business liquid asset holdings to GDP

Note. The figure plots the time series of the liquid assets to GDP ratio between 1960Q1 and 2024Q2. The liquid asset stock data is sourced from the Flow of Funds of the Federal Reserve Board, and the nominal GDP is from National Income and Product Accounts (NIPA) from the Bureau of Economic Analysis (BEA). The definition of the measure can be found in Appendix A.1. Seasonal adjustment for liquid assets is done by extracting the trend from a multiplicative seasonal decomposition.

private equity issuance costs, they reallocate resources toward lower-return assets, depressing aggregate household wealth. A social planner would therefore prefer zero cash holdings, accepting higher volatility in exchange for higher ergodic consumption levels.

The source of this state dependence is a novel non-monotonicity in the cross-sectional cash policy function. The core friction is a convex cost of external equity issuance, which creates a precautionary motive for firms to hold cash. As in Hennessy and Whited (2007) and Alfaro et al. (2024), this motive is nonlinear: it operates strongly when cash is low but vanishes once firms reach a "satiation point" where the marginal benefit of additional liquidity is zero. We show that two competing forces govern where firms sit relative to this satiation point. First, the *precautionary target* decreases in firm productivity: persistent high revenues reduce expected financing costs, lowering the desired buffer. Second, *internal cash flow* increases in productivity, expanding the firm's capacity to accumulate. Low-productivity firms thus face high precautionary demand but insufficient cash flow to act on it; high-productivity firms generate ample cash flow but have little precautionary need. This interaction generates a hump-shaped relationship between idiosyncratic productivity and cash accumulation, partitioning firms into three behavioral regimes: low-productivity firms that *cannot* build precautionary buffers despite wanting to, intermediate-productivity firms that actively accumulate, and high-productivity firms that have reached satiation and distribute all marginal resources. Because households consume dividends, the composition of the firm distribution across these regimes—summarized by the aggregate MPPO—directly shapes aggregate demand and shifts endogenously with aggregate shocks. Crucially, because cash markets are segmented and firms cannot trade liquidity with one another, there is no equilibrium price that smooths out these cross-sectional nonlinearities, unlike the investment-side lumpiness studied by Khan and Thomas (2008). The aggregate economy therefore inherits the nonlinear features of the firm-level policy functions.

We provide empirical support for the key mechanisms in our model. Using firm-level data from Compustat, we document that firms with higher cash-to-asset ratios reduce dividend payouts significantly less during recessions, validating our model's dividend smoothing mechanism. At the household level, PSID data reveals that increases in dividend income are associated with substantial increases in consumption (7.85 cents per dollar), even after controlling for labor income and wealth. This confirms that the "corporate veil" is permeable: changes in firm payout policies translate directly into household expenditure decisions, supporting the transmission channel at the heart of our theory.

Related Literature. Bacchetta et al. (2019) Our paper relates to three different branches of the literature. First, to the literature studying how financial frictions amplify aggregate shocks. Bernanke et al. (1999) introduced the financial accelerator mechanism, where credit market frictions amplify economic shocks due to entrepreneurs bearing all aggregate risk. Several papers such as Gertler and Kiyotaki (2010), Ottonello and Winberry (2020), Begenau and Salomao (2018), Cloyne et al. (2023), and Ferreira et al. (2023) explored how financial frictions amplify firm-level risk, and this increase in risk can spill over to aggregate consumption in response to negative shocks. These insights underscore that the concentration of risk in leverage firms/entrepreneurs is essential to the propagation of shocks and the response of aggregate variables.

We contribute to this literature by showing that, even absent changes in leverage or borrowing costs, firms' precautionary cash hoarding behavior can generate state-dependent consumption responses to TFP shocks through a dividend smoothing channel.

Second, we contribute to the extensive literature that studies corporate cash hoarding as a function of firm-specific risk, financial constraints, and macroeconomic uncertainty. Opler et al. (1999) established that firms accumulate cash as a hedge against adverse financial conditions, according to the results found by Acharya et al. (2007), who emphasize the role of cash in reducing firms' reliance on costly external funding. Bates et al. (2009)

highlighted the growing trend of cash holdings among US firms due to increased volatility in cash flows. Riddick and Whited (2009) argued that firms may accumulate cash even in the absence of financing frictions, as cash holdings optimize investment decisions over time. Chen et al. (2017) further demonstrated that the increase in profits together with dividend stickiness explains the increase in corporate savings.

Our model builds on these insights by linking precautionary cash holdings to macroeconomic amplification, demonstrating how financing frictions can endogenously generate state-dependent consumption dynamics through dividend smoothing.

Third, we relate to the extensive literature on business cycle heterogeneous agent models. While heterogeneous agent models have been widely used to study macroeconomic fluctuations, early work by Aiyagari (1994) and Krusell and Smith (1998) showed that these models exhibit behavior that is largely linear at the aggregate level. Specifically, despite the presence of idiosyncratic shocks, the household savings policy function remains smooth and linear, leading to approximately linear aggregate dynamics. On the firm side, Khan and Thomas (2008) demonstrated that investment policy functions are highly nonlinear due to fixed adjustment costs and capital irreversibility. However, their findings suggest that in a general equilibrium setting, the elasticity of the interest rate offsets firm-level nonlinearities, causing any potential nonlinearities at the micro-level to wash out in the aggregate.

We contribute to this literature by showing that, contrary to prior findings, nonlinear firm behavior—specifically, cash hoarding driven by financing frictions—can survive aggregation and generate significant nonlinearities at the macro level.

Structure The rest of the paper is organized as follows: Section 2 describes and discusses the model mechanisms in a two period setting, Section 3 introduces the business cycle model, in Section 4 we compare the nonlinearity of the cash holdings policy function to a standard Aiyagari (1994) model, Section 5 illustrates the aggregate implications of this micro level nonlinearity, Section 6 presents empirical validation of the micro level mechanisms, and Section 7 concludes.

2 A simple theory on cash holding

This section introduces a simple two-period model that analytically illustrates the main mechanism of the paper. Households, who own firms, receive labor income and dividends in both periods and consume. Firms produce in both periods. In period one, they choose dividend payouts and cash holdings for the next period. In period two, firms distribute all remaining resources as dividends. This model illustrates why firms hold cash and how cash holdings have direct consequences for consumption of households.

Firm The firm enters period 1 with initial cash holdings of n_1. The firm produces $\widetilde{A}_1$ units of output, pays wages w_1, distributes dividends d_1 and decides how much cash n_2 to carry into next period. In period two, the firm produces $\widetilde{A}_2$ units of output, pays wages w_2 and distributes is net worth as dividends d_2 before exiting the market. Productivity in both periods follows the stochastic process:

$$\widetilde{A}_t = \begin{cases} \bar{A} + \Delta_A & \text{with probability } 1/2, \\ \bar{A} - \Delta_A & \text{with probability } 1/2. \end{cases} \tag{1}$$

In either period, if the firm issues equity (i.e. $d_t < 0, \forall t = 1, 2$), the firm incurs a quadratic equity issuance cost $\mathcal{C}(d)$, which is paid by the shareholder.[1] The problem of the firm is:

$$\max_{d_1, d_2, n_2} \quad d_1 - \mathcal{C}(d_1) + \mathbb{E}\left[m(\widetilde{A}_2)(\widetilde{d}_2 - \mathcal{C}(\widetilde{d}_2))\right], \tag{2}$$

$$\text{s.t.} \quad d_1 = A_1 - w_1 - n_2 q^n + n_1, \tag{3}$$

$$\widetilde{d}_2 = \widetilde{A}_2 - w_2 + n_2, \tag{4}$$

$$\mathcal{C}(d) = \frac{\mu}{2} d^2 \mathbb{I}(d < 0), \tag{5}$$

where all the variables with a tilde represent random variables and $m(\widetilde{A}_2) = \beta c_1 / \widetilde{c}_2(\widetilde{A}_2)$ is the stochastic discount factor. q^n is the price of cash, assumed to be greater than or equal to the SDF. A wedge between the return on cash and the risk-free rate is introduced by assuming $q^n = \kappa \mathbb{E} m(\widetilde{A}_2)$, with $\kappa > 1$ (Cooley and Quadrini, 2001; Jeenas, 2023; Alfaro et al., 2024).

The equity-issuance cost $\mathcal{C}(d)$ is the mechanism that gives firms a precautionary motive to stockpile liquidity: by holding cash today they can avoid paying the quadratic cost tomorrow should revenues fall short. The next result formalizes this link between the size of the issuance friction and the cash buffer the firm chooses to carry:

Proposition 1 (Optimal cash holding). *The firm's optimal cash holding n_2^* is (weakly) increasing in the equity-issuance-cost parameter μ and is bounded above by $w_2 + \Delta_A - \bar{A}$.*

Proof. The optimal cash holdings n_2, assuming the firm does not need to issue equity in

[1] We here consider only a quadratic cost function, similar to the quantitative model in Section 3, to guarantee the function is continuously differentiable across the whole domain. Appendix B extends the equity-issuance cost to include a linear component, and Proposition 1 remains valid under this specification.

period 1, and in period 2 only needs to issue equity if the worst productivity shock is realized, is given by

$$n_2^* = w_2 + \Delta_A - \bar{A} + \frac{m(\bar{A} - \Delta_A)(1 - 2\kappa)}{m(\bar{A} - \Delta_A)\mu}.$$

As $q^n > \mathbb{E}m(\widetilde{A}_2)$, the second term is negative and $\partial n_2^* / \partial \mu > 0$. Optimal cash holdings are also going to be bounded above by $w_2 + \Delta_A - \bar{A}$. If the wedge between the return on cash and the stochastic discount factor narrows, the firm accumulates cash up to the point at which it fully insures against the worst productivity realization. ■

Intuitively, a higher μ makes external equity more expensive, so the firm raises its precautionary cash balance; the upper bound reflects the point at which an extra dollar of cash no longer relaxes the period-2 financing constraint.

Household Having established how the equity-issuance cost shapes the firm's cash-holding decision, we now turn to the household in order to trace out the implications for consumption. The household lives for two periods, supplies labor inelastically and receives both labor income and firm dividends in each period. The household's problem is:

$$\max_{c_1, c_2} \quad \log(c_1) + \beta \mathbb{E} \log(\widetilde{c}_2), \tag{6}$$

$$\text{subject to:} \quad c_1 = d_1 + w_1, \tag{7}$$

$$\widetilde{c}_2 = \widetilde{d}_2 + w_2. \tag{8}$$

Although the household ultimately bears the equity-issuance cost $\mathcal{C}(d)$, as the firm deducts it before paying dividends, the cost is immediately rebated to the household and thus does not appear in the budget constraints above. Consequently, $\mathcal{C}(d)$ reallocates resources across time but does not generate a deadweight loss. Its macroeconomic impact arises instead through the firm's precautionary cash behaviour and the resulting path of dividends that enter the household's consumption. The firm's cash buffer transmits directly to households through the dividend stream. Since wages are predetermined, all consumption smoothing in response to productivity shocks operates through the firm's payout policy. The next result characterizes how initial cash holdings shape the consumption response to a negative TFP shock.

Proposition 2 (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.

Proof. As consumption equals wages plus dividends, it suffices to characterize the marginal response of dividends to initial cash holdings. Therefore, there are three distinct situations:

1. Firm issues negative dividends in period 1 and expects to have negative dividends in period 2:

$$\begin{aligned}
&\frac{\partial \left(c_1(n_1^L + \Delta_n, \bar{A} - \Delta_A) - c_1(n_1^L, \bar{A} - \Delta_A)\right)}{\partial \Delta_n} \\
=&\frac{\partial \left(\beta_2^n \left(n_2(n_1^L, \bar{A} - \Delta_A) - n_2(n_1^L + \Delta_n, \bar{A} - \Delta_A)\right) + \Delta_n\right)}{\partial \Delta_n} \\
=&1 - \frac{\kappa}{\kappa^2 E(m(\widetilde{A}_2)) + 1} > 0,
\end{aligned}$$

   As the term $\frac{\kappa}{\kappa^2 E(m(\widetilde{A}_2))+1}$ is smaller than 1 but larger than 0, the above is positive and smaller than 1.

2. If $w_2 + \Delta_A < \bar{A}$, firm implements $n_2 = 0$ and

$$\frac{\partial \left(c_1(n_1^L + \Delta_n, \bar{A} - \Delta_A) - c_1(n_1^L, \bar{A} - \Delta_A)\right)}{\partial \Delta_n} = 1.$$

3. If the firm is already at the satiation point with $n_2^* = w_2 + \Delta_A - \bar{A} + \frac{m(\bar{A}-\Delta_A)(1-2\kappa)}{m(\bar{A}-\Delta_A)\mu}$, then

$$\frac{\partial \left(c_1(n_1^L + \Delta_n, \bar{A} - \Delta_A) - c_1(n_1^L, \bar{A} - \Delta_A)\right)}{\partial \Delta_n} = 1.$$

■

This result shows that higher firm cash holdings smooth consumption by mitigating the impact of negative productivity shocks. Importantly, this smoothing is nonlinear. When firms are either cash-constrained or fully satiated, an additional unit of cash is fully paid out, leading to complete pass-through to consumption. In contrast, when firms operate in the interior of the cash policy function, additional cash is partially retained, dampening the consumption response.

The nonlinearity of the cash policy function therefore generates state-dependent consumption dynamics. A sufficient statistic summarizing this mechanism is the firm's *Marginal Propensity to Pay Out* (MPPO).

Definition 1. *Define the MPPO as*

$$MPPO = \frac{\partial d_t(n_t)}{\partial n_t}.$$

The MPPO measures the fraction of an additional unit of predetermined cash that the firm distributes as dividends. Accordingly, $1 - MPPO$ represents the fraction of the marginal unit of cash that the firm retains on its balance sheet.

The MPPO connects the model directly to a large empirical literature studying how firms adjust payouts in response to liquidity shocks. Early evidence by Fazzari et al. (1988) and Almeida et al. (2004) shows that financially constrained firms exhibit a lower propensity to pay out internal funds, consistent with precautionary saving motives. More recently, Almeida and Campello (2010) and Acharya et al. (2013), document that firms' cash retention rises in periods of heightened uncertainty and tighter financing conditions, further indicating that payout responses to liquidity shocks are state-dependent. These empirical estimates of payout sensitivities—whether based on cash flow shocks, tax windfalls, or credit supply shifts—can therefore be interpreted as reduced-form estimates of the MPPO.

Corollary 1. *Taking the limit as $\Delta_n \to 0$,*

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

A key contribution of the model is to show that MPPO is endogenously nonlinear, depending on firms' cash positions relative to financing constraints and satiation points, and thereby governs how payout behavior transmits financial conditions to aggregate consumption.

In contrast, when cash is held by households rather than firms, optimal saving equates the marginal utility of consumption today and tomorrow, subject to the cost of cash holdings. In this case, the household saving policy is smooth except at the borrowing constraint, which has been shown to be insufficient to generate aggregate state dependence in consumption (e.g. Krusell and Smith, 1998).

By shifting liquidity to firms' balance sheets, the model introduces a nonlinear cash-holding policy even away from borrowing constraints, which translates into state-dependent payout behavior and consumption dynamics. In the next section, we extend the simple framework developed here to a business-cycle model with heterogeneous firms to illustrate how firms' nonlinear cash policies generate aggregate state dependence.

3 Baseline model

We now proceed to include the mechanism of the preceding section into a quantitative general equilibrium model to study its aggregate consequences. There are three sectors in our economy: a production sector, a household sector and a government. The production sector is populated by a continuum of measure one of ex-ante homogeneous firms that face idiosyncratic productivity shocks. These firms can self-insure against future negative shocks that may require costly external finance using cash, in the spirit of Froot et al. (1993). The household sector features a representative household that consumes, prices the risk-free bond, owns the firms and supplies labor. The government collects taxes from firms and distributes them in a lump-sum fashion to the households. Idiosyncratic risk arises from firm-specific productivity shocks in the production sector, while aggregate risk stems from time-varying fluctuations in total factor productivity (TFP).

3.1 Technology

Firms use labor to produce the final good.[2] The production function has decreasing returns to scale and the following functional form:

$$y_{it} = A_t z_{it} l_{it}^{\gamma}, \tag{9}$$

where y_{it} denotes final good output, l_{it} labor demand, $\gamma < 1$ the span of control parameter, and z_{it} and A_t idiosyncratic and aggregate productivities, respectively. Regarding

[2] The absence of capital in the model is equivalent to a setup where firms use both capital and labor, but optimal capital demand is frictionlessly embedded within the labor demand decision.

productivities, we assume that the log of idiosyncratic productivity follows an AR(1) process:

$$\log(z_{it}) = \rho_z \log(z_{it-1}) + \epsilon_{it}, \quad \epsilon_{it} \sim_{i.i.d} N(0, \sigma_z^2), \tag{10}$$

in which σ_z^2 and ρ_z denote the variance of the shock and the persistence of the productivity process, respectively. The stochastic aggregate productivity process is assumed to follow a two-state Markov process.[3] Hence, the transition matrix and set of possible aggregate productivity states are:

$$\Gamma_A = \begin{bmatrix} p(A_{t+1} = A_B | A_t = A_B) & (1 - p(A_{t+1} = A_B | A_t = A_B)) \\ (1 - p(A_{t+1} = A_G | A_t = A_G)) & p(A_{t+1} = A_G | A_t = A_G) \end{bmatrix} \tag{11}$$

$$\text{and} \quad A_t \in \{A_B, A_G\}, \tag{12}$$

where $A_B := 1 - \Delta_A$ and $A_G := 1 + \Delta_A$, and we calibrate Δ_A to match the aggregate output volatility. Due to the presence of aggregate risk and incomplete markets, there will be a time-varying distribution of firms over their idiosyncratic cash holdings n_{it} and productivity status z_{it}. Denote this distribution as Φ and its evolution over time as:

$$\Phi_{t+1}(z_{it+1}, n_{it+1}) = \mathbf{G}(\Phi_t(z_{it}, n_{it}), A_t). \tag{13}$$

where $\mathbf{G}$ denotes the transition operator that maps today's distribution and aggregate productivity into tomorrow's distribution. Finally, for ease of notation, denote the collection of aggregate state variables X_t as:

$$X_t \equiv \{\Phi_t(z_{it}, n_{it}), A_t\}. \tag{14}$$

3.2 Cash holdings and financial frictions

Cash Holdings Firms generate profits that equal revenues net of the wage bill and a fixed operation cost $\xi > 0$ in each period. They then decide how much to distribute as dividends (d_{it}) to their ultimate owners, the households. The portion of earnings retained after dividends (and any financing costs) is allocated to adjusting the firm's cash balance.[4]

[3] This simplification does not affect our results significantly. In particular, the repeated transition method, which is used to solve the model, is able to handle finer discretization than two grid points. For example, Lee (2022) uses a finer discretization (five grid points). However, to simplify the interpretation of recessions and booms, we resort to two grid points only.

[4] In what follows we will, with a slight abuse of terminology, refer to liquid assets and cash holdings interchangeably.

We assume that the evolution of cash holdings follows:

$$n_{it+1} = n_{it} + q_t^n h_{it}, \tag{15}$$

where n_{it} represents the firm's liquid asset holdings, q_t^n is the price of one unit of liquid assets, and h_{it} denotes the net investment in liquid assets. Importantly, firms are subject to a no net borrowing constraint on cash, ensuring that cash balances remain non-negative, $n_{it+1} \geq 0$. This constraint mirrors the standard incomplete markets assumption with borrowing limits, as in Aiyagari (1994) or Huggett (1993).

Critically, we assume that the return on cash is lower than the risk-free rate, closely following Cooley and Quadrini (2001), Jeenas (2023) and Alfaro et al. (2024). Specifically, we set the price as a multiple κ of the risk-free bond price, such that $q_t^n = \kappa q_t$, where $\kappa > 1$ and q_t is the risk-free bond price, ensuring that cash is not an excessively attractive store of value.

On the aggregate level, the net supply of liquid assets is assumed to follow an exogenous process linked to the price of liquid assets q_t^n. In particular, we again follow Alfaro et al. (2024) and impose a constant elasticity of supply specification:

$$N_{t+1}^S = \mathcal{H}(q_t^n)^{\frac{1}{\zeta}}, \tag{16}$$

where ζ governs the elasticity of the liquid asset supply, and $\mathcal{H} > 0$ is a scaling constant. This assumption captures the responsiveness of liquid asset supply to changes in asset prices.

External financing cost Beyond the non-negativity constraint on cash holdings, we assume that firms face external financing costs when dividends are negative. In such cases, firms incur an additional cost $\mathcal{C}(d_{it})$ in the spirit of Jermann and Quadrini (2012) and Riddick and Whited (2009). We assume that this costs takes the following functional form:

$$\mathcal{C}(d_{it}) = \frac{\mu}{2}\mathbb{I}\{d_{it} < 0\}d_{it}^2. \tag{17}$$

where μ governs the magnitude of the financing cost, determining how costly it is for firms to raise external funds when dividends are negative. A higher μ implies that even small equity issuances result in significant costs, discouraging firms from relying on external financing and strengthening their precautionary savings motive. The net dividend is given by $d_{it} - \frac{\mu}{2}\mathbb{I}\{d_{it} < 0\}d_{it}^2$. This function is continuously differentiable ($\mathbb{C}^1$) and concave, ensuring smooth adjustment at $d_{it} = 0$ without kinks. Consequently, the standard theory of concave household utility applies seamlessly to the model.[5]

The external financing cost captures firms' limited ability to adjust funding sources in response to financial conditions, as in Jermann and Quadrini (2012). This also aligns with the empirical literature on dividend smoothing where firms avoid drastic payout fluctuations due to managerial incentives and agency considerations (Leary and Michaely, 2011; Bliss et al., 2015). In particular, Leary and Michaely (2011) show that cash-rich firms smooth dividends significantly more than others, a pattern the model replicates.

Absent external financing costs, holding cash would not be optimal since cash earns a lower return than dividends. However, due to these costs, firms hoard cash as a precautionary measure, ensuring liquidity for adverse conditions (e.g., low z_t or low A_t). This precautionary motive leads firms to smooth dividend payouts in equilibrium, consistent with observed corporate behavior.

3.3 Recursive firm problem

We are now able to formulate the firm's problem in recursive form. At the beginning of each period, a firm i is identified by its idiosyncratic states n and z. Furthermore, firms have rational expectations and are aware of the full distribution of the firm-level state variables and its evolution. Using these pieces of the setup, the recursive formulation of the firm's problem can be written as follows:

$$
\begin{aligned}
J(n, z; X) = \max_{n', d} \quad & d - \mathcal{C}(d) + \mathbb{E}\left[m(X; X')J(n', z'; X')\right] \qquad (18) \\
& \text{subject to:} \\
& d = \pi(z; X) + n - q^n n' + T^f(X), \\
& n' \geq 0, \\
& \pi(z; X) \equiv \max_l zAl^\gamma - w(X)l - \xi, \\
& \mathcal{C}(d) = \frac{\mu}{2}\mathbb{I}(d < 0)d^2, \\
& X \equiv \{\Phi, A\}, \\
& \text{and} \quad \Phi' = G(\Phi, A)
\end{aligned}
$$

where J denotes the value function of a firm, d the dividend, m the stochastic discount factor used to price future payoffs, π the operational profits, $T^f(X)$ the lumpsum subsidy

[5] Jermann and Quadrini (2012) highlight that the convexity assumption aligns with empirical findings by Altinkilic and Hansen (2000) and Hansen and Torregrosa (1992), who document that underwriting fees increase at a rising marginal cost as the offering size grows.

paid by the government, w the wage and ξ the fixed production cost.

3.4 Households

The household sectors is populated by a representative household that chooses labor supply l^H, consumption c, bond holdings b, shares that households invest in firms, denoted by s, and pays a lumpsum tax $T(X)$. Thus, the household problem is given by:

$$V^H(b,s;X) = \max_{c,s',b',l^H} \left[\log(c) - \frac{\eta}{1+\frac{1}{\chi}} (l^H)^{1+\frac{1}{\chi}} + \beta \mathbb{E} \left[V^H(b',s';X') \right] \right] \tag{19}$$

subject to:

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

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

where η is the labor disutility parameter, and χ is the Frisch elasticity parameter.

3.5 Government

The government sets a lumpsum tax $T(X)$ on the household and distribute its proceeds in a lump-sum fashion to the firms, ensuring a balanced budget every period. Consequently, the government budget constraint reads as follows:

$$\int T^f(X) d\Phi = T(X) \tag{20}$$

3.6 Competitive equilibrium

Definition 2. *A recursive competitive equilibrium is a set of functions*

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

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 described in (18), and (N, D, L) are the associated policy functions for firms.*

2. *V^H solves (19) and (C, B, L^H, S) are the associated policy functions for households.*

3. *T solves the government budget constraint described in (20).*

4. *The goods market clears $\int Y(z,X)d\Phi = C(X) + \int[\xi + h(n,z;X)]d\Phi$.*

5. *The market for shares clears $s(X) = \int[J(n,z;X) + \mathcal{C}(D(n,z;X))]d\Phi$ 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.*

4 The role of market incompleteness and the financial frictions

In this section, we analyze the individual firm's cash hoarding patterns in the stationary equilibrium. This analysis is essential to understand why the model can feature highly nonlinear dynamics under aggregate uncertainty. Due to the external financing cost, a firm uses cash as a precautionary savings instrument. However, there exists a target cash level beyond which firms do not accumulate further cash, as illustrated in Section 2. Holding cash beyond this point becomes increasingly costly: once a firm accumulates enough cash to nearly eliminate the risk of future external financing, additional cash holdings yield returns lower than the household discount rate. This logic is formalized in Proposition 3, which establishes the existence of a target cash holding level.[6]

Proposition 3 (The existence of the target cash holding level)**.**
Suppose policy functions are non-trivial: $n'(n,z) > 0$ and $d(n,z) > 0$ for some $n > 0$, given z. Then, there exists $\overline{n}(z) > 0$ such that $n'(n,z) \leq \overline{n}(z)$ for $\forall n \geq 0$.

Proof. To prove the proposition by contradiction, suppose there is no such $\overline{n}(z)$. That is, $n'(n,z) < n'(n+\epsilon,z)$ for $\forall(n,z)$ and $\forall\epsilon > 0$.

[6] It is worth noting that the implication of Proposition 3 differs from Proposition 4 in Aiyagari (1993), which suggests that households with excessively high wealth gradually decumulate. In contrast, the target cash result here implies that a firm with an excessively large cash stock immediately reduces it to the target level.

Define cash on hand as $m(n,z) = \pi(z) + n$. Then,

$$d(n,z) + q^n n'(n,z) = m(n,z).$$

$m(n,z)$ strictly increases in n. Due to the monotone preference on greater d and n' and strict monotonicity of m on n, d and n' weakly increase in n. Now consider $\widetilde{n}$ such that $n'(\widetilde{n},z) > 0$ and $d(\widetilde{n},z) > 0$. Such $\widetilde{n}$ exists as n' and d weakly increase in n. For example $\widetilde{n} = \max\{n_2, n_2\}$.

Then, for a marginal incremental ϵ in cash, the marginal cost of hoarding cash is 1 (forgone dividend), while the marginal benefit out of hoarding cash is $\frac{q}{q^n}$:[7]

$$\underbrace{1}_{\text{Marginal cost}} > \underbrace{\frac{q}{q^n}}_{\text{Marginal benefit}},$$

where, $q = \beta$ at the non-stochastic steady state. This implies that for the extra cash, the firm does not have an incentive to hoard it in the cash reserve. Therefore, $d(n+\epsilon,z) = d(n,z) + \epsilon$, if $d(n,z) > 0$. Then, from a firm's budget constraint,

$$\begin{aligned} q^n n'(\widetilde{n}+\epsilon,z) &= \widetilde{n}\epsilon + \pi(z) - d(\widetilde{n}+\epsilon,z) \\ &= \widetilde{n} + \pi(z) - (d(\widetilde{n}+\epsilon,z) - \epsilon) \\ &= \widetilde{n} + \pi(z) - d(\widetilde{n},z) \\ &= q^n n'(\widetilde{n},z). \end{aligned}$$

Therefore, any extra increase in the current cash stock $\widetilde{n}$ does not change the future cash stock:

$$q^n n'(\widetilde{n},z) = q^n n'(\widetilde{n}+\epsilon,z),$$

which is a contradiction. Therefore, there exists the target cash stock $\overline{n}(z)$. ∎

Therefore, the optimal cash holding policy becomes flat once a firm's current cash stock reaches the target level.[8] The flat region in the cash holding policy function contrasts sharply with the wealth accumulation pattern of households in Aiyagari (1994). To facilitate comparison, we define liquidity on hand, a firm-side analogue to total resources

[7] In this argument, the non-negativity constraint does not matter, as $n'(\widetilde{n},z) > 0$.

[8] This mirrors the behavior in the consumption buffer stock model (Carroll, 1997). Despite the flat region, the policy function is smooth throughout (of class $\mathbb{C}^1$), with no kinks.

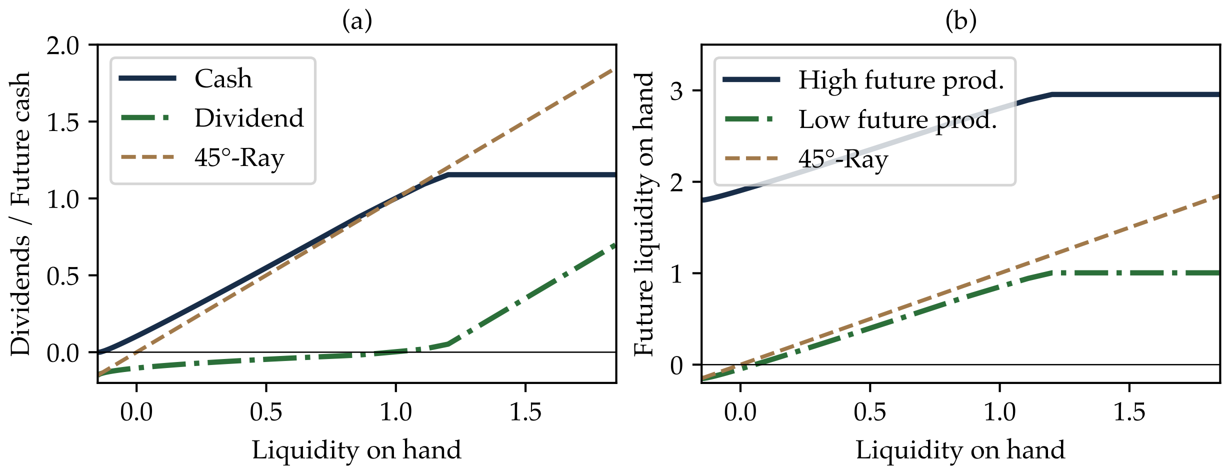


Figure 2: Dividends and cash holdings and liquidity on hand policy functions (when $z = min\mathbb{Z}$)

Notes: This figure is the firm-side counterpart of Figure I in Aiyagari (1994).

in the Aiyagari framework:

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

Figure 2 plots the cash holdings and dividend policies in panel (a) and the future liquidity on hand in panel (b) as functions of today's liquidity on hand. This figure is the firm-side counterpart of Figure I in Aiyagari (1994).[9] For a sharp illustration, we only plot the policy functions for a firm at the lowest productivity ($z = min\mathbb{Z}$). Just as in the household case, borrowing constraints bind in certain regions, resulting in flat saving policies near the constraint. [10]

4.1 The non-monotone cross-sectional cash policy

The preceding analysis establishes that the target cash level $\bar{n}(z)$ is decreasing in productivity, while the capacity to save rises with productivity through higher operating profits. We now demonstrate that the interaction of these two forces generates a non-monotone relationship between idiosyncratic productivity and equilibrium cash accumulation—a

[9]Dividend d is the counterpart of consumption c, and future cash holding n' is the counterpart of future wealth a_{t+1}.

[10]A similar kinked saving pattern appears in Krusell and Smith (1998). However, in both Aiyagari (1994) and Krusell and Smith (1998), the fraction of these constrained households is negligibly small. Especially, this is one of the major reasons why the aggregate dynamics in Krusell and Smith (1998) do not feature a nonlinearity.

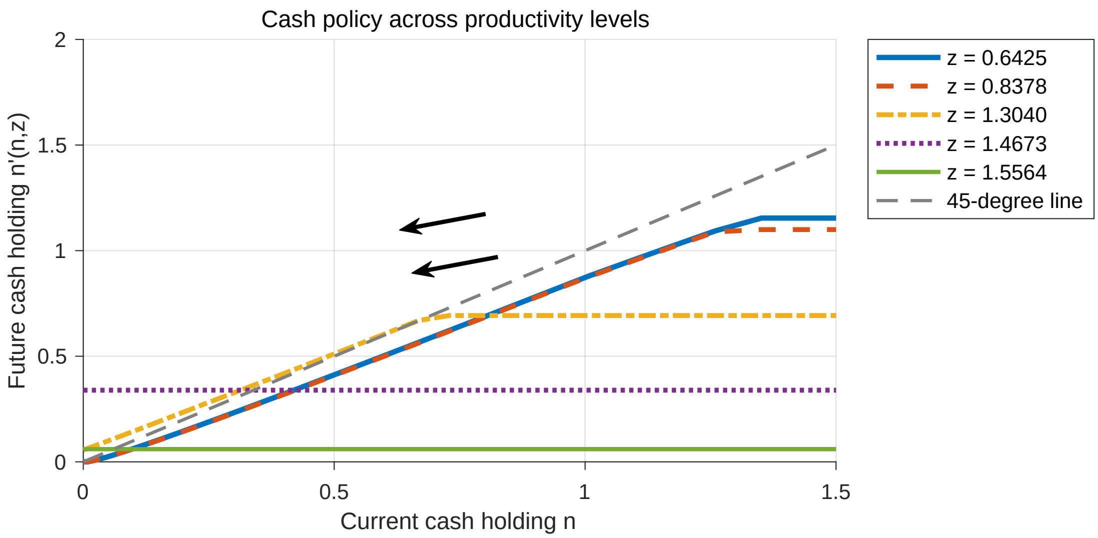


Figure 3: Cash holding policy function across productivity levels

Note. The figure plots the future cash holding policy function $n'(n, z)$ as a function of current cash n for five productivity levels. The flat region of each curve corresponds to the target cash level $\bar{n}(z)$, which is strictly decreasing in productivity. Arrows indicate the direction of policy function move when the firm-level productivity increases.

pattern that, to our knowledge, has not been documented in the macroeconomics literature and that turns out to be the deeper source of the aggregate nonlinearity.

Figure 3 plots the future cash holding $n'(n, z)$ as a function of current cash n for five productivity levels spanning the ergodic distribution. The figure reveals two key features. First, the flat region of each curve—the target cash level $\bar{n}(z)$—is strictly decreasing in productivity: the lowest-productivity firms ($z = 0.64$, blue solid) target $\bar{n} \approx 1.1$, while the highest-productivity firms ($z = 1.56$, green solid) target $\bar{n} \approx 0.05$. This ordering reflects the precautionary motive: persistent high productivity reduces expected financing costs, lowering the buffer firms wish to maintain. Second, the slope of the policy function in the accumulation region varies with productivity. Low-productivity firms have steep slopes but their curves lie close to the 45-degree line, indicating slow convergence toward a distant target. High-productivity firms have flatter slopes and their curves lie well below the 45-degree line, indicating rapid convergence toward a nearby (and low) target. The arrows illustrate this convergence: regardless of initial position, firms drift toward their productivity-specific target $\bar{n}(z)$.

The non-monotonicity becomes visible when we read the figure horizontally rather than vertically. Fix an initial cash position—say, $n = 0.3$—and trace across productivity levels. For the lowest-productivity firm ($z = 0.64$), future cash is approximately $n' \approx 0.55$: the firm is accumulating, but slowly, because low profits constrain its saving capacity

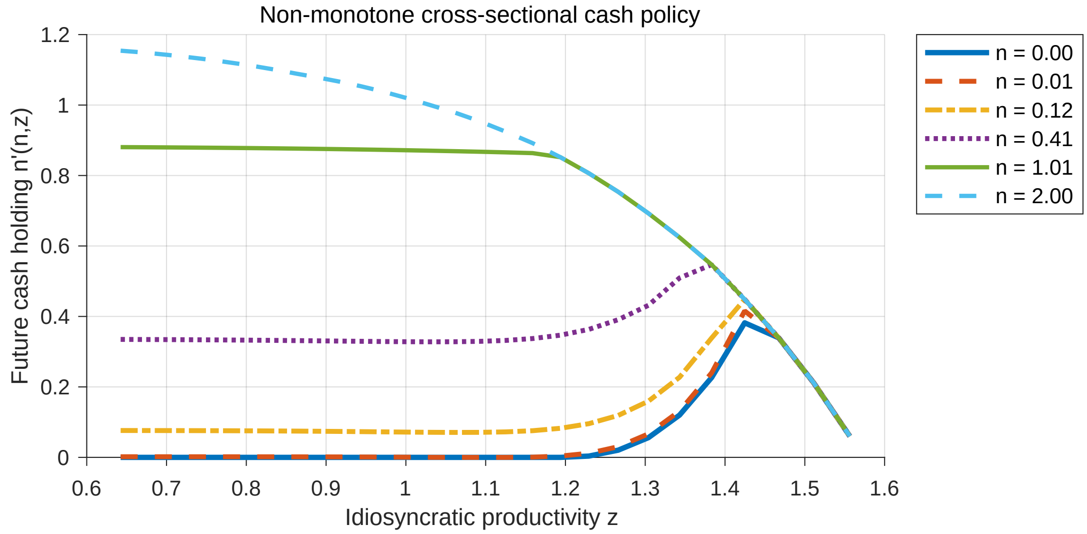


Figure 4: Non-monotone cross-sectional cash policy along firm-level productivity

Note. The figure plots the future cash holding $n'(n,z)$ as a function of idiosyncratic productivity z for several values of initial cash n. For low initial cash levels, the relationship is hump-shaped: future cash rises sharply at intermediate productivity and declines at high productivity as the satiation point falls. For high initial cash, the firm decumulates toward the target across all productivity levels. All curves converge at high z, reflecting the uniqueness of the satiation point.

despite the high precautionary target. For an intermediate-productivity firm ($z = 1.30$, yellow dash-dotted), future cash jumps to $n' \approx 0.70$: profits are now sufficient to fund rapid accumulation toward the target. For the highest-productivity firm ($z = 1.56$), future cash collapses to $n' \approx 0.05$: the firm has already exceeded its (very low) target and is decumulating. The resulting pattern—low, then high, then low again—is the hump shape in $n'(n,z)$ as a function of z for fixed n.

This hump reflects the interaction of two opposing forces. First, the *precautionary target* $\bar{n}(z)$ is decreasing in productivity: persistent high revenues reduce expected financing costs, so that $\partial \bar{n}(z)/\partial z < 0$. Second, *internal cash flow* $\pi(z;X) = \max_l zAl^\gamma - w(X)l - \xi$ is increasing in productivity, expanding the firm's accumulation capacity, so that $\partial \pi(z;X)/\partial z > 0$. Low-productivity firms thus face high precautionary demand but insufficient cash flow to act on it; high-productivity firms generate ample cash flow but have little precautionary need. The non-monotonicity arises in the intermediate range where these two forces are most tightly in tension: profits have risen enough to enable accumulation, but the precautionary target has not yet collapsed.

Figure 4 makes this hump shape explicit by plotting $n'(n,z)$ directly as a function of z for several initial cash levels. For a firm with low initial cash ($n = 0.12$), future cash rises sharply from near zero at low productivity to a peak around $z \approx 0.9$, then declines monotonically as the satiation point falls with higher productivity. For a firm with high initial cash ($n = 1.01$ or $n = 2.00$), the pattern is monotonically decreasing throughout: such firms are already above the target for all productivity levels and simply decumulate toward $\bar{n}(z)$. The key observation is that for any initial cash below the maximum target, there exists an interior productivity level $z^*(n)$ at which future cash is maximized.

The next result formalizes this structure.

Proposition 4 (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 $z^*(n)$. The strict inequality in part (ii) *follows from $\bar{n}(z)$ being strictly decreasing in z by Proposition 3.*

Proof. The proof characterizes the first-order condition of the firm's problem with respect to n', evaluated at varying z for fixed n. The Euler equation for cash holdings is

$$q^n \left[1 - \mu\, d \cdot \mathbf{1}(d < 0)\right] \geq \mathbb{E}\left[m(X; X') \frac{\partial J(n', z'; X')}{\partial n'}\right], \tag{21}$$

with equality if $n' > 0$. The left-hand side is the marginal cost of cash accumulation—forgone dividends today, adjusted for the equity issuance cost if $d < 0$—and the right-hand side is the marginal benefit, the expected discounted shadow value of cash tomorrow.

For z just above $\underline{z}(n)$, profits are sufficient for $n' > 0$ and $d > 0$. The firm remains below its target $\bar{n}(z)$, so the marginal benefit of cash on the right-hand side of (21) exceeds the marginal cost at $n' = 0$, and the firm accumulates. As z increases further, higher profits expand cash on hand while the target $\bar{n}(z)$ falls—but the firm has not yet reached it. The profit effect dominates in this region, so $\partial n'/\partial z > 0$, establishing part (i).

At $z = z^*(n)$, the firm's optimal unconstrained cash choice meets the declining target $\bar{n}(z)$. For $z > z^*(n)$, additional profits do not raise n' because $\bar{n}(z)$ is decreasing in z. In particular, whenever $n'(n,z) = \bar{n}(z)$, the firm tracks the target and $\partial n'/\partial z = \bar{n}'(z) < 0$, which is strictly negative by Proposition 3. All marginal resources are paid out as dividends. This establishes part (ii). ■

A striking feature of both figures is the convergence property at high productivity. In Figure 3, the curves for intermediate and high productivity ($z \geq 1.30$) all flatten out at their respective (low) targets, and the vertical distance between these flat regions is small relative to the distance between the low-productivity targets. In Figure 4, all initial cash levels converge to a narrow band of future cash at $z \approx 1.4$–1.5. This convergence reflects the uniqueness of the satiation point: once productivity is sufficiently high, the target $\bar{n}(z)$ is pinned down independently of the firm's initial position. Firms with excess cash decumulate toward $\bar{n}(z)$ from above, while firms with insufficient cash accumulate toward it from below. An immediate implication is that the cross-sectional dispersion of cash holdings is endogenously compressed at high productivity levels and expanded at low productivity levels—a prediction borne out by the data.[11]

The non-monotone pattern documented here differs fundamentally from the household savings policy in Aiyagari (1994) and Krusell and Smith (1998). In those models, savings increase monotonically in both wealth and income. Nonlinearity arises solely from the borrowing constraint at $a = 0$, which binds for a negligibly small fraction of the population in equilibrium. Here, the non-monotonicity arises *away from any constraint*, in the interior of the policy function, and affects a substantial fraction of the firm distribution. The pattern reflects a structural feature of the corporate cash-holding problem that is absent from the household savings problem: because the precautionary target depends strongly on the income state through persistence, the precautionary target and internal cash flow move in opposite directions across the productivity distribution.

4.2 The marginal propensity to pay out across the productivity distribution

The non-monotone cash policy has direct implications for firms' payout behavior, as captured by the Marginal Propensity to Pay Out (MPPO) introduced in Definition 1. From the firm's budget constraint $d = \pi(z; X) + n - q^n n' + T^f(X)$, the MPPO satisfies

$$MPPO(n, z) \;=\; \frac{\partial d(n, z)}{\partial n} \;=\; 1 \;-\; q^n \, \frac{\partial n'(n, z)}{\partial n}. \tag{22}$$

The MPPO thus equals one minus the fraction of a marginal unit of cash that the firm retains on its balance sheet. Since the retention rate $q^n \partial n' / \partial n$ varies systematically with the firm's position in the productivity distribution, the MPPO inherits the cross-sectional structure established in Section 4.1—but in mirror image.

At the bottom of the productivity distribution, where the firm cannot fund positive

[11] This is a theoretical statement that we find holds in equilibrium in the calibrated model. We also find in the Compustat data that the standard deviation of the cash-to-asset or cash-to-sales ratio is decreasing in firm size indicators. For more details, please see Appendix A.4.

savings, future cash is insensitive to the initial cash position: $\partial n'/\partial n \approx 0$. Marginal resources therefore flow entirely to dividends, and the MPPO is close to unity. The firm behaves, in effect, like a hand-to-mouth agent—not by choice, but by necessity. At intermediate productivity, the firm is actively building its cash reserve, and a portion of any additional initial cash is retained rather than distributed. In this range, $\partial n'/\partial n > 0$, and the MPPO falls below unity, potentially well below it. The firm absorbs marginal resources into its balance sheet, dampening the pass-through to dividends. At the top of the productivity distribution, the firm has reached its satiation point. Additional cash beyond the target serves no precautionary purpose and earns a return below the discount rate, so it is fully distributed: $\partial n'/\partial n$ returns to zero and the MPPO returns to unity.

Corollary 2 (U-shaped cross-sectional MPPO)**.**
Under the conditions of Proposition 4, 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 $MPPO(n,z) < 1$.

Figure 5 confirms this pattern quantitatively. The U-shape is clearly visible for intermediate initial cash levels, where the three behavioral regions are most distinct. A key observation is that the MPPO equals unity at both tails of the productivity distribution, but for entirely different economic reasons. At the lower tail, the firm distributes because it cannot afford to save—its budget is too tight to fund any precautionary accumulation. At the upper tail, the firm distributes because it has no reason to save—the buffer is already full. This distinction is invisible in any scalar summary of payout behavior but has first-order consequences for how the economy responds to aggregate shocks. A firm forced to pay out by tight budgets will respond very differently to a fiscal transfer than a firm that pays out by choice from a position of satiation: the former will pass the transfer through immediately, while the latter—if pushed back into the accumulation region by a negative shock—may retain it.

The aggregate MPPO is a weighted average over the firm distribution,

$$\overline{MPPO}(X) \; = \; \int MPPO(n,z)\, d\Phi(n,z), \tag{23}$$

and its value depends critically on where the mass of Φ lies relative to the cross-sectional U-shape. When aggregate cash is high, a large fraction of firms are in the accumulation region where the MPPO is low, pulling the aggregate toward the trough of the U. When aggregate cash is low, firms are compressed toward the lower tail of the productivity distribution where the MPPO is high, pushing the aggregate toward the left peak of the U.

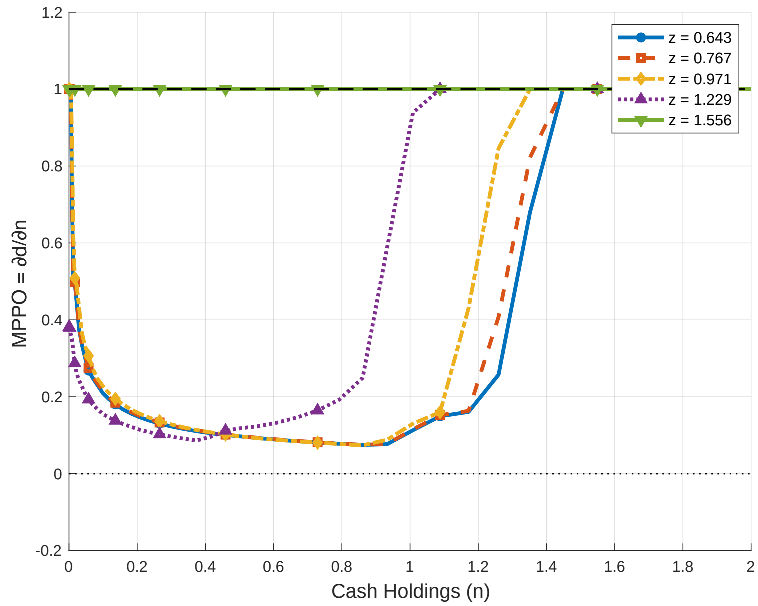


Figure 5: U-shaped cross-sectional MPPO

Note. The figure plots the Marginal Propensity to Pay Out $MPPO(n,z) = 1 - q^n\, \partial n'(n,z)/\partial n$ as a function of idiosyncratic productivity z for several values of initial cash n. The MPPO is near unity at low and high productivity and falls below unity at intermediate productivity, tracing a U-shape. The dashed horizontal line marks $MPPO = 1$.

Small shifts in the aggregate state—via changes in A_t—can therefore cause large movements in $\overline{MPPO}$ if they push a substantial mass of firms across the boundary between the accumulation region and the pass-through region. This composition effect is the precise mechanism through which the non-monotone micro-level cash policy generates aggregate state dependence, as we demonstrate quantitatively in the next section.

5 Nonlinear business cycle and endogenous consumption risk

In this section, we quantitatively analyze the recursive competitive equilibrium allocations computed from the global nonlinear solution method in the sequence space. For tractability, we normalize the firm's value function by contemporaneous consumption c_t following Khan and Thomas (2008). We define the marginal utility price of consumption as $p_t := 1/c_t$ and the normalized value function $\tilde{J}_t := p_t J_t$. From the household's intratemporal and intertemporal optimality conditions, we have $w_t = \eta/p_t$ and $q_t =$

Table 1: Fixed Parameters

Parameter	Description	Value	Source
Households			
β	Discount factor	0.995	Chen (2017)
χ	Frisch labor supply elasticity	1.000	Kaplan et al. (2018)
Production			
γ	Span of control	0.930	Standard calibration
κ	Cash return wedge	0.870	Cooley and Quadrini (2001)
ρ_z	Idiosyncratic shock persistence	0.861	Bachmann et al. (2013)
σ_z	Idiosyncratic shock volatility	0.075	Bachmann et al. (2013)
Aggregate			
$p(A_B\|A_B)$	Persistence of low aggregate TFP	0.875	Krusell and Smith (1998)
$p(A_G\|A_G)$	Persistence of high aggregate TFP	0.875	Krusell and Smith (1998)

Note. This table presents the fixed parameters used in the model, along with their sources. For cash return wedge, we back out the ratio wedge κ implied by the calibration used in Cooley and Quadrini (2001): $r/(1/\beta - 1)$. For the idiosyncratic shock volatility σ_z we sum both the idiosyncratic and sector specific shock volatility from Bachmann et al. (2013).

$\beta p_{t+1}/p_t$. Thus, p_t is the only price to characterize the equilibrium.

5.1 Calibration and solution

We adopt a standard calibration strategy: some parameters are fixed based on the literature, while others are estimated to match empirical moments. The model period is a quarter, so we set the household discount factor β to 0.995, consistent with Chen et al. (2017), implying an annualized real rate of approximately 2% at the non-stochastic steady state. The Frisch labor supply elasticity is set equal to 1, consistent with previous literature, in line with Kaplan et al. (2018).[12] On the firm side, we set the span of control parameter equal to 0.930,

The two key parameters to be calibrated are the external financing cost μ and the operating cost ξ. The external financing cost is identified using the corporate cash-to-output ratio. The cash quarterly data comes from the Flow of Funds (Federal Reserve), and output is measured using GDP from the National Income and Product Accounts (NIPA,

[12] Chetty et al. (2011) show that micro estimates imply a Frisch elasticity of 0.82. Our value is slightly above this.

Table 2: Calibrated Parameters and Target Moments

Parameters	Description	Data	Model	Calibration
Targeted moments				
μ	Corporate cash holdings relative to output (%)	10.00	9.95	0.08
ξ	Consumption relative to output (%)	66.00	63.63	0.15
η	Hours worked relative to time available (%)	33.00	32.90	13.50
Δ_A	Output volatility (% *p.q.*)	1.45	1.72	0.02
Untargeted moments				
	Dividend to output (%)	1.91	1.98	

Note. This table presents the calibrated parameters along with the corresponding target moments, observed data values, model-implied values, and the level of precision achieved. The observed data values are averages over quarterly data spanning from 1970 to 2019.

BEA).[13] As μ increases, firms accumulate more cash due to heightened precautionary motives, raising the cash-to-output ratio.

The identifying moment of the operating cost parameter ξ is the consumption-to-output ratio. The consumption quarterly data is from NIPA.[14] As operating costs increase, dividend payouts fall, reducing aggregate consumption. The calibrated parameters and the corresponding moments are summarized in Table 2. Data moments are calculates as quarterly averages between 1970 and 2019.

The model on top of matching the targeted moments, equally matches well some untargeted moments. First, it generates a dividend to output ratio of 1.98%, close to the data counterpart of 1.91%. Second, at the micro level, it generates a negative correlation of both cash holdings to output ratio and the standard deviation of this ratio with output, in line with the micro distribution of cash holdings to sales in the Compustat data.[15] For more details on the comparison of the cash holdings distribution in the model and in the data, please see Appendix A.4.

5.2 Algorithm - Repeated transition method

Despite its relatively parsimonious formulation, our model's computation of recursive competitive equilibrium presents several significant methodological challenges:

[13] See Appendix A.1 for the detailed definition of aggregate cash holdings.

[14] Consumption includes both durable and non-durable consumptions.

[15] For details on the data cleaning procedure, please see Appendix A.2.

1. highly nonlinear aggregate fluctuations,
2. non-trivial market clearing conditions for both labor and consumption goods, and
3. occasionally binding constraints.

We employ the global nonlinear solution method in sequence space developed by Lee (2025), which can efficiently solve this problem. The method solves the problem backward over a long sequence of simulated exogenous aggregate states. During this backward iteration process, conditional expectations are calculated by integrating the realized value functions from previous *iterations*, thereby eliminating the need to explicitly specify aggregate laws of motion.

Furthermore, the algorithm traces multiple price vectors throughout the iteration process, updating them according to implied price levels derived from market clearing conditions. It is important to distinguish between implied price levels and market clearing prices—the former assumes either supply or demand is exogenously determined by current-iteration guesses. As iterations progress, true market clearing prices emerge asymptotically as both supply and demand converge to equilibrium values. This approach achieves market clearing only at the limit, substantially reducing computational burden.

Our model features non-trivial market clearing for both labor and consumption goods. According to Lee (2025), incorporating even a single non-trivial market clearing condition yields approximately tenfold computational efficiency gains compared to state-space methods such as the Krusell and Smith (1997) algorithm. Given our model's dual market clearing requirements, theoretical computational gains could approach two orders of magnitude.

5.3 Nonlinear business cycle

Using the repeated transition method, we compute the recursive competitive equilibrium allocations over the simulated path of aggregate shocks. The sufficient statistic used is the aggregate cash stock. The dynamics of the aggregate cash stocks are highly nonlinear for two reasons: (1) the individual firm's cash holding policy function becomes flat for high levels of individual cash stocks, as described in Sections 2 and 4; (2) the general equilibrium effect does not strongly affect each firm's cash holding demand. It is because the wedge between price of cash holding and the risk-free bond is exogenously fixed at κ, as the cash is not allowed to be traded across the firms.

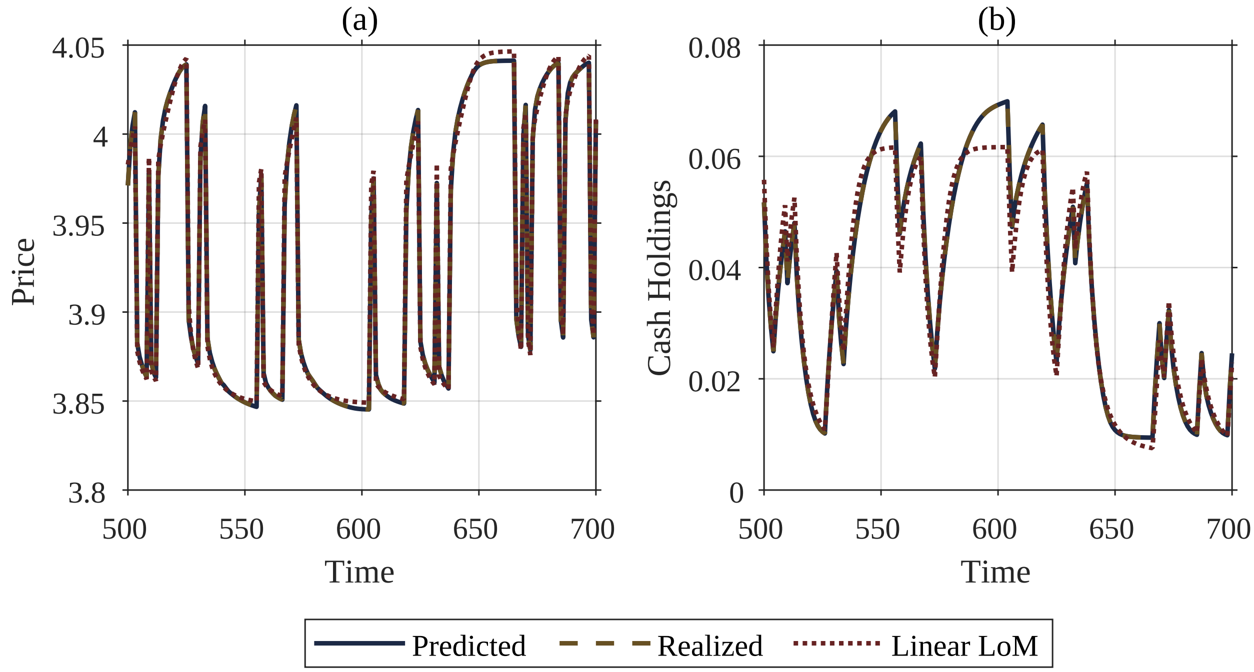


Figure 6: Aggregate fluctuations in the baseline model

Notes: The figure plots the time series of the price p_t the aggregate cash stock N_t in the baseline model. In both panels, the solid line is the predicted time series (n^{th} guess) $\{p_t^{(n)}, N_t^{(n)}\}_{t=400}^{500}$; the dash-dotted line is the realized time series $\{p_t^*, N_t^*\}_{t=400}^{500}$; the dashed line is the predicted time series implied by the linear law of motion.

Figure 6 plots a sample of the simulated path of the price p_t (panel (a)) and aggregate corporate cash holding N_t (panel (b)) obtained from both the repeated transition method and the log-linear specification of the law of motion. The solid line plots the expected allocations (guess from the n^{th} iteration), and the dash-dotted line plots the realized allocations (simulation based on the policy in $(n+1)^{th}$ iteration) in the repeated transition method. The dashed line represents the dynamics of the allocations in the log-linear specification of the law of motion. To obtain the parameters in the log-linear specification, we fit the equilibrium allocations from the repeated transition method into the log-linear specification, and the result is as follows:

$$
\begin{aligned}
log(N_{t+1}) &= -0.5473 + 0.8899 * log(N_t), \quad \text{if } A_t = A_B, \text{ and } R^2 = 0.9977, \ MSE = 0.0006 \\
log(N_{t+1}) &= -0.7437 + 0.7331 * log(N_t), \quad \text{if } A_t = A_G, \text{ and } R^2 = 0.9914, \ MSE = 0.0011 \\
log(p_t) &= 1.3545 - 0.0093 * log(N_t), \quad \text{if } A_t = A_B, \text{ and } R^2 = 0.9332, \ MSE = 0.0000 \\
log(p_t) &= 1.3284 - 0.0073 * log(N_t), \quad \text{if } A_t = A_G, \text{ and } R^2 = 0.9573, \ MSE = 0.0000
\end{aligned}
$$

The repeated transition method generates near-perfect alignment between expected and realized paths ($R^2 \approx 1$, MSE $\approx 10^{-6}$). In contrast, the log-linear fits have notably lower R^2 and larger MSEs, indicating substantial model misspecification if linearity is imposed.

One important reason for the nonlinearity is the nature of the market for cash. As cash is not tradable across firms, the dynamics of the price of cash and aggregate cash stocks are smoothed. For example, when there is a surge of cash holding demand, the price of cash does not go up enough to mitigate the surge and vice versa for the case of decreasing cash holding demand. In many of the models in the literature, the flattening force from the general equilibrium has been proven to be powerful enough to guarantee the log-linear specification as the true law of motion. One example is Khan and Thomas (2008), where the micro-level lumpiness is smoothed out by real interest rate dynamics. However, due to the friction in the market for cash, the log-linear prediction rule fails to capture the true law of motion in this paper.

On top of the nonlinearity, there is another complication in the model that the prototype method of Krusell and Smith (1998) cannot simply address: there is a non-trivial market-clearing condition with respect to price p_t. Krusell and Smith (1997) suggests an algorithm to solve this problem by considering an external loop in the algorithm that solves the market-clearing price p_t in each iteration. This algorithm is known to successfully solve the log-linear models with non-trivial market-clearing conditions, such as Khan and Thomas (2008). However, due to the extra loop in each iteration, the algorithm entails high computation costs. In contrast, the repeated transition method tracks the implied price instead of the market clearing price on the simulated path. Therefore, the method does not require an extra loop for computing the market-clearing price, so it saves a great amount of computation time.

5.4 The endogenous consumption risk and state-dependent consumption responsiveness

This section explores the role of corporate cash in shaping consumption dynamics. In the model, aggregate productivity A_t switches between two states, A_G and A_B, following a persistent Markov process. We define a negative shock as a transition from A_G to A_B and a positive shock as the reverse.

A key mechanism in the model is that firm-level dividend sensitivity to TFP shocks depends on cash holdings. Section 4.1 shows that the MPPO exhibits a U-shaped relationship with cash. Firms operating at the cash constraint respond aggressively to negative shocks by cutting dividends, while cash-rich firms at the satiation point also display an MPPO of one. This generates state-dependent household consumption responses, as con-

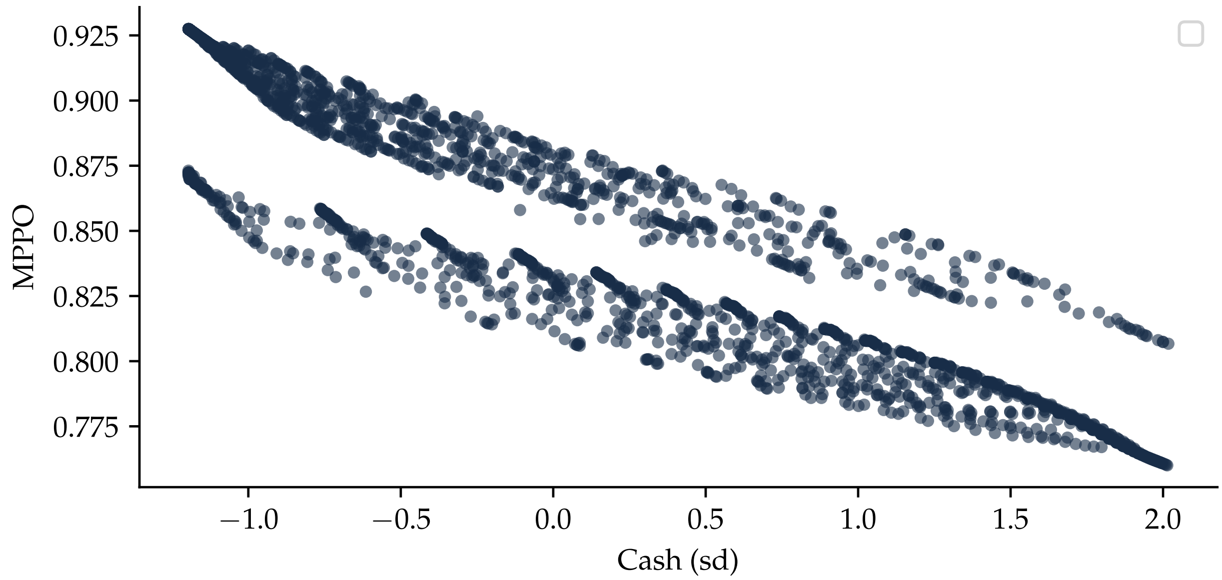


Figure 7: MPPO and cash-holdings

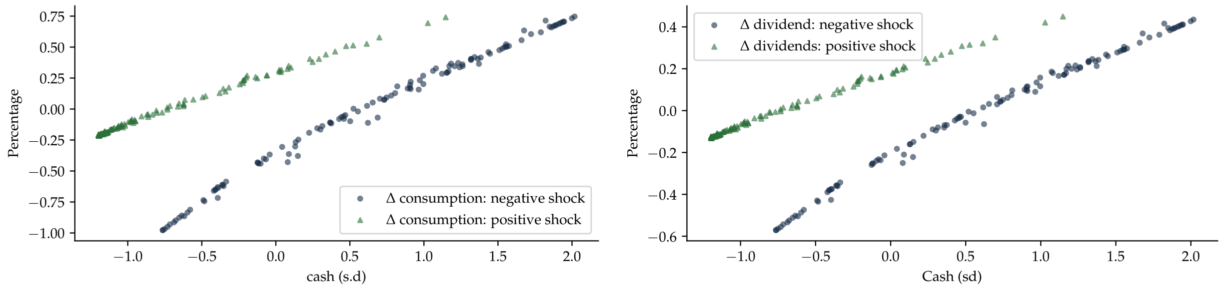
Notes: The figure plots the aggregate MPPO as a function of lagged aggregate cash stocks on the horizontal axis. The slope of curve is -0.914.

sumption depends on dividends and therefore on the aggregate cash stock, as established in Section 2.

To illustrate this relationship quantitatively, Figure 7 plots the MPPO over the business cycle as a function of aggregate cash holdings. The figure shows a clear negative relationship: higher cash holdings are associated with a lower MPPO. While the theoretical results in Sections 2 and 4.1 imply a U-shaped relationship at the firm level, the aggregate cash levels observed over the business cycle lie predominantly on the left side of the U, where MPPO declines with cash. Despite the negative correlation between cash and MPPO, there remains dispersion in MPPO for similar levels of cash. This dispersion is driven mainly by the aggregate productivity state: when TFP is high, more firms are pushed away from the constraint, lowering the aggregate MPPO.

Differences in MPPO across cash levels and aggregate productivity states translate into heterogeneous dividend and consumption responses to TFP shocks. Figure 8 plots the responsiveness of dividends and consumption to negative (blue dots) and positive (green triangles) aggregate TFP shocks as a function of lagged aggregate cash holdings. The magnitude of the aggregate shock is fixed at $|A_G - A_B| = 4\%$. Hence, variation in consumption responses across periods reflects endogenous state dependence rather than differences in shock size.

For negative aggregate shocks, consumption responsiveness decreases with aggregate



(a) Consumption

(b) Dividends

Figure 8: Endogenous state-dependence in the shock responses of consumption and dividends

Notes: The figure plots consumption/dividends responses relative to average consumption/dividend response $\Delta X_t/\mathbb{E}(\Delta X_t)$, $\quad X = \{C, D\}$ to negative (blue dots) and positive (green dots) aggregate TFP shocks as a function of lagged aggregate cash stocks on the horizontal axis. The slope of the negative shock curve is 0.605 and for the positive shock curve is 0.419 for consumption.

cash holdings: when firms are liquid, they smooth dividends and shield households from income losses. For positive aggregate shocks, consumption responsiveness increases with aggregate cash, reflecting a greater pass-through of productivity gains to households. This asymmetric pattern reflects firms' precautionary behavior and is mirrored in the dividend responses shown in the right panel of Figure 8.

Quantitatively, a one-standard-deviation increase in lagged aggregate cash reduces the consumption response to a negative TFP shock by 0.17 percentage points. For a positive TFP shock, the corresponding change is 0.07 percentage points.

Aggregate cash holdings therefore provide a consumption buffer against negative aggregate shocks by smoothing dividend payments. At the same time, higher cash holdings facilitate the pass-through of positive productivity shocks to consumption. The buffering effect on the downside is quantitatively stronger than the amplification effect on the upside.

Figure 9 further illustrates this state dependence by reporting the generalized impulse response function (GIRF) of consumption to a negative TFP shock at different levels of cash. When cash is at its lowest level in the simulation, consumption drops almost three times more than when cash is at its median level. This amplification reflects the high MPPO in low-cash states, which forces firms to pass the shock through to households almost one-for-one.

Role of heterogeneity To illustrate the importance of firm heterogeneity in driving the consumption state dependence we compare the baseline model to a representative firm

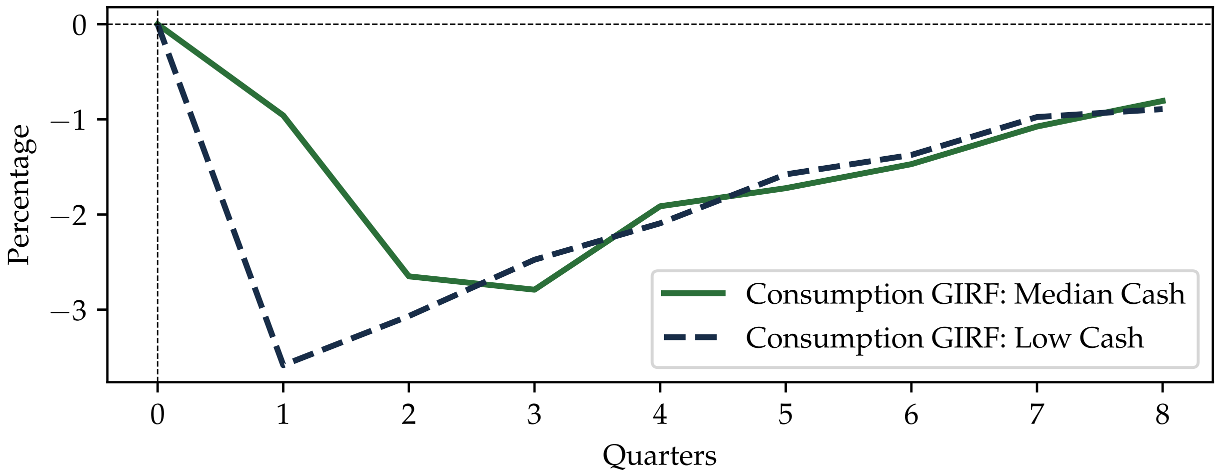


Figure 9: GIRF: Consumption responses to negative shocks for median and low cash

Notes: The figure plots the consumption % change to a negative aggregate TFP shocks when cash is at median level (green solid line) vs lowest level (blue dashed line) over the entire simulation.

model. Essentially, we shut down the idiosyncratic productivity shock, keeping the market incompleteness and the aggregate productivity shocks. We keep all the parameters fixed at the baseline model value.

Figure 10 compares the results for the baseline, heterogeneous firms model, and the representative firm model. As is illustrated by the figure, the state dependence is considerably stronger in the baseline model. Two reasons explain the difference: 1) in the heterogeneous firms model, what matters, besides the average cash holdings, is the mass of firms that are on either of the flat parts of the cash holdings policy function – the constraint on the bottom part, or the satiation point on the upper part – while in the representative firm model, either of the constraints rarely binds and the MPPO is always below one; 2) the cash fluctuations over the cycle are much more muted in the representative firm model, as the firm can more easily insure against aggregate fluctuations. The idiosyncratic productivity component creates an additional layer against which the firms try to insure, and generates consistently higher dispersion and fluctuation of cash holdings over the cycle.

In Appendix F.1, we present further evidence that a negative TFP shock in both the baseline and representative firm models yields different results. GIRFs to a negative TFP shcoks in both models indicate that the state dependence is three times stronger in the heterogeneous agents model.

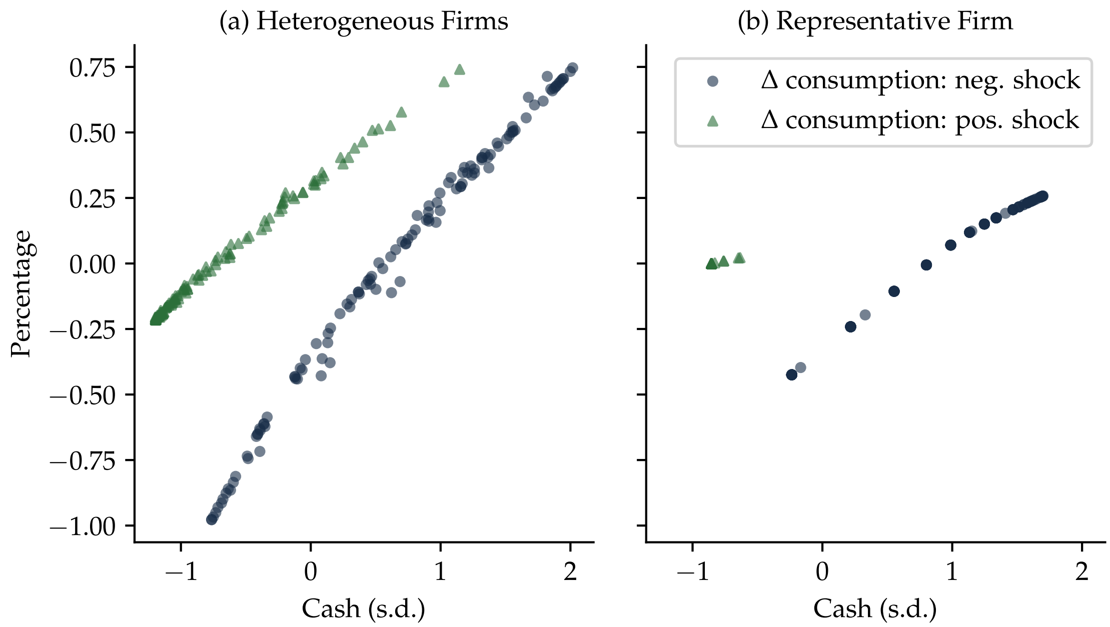


Figure 10: Endogenous state-dependence in consumption responses to negative and positive shocks in the baseline (a) and representative firm (b) models

Notes: The figure plots consumption responses (relative to average consumption, in percentages) to negative (blue dots) and positive (green dots) aggregate TFP shocks as a function of lagged aggregate cash stocks on the horizontal axis. Panel (a) plots the results for the baseline, heterogeneous firms model, while panel (b) plots the results for the representative firm model.

Efficient benchmark As we establish that the firms' cash holdings affect the consumption responsiveness to TFP shocks, one can ask if firms are holding the socially optimal amount of cash. We now compare the baseline heterogeneous firms model with the social planner's, which coincides with the standard RBC model, as well as with the representative firm model.[16]

Table 3 shows that the social optimal cash holdings are zero. Despite the increase in consumption volatility with zero cash holdings, there is a negative cash externality, which leads the planner to choose no cash. The negative cash externality takes the form of a negative wealth effect due to the reallocation of resources towards a lower return asset, and dominates the decrease in consumption volatility. This result indicates that the true cost of frictions over of the business cycle is not on if volatility is amplified, but rather on the effects on ergodic averages over the cycle. In this case, the representative firm model, which has lower cash holdings, much more closely replicates the social planner solution.

An extension of the theory in Section 2 pins down the exact mechanisms at play. While in one hand higher cash holdings diminish the consumption volatility, there is a cash

[16]For a detail description of the social planner's problem, please see Appendix E.

Table 3: Business cycle comparison across models

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

Notes: The table reports business cycle statistics across the baseline heterogeneous firms model, the social planner, and the representative firm model. The table reports the standard deviation of log consumption, log output and cash holdings, as well as the average cash holdings and the correlation between loc consumption and log output.

externality, which reduces the overall household's wealth. As it is costly to hold cash, the social planner strictly prefers zero cash holdings to eliminate the cash externality and increase overall consumption, in line with the results in Table 3. For more details, please see Appendix B.2.

5.5 Fiscal policy

We now use the model to study the aggregate effects of government transfers when firms hold different amounts of internal liquidity. The key object of interest is how the transmission of fiscal transfers depends on firms' payout behavior, summarized by the MPPO, and how this interaction generates nonlinear output responses over the business cycle.

Transfer process Government transfers follow a two-state Markov process that is independent of aggregate productivity. Let $T_t \in \{T_B, T_G\}$ denote the transfer paid by the representative household at time t and equally distributed among firms. We calibrate the size of the fiscal intervention to match the scale of the *Troubled Asset Relief Program* (TARP). Specifically, we set the high-transfer state T_G to equal 2.4% of steady-state output, corresponding to the initial \$350 billion tranche authorized in late 2008 relative to aggregate GDP:

$$T_B = 0 \qquad \text{and} \qquad T_G = 2.4\% Y_{ss}.$$

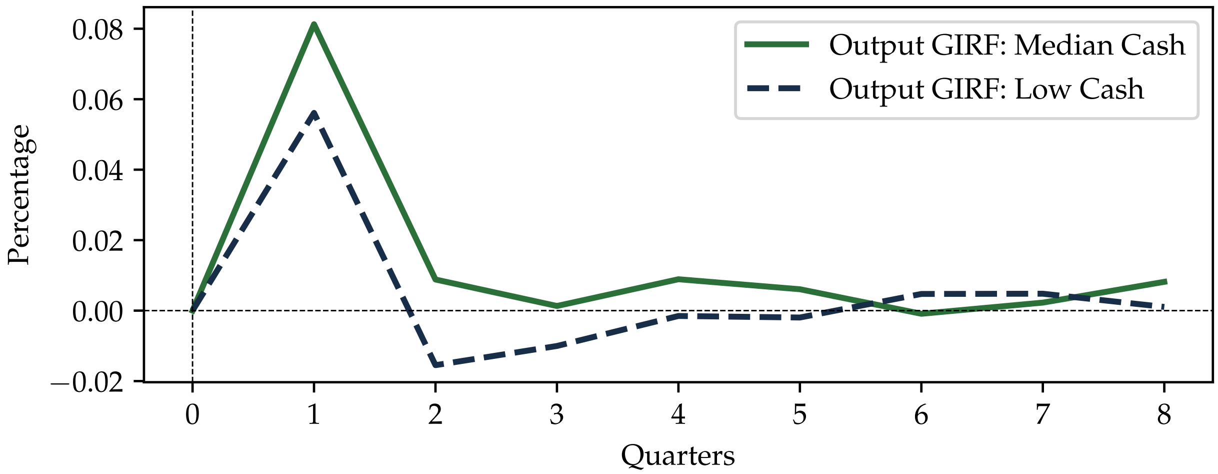


Figure 11: GIRF: Output response to fiscal subsidy during recessions for median and low cash

Notes: The figure plots the output % change to a subsidy shock when aggregate TFP is in state A_B and when cash is at median level (green solid line) vs lowest level (blue dashed line) over the entire simulation.

The transition matrix governing the transfer process is given by

$$\Gamma_T = \begin{bmatrix} p(T_{t+1} = T_B \mid T_t = T_B) & 1 - p(T_{t+1} = T_B \mid T_t = T_B) \\ 1 - p(T_{t+1} = T_G \mid T_t = T_G) & p(T_{t+1} = T_G \mid T_t = T_G) \end{bmatrix}, \tag{24}$$

with

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

Hence, transfers arrive as rare and transitory fiscal expansions: once the economy enters the high-transfer state T_G, it deterministically reverts to the no-transfer state in the subsequent period. This specification isolates the short-run propagation of fiscal policy and abstracts from long-lived wealth effects.

Subsidy effect Figure 11 plots the generalized impulse response function (GIRF) of aggregate output to a one-period transfer shock, conditional on the initial distribution of firm cash holdings. We report responses starting from two states: a low-cash economy, in which a large fraction of firms operate close to their cash constraint, and a median-cash economy, in which firms hold substantially more internal liquidity.

The figure shows that output responds significantly more when aggregate cash holdings are high. In contrast, when firms start from a low-cash state, the output response is muted and short-lived. The mechanism underlying this result follows from firms' endogenous payout behavior and the household labor-supply decision. When transfers are paid, they initially accrue to firms' balance sheets. Whether these resources affect real activity depends on how much of the transfer ultimately remains on the firm side of the economy.

When firms hold little cash, many of them operate at the cash constraint and exhibit a high MPPO. In this region of the policy function, firms behave like hand-to-mouth households: any additional liquidity that reaches the firm is immediately distributed as dividends. In equilibrium, the transfer therefore circulates from households to the government, from government to firms, and back to households through dividends. Because resources immediately return to the household sector, household wealth is largely unaffected and labor supply changes little. As a result, the output response is small.

In contrast, when firms enter with high cash holdings, the MPPO is low. Firms optimally retain a substantial fraction of the increased liquidity in the form of additional cash rather than distributing them immediately. In this case, fiscal transfers effectively reallocate resources away from households and into firms' balance sheets. Households become temporarily poorer and increase labor supply in order to smooth consumption. The resulting increase in labor supply leads to a rise in equilibrium output.

This mechanism also clarifies the limiting cases. If the MPPO were equal to one for all firms, transfers would be neutral: resources taken from households would be returned one-for-one through dividends, leaving household wealth, labor supply, and output unchanged. Real effects arise precisely because the MPPO is strictly below one for a non-negligible mass of firms, allowing fiscal policy to affect the timing of resource use.

An important distinction between this mechanism and standard fiscal policy channels is that transfers do not involve wasteful spending or direct distortions. Resources are not destroyed nor inefficiently used; instead, they are temporarily held on firms' balance sheets. By preventing these resources from immediately flowing back to households and being used for consumption today, firms effectively delay their use over time. The output response therefore reflects an intertemporal reallocation driven by endogenous payout policies, rather than inefficient government expenditure.

The GIRF evidence highlights a central implication of the model: the effectiveness of fiscal policy depends critically on the endogenous distribution of firm liquidity. Transfers are most powerful when firms are liquid and payout behavior is muted, and least effective when firms are cash-poor and behave in a hand-to-mouth fashion. This state dependence is a direct consequence of the nonlinear cash policy function and would be absent in models with linear or exogenous payout behavior.

Taken together, these results show that corporate cash holdings are not merely a buffer against shocks but also a key determinant of fiscal transmission, shaping when and how government transfers translate into real economic activity.

6 Micro evidence of the mechanism

Our proposed mechanism relies on two key factors. First, firms using cash holdings to smooth dividends. Papers such as Opler et al. (1999) and Gao et al. (2013) show that large, publicly listed firms tend to hold more cash, and that these firms use this cash to smooth their dividend over time. Using annual Compustat data, we provide evidence in support of the model proposed mechanism. In particular, we show that firms with larger cash holdings reduce dividend payments less during recessions.

Second, dividends being an important part of households' consumption. Papers such as Baker et al. (2006), Di Maggio et al. (2020) and Bräuer et al. (2022) have documented that consumption responds positively to dividends, more than to other capital gains.[17] We here proceed to test for the correlation between consumption and dividends and how consumption reacts to changes in dividends. To do so, we use micro data from PSID (2005-2021), which contains bi-annual data on total household expenditure together with dividend and labor income.

6.1 Cash holdings and dividend smoothing

In this section we use annual Compustat data for the period 1980-2019 to show that firms with more liquid assets tend to smooth their dividends.[18] To test for how the firm's dividend issuance during crisis periods depends on cash holdings, we run the following local projection

$$d_{it+h} = \beta \text{rec}_t + \delta n_{it-1} + \gamma \text{rec}_t \times n_{it-1} + \Gamma_h \mathbf{X}_{it-1} + \alpha_i + \epsilon_{it} \tag{25}$$

where d_{it+h} is the log of the real dividends by firm i in year $t+h$, rec_t is an indicator variable that takes the value of 1 whenever real GDP growth is negative, n_{it-1} represents the ratio of cash and short-term investments to total assets, and X_{it-1} is a vector of controls that includes the lag of log real total assets, leverage, and real sales growth.[19] α_i represents the firm fixed effects and standard errors are clustered at the firm level.

Panel (a) on Figure 12 plots the base effect (β) of recessions on dividends on the left

[17] Notice these papers show this result in a cross-section of households. We show this result holds within household over time.

[18] Appendix A.2 provides the full data cleaning procedure.

[19] All variables except cash are deflated using the CPI.

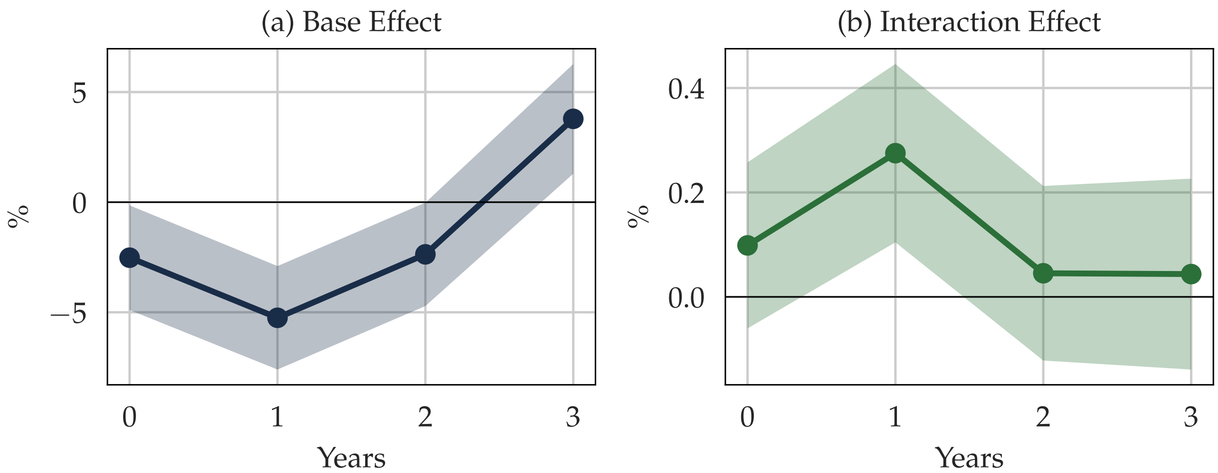


Figure 12: Dynamic dividend reaction to negative GDP and interaction with cash to assets

Note. The figure plots the impact of recessions on panel (a) up to three years after the recession. Panel (b) plots the coefficient associated with the interaction term between cash to total assets ratio and the recession indicator. Shaded bands represent 90% confidence intervals

panel, and on the right panel the effect of cash holdings on dividends during recessions (γ). For firms with no cash holdings, dividends drop by approximately 2.5 percentage points during a recession, but recover after two years. Importantly, panel (b) illustrates that firms which have a higher cash-to-asset ratio do not reduce their dividend issuance as much after a year of negative GDP growth, as the coefficient is positive and statistically significant in both Year 0 and Year 1. One year after the recession, a 1 percentage point increase in the cash-to-assets ratio mitigates the dividend drop by 0.1 percentage points. Using the distribution of the cash-to-asset ratio in the sample, this implies that a one standard deviation increase in cash holdings reduces the dividend drop by approximately 50%.[20]

This result is supportive of the precautionary mechanism proposed in our model. Firms, to avoid costly equity issuance, hoard cash to be able to smooth their dividend over time and are able to do so during recessions. This is also in line with results presented by Opler et al. (1999) and Gao et al. (2013).

Replication with model simulated data We replicate the empirical exercise using model generated data.[21] Figure 13 plots the overall effect of the impact of a recession on divi-

[20] Appendix A.5 shows the results when considering the observations when dividends are zero, by using the log of one plus the real dividends. The results are qualitatively and quantitatively similar.

[21] Notice that in the model the firm has no assets besides cash. So we use cash as a % of output. The control variables are just output. Equally, to stay as close to the data as possible, we consider a recession whenever aggregate TFP is in its lower state.

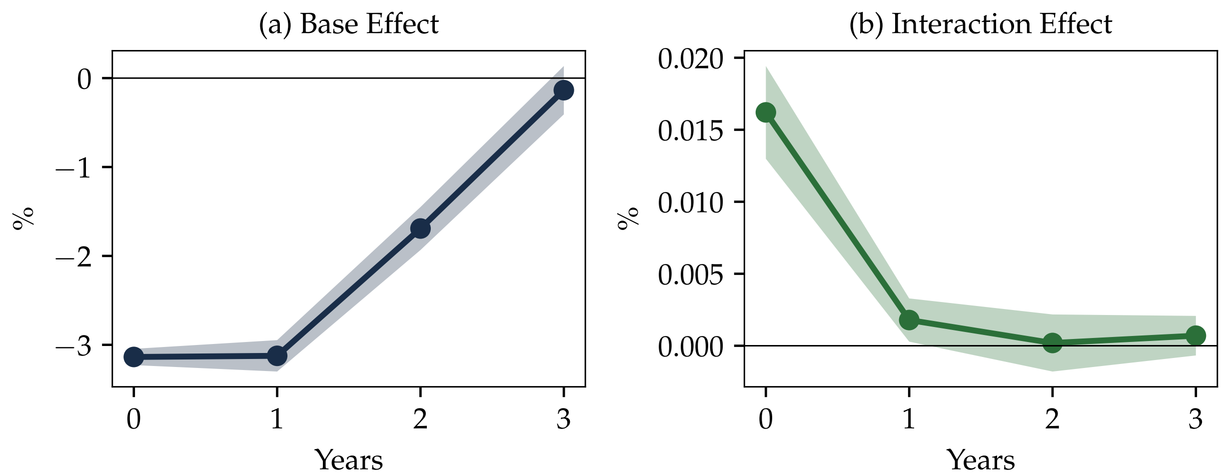


Figure 13: Model implied dynamic dividend reaction to negative GDP and interaction with cash to assets

Note. The figure plots the impact of recessions on panel (a) up to three years after the recession. Panel (b) plots the coefficient associated with the interaction term between cash to total assets ratio and the recession indicator, using model simulated data. Shaded bands represent 90% confidence intervals

dends and the coefficient on the interaction with cash. Overall, dividends drop by approximately 3% in the first period of a recession, qualitatively and quantitatively similar to the 2.5% found using Compustat data. Additionally, an increase of cash to output of 1% reduces the dividend decrease by 0.016 percentage points. This implies that a one standard deviation increase in cash holdings reduces the dividend fall by approximately 50%, very similar to the data counterpart.

6.2 Household consumption and dividend income

Our result of corporate dividend state-dependency carrying over into consumption relies on dividends being a key determinant of consumption at the household level. In order to show this connection empirically, we utilize household-level bi-annual data from the PSID between 2005 and 2021.[22] The PSID records dividends received at the household level from 2005 onwards along with total expenditure.[23] Using the PSID, we then run the following regression:

$$c_{it} = \beta d_{it-1} + \Gamma X_{it-1} + \mu_i + \mu_t + \epsilon_{it}, \tag{26}$$

[22] Appendix A.3 describes the cleaning steps involved in the preparation of the PSID panel.

[23] Total expenditures include food (at home, delivered, or eaten out), housing (mortgage or rent, utilities, internet & phone, insurance, property taxes, repairs, furnishings), health (hospital, doctor bills, prescriptions, health insurance), transportation (vehicle loans, leases, down payments, insurance, repairs, gasoline, parking, public transport, taxis), children & education (childcare, education), and personal & recreation (clothing, trips, other recreation expenses).

Table 4: Effects of real dividend income on real expenditure

	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

Note. This table shows the effects of a one dollar increase of dividends on real expenditure. Household covariates include financial and business wealth, housing wealth, financial asset income, labor income, age and education. Standard errors clustered at the household level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Equation (26) estimates the relationship between household consumption c_{it} and dividend income d_{it-1}, where i indexes households and t indexes time. The coefficient β captures the marginal effect of dividends on consumption. The vector X_{it-1} includes a set of lagged household-level control variables: labor income, financial income, non-housing wealth, housing wealth, age, and education in order to account for other determinants of consumption. We also include household fixed effects μ_i to control for time-invariant household characteristics, and time fixed effects μ_t to absorb aggregate shocks common to all households. This specification tests whether within-household changes in dividend income are systematically associated with changes in consumption, after accounting for a rich set of controls and fixed effects.

Results are presented in Table 4 and show that an increase in dividend income in year $t-1$ is positively correlated with expenditure in year t across a number of different specifications. In our strictest specification, with household covariates, fixed effects and time fixed effects, a 1 dollar increase in dividend income is associated with a 7.85 cent increase in real expenditures. This result is in line with papers such as Baker et al. (2006), Di Maggio et al. (2020) and Bräuer et al. (2022), who show for example that consumption responds positively to dividends in the CEX or transaction level data from a German bank.

7 Concluding remarks

This paper studies how the accumulation of corporate liquidity reshapes aggregate fluctuations. We develop a heterogeneous-firm business cycle model in which firms hold precautionary cash to hedge against convex equity issuance costs. Because corporate cash is non-tradable, firm-level nonlinearities survive aggregation and generate endogenous state dependence in macroeconomic dynamics.

We show that corporate liquidity fundamentally alters the transmission of both productivity and fiscal shocks. High cash holdings dampen consumption volatility by allowing firms to smooth payouts. Fiscal policy operates through the same channel: transfers are most effective when firms are liquid and retain resources, inducing a labor-supply response rather than immediate consumption. The aggregate *Marginal Propensity to Pay Out* (MPPO) emerges as a sufficient statistic summarizing these effects.

At the same time, we uncover a volatility-efficiency paradox in liquidity accumulation. While cash buffers stabilize the economy, decentralized firms over-accumulate liquidity, which depresses household wealth due to a pecuniary externality. A planner would trade off higher volatility for higher long-run consumption by discouraging corporate cash hoarding.

Empirical evidence from firm- and household-level data supports the model's key mechanisms, linking corporate payout behavior to household consumption and aggregate outcomes. Together, our results suggest that corporate liquidity is not merely a passive buffer against shocks but an active determinant of business cycle dynamics and fiscal policy effectiveness. Understanding fluctuations therefore requires accounting for the balance-sheet decisions of firms, not only their investment choices.

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