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Fiscal Uncertainty in Habit-Forming and Lumpy Economies*

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Abstract

We study dividend-tax-induced fiscal uncertainty tied to deficit-financing concerns in a production-based general equilibrium model with habit-forming consumption and partially irreversible investment. Habits generate countercyclical investment and asset price dynamics following tax adjustments. Irreversibility and tax risk, in turn, bring asset price volatility closer to the data, trigger lumpy investment behavior, and raise medium-run fiscal spending multipliers. Tax-smoothing and irreversibility significantly enhance welfare despite increased valuation risk, while also revealing a trade-off between debt stabilization and stock price volatility. The irreversibility-habit-augmented model reconciles the limited decline and rapid recovery (i.e., lumpiness) in nonfinancial corporate investment following the 2012 American Taxpayer Relief Act.

Keywords: partial irreversibility; habit formation; asset prices; deficit-financing dividend taxes; public debt.

JEL Classification: E22; E44; G12; H25; H30.

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1 Introduction

Rising public debt levels and persistent government budget consolidation pressures have renewed interest in the macroeconomic and financial implications of corporate tax policies aimed at stabilizing public finances. A notable recent consolidation episode occurred around the 2012 American Taxpayer Relief Act (ATRA), which raised effective dividend tax rates to avert a fiscal cliff following the massive deficit-financed stimulus response to the 2007-2009 Great Recession.[1] Although statutory corporate tax reforms are infrequent, dividend taxation remains a recurrent policy instrument in consolidation proposals and continues to feature in debates over public debt sustainability, especially in the aftermath of the COVID-19 stimulus surge.[2] As fiscal pressures continue to mount, uncertainty over how and when governments adjust taxes, including shareholder taxes, has become increasingly salient for business cycle dynamics, asset prices, and welfare.[3]

To this end, we develop a production-based general equilibrium model that uncovers new adjustment margins whereby fiscal uncertainty linked to *deficit-financing dividend taxes* propagates via consumption habits and partial investment irreversibility.[4] The tight interaction between tax uncertainty, habits, and irreversibility generates rich macro-financial dynamics consistent with observed patterns in the data. Particularly, dividend-tax-induced fiscal risk produces more realistic stock price dynamics, countercyclical and lumpy investment behavior, state-dependent fiscal multipliers, and macro-financial-welfare trade-offs across alternative fiscal policy rules. These rules span an immediate zero-deficit adjustment and tax-smoothing schemes that allow deficits and debt to evolve gradually over time.

[1] Throughout the text, the terms dividend taxes, payout taxes, and shareholder taxes are used interchangeably. Such taxes fall under the broader corporate (business) tax schedule, which also includes corporate income (profit) taxes and investment tax wedges. While profit taxes reduce investment by lowering after-tax marginal returns, dividend taxes affect capital costs by altering shareholder returns, payout behavior, and firm valuations at both long-run and business cycle frequencies (McGrattan and Prescott 2005; Sialm 2009). Consistent with U.S. tax code, dividends are defined as profits net of investment, making investment exempt from dividend taxation, whereas profits are taxed prior to investment decisions (e.g., Santoro and Wei 2011).

[2] For the U.S., in particular, recent work documents an increasingly unsustainable long-run fiscal trajectory (Dynan and Elmendorf 2025), which underscores the importance of understanding consolidation tools and their macro-financial consequences.

[3] Evidence on the aggregate effects of dividend taxation remains mixed: Yagan (2015) finds that the 2003 Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) had virtually-zero macroeconomic impact, whereas Auerbach and Hassett (2006) show it raised the share prices of high-dividend firms, yielding a lower cost of equity financing and stronger investment incentives. Our focus on dividend income taxes is also motivated by their historical comovement with labor income taxes, especially before the 2003 JGTRRA, and by the fact that they can adjust without distorting labor supply, offering a 'clean' instrument to study fiscal risk and valuation dynamics.

[4] Our notion of fiscal risk follows Davig, Leeper, and Walker (2010); Croce, Kung, Nguyen, and Schmid (2012), where deficit-financing pressures generate uncertainty about current and future tax paths under perfect information, in contrast to the political-learning channel emphasized by Pastor and Veronesi (2012).

Our framework offers a unified explanation for two macro-financial empirical features that standard real business cycle (RBC) environments struggle to capture. First, it reproduces the moderated decline and rapid rebound of investment following deficit-financed spending expansions with tax increases. In particular, we capture the countercyclical and lumpy nonfinancial corporate investment adjustment observed after the 2012 ATRA dividend tax hike, which we discipline using a cumulative impulse response (CIR) validation in the spirit of Baley and Blanco (2021, 2025) and McGrattan's (2023) data on effective marginal tax rates. Second, the model generates equity price fluctuations that help reconcile the excess volatility (Shiller 1981) puzzle without relying on extreme risk aversion, strong habit formation, large convex adjustment costs, or recursive preferences (Jermann 1998; Santoro and Wei 2011; Croce, Kung, Nguyen, and Schmid 2012). Fiscal uncertainty amplifies fluctuations in equity valuations and investment, whereas irreversibility limits downside investment adjustment and, through its interaction with habits, stabilizes consumption volatility. Taken together, these frictions increase equity price movements relative to fundamentals and deliver a more empirically-consistent volatility configuration across financial and real aggregates.

Two transmission mechanisms drive these results. The first is a *habit-augmented user-cost channel à la* Jorgenson (1963). Habits increase the marginal utility cost of consumption declines, making the user-cost-of-capital more sensitive to current and expected tax paths. Dividend tax hikes therefore reduce equity valuations and increase the required return on capital, generating a sharp initial contraction in investment rather than the expansion implied by the intertemporal tax arbitrage mechanism highlighted in Korinek and Stiglitz (2009); Gourio and Miao (2011). Such immediate investment contraction is then followed by a hump-shaped recovery as the expected tax rate gradually falls.

The second transmission mechanism operates via a *tax-augmented irreversibility channel* that emerges when the investment floor is reached. We model partial irreversibility as an occasionally-binding lower bound that prevents aggregate investment from falling below a fixed share of its steady-state level. This more realistic macro-level formulation, compared with complete irreversibility that almost never binds in aggregate data, parallels the functional form of the micro-level investment constraint used in the heterogeneous-firm models of Veracierto (2002); Wang and Wen (2012), while its implementation follows the piecewise-linear solution approach of Guerrieri and Iacoviello (2015). When the lower bound is triggered, the irreversibility friction gives rise to a time-varying, tax-adjusted wedge between the internal marginal value of capital (Tobin's 1969 q) and its external stock market valuation.

More specifically, the tax-augmented irreversibility channel operates through two sub-mechanisms: *(i)* a *tax-augmented user-cost irreversibility channel*, in which the expected value of the tax-adjusted irreversibility wedge discourages current investment. When the firm anticipates that the constraint will bind in the future, the option value of waiting rises. Higher taxes increase the user-cost-of-capital, and irreversibility distorts this effect by limiting investment contractions in a downturn. As expected taxes fall and financing conditions improve, the user-cost declines and investment recovers; *(ii)* a *tax-augmented hangover channel*, which becomes active once the constraint binds today and excess capital cannot be shed. In this case, investment becomes dependent on past capital accumulation, and high taxes prolong the overhang by depressing marginal profitability. As depreciation erodes the inherited capital stock and the tax burden eases, investment accelerates, a rebound further reinforced by the habit-augmented Jorgenson mechanism described above.

We consider two alternative deficit-financing dividend tax rules. Under a zero-deficit rule, taxes adjust immediately to stabilize public debt. In contrast, tax-smoothing policies adjust shareholder taxes gradually in response to both the debt-to-GDP ratio (hereafter, the debt ratio) and the cyclical position of the economy, proxied by deviations of consumption from its steady-state level. Building on these insights, we offer three policy-oriented results:

1. **A macro-financial-fiscal trade-off: stabilizing debt and consumption raises the volatility of equity valuations.** Irreversibility limits investment cutbacks and thus stabilizes the debt ratio, while tax-smoothing stabilizes consumption by spreading dividend tax burdens across states. Yet both mechanisms shift more adjustment onto financial variables. Tax-smoothing increases investment and equity volatility directly, and irreversibility, by limiting real adjustment, heightens the sensitivity of equity valuations to fiscal shocks even as it dampens investment volatility. Put differently, greater stability in debt and consumption comes at the cost of more volatile asset prices.

2. **Dividend-tax-based consolidations generate dynamic state-dependent fiscal spending multipliers.** In the short-run, investment and output contract, resulting in negative multipliers. However, the firm responds to expected tax relief by ramping up investment over time, particularly under irreversibility. This produces rising cumulative expenditure multipliers and stronger medium- to long-run output gains.

3. **Welfare improves most under the joint presence of irreversibility and tax-smoothing.** While consumption initially declines due to intertemporal substitution effects, the subsequent recovery in real activity raises average utility. Relative to a stochastic steady-state RBC benchmark with a zero-deficit tax rate, the combination of irreversibility and tax-smoothing delivers the highest welfare gain, exceeding 1% of steady-state consumption in the Lucas (1987) sense. These findings complement Dávila and Hébert (2023), where dividend taxes may be less harmful to long-term output and, in a lumpy, habit-forming economy with fiscal risk like ours, also to overall welfare.

In summary, the interaction of habits, asymmetric investment frictions, and fiscal adjustment rules is central to understanding the wide-ranging consequences of payout-tax-based consolidation in high-debt economies and to identifying the trade-offs and macro-financial-welfare risks these economies face under persistent fiscal pressure.[5]

Related Literature. This paper contributes to three strands of research. First, we relate to the literature studying fiscal policy, public debt, and tax-based consolidation in dynamic general equilibrium models. Prior work by Leeper and Yang (2008); Davig, Leeper, and Walker (2010); Croce, Nguyen, and Schmid (2012); Drautzburg and Uhlig (2015), among others, emphasizes the macroeconomic consequences of deficit-financing household labor and capital tax rules. In contrast, we focus on dividend taxation as a consolidation instrument and study its asset pricing, business cycle, and welfare implications in the presence of investment asymmetries. While McGrattan and Prescott (2005); Sialm (2006); Gourio and Miao (2011); Santoro and Wei (2011); Atesagaoglu (2012); Chang, Kuo, Lin, and Yang (2023); Ábrahám, Brendler, and Cárceles-Poveda (2024); Ghilardi and Zilberman (2024) do examine various business tax distortions, they do not analyze how such taxes interact with public debt management and investment lumpiness.[6] Croce, Kung, Nguyen, and Schmid (2012) is arguably the closest related contribution, examining corporate profit tax financing regimes and their implications for macroeconomic fluctuations, asset returns, fiscal balances, and welfare. However, they abstract from partial irreversibility and the regime-switching investment behavior that arises in our piecewise-linear framework, which we show to be central for the transmission of dividend tax risk across short-, medium-, and long-run horizons.

Second, we speak to the literature on the (ir)relevance of irreversibility and lumpiness in general equilibrium models (e.g., Sargent 1980; Dow and Olson 1992; Coleman 1997; Faig 2001; Kogan 2001; Thomas 2002; Veracierto 2002; Gourio and Kashyap 2007; Fiori 2012; Lanteri 2018). We analyze how debt-offsetting payout tax policies interact with an occasionally-binding irreversibility constraint without requiring aggregate investment to reach zero for the constraint to frequently bind. While Thomas (2002); Veracierto (2002) suggest virtually-zero aggregate effects from micro-level lumpiness, our asset pricing approach shows that irreversibility materially influences macroeconomic dynamics following shocks and fiscal adjustments, even without considering capital reallocations as in Ramey and Shapiro (1998); Bachmann, Caballero, and Engel (2013); Cui (2022).[7]

[5] For a comprehensive review of expenditure- versus tax-based approaches during fiscal austerity episodes, see Alesina, Favero, and Giavazzi (2019).

[6] Earlier partial equilibrium studies on investment and corporate tax policy interactions include Hall and Jorgenson (1967); Abel (1982); Poterba and Summers (1983).

[7] The importance of irreversibility is also highlighted in the earlier theoretical partial equilibrium works of Demers (1991); Bertola and Caballero (1994); Abel and Eberly (1996, 1999); Bloom, Bond, and Van Reenen (2007); Caggese (2007), and is further supported by empirical evidence (see Chirinko and Schaller

Recent contributions by Winberry (2021), using a general equilibrium model, and Baley and Blanco (2025), employing a parsimonious investment framework, quantify the aggregate impact of micro-level investment lumpiness generated by nonconvex adjustment costs or wedges between capital purchase and resale prices, respectively. Our approach differs by generating an endogenous, tax-augmented (partial) irreversibility wedge at the aggregate level, allowing dividend tax risk to rescale the irreversibility-related user-cost and hangover effects first emphasized in the partial equilibrium analyses of Bertola and Caballero (1994); Abel and Eberly (1996, 1999). To retain tractability, we model heterogeneity through endogenous and occasionally-switching investment regimes faced by the 'average firm'.[8] Compared to the irreversibility-based asset pricing model of Kogan (2004), we highlight the role of fiscal policy uncertainty as a distinct source of valuation risk.

Third, we complement studies linking tax and subsidy policies to corporate adjustment under asymmetric investment frictions—such as Faig and Shum (1999); Altug, Demers, and Demers (2009); Miao and Wang (2014); Miao (2019); Winberry (2021); Chen, Jiang, Liu, Serrato, and Xu (2023)—by introducing public debt dynamics and fiscal rules into a tractable general equilibrium framework. This enables a deeper examination of the trade-offs between macroeconomic, financial, and welfare distortions and fiscal sustainability under alternative dividend tax consolidation regimes.

Outline. The paper proceeds as follows. Section 2 presents the model. Section 3 describes the calibration, estimation, and solution techniques. Section 4 shows the main quantitative results, including second moments, impulse responses, quantitative channel decomposition, as well as multiplier and welfare calculations. Section 5 validates the model against the 2012 ATRA episode using a CIR analysis. Section 6 concludes.

2009; Kermani and Ma 2023 as well as references therein).

[8]Essentially, we complement the micro-level lumpy investment literature by allowing *partial* irreversibility to occasionally arise at the aggregate level, contingent on the size and direction of aggregate shocks and fiscal policies. This approach differs from tracking the cross-sectional distribution of firm-level investment but remains empirically-relevant, as investment lumpiness has also been documented at the aggregate level (e.g., Gourio and Kashyap 2007; Fiori 2012). The representative-firm framework enables us to isolate key mechanisms in a tractable manner without introducing additional heterogeneity that could obscure these effects. Given that the model already includes two endogenous state variables—physical capital and public debt—extending it to capture the time-varying distribution of heterogeneous firms and regime shifts within the distribution would introduce substantial additional computational complexity (see Senga and Varotto 2025 for a recent contribution). While challenging, such an extension could offer valuable insights and remains a promising direction for future research.

2 The Model

A decentralized economy is cast in an infinite-horizon, discrete-time setting with a representative household-shareholder, a perfectly-competitive corporate firm, and a government. This section outlines the behavior of each agent and the associated equilibrium conditions, with analytical insights provided throughout.

2.1 Representative Household

The household-shareholder derives lifetime utility from habit-adjusted consumption:

$$U\left(C_t, C_{t-1}\right) = E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t - bC_{t-1}\right)^{1-\gamma}}{1-\gamma} \right], \tag{1}$$

where E_0 is the expectations operator, C_t is consumption, $\beta \in (0,1)$ is the discount factor, $\gamma > 0$ is the constant relative risk aversion (CRRA) coefficient, and $b > 0$ measures the persistence in habit formation. Since leisure is excluded from utility, the agent supplies their entire unit endowment of time to labor, $N_t = 1$, earning a wage rate W_t.

Ownership of firm equity S_t, priced at p_t per-share, entitles the shareholder to receive an after-tax net dividend per-share of $\bar{D}_t \equiv \left(1 - \tau_t^D\right) D_t$. Here, τ_t^D denotes the dividend tax rate, and D_t is the gross dividend—i.e., the amount net of corporate income and investment taxes but before applying τ_t^D. The household also purchases one-period government bonds B_t that pay an intertemporal gross return of R_t. The budget constraint is therefore:

$$C_t + p_t S_{t+1} + B_t \leq W_t N_t + \left[\left(1 - \tau_t^D\right) D_t + p_t\right] S_t + R_{t-1} B_{t-1}. \tag{2}$$

For $S_t > 0$, and taking taxes, dividends, equity prices, the bond interest rate, and the wage rate as given, maximization of (1) subject to (2) yields the first-order conditions:

$$U_{C,t} \equiv \Lambda_t = \left(C_t - bC_{t-1}\right)^{-\gamma} - \beta E_t b \left(C_{t+1} - bC_t\right)^{-\gamma}, \tag{3}$$

$$p_t = \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^D\right) D_{t+1} + p_{t+1}\right], \tag{4}$$

$$1 = \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t} R_t. \tag{5}$$

The Lagrange multiplier on the budget constraint Λ_t represents the habit-augmented marginal utility of consumption, as shown through equation (3). Conditions (4) and (5) are typical Euler equations with respect to firm equity and government bonds, respectively.

Furthermore, defining the after-tax equity return between period t and $t+1$ as $R^S_{t,t+1} \equiv \left[\left(1-\tau^D_{t+1}\right)D_{t+1}+p_{t+1}\right]/p_t$, the share price is:

$$p_t = E_t \frac{\left[\left(1-\tau^D_{t+1}\right)D_{t+1}+p_{t+1}\right]}{R^S_{t,t+1}}. \tag{6}$$

Finally, the usual transversality conditions hold in equilibrium.

2.2 Representative Firm

Production. A corporate firm hires labor N_t, owns predetermined capital K_{t-1}, and combines them to produce output Y_t using a constant-returns-to-scale (CRS) technology:

$$Y_t = A_t K^{\alpha}_{t-1} N^{1-\alpha}_t, \tag{7}$$

where $\alpha \in (0,1)$ is the capital share. Total factor productivity (TFP) A_t follows an $AR(1)$ process:

$$\ln(A_t) = \rho_A \ln(A_{t-1}) + \varepsilon_{A,t}, \tag{8}$$

where $\rho_A \in (0,1)$ is the degree of persistence, and $\varepsilon_{A,t} \sim i.i.d.\mathcal{N}(0,\sigma^2_A)$.

Finally, let $\delta \in (0,1)$ denote the capital depreciation rate, with investment I_t expanding the capital stock according to the accumulation equation:

$$K_t = (1-\delta)K_{t-1} + I_t. \tag{9}$$

Partial Irreversibility. Following Veracierto (2002); Wang and Wen (2012); Guerrieri and Iacoviello (2015), we model irreversibility as a lower bound tying investment to a fixed share of its steady-state level:

$$I_t \geq \phi I, \tag{10}$$

with $I = \delta K$ denoting steady-state investment and $\phi \in (0,1)$ the degree of irreversibility.[9,10]

When $\phi = 0$, the occasionally-binding constraint (10) reduces to the standard 'hard' non-negativity constraint ($I_t \geq 0$) used in models of complete irreversibility (e.g., Demers 1991; Caggese 2007). The partial irreversibility formulation instead captures the idea that once capital goods are produced, they cannot be fully undone: a fraction of steady-state

[9] Steady-state variables are denoted without the time subscript.

[10] See Lanteri (2018) for a heterogeneous-firm general equilibrium model where partial investment irreversibility arises endogenously from physical capital reallocations. We abstract from this to keep a tractable representative-agent framework highlighting the core mechanisms emerging from irreversibility-tax risk interactions.

investment is effectively committed in each period. At the aggregate level, investment rarely collapses to zero (Kogan 2001; Bloom, Bond, and Van Reenen 2007). Thus, a strictly positive lower bound provides a more realistic and parsimonious macro-level approximation than the extreme $I_t \geq 0$, while retaining tractability in a representative-agent model.

In this sense, $\phi \gg 0$ places a realistic floor on aggregate investment without introducing firm-level heterogeneity or relying on implausibly large idiosyncratic shocks. By ruling out extreme collapses, the constraint alters how aggregate risk is transmitted: it limits the depth of investment downturns while reallocating volatility toward other margins, such as consumption and asset prices. Partial investment irreversibility is therefore a central driver of business cycle dynamics, shaping how fiscal policy risk, investment, asset prices, and welfare interact.

Dividend Flows and Convex Capital Adjustment Costs. The firm's before-tax dividend in period t is:

$$D_t^b = Y_t - W_t N_t - I_t - \Phi\left(\frac{I_t}{K_{t-1}}\right), \tag{11}$$

with corporate income defined as $\pi_t \equiv Y_t - W_t N_t$. Following Hayashi (1982); Poterba and Summers (1983), we introduce convex adjustment costs $\Phi\left(\frac{I_t}{K_{t-1}}\right) = \frac{\Psi}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}$ that are deducted directly from the pre-corporate-income-tax dividend stream.[11] The parameter $\Psi > 0$ measures the magnitude of the convex adjustment costs. These symmetric adjustment costs are incurred regardless of whether the firm decides to invest or disinvest, unlike the nonconvex asymmetric costs associated with partial irreversibility.

Defining τ^π as the corporate income tax rate and τ^I as an investment-related tax wedge, both of which are held constant, the after-corporate-income-tax and after-investment-tax, but pre-dividend-tax, *gross* dividend is:

$$D_t = (1 - \tau^\pi)(Y_t - W_t N_t) - \left(1 + \tau^I\right) I_t - \Phi\left(\frac{I_t}{K_{t-1}}\right). \tag{12}$$

From (12), and as in Santoro and Wei (2011), net investment and the quadratic adjustment costs are expensed out of profits after τ^π and τ^I are levied.

The Investment-Related Tax Wedge. Following Ghilardi and Zilberman (2024), the inclusion of τ^I can account for any additional wedges between q and stock price value $\left(1 - \tau^D\right)$, extending beyond the shadow value of the irreversibility constraint (see equations (15) and (17) below). Indeed, in our framework, τ^I functions as a steady-state calibration tool to match observed asset valuations and capital stock levels. More broadly, τ^I may capture a

[11] We also experimented with fixed investment costs (e.g., Chirinko and Schaller 2009) and convex adjustment costs that enter the capital accumulation equation (e.g., Jermann 1998), but found that neither materially affected our results.

range of omitted frictions that affect investment behavior, including higher depreciation rates associated with intangible capital, capital gains taxes net of investment subsidies, tax-related allowances, and financial frictions.

Dividend Policy. Following standard practice in the macro-finance literature (e.g., Jermann 1998; Santoro and Wei 2011; Croce, Kung, Nguyen, and Schmid 2012), the firm maximizes the present discounted value of *net* dividends paid to the shareholder $\bar{D}_t$.[12] Denoting τ_t^D as the deficit-financing dividend tax rate, the firm solves:

$$\max_{N_t, K_t, I_t} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\Lambda_t}{\Lambda_0} \underbrace{\left(1-\tau_t^D\right)\left[\left(1-\tau^\pi\right)\left(Y_t - W_t N_t\right) - \left(1+\tau^I\right) I_t - \Phi\left(\frac{I_t}{K_{t-1}}\right)\right]}_{\bar{D}_t},$$

subject to (7), (9), and (10). The term $\beta^t \left(\Lambda_t / \Lambda_0\right) \equiv M_{0,t}$ represents the firm's stochastic discount factor between period 0 and period t, with Λ_t given by (3).

Tobin's q Theory and Stock Prices with Irreversibility. Defining q_t as the shadow price of installed capital (the Lagrange multiplier on (9)), and λ_t as the Lagrange multiplier on the irreversibility constraint (10), the firm's first-order conditions, together with the complementary-slackness condition, can be written as:

$$\left(1-\alpha\right) \frac{Y_t}{N_t} = W_t, \tag{13}$$

$$q_t = \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t} \left\{ \left(1-\tau_{t+1}^D\right) \left[\left(1-\tau^\pi\right) \alpha \frac{Y_{t+1}}{K_t} - \Phi_{K,t+1}\right] + q_{t+1}\left(1-\delta\right) \right\}, \tag{14}$$

$$q_t = \left(1-\tau_t^D\right)\left[\left(1+\tau^I\right) + \Phi_{I,t}\right] - \lambda_t, \tag{15}$$

$$\lambda_t \left(I_t - \phi I\right) = 0; \quad \lambda_t \geq 0. \tag{16}$$

Equation (13) determines the optimal labor demand. Equation (15) demonstrates that q_t is inversely related to both τ_t^D and λ_t. When I_t reaches its lower bound, q_t decreases due to the binding irreversibility constraint, making investment less attractive. Also implied from (15), the firm remains active up to the point where it is indifferent between investing in an additional unit of capital with effective price $\left(1+\tau^I+\Phi_{I,t}\right)^{-1}\left(q_t+\lambda_t\right)$, and paying out dividends with value $\left(1-\tau_t^D\right)$. During an inactivity spell, a higher τ_t^D that reduces the firm's market valuation must be met with either a lower λ_t, mitigating the cost of irreversibility, and/or a lower q_t, keeping the firm in the inaction region.

[12] Extending the framework to explicitly incorporate buybacks or capital gains (e.g., Gourio and Miao 2011; Chang, Kuo, Lin, and Yang 2023) would require substantial modifications to the model, which we leave for future research.

The irreversibility shadow value λ_t essentially drives a wedge between the dividend-tax-adjusted market valuation of capital and its convex-adjustment-cost-augmented internal valuation. Formally, the state-contingent irreversibility shadow value satisfies:

$$\lambda_t = \max\left\{\left[\left(1+\tau^I\right)+\Psi\left(\frac{I_t}{K_{t-1}}-\delta\right)\right]\left(1-\tau_t^D\right)-q_t, 0\right\}. \tag{17}$$

A firm will therefore undertake positive investment if $q_t\left[\left(1+\tau^I\right)+\Psi\left(\frac{I_t}{K_{t-1}}-\delta\right)\right]^{-1} \geq \left(1-\tau_t^D\right)$, and disinvest or remain inactive otherwise.

Importantly for our purposes, the equality between marginal and average q persists by applying conditions (4), (7), (12), and (14), even in the presence of irreversibility. This celebrated equality holds when utilizing a CRS production function in combination with profit and convex adjustment cost functions that adhere to Hayashi's (1982) criteria of proportionality and homogeneity with respect to capital and investment. Since λ_t enters directly into q_t, it does not alter the equivalence between the marginal and average q.[13]

Analytically, q_t and p_t are related through the relation $p_t = q_t K_t$ with $S_t = 1$, $\forall t$, and without loss of generality. This allows us to map the otherwise unobservable marginal q from (15) directly into the observed p derived in (6) via:

$$p_t = E_t M_{t,t+1}\left(1-\tau_{t+1}^D\right)\left[D_{t+1}+\left(1+\tau^I+\Phi_{I,t+1}-\frac{\lambda_{t+1}}{\left(1-\tau_{t+1}^D\right)}\right)K_{t+1}\right]. \tag{18}$$

Equation (18) shows that a higher expected irreversibility shadow value λ_{t+1} relative to the future tax wedge $\left(1-\tau_{t+1}^D\right)$ depresses p_t. Since the stochastic discount factor is $M_{t,t+1} = \beta\left(\Lambda_{t+1}/\Lambda_t\right)$, and Λ_t reflects habit-based marginal utility, valuations internalize both intertemporal preferences and investment frictions. When the irreversibility constraint binds, the firm assigns a lower continuation value to capital, reducing both q_t and consequently p_t.

The habit-adjusted stochastic discount factor amplifies stock price volatility as dividend tax risk tightens the irreversibility constraint and widens the gap between the internal and market valuation of capital. Further, uncertainty over future tax liabilities, combined with the inability to fully disinvest, strengthens precautionary motives: the firm delays investment not only because of current valuation gaps, but also to avoid future states where capital is illiquid. This forward-looking buffer in the investment rule further depresses equity prices and heightens the sensitivity of asset values to fiscal shocks.

Optimal Investment and the User-Cost-of-Capital. We combine (14) and (15), apply the quadratic adjustment cost function $\Phi(\cdot)$, and use the stochastic discount factor

[13] Ghilardi and Zilberman (2024) make a similar argument with respect to investment credit limits.

$M_{t,t+1}$ to obtain the capital-investment Euler equation:

$$
\begin{aligned}
&\left(1-\tau_t^D\right)\left[\left(1+\tau^I\right)+\Psi\left(\frac{I_t}{K_{t-1}}-\delta\right)-\frac{\lambda_t}{\left(1-\tau_t^D\right)}\right] \\
= \;& E_t M_{t,t+1}\left(1-\tau_{t+1}^D\right)\left\{\begin{array}{c}\left[\left(1-\tau^\pi\right)\alpha\frac{Y_{t+1}}{K_t}+\frac{\Psi}{2}\left(\left(\frac{I_{t+1}}{K_t}\right)^2-\delta^2\right)\right] \\ +(1-\delta)\left[\left(1+\tau^I\right)+\Psi\left(\frac{I_{t+1}}{K_t}-\delta\right)-\frac{\lambda_{t+1}}{\left(1-\tau_{t+1}^D\right)}\right]\end{array}\right\}. \qquad (19)
\end{aligned}
$$

The left-hand-side of equation (19) is the marginal cost of investment, while the right-hand-side is the expected marginal benefit. With investment irreversibility, accumulating an extra unit of capital today increases tomorrow's capital commitments and reduces the expected marginal benefit of investment by $E_t M_{t,t+1}(1-\delta)\lambda_{t+1}$. This forward-looking *user-cost irreversibility effect*, highlighted by Abel and Eberly (1996, 1999), acts to lower the capital stock (see also our dynamic user-cost-of-capital analysis below). At the same time, the inability to dispose excess capital when the constraint bites reduces the firm's current effective marginal cost by λ_t, potentially leading to a higher capital stock under irreversibility (Bertola and Caballero 1994; Abel and Eberly 1999). As explained in Abel and Eberly (1999), the current capital stock with irreversibility is constrained by past investment behavior. This is the *hangover effect* that leads the firm to invest in more capital than is desired compared to a world with full investment flexibility. The opposing irreversibility user-cost and hangover mechanisms form the overall *irreversibility channel*, appear directly in the capital-investment Euler equation, and help explain the general equilibrium impact of shocks, cumulative multiplier effects, and welfare in Section 4.

Turning to the impact of exogenous business tax policies at this stage, notice first that even a flat dividend tax rate ($\tau_t^D = \tau_{t+1}^D = \tau^D$) produces asymmetric effects on the marginal cost and benefit of investment when the irreversibility constraint is occasionally-binding. This tax-induced distortionary outcome is in the tradition of the 'old' view of dividend taxation (e.g., Poterba and Summers 1983). Nevertheless, the 'new' view, wherein flat dividend taxes have no impact on marginal investment decisions (e.g., McGrattan and Prescott 2005), prevails when $\lambda_t = 0$, $\forall t$. By contrast, a potential increase in τ^π would always distort investment by lowering the after-tax marginal product of capital, thereby prolonging investment inactivity spells.

To better understand the nontrivial effects of payout taxes and costly reversibility on investment, we adopt the user-cost-of-capital approach originally introduced by Jorgenson (1963), extended by Hall and Jorgenson (1967) to incorporate corporate tax policy, and further developed by Abel (1982) to account for temporary tax consequences in an investment-q model with convex adjustment costs.

Define the user-cost-of-capital u_t as the after-corporate-income-tax marginal cash flow of an additional unit of capital corrected for the quadratic adjustment costs:

$$u_t = (1-\tau^{\pi})\,\alpha\frac{Y_{t+1}}{K_t} + \frac{\Psi}{2}\left[\left(\frac{I_{t+1}}{K_t}\right)^2 - \delta^2\right]. \tag{20}$$

Considering the deterministic case for simplicity, substitute (20) in (19) to derive:

$$\begin{aligned} u_t \;=\; & M_{t,t+1}^{-1}\frac{\left(1-\tau_t^D\right)}{\left(1-\tau_{t+1}^D\right)}\left[\left(1+\tau^I\right)+\Psi\left(\frac{I_t}{K_{t-1}}-\delta\right)\right]-(1-\delta)\left[\left(1+\tau^I\right)+\Psi\left(\frac{I_{t+1}}{K_t}-\delta\right)\right] \\ & +\frac{1}{\left(1-\tau_{t+1}^D\right)}\left[(1-\delta)\,\lambda_{t+1}-M_{t,t+1}^{-1}\lambda_t\right]. \end{aligned} \tag{21}$$

Regardless of the irreversibility constraint, transitory shifts in dividend taxes first influence u_t and I_t through an *intertemporal dividend tax arbitrage channel* (Korinek and Stiglitz 2009; Gourio and Miao 2011). Specifically, a temporary rise in taxes today relative to tomorrow, $\left(1-\tau_t^D\right)/\left(1-\tau_{t+1}^D\right)<1$ keeping $M_{t,t+1}^{-1}$ fixed, lowers the user-cost-of-capital and raises current investment. Intuitively, anticipating a future reversal of a tax hike implemented in period t causes a reduction in payouts today, resulting in procyclical capital investment behavior. Once variations in $M_{t,t+1}^{-1}$ are allowed for, a lower stochastic discount factor (a higher interest rate) raises the opportunity cost of capital and can overturn the rise in investment triggered by the intertemporal arbitrage channel. The effects of temporary dividend tax hikes on investment are therefore ambiguous and depend on how interest rates move relative to intertemporal arbitrage motives.

A central contribution of this paper is to show that introducing consumption habits, which magnify asset price fluctuations, endogenously tilts this balance. Particularly, dividend tax hikes deepen equity price declines and initially depress investment, as the habit-augmented *Jorgenson user-cost channel* dominates and gives rise to a countercyclical investment response to tax risk.

When the irreversibility constraint is occasionally-binding, the present and future shadow costs of the investment friction as a fraction of the firm's future stock market valuation, $M_{t,t+1}^{-1}\lambda_t/\left(1-\tau_{t+1}^D\right)$ and $(1-\delta)\,\lambda_{t+1}/\left(1-\tau_{t+1}^D\right)$, have direct and opposing effects on u_t through the irreversibility-driven hangover and user-cost channels described above. Following a large unfavorable shock that pushes I_t down to ϕI, excess capital cannot be sold, and as a result u_t decreases through the decline in $(1-\tau^{\pi})\,\alpha Y_{t+1}/K_t$. Such hangover effect is compensated by an increase in λ_t on the right-hand-side of equation (21). Here, a lower stochastic discount factor increases the tightness of the irreversibility constraint in period t by making the future less important. All else equal, a higher interest rate can foster current investment spending by mitigating the adverse effects associated with committing to a larger future capital stock (e.g., Faig and Shum 1999).

Furthermore, the possibility of a future binding constraint, $\lambda_{t+1} > 0$, makes the firm more cautious about capital investment, thereby triggering an increase in u_t via the user-cost irreversibility channel. Due to the risks and additional costs associated with unfavorable future market conditions and disinvestment, the forward-looking corporate firm preemptively restricts capital accumulation today to prevent future overcapacity. The depreciation rate attached to λ_{t+1} acts to relax the expected tightness of the irreversibility friction in this case as it limits the need to engage in costly investment reversals. As in any investment model, depreciation also raises the opportunity cost of capital and reduces investment, as seen from the second term on the right-hand-side of (21).

The Tax-Augmented Irreversibility and Adjustment Cost Channels. How do dividend taxes interact with λ_t and λ_{t+1}? The total *tax-adjusted irreversibility channel*, captured by the term

$$\left(1-\tau_{t+1}^{D}\right)^{-1}\left[\left(1-\delta\right)\lambda_{t+1}-M_{t,t+1}^{-1}\lambda_t\right]$$

in (21) reveals that shareholder taxes amplify the hangover and user-cost effects inflicted by the present and expected investment friction shadow costs on u_t and, consequently, on I_t. Intuitively, an elevated payout tax rate under irreversibility reduces the firm's equity valuation and prompts the shareholder to demand a higher rate of return. As the opportunity cost of capital rises, the firm delays investment further which acts to raise u_t for given values of λ_t and λ_{t+1}. The net effect of the irreversibility cost as a fraction of the tax wedge $\left(1-\tau_{t+1}^{D}\right)$ is determined by variations in the stochastic habit-augmented interest rate $M_{t,t+1}^{-1}$ relative to the nondepreciated value of capital $(1-\delta)$. Owing to the tight link between shareholder taxes and irreversibility, the overall irreversibility channel and linked sub-mechanisms are all *tax-augmented.*

An additional, albeit weaker, mechanism influencing the user-cost equation is the *tax-augmented convex adjustment cost channel* associated with:

$$M_{t,t+1}^{-1}\frac{\left(1-\tau_{t}^{D}\right)}{\left(1-\tau_{t+1}^{D}\right)}\Psi\left(\frac{I_t}{K_{t-1}}-\delta\right)-\left(1-\delta\right)\Psi\left(\frac{I_{t+1}}{K_t}-\delta\right),$$

which shows how taxes interact with symmetric capital adjustment frictions. The first term represents the adjustment cost as a fraction of intertemporal tax variation, while the second denotes the continuation value of installed capital. Together, these components demonstrate how payout tax policy subtly affects investment by altering the marginal value of capital under convex adjustment costs.

A Note on Steady-State Capital. To illustrate how the steady-state capital stock is affected by the cost of irreversibility and corporate taxes, consider a scenario where the firm faces a permanently binding long-run equilibrium with $\lambda > 0$. By suppressing time subscripts and combining equations $N = 1$, (7), (9), and (19), we obtain:

$$K = \left\{ \frac{\alpha (1 - \tau^{\pi})}{\left[\beta^{-1} - (1 - \delta)\right] \left[(1 + \tau^{I}) - \lambda (1 - \tau^{D})^{-1}\right]} \right\}^{\frac{1}{1-\alpha}}, \tag{22}$$

where the denominator on the right-hand-side of (22) is precisely the steady-state value of u_t. In the absence of uncertainty and for $\beta^{-1} > 1 > (1 - \delta)$, tighter irreversibility unambiguously leads to a higher K in the deterministic steady-state. Put differently, the hangover effect globally dominates the irreversibility user-cost mechanism in the long-run, a result consistent with Bertola and Caballero (1994). The underlying logic is that excess capacity erodes gradually through depreciation applied to the shadow value of the constraint, reducing the value of disinvestment over time.

Importantly, a permanent rise in τ^D raises the irreversibility cost-payout tax wedge ratio, $\lambda / \left(1 - \tau^D\right)$, thus tending to exacerbate the firm's inability to sell capital and strengthening the hangover effect in the long-run. However, in the simulations presented throughout Section 4, we will assume that the firm always starts from a slack steady-state equilibrium. Concretely, for $\lambda = 0$, K derived in (22) aligns with the neoclassical capital stock distorted by only τ^{π} and τ^I, and with τ^D following the 'new' view of dividend taxation in the long-run. Indeed, the focus of our paper is to analyze the aggregate effects of time-varying fiscal policies in the presence of an *occasionally-binding* irreversibility constraint.

2.3 Government

The government chooses taxes $(\tau_t^D, \tau^I, \tau^{\pi})$, public debt (B_t), and government spending (G_t) to satisfy its flow budget constraint:

$$\tau^{\pi} (Y_t - W_t N_t) + \tau^I I_t + \tau_t^D D_t + B_t = G_t + R_{t-1} B_{t-1}. \tag{23}$$

Government spending G_t follows an $AR(1)$ process relative to output Y_t:

$$\ln\left(\frac{G_t}{Y_t}\right) = (1 - \rho_G) \ln(g) + \rho_G \ln\left(\frac{G_{t-1}}{Y_{t-1}}\right) + \varepsilon_{G,t}, \tag{24}$$

where $\rho_G \in (0, 1)$ measures persistence, $g \equiv G/Y$, and $\varepsilon_{G,t} \sim i.i.d.\mathcal{N}(0, \sigma_G^2)$. This specification captures the gradual mean reversion of government spending toward a long-run share of output (Croce, Nguyen, and Schmid 2012). Additionally, the fiscal shock is modeled as a purely exogenous business cycle trigger, capturing the persistent rise in debt ratios, expected future increases, and potential corporate tax responses (see also Le Grand and Ragot 2025).

Following Croce, Nguyen, and Schmid (2012); Croce, Kung, Nguyen, and Schmid (2012), we examine two alternative tax regimes, adapting their methodology to the context of dividend taxation rather than labor income or corporate profit taxation. Under the first benchmark regime, the government commits to a zero-deficit policy, setting $B_t = 0, \forall t$. This pins down the corresponding zero-deficit dividend tax $\tau_t^{D,zd}$ to:

$$\tau_t^{D,ZD} = \frac{1}{(D_t/Y_t)} \left(\frac{G_t}{Y_t} - \tau^{\pi}\alpha - \tau^I \frac{I_t}{Y_t} \right). \tag{25}$$

In this case, $\tau_t^{D,ZD}$ inherits the dynamics of the government spending shock but is also influenced by endogenous fluctuations in the broader tax base, including gross dividends, corporate profits, and investment. Note that the rule is scaled by the inverse of the gross dividend-to-output ratio $(D_t/Y_t)^{-1}$, reflecting the idea that a narrower dividend tax base requires larger τ_t^D adjustments to achieve a given fiscal target.

Under the second alternative tax regime, by contrast, the government is permitted to run fiscal deficits by accumulating public debt, which enables τ_t^D to deviate from its zero-deficit rate $\tau_t^{D,ZD}$. Here, the debt ratio evolves according to:

$$\frac{B_t}{Y_t} = \rho_B \frac{B_{t-1}}{Y_{t-1}} - \psi_B (C_t - C), \tag{26}$$

where $\rho_B \in (0,1)$ is the persistence of the debt ratio, or the inverse of the speed of debt repayment, and $\psi_B > 0$ governs the responsiveness of debt to deviations in consumption from its long-run level. A higher ψ_B implies that public debt responds more strongly to changes in the state of the economy, as proxied by $C_t - C$.

To map the debt rule into a tax-smoothing policy, combine (23), (25), and (26) to obtain:

$$\tau_t^D = \tau_t^{D,zd} + \frac{1}{(D_t/Y_t)} \left[\left(\frac{R_{t-1}}{Y_t/Y_{t-1}} - \rho_B \right) \frac{B_{t-1}}{Y_{t-1}} + \psi_B (C_t - C) \right]. \tag{27}$$

The tax rule in (27) shows that deviations of the actual shareholder tax from its zero-deficit counterpart are governed by two components: fluctuations in the lagged debt ratio and cyclical consumption, both also scaled by $(D_t/Y_t)^{-1}$. The government effectively adjusts τ_t^D by reducing (increasing) debt issuance when consumption is above (below) average.

Note that both the zero-deficit and tax-smoothing rules involve a combination of exogenous and endogenous uncertainty. While (25) reflects risk from stochastic shocks and tax base adjustments, (27) encompasses these elements and additionally includes fluctuations in public debt and consumption. Lastly, in the language of Leeper and Yang (2008), $\rho_B < 1$ ensures debt stationarity and model stability by preventing explosive debt dynamics.

2.4 Competitive Equilibrium

For $S_t = 1$, $\forall t$, and an occasionally-binding irreversibility constraint, a competitive rational expectations equilibrium is defined as the household's decisions $\{C_t, B_t\}_{t=0}^{\infty}$, the firm's decisions $\{K_t, I_t\}_{t=0}^{\infty}$, prices $\{p_t, q_t, R_t, W_t\}_{t=0}^{\infty}$, technology $\{A_t\}_{t=0}^{\infty}$, and policy variables $\left\{\tau_t^D, B_t, G_t\right\}_{t=0}^{\infty}$, such that given the initial levels of capital and public debt, K_{-1} and B_{-1}, the optimality conditions for the household and firm hold in each period; all markets clear with

$$Y_t = C_t + I_t + G_t + \frac{\Psi}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}; \tag{28}$$

the transversality conditions are met; and the government's budget constraint and policy functions are satisfied under either the zero-deficit or tax-smoothing regimes.

3 Calibration and Estimation

The model is calibrated for some parameters and estimated for others, with each period representing a quarter. Table 1 reports the structural parameters and steady-state fiscal policy values that approximately match average macroeconomic and financial ratios in the U.S. nonfinancial corporate sector.[14]

Structural Parameters. Most structural parameter choices are standard and common across all model specifications examined below. The CRRA coefficient and the degree of habit persistence are $\gamma = 4$ and $b = 0.78$, respectively, values that lie within the range reported in Jermann (1998); Santoro and Wei (2011). We select $\beta = 0.984$ to match an annualized long-run risk-adjusted rate of return of approximately 6.4%. Further, the depreciation rate is calibrated to $\delta = 0.0195$ to match an average annual nonfinancial corporate investment-to-capital ratio of 7.8%. Finally, the capital share in production is set at $\alpha = 0.36$, and the adjustment cost parameter is calibrated to $\Psi = 2$, which falls within the conservative range reported in the aforementioned studies.

Fiscal Parameters and Key Steady-State Ratios. Following Croce, Nguyen, and Schmid (2012), our parameter choices are based on a benchmark zero-deficit policy, under

[14] Data statistics are drawn from the Federal Reserve Economic Data (FRED) of the Federal Reserve Bank of St. Louis and McGrattan (2023).

which the steady-state dividend tax rate is derived from equation (25) and given by:

$$\tau^{D,zd} = \frac{1}{\left[(1-\tau^{\pi})\,\alpha - (1+\tau^{I})\,\delta K^{1-\alpha}\right]}\left(g - \tau^{\pi}\alpha - \tau^{I}\delta K^{1-\alpha}\right). \tag{29}$$

To derive $\tau^{D,zd}$ in (29), we have used the steady-state ratios D/Y, I/Y, and $g \equiv G/Y$, where output is $Y = K^{\alpha}$, capital K given by (22), and a zero irreversibility shadow value in the long-run, $\lambda = 0$ (see also discussion around (22)). When $\lambda = 0$, dividend taxes are nondistortionary and behave like lump-sum taxes, providing a convenient and analytically tractable steady-state benchmark for analyzing the model's dynamic properties.[15]

We set $\tau^{\pi} = 0.35$, consistent with average effective marginal corporate profit tax rates over the period $1960 - 2024$. The investment tax rate is set to $\tau^{I} = 0.28$, and government spending is calibrated to average 18% of output, i.e., $g \equiv G/Y = 0.18$. These values imply a steady-state payout tax rate of approximately 24.5%, which aligns with empirical estimates of marginal effective dividend tax rates for this period, as documented by McGrattan (2023).[16] Taken together, the model delivers an investment-to-output ratio of 0.10, an after-tax net dividend-to-output ratio of 0.08, a capital-to-output ratio of 1.278, and an equity price-to-output ratio of 1.235. These annualized steady-state ratios closely correspond to observed long-run U.S. nonfinancial corporate data expressed as fractions of GDP (see also McGrattan and Prescott 2005; McGrattan 2023).

Tax-Smoothing Rule Calibration. Under the alternative tax-smoothing regime, we fix $\psi_B = 0.08$ to analyze the broad implications of fiscal responsiveness to consumption deviations from steady-state. We calibrate ψ_B such that the model-implied annualized standard deviation of τ_t^D does not exceed its empirical counterpart across all tax policy scenarios, given the shock moments estimated below.[17] Additionally, We calibrate $\rho_B = 0.96$ to approximately match the empirical long-run persistence of the U.S. debt ratio.

Shock Estimation. We estimate the fiscal shock process in equation (24) using the government consumption expenditures and gross investment-to-GDP ratio over the period $1948 : Q1 - 2024 : Q4$, yielding approximately $\rho_G = 0.972$ and $\sigma_G = 0.018$.

For the TFP moments $[\rho_A, \sigma_A]$, we set $\rho_A = 0.974$ and $\sigma_A = 0.006$ to strike a balance between two targets: *(i)* ensuring that the model-generated standard deviation of the log

[15] Our dynamic results remain robust even when τ^{π} or τ^{I}—both of which are inherently distortionary in the long-run including when $\lambda = 0$—are adjusted to ensure a zero-deficit in the steady-state.

[16] According to McGrattan (2023), the average marginal dividend tax rate was around 14% from 2019 to 2022, and our calculations suggest it remained virtually unchanged in 2023 and 2024. Extending McGrattan's sample from 1960 to include 2023 and 2024 yields an average dividend tax rate of approximately 24.5%.

[17] We allow for greater variation in τ_t^D than in the τ_t^{π} analysis of Croce, Kung, Nguyen, and Schmid (2012), who target a tax volatility of up to 50% of its empirical benchmark. Our choice can be justified by the higher observed volatility of τ_t^D relative to τ_t^{π} in McGrattan's (2023) data.

investment-to-GDP ratio in the linear RBC model (without irreversibility) under a zero-deficit policy approximates its long-run empirical counterpart; and *(ii)* keeping the model-implied volatility of the average dividend tax rate below its empirical benchmark across all specifications with dividend tax rate adjustments, as explained above and shown in Table 2 below.[18]

Table 1: Baseline Calibration

Parameter	Value	Description
Common Parameters		
β	0.984	Discount Factor
γ	4.00	CRRA
b	0.78	Degree of Habit Persistence
δ	0.0195	Capital Depreciation Rate
α	0.36	Capital Share in Production
τ^{π}	0.35	Corporate Income Tax Rate
τ^{I}	0.28	Investment Tax Rate (Wedge)
τ^{D}	0.245	Zero-Deficit Dividend Tax Rate
g	0.18	Government Spending-to-GDP Ratio
Ψ	2.00	Capital Adjustment Cost Parameter
Shock Moments		
ρ_A	0.974	Persistence in TFP Shock
σ_A	0.006	Std. Dev. of TFP Shock
ρ_G	0.972	Persistence in Government Spending Shock
σ_G	0.018	Std. Dev. of Government Spending Shock
Tax-Smoothing Model Parameters		
ρ_B	0.96	Persistence in Debt Ratio Rule
ψ_B	0.08	Intensity of Debt Ratio to Consumption
Piecewise-Linear Model Parameter		
ϕ	0.93	Threshold for Investment Constraint

The Degree of Irreversibility. We impose a moderate lower bound on aggregate investment to capture business cycle asymmetries: investment contractions are limited, while recoveries can remain strong. Specifically, we set $\phi = 0.93$, which prevents investment from falling by more than 7% below its steady-state level in response to adverse shocks.

The calibrated value of ϕ also implies that the irreversibility constraint binds (i.e., $\lambda_t > 0$) in 15.25% of simulated periods under a zero-deficit policy with both estimated shocks, and

[18] Our TFP shock moments are also largely in line with those estimated by Winberry (2021).

in 15.85% of periods under tax-smoothing rules. These frequencies are consistent with micro evidence on lumpy investment, where $8\% - 20\%$ of firms adjust non-convexly in a given period (Gourio and Kashyap 2007; Fiori 2012), and they lie below the more aggressive 40% benchmark of Guerrieri and Iacoviello (2015).

Admittedly, investment fell by more than 7% in unusually deep contractions such as the 2007-2009 Great Recession and the COVID-19 crisis. Yet in most postwar U.S. downturns, declines were more moderate, making a strictly positive but moderate lower bound a plausible macro-level approximation. While heterogeneous-firm models can generate similar aggregate dynamics from micro-level irreversibility (e.g., Lanteri 2018; Winberry 2021; Baley and Blanco 2025), they require explicit distributions of idiosyncratic shocks (see also Veracierto 2002; Wang and Wen 2012). Our approach instead provides a tractable representative-agent benchmark that captures the aggregate effects of such frictions. Most importantly for our purposes, a moderate degree of irreversibility is essential to reproduce empirically-plausible asset price volatility and lumpy investment dynamics, as we show below.

Solution Method. The occasionally-binding model is solved using the piecewise-linear OccBin algorithm developed by Guerrieri and Iacoviello (2015) and the DynareOBC algorithm developed by Holden (2016, 2023), both of which produce identical results. Unlike smooth convex penalty approximations (e.g., Croce, Kung, Nguyen, and Schmid 2012 for borrowing limits), our approach directly captures the nonconvex investment irreversibility costs without requiring 'convexification'.

4 Results

This section studies how alternative deficit-financing shareholder tax policies affect macroeconomic outcomes, asset prices, public debt, and welfare while emphasizing the role of investment irreversibility (IRR) in shaping model dynamics. We analyze four model specifications:

1. Model 1: zero-deficit tax policy without IRR.
2. Model 2: zero-deficit tax policy with IRR.
3. Model 3: tax-smoothing policy without IRR.
4. Model 4: tax-smoothing policy with IRR.

We begin by evaluating key second moments from the model in response to stochastic government spending and TFP shocks, assessing their empirical relevance and variation across the four model variants.

We then examine impulse response functions (IRFs) of macroeconomic and financial variables to positive government spending and negative technology shocks, which clarify the underlying transmission channels and enhance economic intuition. Within the government expenditure shock analysis, we also quantitatively decompose the channels driving investment and consumption responses and compute net cumulative present-value multipliers (CPVMs) for selected macroeconomic variables over various horizons.

Lastly, we conduct a welfare analysis in the spirit of Lucas (1987), measuring the welfare costs/benefits of business cycle fluctuations in each model relative to the stochastic steady-state benchmark of Model 1. This allows us to assess the normative implications of IRR and tax-smoothing for welfare-based policy evaluation.

4.1 Moments Analysis and Model Fit

Table 2 presents the standard deviations of key variables in both the U.S. data and the four models.

The first key takeaway from Table 2 is that the IRR constraint significantly reduces the volatility of investment and, to a lesser extent, consumption, both measured relative to output, as shown by comparing Models 1 vs. 2 and Models 3 vs. 4. Similarly to Dow and Olson (1992); Guerrieri and Iacoviello (2015); Senga and Varotto (2025), our model confirms that an occasionally-binding IRR constraint dampens investment volatility. Notwithstanding, it also generates a decline in consumption volatility due to the additional role of habit formation, which is not present in the aforementioned frameworks. At the same time, the IRR friction amplifies volatility in asset valuations, reflecting the heightened sensitivity of q to marginal investment adjustments when the constraint occasionally bites (see equations (15) and (18)).[19]

Turning to fiscal variables, τ_t^D volatility rises under tax-smoothing regimes, reflecting the more active use of tax adjustments to stabilize the economy over time. Such policy effectively reduces the volatility of the consumption-to-GDP ratio across both RBC and IRR specifi-

[19] When applying an HP-filter with smoothing parameter 1600 to isolate cyclical fluctuations, we find that the IRR constraint *raises* the volatility of investment and consumption, in contrast to the baseline results in Table 2 based on unfiltered second moments. This reversal arises because the HP-filter emphasizes the high-frequency, lumpy adjustments induced by the occasionally-binding constraint. Importantly, the IRR constraint amplifies equity price volatility in both filtered and unfiltered cases, confirming its prominent role in driving financial market fluctuations. Quantitatively speaking, the HP-filtered standard deviation of $\ln(p_t/Y_t)$ rises from 5.37% in Model 1 to 23.58% in Model 2, and from 4.84% in Model 3 to 25.33% in Model 4. For comparison, the HP-filtered standard deviation of $\ln(p_t/Y_t)$ from the data is approximately 11.54%. Note that in the IRR specifications (Models 2 and 4), the HP-filtered volatility in asset prices remains nearly indistinguishable from its unfiltered counterpart. Given our focus on asset pricing, fiscal risk, and debt sustainability, and in line with standard practice in the macro-finance literature, we rely on unfiltered volatility measures throughout the remainder of our analysis.

cations (Models 1 vs. 3 and Models 2 vs. 4). However, this gain in consumption stability comes at the expense of greater fluctuations in investment and asset prices, highlighting a trade-off between intertemporal consumption-smoothing and capital market volatility.

Table 2: A Comparison of Key Second Moments under Different Model Specifications

	Data	Model 1 (RBC+ZD)	Model 2 (IRR+ZD)	Model 3 (RBC+TS)	Model 4 (IRR+TS)
$\sigma\left(\tau_t^D\right)$ (%)	12.81	12.43	12.39	12.72	12.57
$\sigma\left(\frac{B_t}{Y_t}\right)$ (%)	21.86	0	0	16.37	13.48
$\sigma\left(\ln\frac{I_t}{Y_t}\right)$ (%)	9.82	9.75	6.94	11.29	7.81
$\sigma\left(\ln\frac{C_t}{Y_t}\right)$ (%)	5.06	2.59	2.30	2.53	2.22
$\sigma\left(\ln\frac{p_t}{Y_t}\right)$ (%)	48.38	16.85	23.58	18.68	25.33

Notes:

(i) Data cover the period $1960:Q1-2024:Q4$.

(ii) Std. Dev. are computed from 50,000 simulations keeping A_t and G_t/Y_t stochastic.

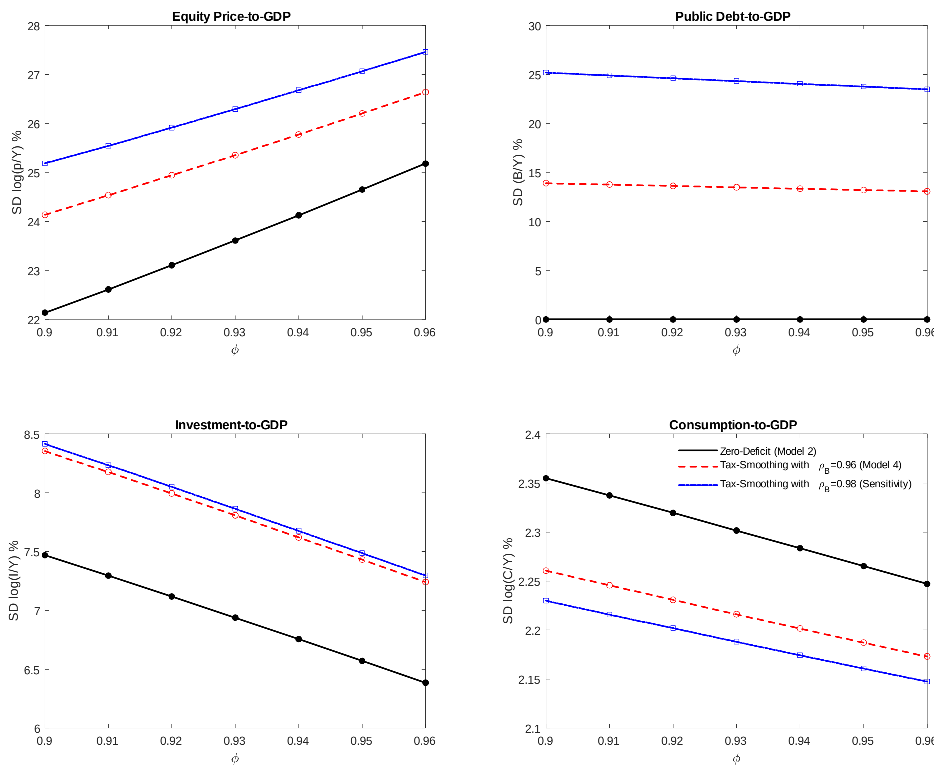
(iii) 'ZD'=zero-deficit; 'TS'=tax-smoothing; 'RBC'=linear RBC model without IRR.

Debt dynamics differ markedly across fiscal regimes. Under zero-deficit rules (Models 1 and 2), debt remains constant at zero by construction. Conversely, tax-smoothing policies (Models 3 and 4) generate substantial debt ratio volatility, particularly in Model 3. The intuition is that when investment is subject to an IRR constraint in the piecewise-linear framework, downside fluctuations are curtailed, leading to more stable output and, consequently, a more stable B_t/Y_t. This highlights another key trade-off: while IRR can dampen debt ratio fluctuations, it does so at the cost of increased asset price volatility.

To further explore the effects of asymmetric investment frictions, Figure 1 illustrates how volatilities in key fiscal, macroeconomic, and financial variables respond to changes in the degree of irreversibility (ϕ ranging from 0.90 to 0.96) across different tax regimes. These dynamics reinforce the main messages stemming from Table 1. Within each regime, a tighter irreversibility constraint dampens fluctuations in investment and consumption by constraining downward capital adjustments. At the same time, equity price volatility rises due to the heightened responsiveness of q when the constraint binds more frequently.

Across regimes, tax-smoothing delivers steadier consumption dynamics but at the cost of greater investment volatility relative to the zero-deficit rule, a trade-off that becomes even more pronounced when debt is more persistent ($\rho_B = 0.98$). Although debt ratio volatility declines modestly with a higher degree of IRR, it remains highest under tax-smoothing with sluggish fiscal adjustment. All in all, Table 2 and Figure 1 underscore how fiscal design and nonconvex investment frictions jointly shape the economy's volatility trade-offs in quantitatively relevant ways.

Figure 1: Volatility Effects of Irreversibility Under Alternative Fiscal Rules



Notes: (i) Standard deviations (SD) under each degree of IRR are computed from $50,000$ simulations keeping A_t and G_t/Y_t stochastic in the piecewise-linear model; (ii) In both tax-smoothing scenarios with $\rho_B = 0.96$ and $\rho_B = 0.98$, we set $\psi_B = 0.08$.

Although excluded from Table 2 to keep the focus on fiscal uncertainty, we have analyzed a version of the model with constant tax rates following the two shocks (i.e., no tax risk). We do so because a realistic corporate tax model must deliver plausible outcomes for asset prices and investment behavior even in the absence of tax uncertainty, in order to meaningfully assess counterfactual scenarios (see also Croce, Kung, Nguyen, and Schmid 2012).

In the absence of tax uncertainty, the standard deviation of $\ln(p_t/Y_t)$ increases from 4.62% in the linear RBC model with habits and convex adjustment costs to 19.16% when the IRR constraint is introduced and allowed to occasionally bind. Such sizeable rise in stock price volatility does not come at the expense of empirical realism in other key macroeconomic ratios. Moreover, when convex adjustment costs are removed ($\Psi = 0$), the equity price-to-GDP standard deviation is 4.77% in the linear model and remains high at 19.22% under the piecewise-linear specification with IRR. Thus, with habits included, introducing the IRR friction alone substantially increases asset price volatility in the piecewise-linear model. The role of Ψ is minimal, and the resulting surge in volatility does not depend on recursive preferences or an implausibly-high degree of risk aversion.

Our results demonstrate that an occasionally-binding irreversibility constraint plays a quantitatively significant role in influencing macroeconomic outcomes, asset prices, and debt dynamics under different deficit-financing dividend tax policies. This friction helps generate more plausible stock price dynamics and improve the empirical realism of production-based asset pricing models, even in the absence of tax uncertainty. In particular, the interaction between dividend taxation, habits, and asymmetric investment frictions produces sizeable asset price volatility much closer to observed empirical magnitudes. In this way, the framework offers a partial resolution to the Shiller (1981) puzzle by amplifying stock price volatility relative to fundamentals, with output serving as the fundamental in our setting, following McGrattan and Prescott (2005).[20] The simulated moments across model specifications remain broadly consistent with their empirical counterparts.

4.2 Impulse Response Analysis

4.2.1 Government Spending Shock

Figure 2 presents the IRFs of key model variables following a large temporary 10% increase in government spending relative to GDP.

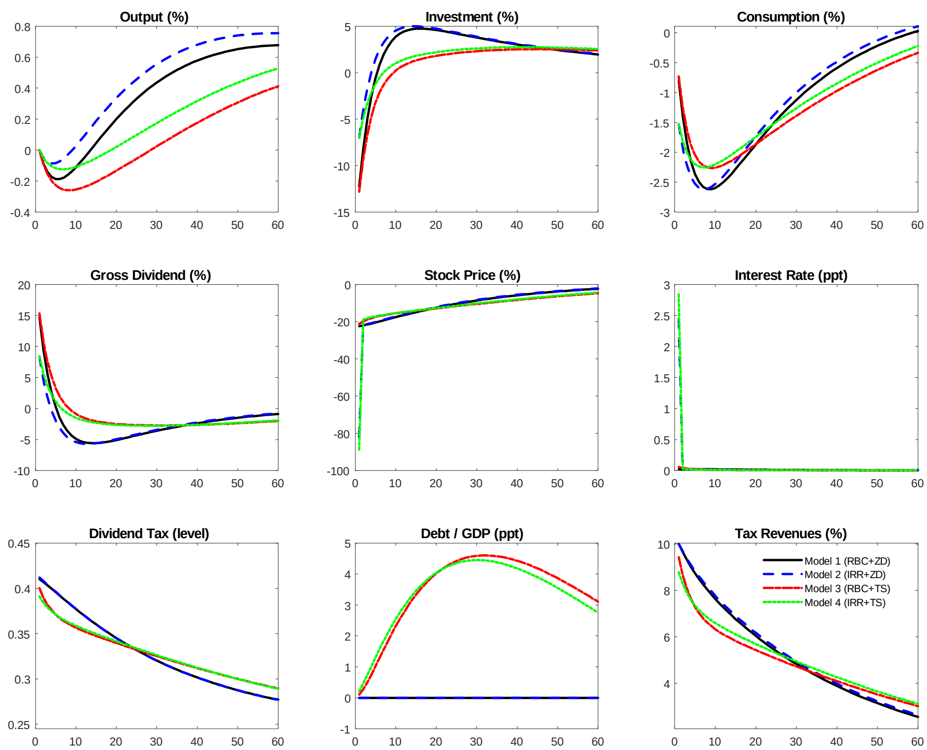
Zero-Deficit. Under the zero-deficit regime, the firm's investment response to fiscal uncertainty differs meaningfully across Models 1 and 2. In both models, investment initially contracts due to the Jorgenson user-cost effect: tax-financed spending raises the effective cost of capital, discouraging immediate investment. In Model 2, this effect is distorted by the irreversibility user-cost channel, which increases the marginal value of capital when the firm seeks to scale back investment. The IRR constraint limits the decline in investment to 7% below its steady-state level, which moderates the initial contraction. Without this constraint, as in Model 1, investment falls by around 12.8% on impact.

As expected, taxes decline over time because of the $AR(1)$ nature of the shock and the zero-deficit requirement. This gradual fiscal unwinding lowers the expected user-cost-of-capital, resulting in a hump-shaped investment rebound. In Model 2, this rising dynamic

[20] Since dividends in our model can be expressed as a function of capital and therefore of output, we report equity prices relative to GDP. Alternatively, one could directly follow Shiller (1981) and express equity prices relative to dividends, but this would not alter our key takeaways.

is amplified by the tax-augmented hangover channel: the firm anticipates that by investing more today, it can avoid future capital adjustment when taxes fall, particularly since downward investment adjustment is constrained. This forward-looking behavior leads to a sharper investment rebound in Model 2, with investment peaking at 5% above steady-state in period 15, compared to a 4.7% peak in period 17 in Model 1. The IRR constraint thus accelerates the medium-run hump-shaped recovery, converting what is a smooth medium-run hump in Model 1 into a more abrupt surge in Model 2.

Figure 2: Positive 10% Government Spending-to-GDP Shock



Notes: (i) 'ZD'=zero-deficit; 'TS'=tax-smoothing; 'RBC'=linear RBC model without IRR; (ii) Periods represent quarters.

Since capital directly drives production, the quicker pickup in I_t in Model 2 accelerates the upturn in Y_t relative to Model 1. Habits exacerbate the initial downturn but also contribute to a stronger recovery as C_t gradually adjusts to the improving income path. In both models, the initial decline in consumption is magnified by intertemporal substitution effects. However, in Model 2, the faster bounce in I_t and Y_t leads to an earlier and sharper rebound in C_t at the cost of a larger fall in this variable upon impact.

In the stock market, equity prices drop more drastically under Model 2 than in Model 1.[21] The occasionally-binding IRR constraint heightens the sensitivity of the marginal value of installed capital, leading to a sharper immediate negative response in both q_t and p_t. This reflects the amplification role of IRR in equity markets when the constraint occasionally binds. The real interest rate also rises more noticeably in Model 2, primarily due to its inverse relationship with p_t (see equations (6) and (18)). Such interest rate hike helps maintain intertemporal optimality by compensating for the stronger expected rebound in I_t and C_t, which lowers future marginal utility.

The intertemporal arbitrage mechanism, whereby the firm adjusts payout timing in response to expected tax changes as emphasized by Korinek and Stiglitz (2009); Gourio and Miao (2011), is present in the model but plays a limited role. It modestly dampens the countercyclical effects of dynamic τ_t^D adjustments without dominating the overall dynamics.[22]

Furthermore, the persistence in τ_t^D dynamics reflects the endogenous response of the tax base. Although the fiscal shock is persistent based on our estimation, payout behavior critically influences the duration of the tax adjustment. In Model 1, gross dividends rise immediately as the firm sharply cuts investment, resulting in higher distributions that remain above steady-state. In Model 2, D_t exhibits a moderated initial rise due to downward investment rigidities, then declines below steady-stated before gradually recovering as K_t adjusts. This delayed rebound in the tax base forces τ_t^D to stay elevated for longer in order to satisfy the zero-deficit condition (see also (25)).

Despite the pronounced differences in real and financial variables, the tax revenue response remains nearly identical across Models 1 and 2. Put differently, the IRR constraint significantly changes the timing and strength of macroeconomic adjustment but does not materially affect the overall revenue path under a zero-deficit policy.

Tax-Smoothing. Turning to Models 3 and 4, which feature tax-smoothing, we find that the effects of IRR are qualitatively similar to those observed under the zero-deficit regime. Nevertheless, tax-smoothing itself significantly alters the dynamic effects of fiscal risk. Most notably, investment recovers at a significantly slower pace than under the zero-deficit regime. While the initial drop in consumption is more muted under tax-smoothing—thanks to reduced front-loading of taxes—the subsequent recovery in C_t is slower, coinciding with a hump-shaped rise in the public debt ratio.

The tax-augmented IRR channel continues to generate lumpy investment behavior, but its

[21] On the adverse effects of government spending shocks and fiscal uncertainty on asset prices, see also Ardagna (2009); Pastor and Veronesi (2012).

[22] Simulations without habit formation ($b = 0$), which highlight the dominance of the intertemporal tax arbitrage channel and the resulting procyclical investment response to payout tax adjustments, are available upon request.

amplification is more subdued under tax-smoothing policies. In Models 3 and 4, investment rises above its steady-state only by periods 10 and 8, respectively, compared to periods 6 and 4 in the zero-deficit counterparts (Models 1 and 2). While the debt ratio initially rises more quickly in Model 4 than in Model 3, the stronger medium-run recovery in investment under the lumpy model helps moderate the long-run debt ratio response.

Finally, stock prices fall in a more abrupt fashion in the IRR model with tax-smoothing, consistent with the comparative dynamics under the zero-deficit regime. At the same time, public debt rises at a faster pace in the short-run, highlighting the trade-off between asset valuation dynamics and fiscal stabilization. This trade-off nevertheless fades over time as the debt ratio converges toward a new trajectory. In the end, tax-smoothing dampens short-run fluctuations in consumption and taxes but slows the rebound in investment and output, while irreversibility continues to affect both real and financial dynamics in line with the qualitative patterns observed under the zero-deficit scenario.

4.2.2 Channel Decomposition

To illuminate the mechanisms driving aggregate investment and consumption dynamics, we now perform a quantitative channel decomposition of the model's responses to a government spending shock across four scenarios. Specifically, we compare the following cases:

1. Case A: Tax Adjustment without IRR.
2. Case B: Tax Constant without IRR.
3. Case C: Tax Adjustment with IRR.
4. Case D: Tax Constant with IRR.

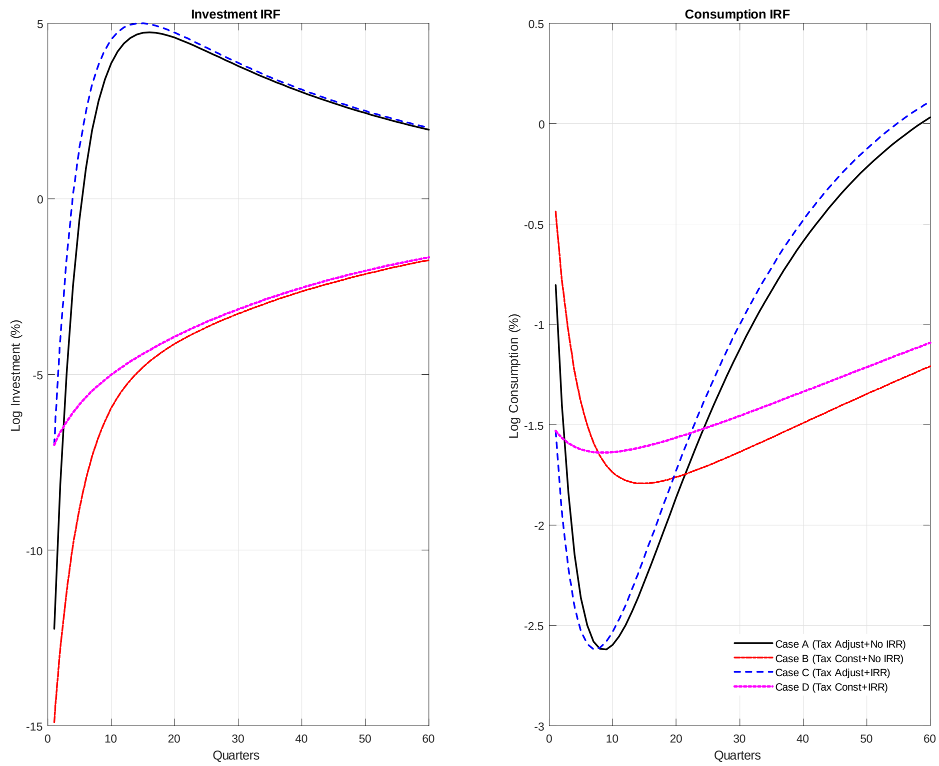
This analysis is conducted only under the zero-deficit regime, as assuming constant taxes under tax-smoothing would generate nonstationary and explosive debt dynamics.[23] By contrasting the IRFs of investment and consumption across these configurations, we reveal how each friction contributes to the magnitude and persistence of macroeconomic adjustments.

Figure 3 compares the dynamic responses of investment and consumption across the four scenarios. In both cases with dynamic dividend tax adjustments (Cases A and C), investment initially declines but rebounds strongly in the medium-run. When the irreversibility channel is active (Case C), the initial drop in investment is notably muted and followed by a larger

[23] We could include a debt-driven nondistortionary lump-sum tax rule to avoid explosive dynamics in the dividend-tax-smoothing model. The amplified lumpy investment from IRR-tax risk interactions remains present in this case but is weaker than under zero-deficit policies, as implied from Figure 2.

and faster hump-shaped recovery relative to Case A. This pattern reflects the interaction of partial irreversibility with anticipated shareholder tax relief described above.

Figure 3: Decomposition of Investment and Consumption IRFs Across Tax and Irreversibility Cases



Notes: (i) Cases A and C correspond with Models 1 and 2 in Figure 2, respectively; (ii) Decomposition is performed under the zero-deficit policy following a 10% rise in G_t/Y_t.

Conversely, the constant-tax cases (Cases B and D) fail to generate a sustained investment boom, although the irreversibility mechanism alone (Case D) still dampens the initial contraction compared to Case B. For consumption, Case C exhibits a deeper initial decline, driven by stronger intertemporal substitution, followed by a quicker convergence toward steady-state as investment recovers.

To conclude, the decomposition highlights how the combination of irreversibility and tax risk produces more pronounced hump-shaped investment and consumption dynamics, aligning more closely with the data.

4.2.3 Government Spending Multipliers

To summarize the quantitative effects of public expenditure shocks under alternative fiscal rules, we follow Drautzburg and Uhlig (2015) and compute net discounted cumulative present-value multipliers (CPVM) across the four scenarios (Models 1-4) previously analyzed in the IRFs section. For each model, we calculate discounted CPVMs for the investment-to-GDP, consumption-to-GDP, and debt-to-GDP ratios, defined as the present-value change in each ratio up to horizon t, divided by the corresponding discounted present-value change in the government spending-to-GDP ratio. Since our model specifies fiscal expenditures as a share of output, $G_t/Y_t \equiv g_t$, following Croce, Nguyen, and Schmid (2012), we define multipliers in *ratio level* terms rather than in absolute levels. This approach ensures that deviations in g_t remain consistent across the four model variants, regardless of endogenous changes in output, and facilitates meaningful comparisons of fiscal transmission.[24] By focusing on relative metrics, we better capture the compositional dynamics of macroeconomic adjustment to fiscal policy. For completeness, we also report the CPVM of output.

The CPVM at horizon t is defined as:

$$CPVM_t = \frac{E_t \sum_{s=1}^{t} \left(\prod_{j=1}^{s} R_j^{-1} \right) (X_s - X)}{E_t \sum_{s=1}^{t} \left(\prod_{j=1}^{s} R_j^{-1} \right) (g_s - g)},$$

with $(X_s - X)$ standing for the difference in the I/Y, C/Y, B/Y ratios and Y from their respective steady-state levels, and $(g_s - g)$ denoting the level difference in G_t/Y_t ratio from its long-run average g. The habit-adjusted stochastic discount factor is represented by the inverse of the interest rate.

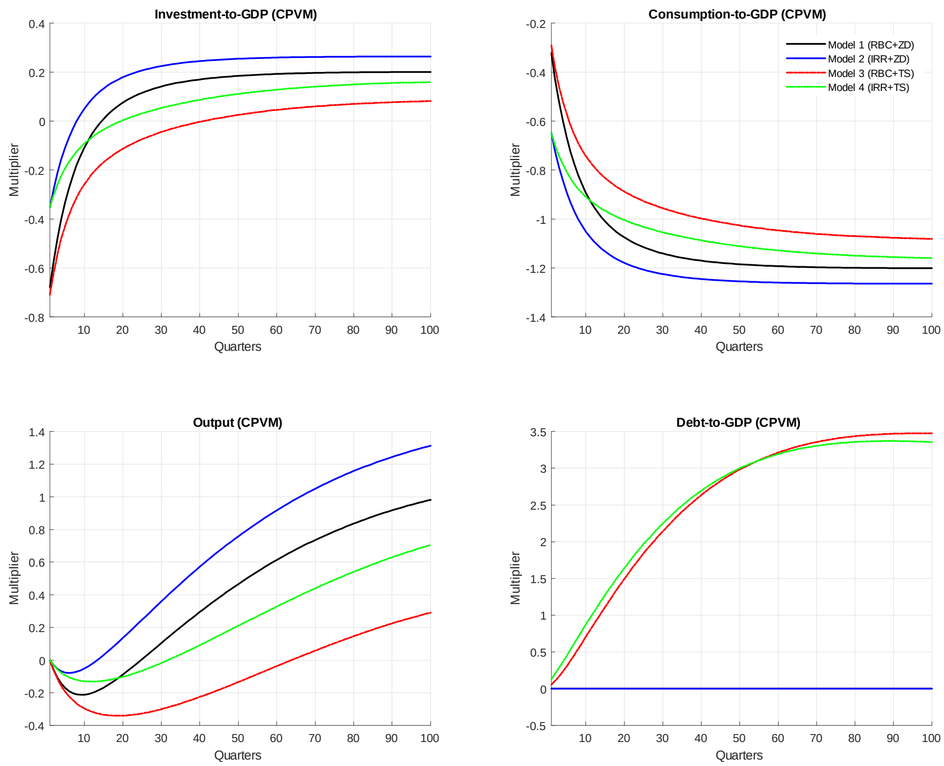
Figure 4 displays the discounted CPVMs across the four model variants over a 100-quarter horizon (25 years), following an initial rise in g_t from 0.18 to 0.20. We deliberately use a larger-than-unit ratio increase to ensure that the IRR constraint binds on impact. This is important, as the activation of the IRR constraint in the impulse responses is highly sensitive to the size of the government expenditure shock in this framework.

The CPVM analysis in Figure 4 confirms and sharpens the insights from the impulse responses presented in Figure 2. Across all model variants, the output multiplier increases over time, reflecting persistent effects of fiscal spending shocks. Crucially, Y multipliers are

[24] A ratio-type CPVM of, for example, 0.2 for investment implies that a 1 percentage point increase in government spending as a share of GDP leads to a 0.2 percentage point increase in the investment-to-GDP ratio, in discounted present-value terms, over the given horizon.

consistently higher in the models with IRR (Models 2 and 4) compared to their frictionless counterparts (Models 1 and 3), highlighting the medium- to long-run stimulative role of investment under the lumpy frameworks.[25] This arises from a combination of the IRR-related user-cost and hangover effects, and the habit-augmented Jorgenson channel, which together promote countercyclical lumpy investment dynamics.

Figure 4: Cumulative Present-Value Multipliers (CPVMs)



Notes: (i) Each panel shows the CPVM over a 100-quarter horizon following a fiscal shock that raises g_t from 0.18 to 0.20; (ii) The CPVM is computed as the discounted sum of deviations in the relevant variable relative to the discounted increase in g_t, using the model-consistent stochastic discount factor.

In particular, the I/Y CPVM turns positive by quarter 9 in Model 2 and by quarter 20 in Model 4. While the investment multiplier is initially negative across all models, it is less negative and eventually becomes positive, and notably larger, under irreversibility. At

[25]The cumulative output multipliers under all model specifications lie within the ranges found in the empirical and theoretical literature, specifically when excluding the zero lower bound on nominal interest rates (see Ramey 2019 for a review).

its peak, the investment multiplier reaches 0.26 in Model 2 (around quarter 60), compared to a more muted 0.16 in Model 4 by quarter 100. This difference highlights the dampening role of tax-smoothing, which constrains the fiscal transmission mechanism by reducing the responsiveness of taxes and thereby the full pass-through of the irreversibility channel.

Consumption multipliers, by contrast, are more negative under irreversibility. This reflects a trade-off where IRR boosts medium-term investment by encouraging delayed capital adjustment but exacerbates the negative consumption response due to stronger intertemporal substitution and crowding-out effects. In other words, the tax-adjusted IRR mechanism intensifies the consumption drag while increasing the discounted multiplier on investment.

Finally, tax-smoothing leads to a larger initial accumulation of public debt (compare Models 3 vs. 4), but the B/Y CPVM stabilizes relatively more quickly from around period 50 under irreversibility (Model 4). This result stems from stronger investment-driven output growth in the lumpy models, which improves the denominator of the debt ratio in the medium- to long-term when tax-smoothing allows fiscal policy to spread taxes over time.

4.2.4 Technology Shock

Figure 5 displays the IRFs of key variables in response to a 1.5% negative technology shock.

Output, investment, and consumption decline across all models, and due to the high persistence and the shock size, these real variables remain below their steady-state levels for a prolonged period. Unlike the government spending shock, there is no transparent overshooting or later-period boom; recovery is slower and more muted.[26] As in the government expenditure shock case, IRR dampens the initial drop in investment and facilitates a quicker recovery (Models 2 vs. 1 and 4 vs. 3). Consumption falls more sharply on impact in the IRR models due to intertemporal substitution but stabilizes faster over time, supported by the smaller initial contraction and stronger medium-run rebound in investment and output.

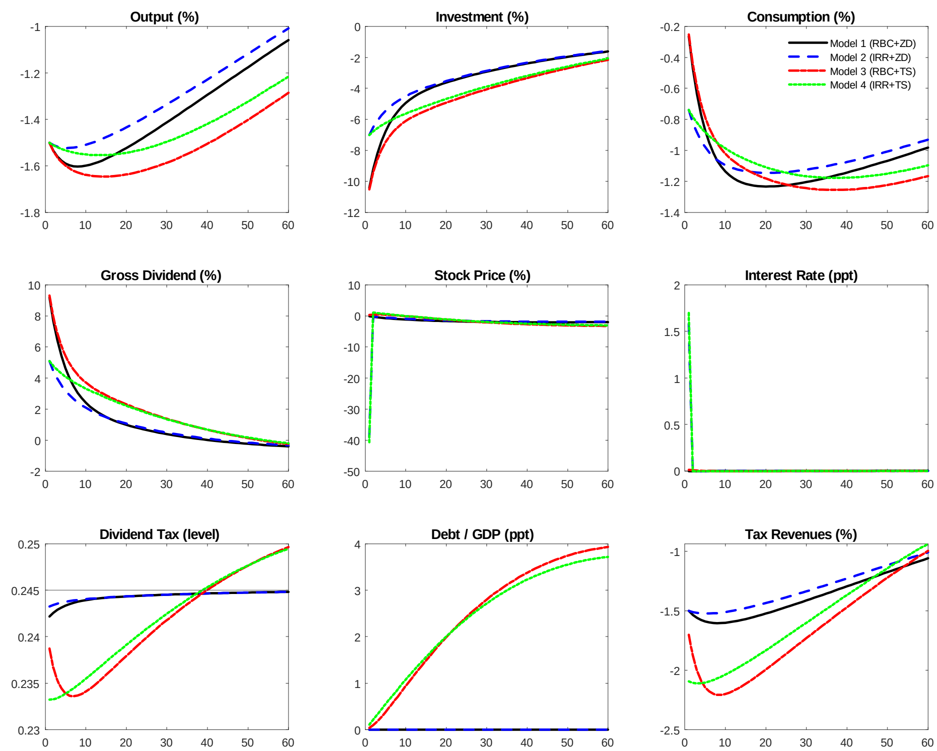
Moreover, the pronounced countercyclical movement in R_t in the IRR models aligns with Winberry (2021), where micro-level lumpiness and habits generate more realistic R_t dynamics. Put differently, the higher real interest rate sensitivity to TFP shocks helps explain the muted initial investment response when the IRR constraint temporarily binds.

The key difference between the models lies in the behavior of the dividend tax rate and associated consumption dynamics. Under the zero-deficit policy (Models 1 and 2), the dividend tax rate declines on impact. This occurs because the gross dividend-to-GDP ratio rises by more than the τ^I-scaled investment-to-GDP ratio, temporarily expanding the tax base and easing the immediate need for higher tax rates (see (25)). Although the

[26] Significantly reducing the persistence of the TFP shock would make the rebound in investment and the medium-run rise above steady-state more transparent, similar to the government spending shock case.

government is required to balance the budget period-by-period, the decline in revenues is relatively modest, since the expanding tax base offsets part of the output loss. A more gradual adjustment in τ_t^D becomes feasible, limiting the immediate fiscal response. As a result, consumption experiences a steeper initial fall in Models 1 and 2 relative to the tax-smoothing environments of Models 3 and 4, where debt issuance allows the government to spread the fiscal burden intertemporally.

Figure 5: Adverse 1.5% Technology Shock



Notes: (i) 'ZD'=zero-deficit; 'TS'=tax-smoothing; 'RBC'=linear RBC model without IRR; (ii) Periods represent quarters.

More specifically, Models 3 and 4 feature a faster initial cut in the dividend tax rate than Models 1 and 2, linked to the early weakness in consumption spending. Over time, the tax rate rises steadily as public debt accumulates and enters the tax rule, eventually exceeding its average level around period 40. In Model 4, irreversibility amplifies the initial fall in consumption relative to Model 3, resulting in a larger cut in the tax rate. Yet, as the debt ratio grows at a quicker pace, τ_t^D begins to rise sooner over the medium-run. At the same time, consumption in Model 4 becomes smoother from period 8 onward, as the investment rebound supports a milder decline relative to Model 3. This creates a trade-off in consumption dynamics: irreversibility intensifies the initial contraction but helps stabilize consumption over time. As a result of these offsetting forces, the tax trajectories in Models 3 and 4 differ in the short-run but converge closely in the long-run.

4.3 Welfare Analysis

To square the positive analysis of tax risk and irreversibility with their normative implications, we now turn to evaluating household welfare using a Lucas (1987)-style consumption equivalent variation (CEV) metric. This metric captures the permanent percentage change in consumption that would make a representative household indifferent between a given stochastic environment and the benchmark, defined by Model 1. For each alternative model, the CEV is computed relative to the long-run average utility in Model 1's *stochastic* steady-state. A positive CEV indicates that the alternative environment delivers higher welfare than the benchmark, while a negative value implies a welfare loss.

Table 3: CEV Comparisons Relative to the Zero-Deficit Stochastic Steady-State (Model 1)

	Model 1 (RBC+ZD)	Model 2 (IRR+ZD)	Model 3 (RBC+TS)	Model 4 (IRR+TS)
CEV (%)	0.000	0.911	0.029	1.144

Notes:

(i) Welfare losses are computed from 50,000 simulations keeping A_t and G_t/Y_t stochastic.

(ii) We use second-order perturbation with pruning to capture risk effects while avoiding explosive paths.

(iii) 'ZD'=zero-deficit; 'TS'=tax-smoothing; 'RBC'=linear RBC model without IRR.

CEV captures how volatility, mean consumption, and asset prices jointly affect welfare across regimes, highlighting that fiscal policy and investment frictions influence welfare not only through risk but also through shifts in average consumption and asset valuation in general equilibrium. More specifically, it is important to emphasize that these welfare comparisons across model specifications (with and without IRR) are intended to assess the impact of introducing asymmetric investment frictions alongside different fiscal closure policies relative to a baseline zero-deficit RBC environment. Table 3 summarizes the results.

In the baseline Model 1, the household's expected utility under business cycle risk exactly matches that in its own stochastic steady state, yielding a CEV of 0% by construction. Introducing irreversibility (Model 2) improves welfare substantially: by limiting extreme investment collapses, the economy avoids large consumption downturns, and the precautionary benefits outweigh the costs of reduced flexibility. The resulting CEV gain is 0.911%. Allowing for tax-smoothing in the standard RBC framework (Model 3) produces only a marginal welfare gain of 0.029%, as it raises mean consumption but does little to reduce volatility. The combination of irreversibility and tax-smoothing (Model 4) delivers the largest welfare improvement, with a CEV of 1.144%, implying that the household would require more than a 1% permanent increase in consumption to be indifferent between the baseline and this enhanced policy environment.

The sizeable welfare gains in Models 2 and 4 are consistent with the multiplier dynamics discussed earlier. The irreversibility constraint stabilizes output by mitigating severe investment contractions, while tax-smoothing policies raise mean consumption. Although these features increase asset price volatility and can amplify short-run negative multipliers, they improve welfare by lowering the incidence and severity of macroeconomic downturns. Overall, the welfare analysis shows that households prefer environments where irreversibility and forward-looking fiscal rules jointly influence business cycle volatility, as limiting deep investment busts and raising average consumption more than offsets the costs of greater financial volatility and sharper short-run multipliers.

5 Model Validation via CIRs: The 2012 American Taxpayer Relief Act (ATRA)

We now turn to demonstrate the model's empirical relevance using the 2012 ATRA as a case study and by applying the CIR methodology of Baley and Blanco (2021, 2025). This approach allows to assess whether our model can better replicate the short- to medium-run nonfinancial corporate investment response to dividend tax changes observed following the ATRA. The ATRA reform is particularly well-suited to our model's structure, as it involved a meaningful increase in the *effective* dividend tax rate—approximately 5 percentage points based on McGrattan (2023)—implemented in an environment of rising debt pressures and the need for averting a fiscal cliff.

We interpret fiscal imbalances as sustained government spending needs and model the episode using a quasi-permanent increase, rather than an $AR(1)$ process, in the government spending-to-GDP ratio, assumed to last for 40 quarters (10 years). The CIR analysis focuses on a 20-quarter window following the shock, consistent with the period from $2012 : Q4$ to $2017 : Q3$, ending prior to the enactment of the 2017 Tax Cuts and Jobs Act (TCJA).[27]

[27]Note that we can obtain single CIR value at each date t, but we focus on $t = 20$ as a representation of the medium-run CIR measure following the ATRA.

Table 4: **CIR of the Log Investment-to-GDP Ratio after 20 Quarters**

	Data	Model 1 (RBC+ZD)	Model 2 (IRR+ZD)	Model 3 (RBC+TS)	Model 4 (IRR+TS)
$\text{CIR}\left(\ln\frac{I_t}{Y_t}\right)$ (%)	52.42	21.40	27.13	9.73	16.37

Notes:

(i) Data cover the period $2012:Q4-2017:Q3$.

(ii) 'ZD'=zero-deficit; 'TS'=tax-smoothing; 'RBC'=linear RBC model without IRR.

(iii) In IRR-augmented Models 2 and 4 we set $\phi = 0.98$.

(iv) In TS-augmented Models 3 and 4 we keep ρ_B= 0.96 and ψ_B= 0.08.

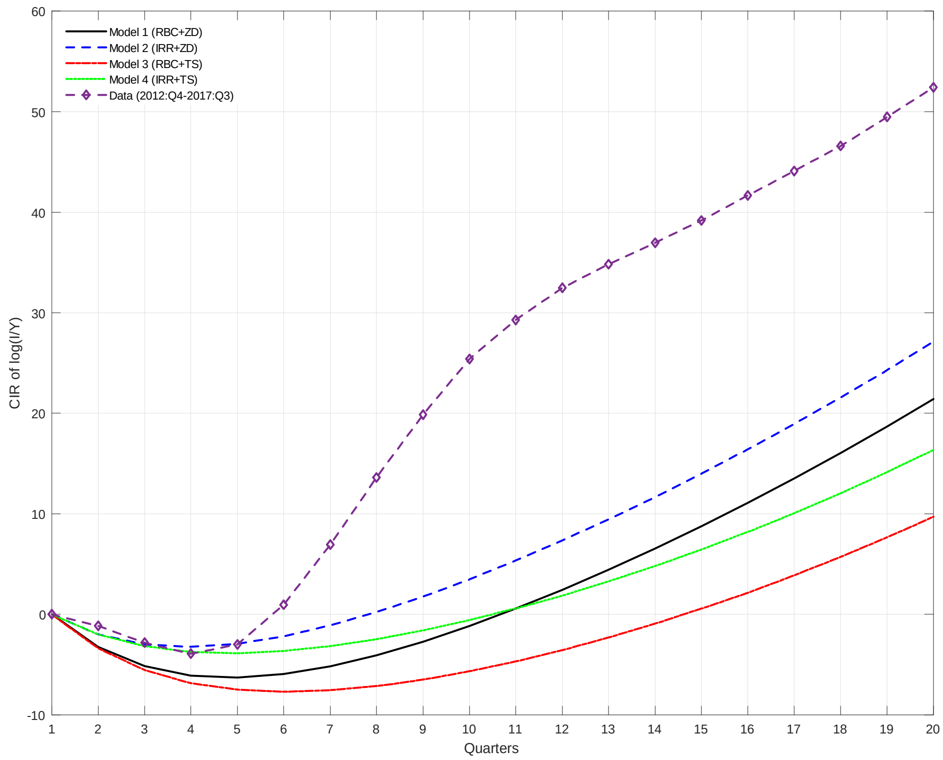
In this perfect-foresight experiment, we raise the degree of IRR by tightening the lower bound from $\phi = 0.93$ to $\phi = 0.98$. Such adjustment is motivated by the empirical observation that real nonfinancial corporate investment did not decline by more than 1.7% below its steady-state during the relevant period. Under $\phi = 0.98$, the model permits investment to decline by up to 2% below its long-run average—still a conservative calibration of the IRR constraint, particularly for the timeframe in question. Furthermore, we recalibrate the investment tax rate to $\tau^I = 0.55$ to ensure that the steady-state dividend tax rate approximately matches with the pre-ATRA level, $\tau^{D,zd} = \tau^D_{2008-2012} = 0.082$. Although the updated value for τ^I may appear high, it can be interpreted as capturing both the elevated degree of financial market imperfections that characterized the post-Great Recession period and the implementation of an additional investment surtax within the ATRA reform to support the 2010 Affordable Care Act (ACA). Importantly, as explained earlier, τ^I functions primarily as a calibration device in the model without compromising empirical realism.

Following the above recalibration that more closely captures the $2012:Q4-2017:Q3$ episode, we set the size of the government spending shock such that τ^D rises from 8.2% to 13.2%, with the latter corresponding to the average effective payout tax rate over 2013 to 2022. We reproduce this 5 percentage point hike in the RBC zero-deficit Model 1.[28]

We compute the CIR for the investment-to-GDP ratio to illustrate how fiscal adjustments propagate through real variables, depending on whether partial irreversibility and tax-smoothing are present (Models 1-4). Table 4 displays the CIR value of $\ln(I_t/Y_t)$ over a 20-quarter horizon, while Figure 6 illustrates its evolution over time. All model variants are benchmarked against the corresponding empirical counterpart.

[28] McGrattan (2023) documents modest fluctuations in the effective τ^D between 2013 and 2022. For simplicity, we assume a constant post-reform rate in our simulations across all model specifications. As shown in the IRFs analysis, the IRR constraint modestly alters the initial dynamics of τ^D upon impact, yet across all models considered in this section, the tax rate hike consistently falls within a range of 4.2 to 5 percentage points.

Figure 6: CIR of Log Investment-to-GDP Ratio Over Time



Note: Quarter 1 represents the steady-state average prior to the tax reform.

Models 2 and 4 generate a smaller initial decline in $\ln(I_t/Y_t)$ relative to Models 1 and 3, and a stronger medium-run rebound. This results in a higher CIR that more closely matches the observed persistence in the investment-to-GDP ratio during the ATRA window. Particularly, Models 2 and 4 display a near-perfect match to the data in the immediate aftermath of the tax reform, underscoring the ability of IRR to dampen the initial investment contraction and amplify the recovery.

Over the full adjustment horizon, Model 2 offers the most compelling explanation for the investment-to-GDP dynamics, as it combines zero-deficit motives, consistent with the reform's goal of debt reduction. The overall tax-adjusted IRR channel largely accounts for both the muted initial decline and the sustained rebound in investment observed in the data. This novel mechanism enhances persistence and prolongs the investment cycle, giving rise to investment-to-GDP dynamics that more closely track the empirical path.

In conclusion, we validate the model's ability to approximate key empirical patterns following tax reform and demonstrate the importance of incorporating nonconvex investment frictions when evaluating tax-based fiscal consolidations. While other macroeconomic and monetary forces likely contributed to the investment path during this period, the irreversibility-habit model helps account for much of the muted contraction and amplified recovery in the nonfinancial corporate investment-to-GDP ratio after the ATRA. The observed larger investment boom in the data most likely reflects additional lumpiness induced by the effective zero lower bound (ZLB) that prevailed throughout most of the period. Admittedly, our validation exercise, in line with Gourio and Miao (2011), is illustrative rather than a fully structural estimation. Nevertheless, the model captures the core dynamic, state-contingent asymmetries driven by irreversibility and dividend taxation and offers a parsimonious yet powerful explanation for the persistent lumpy investment cycle evident in the data.

6 Conclusion

This article has shown how dividend tax uncertainty affects macroeconomic dynamics, asset prices, public debt, and welfare within a simple production-based RBC framework that incorporates empirically-relevant investment and asset pricing frictions. A key strength of the representative-agent approach is its tractability, which enables to disentangle how dividend tax risk, habits, and partial investment irreversibility, jointly or independently, generate persistent investment lumpiness and asset price volatility. Our piecewise-linear model highlights the importance of macro-level shareholder tax risk and irreversibility, providing a disciplined benchmark for future work with richer agent heterogeneity. To our knowledge, this is the first study to examine the broad effects of dividend-tax-induced fiscal uncertainty and its interaction with consumption habit formation and lumpy investment behavior.

Our results uncover key trade-offs involved in using shareholder taxation to manage public debt. While zero-deficit rules combined with irreversibility generate the largest medium- to long-term investment multipliers, tax-smoothing policies with irreversibility deliver the highest welfare gains. The model also better replicates the persistence of nonfinancial corporate investment following the 2012 ATRA, reinforcing its empirical relevance. While calibrated to U.S. data, the model's insights are also pertinent for the U.K., which is grappling with unprecedented debt levels and contested debates over whether and how to raise dividend taxes in upcoming Budgets. Our results imply that how a country raises taxes matters as much as whether it does so. More broadly, this paper advances our understanding of the complex interplay between macroeconomic dynamics, corporate finance, and public finance.

Future research should explore the optimal design of debt-driven adjustments to payout, profit, and personal tax policies. Comparing dividend tax uncertainty to alternative fiscal instruments would offer a broader perspective on the interaction between tax policy and public debt, as emphasized by Le Grand and Ragot (2025). Incorporating firm heterogeneity in capital stocks or productivity (Veracierto 2002; Gourio and Miao 2011), as well as household distributional concerns (Anagnostopoulos, Cárceles-Poveda, and Lin 2012), could further illuminate the aggregate and redistributive consequences of business taxation, debt dynamics, and investment irreversibility. Finally, examining how investment borrowing limits (e.g., Wang and Wen 2012; Ghilardi and Zilberman 2024) interact with lumpy investment and corporate taxation presents a promising direction for further refining the model's asset price implications.

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