Macroeconomic Effects of Dividend Taxation with Investment Credit Limits*

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Abstract

A dynamic general equilibrium model augmented for an occasionally-binding investment borrowing limit reconciles competing views on the macroeconomic effects of dividend taxation. Permanent tax reforms are distortionary in the credit-constrained long-run equilibrium but are neutral otherwise. In the short- to medium-term, tax cuts produce muted, expansionary, or contractionary impacts depending on their scale, duration, and the firm's initial and interim credit position. Interactions between dividend tax shocks and the financial constraint tightness generate state-contingent, non-linear, and asymmetrical macroeconomic dynamics. These findings can explain investment rate fluctuations observed following historical tax reforms.

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1 Introduction

The key question addressed in this paper is: what are the long-, medium-, and short-term macroeconomic implications of dividend tax reforms? Existing theoretical and empirical studies present mixed answers to this old yet still highly topical and politically contentious question. Under the 'traditional' view of dividend taxation, corporate payout tax incentives raise the return to capital that is used to distribute dividends, and thus have a favorable impact on aggregate investment (Harberger 1962; Feldstein 1970; Poterba and Summers 1983, 1985).[1] Auerbach and Hassett (2006) and Campbell, Chyz, Dhaliwal, and Schwartz (2013) provide empirical support for this viewpoint in the context of the U.S. 2003 Job Growth and Taxpayer Relief Reconciliation Act (JGTRRA). These articles document that the 2003 large payout tax cut elevated share prices of high dividend-paying stocks, implying a lower marginal cost of equity finance and an improvement in corporate investment. More recent applied studies by Jacob (2021) and Moon (2022) find that the corporate distribution tax reforms implemented in Sweden and South Korea in 2006 and 2014, respectively, also resulted in overall expansionary effects on the business activity. Such positive economic outcomes following the tax reforms in both countries were driven primarily by increased investment from firms with limited internal funds.[2] By contrast, proponents of the competing 'new' view argue that permanent dividend tax changes are fully capitalized in share prices and have no impact on capital formation when firms rely on retained earnings to finance new investment (King 1977; Auerbach 1979; Bradford 1981; McGrattan and Prescott 2005).[3] Even in the short-run, Desai and Goolsbee (2004), Chetty and Saez (2005), and Yagan (2015) estimate that the 2003 JGTRRA caused little to zero change in near-term aggregate investment and mainly resulted in inflated dividend payouts.[4]

We contribute to this enduring debate by examining the macroeconomic consequences of dividend taxation in a dynamic general equilibrium business cycle model with a representative corporate firm subject to an endogenous *occasionally-binding* investment borrowing constraint and capital adjustment costs. The forward-looking firm undertakes investment in anticipation of future financing

[1]Dividend taxes are interchangeably referred to as (corporate) payout taxes, (corporate) distribution taxes, and shareholder taxes throughout the text. As our focus is primarily on the macroeconomic effects of dividend taxes, we also occasionally refer to them as simply 'taxes'.

[2]See also Becker, Jacob, and Jacob (2013) who demonstrate that dividend tax alterations distorted investment decisions across and within countries during the period 1990-2008. Moreover, Bilicka, Guceri, and Koumanakos (2023) show that the introduction of higher dividend taxes in Greece led to a fall in dividend payouts and a *rise* in aggregate investment.

[3]Poterba and Summers (1985), Auerbach (2002), and Auerbach and Hassett (2003) further elaborate on the implicit assumptions underlying each view. Moreover, Sinn's (1991) life-cycle model suggests that firms progress from the 'traditional' to the 'new' view, whereas in Chetty and Saez's (2010) firm agency setup, the two views are reconciled by introducing a divergence between the preferences of managers and shareholders.

[4]Isakov, Pérignon, and Weisskopf (2021) also find that the 2011 dividend tax policy cut in Switzerland did *not* stimulate corporate investment.

needs and with a view to maximizing shareholder value. In the current setup, dividend taxes τ^D and the investment loan-to-value (LTV) ratio jointly determine the tightness of the collateral constraint ϕ and the firm's financial position. The constraint tightness, in turn, dictates whether dividend taxation conform to the 'traditional' or the 'new' view in the long-run, and whether temporary dividend tax cuts have muted, expansionary, or contractionary economic impacts in the near- to medium-term. A key insight of this paper is that a decline in τ^D improves the collateralized value of capital through a finance-weighted Tobin's (1969) q, stimulates investment I, and spurs the economic activity *up to the point* where the initially binding investment debt limit turns slack.[5] In fact, bigger sudden temporary tax cuts and looser expected credit conditions (measured as a fraction of the firm's stock market value $1 - \tau^D$) dilute the future valuation of collateralized capital, resulting in a reduction in investment and output, while causing an increase in dividend payouts and asset prices. The direct link between the scale of tax reforms and the tightness of the periodically switching collateral constraint merges the various perspectives on dividend taxation by generating state-contingent and non-linear dynamics as well as strong macroeconomic asymmetries following equally-sized tax cuts and hikes.

Previous dynamic general equilibrium frameworks analyzing shareholder taxation under various equity, payout, and liquidity restrictions find that debt financing per-se is largely irrelevant in explaining real dynamics following temporary and permanent dividend tax adjustments (Gourio and Miao 2010, 2011; Santoro and Wei 2011). Nevertheless, when a Kiyotaki and Moore (1997)-type contractual financial constraint directly ties *investment loans* to the liquidation value of the collateralized capital stock, dividend taxes produce non-trivial effects on the credit market conditions, asset prices, and the real economy in both the deterministic steady-state and the dynamic setting. The main contribution of this paper is to illustrate the qualitative and quantitative importance of the investment borrowing limit in shaping the responses of key aggregate macroeconomic and financial variables following temporary and permanent dividend tax reforms of various magnitudes.

To validate our theoretical results and counterfactual predictions, we compare the investment rates, average q, and financial constraint tightness responses in our simulated model with their actual time-series data counterparts following the major Tax Acts legislated in the U.S. during 1981, 1986, and 2003. The shadow cost of debt in our framework is approximated by an average of empirically-relevant credit spreads, a common approach in the literature (e.g., Gertler and Karadi 2011). We utilize U.S. time-series data of the *effective* distribution tax rate, as calculated by

[5] Despite the presence of an endogenous investment debt limit, we prove that the equality between marginal and average q is preserved when using a constant-returns-to-scale (CRS) production function together with profit and adjustment cost functions that conform to Hayashi's (1982) criteria of proportionality and homogeneity with respect to capital and investment. This outcome enables us to use the observable finance-weighted average q when taking the model to the aggregate data.

McGrattan and Prescott (2005) and McGrattan (2023), to represent the dividend tax rate. For the validation exercises, we carefully calibrate the model in order to match certain quantities with their average pre-tax regime values. We then quantitatively evaluate the short-term effects caused by the payout tax reliefs across the three different episodes. Our analysis demonstrates that the extent of the dividend tax cuts, their expected duration, and the pre- and post-reform credit position of the average firm could have contributed to the noticeably different macroeconomic outcomes observed in the years after the reforms had been enacted.

The intuition behind our main results can be explained as follows. In the non-stochastic steady-state, a permanent cut (hike) in τ^D raises (lowers) the capital stock when the economy is credit-constrained, corresponding with the 'traditional' view of dividend taxation. In this liquidity-constrained environment, the tightness of the borrowing constraint drives a wedge between the internal and external valuation of the firm.[6] A dividend tax cut elevates the market value of the existing capital stock that can be used to support additional investment loans and relax the tightness of the credit friction. As asset prices rise, the household-shareholder accepts a lower effective rate of return, thereby reducing the cost of capital and prompting a rise in the capital-to-labor ratio and output. In an unconstrained regime, constant dividend tax adjustments are irrelevant for the marginal investment decision because they symmetrically impact the marginal cost and marginal benefit of investment, as postulated by the 'new' view. We show that large tax cuts in the steady-state can shift the firm's financial position from being constrained to unconstrained, thus nullifying the real long-run effects of further tax reductions or rising LTV ratios.

Turning to the short-run and medium-term, a temporary, unexpected, and moderate dividend tax relief expands business activity upon impact when the collateral constraint is initially binding in the steady-state. The payout tax reduction immediately relaxes the firm's borrowing constraint that becomes slack during the period of the fiscal reform. Moreover, as the value of capital improves and with easier access to external borrowing, the firm increases investment and limits dividend payouts at the time when the reform is implemented.[7] At the same time, part of the instantaneous jump in investment and output is dampened due to the persistent expected duration of the slack regime in which the firm is incentivized to pay out a higher dividend from internal funds and moderate

[6]In order to account for any further discrepancies between the firm's internal and external valuations, we incorporate an investment tax-subsidy that directly influences the capital price q. This inclusion enhances the precision of calibration, but does not impact any of the implications associated with dividend tax policies.

[7]Stojanović (2022) shows that the inclusion of sticky wages, dividend adjustment costs, and an *endogenous* share repurchase constraint leads to a positive correlation between dividend payouts, aggregate investment, and share repurchases. This finding is consistent with several studies that have identified the comovement among these variables following the 2003 JGTRRA. In our model, and similar to Gourio and Miao (2011), dividend payouts and investment serve as *short-run* substitutes in the absence of an endogenous share buyback friction. While we recognize the importance of such constraint in shaping payout strategies, our simplified model focuses instead on the relationship between τ^D, the investment borrowing friction ϕ, asset prices, and the real economic activity.

capital investment. Larger tax cuts that produce a looser expected credit environment can reverse the otherwise expansionary macroeconomic effects triggered by more subtle tax reforms. In fact, if the economy indefinitely faces an unconstrained credit regime, the firm prioritizes accelerating dividend payments over increasing investment, causing a severe economic contraction. We argue that the efficacy of a tax reform in boosting short-term investment is determined by its scale, length, as well as by the firm's initial steady-state and temporary credit position.

This paper is closely related to Gourio and Miao (2010, 2011). In Gourio and Miao's (2010) heterogeneous-firm setup, dividend tax cuts reduce frictions in the reallocation of capital, thereby raising long-run investment and productivity. The authors show that the 'traditional' view at the aggregate level is pertained only with the assumption of heterogeneous firms subject to different dividend distribution, equity issuance, and liquidity constrained regimes. Specifically, different firms respond to a tax relief in non-identical ways depending on which financial regime they face.[8] Otherwise, the 'new' view always holds in steady-state within a representative-firm framework even in the presence of various financial market imperfections.[9] By contrast, our model encompasses both dividend tax views within a representative-agent setup that emphasizes the importance of the occasionally-binding investment credit limit in determining the long-run efficacy of invariable dividend tax reforms.[10] In their companion paper, Gourio and Miao (2011) argue that the macroeconomic upshots of dividend tax reforms depend crucially on whether tax cuts are permanent or temporary. Contributing to this line of work, we claim that occasionally-binding investment borrowing constraints and the size of tax shocks matter, and can significantly alter the transitional dynamics of real variables and asset prices relative to a setup without a limit on investment spending.

Considered more broadly, our article speaks to the growing dynamic general equilibrium literature examining the interactions between corporation tax policies, investment, asset prices, and the economic activity (McGrattan and Prescott 2005; House and Shapiro 2006; Santoro and Wei 2011; Croce, Kung, Nguyen, and Schmid 2012; Miao and Wang 2014; Barro and Furman 2018; Erosa and González 2019; Anagnostopoulos, Atesagaoglu, and Eva Cárceles-Poveda 2022; Occhino

[8] In a partial equilibrium life-cycle model, Korinek and Stiglitz (2009) also illustrate that firms respond differently to anticipated dividend tax changes depending on their age and financing position over the life-cycle.

[9] Using a model with incomplete markets and heterogeneous households, Anagnostopoulos, Cárceles-Poveda, and Lin (2012) show that dividend tax cuts lead to a *decrease* in capital and investment in the steady-state.

[10] Employing a representative-agent model enables also to disentangle the direct potentially distortionary effects of dividend taxation from distributional and reallocation issues that arise otherwise, and which are not necessarily supported by the data (Yagan 2015). While we acknowledge that heterogeneity can play a crucial role in explaining investment behavior following tax changes (e.g., Zwick and Mahon 2017; Bilicka, Guceri, and Koumanakos 2023), this is a feature we do not directly confront. Instead, our model captures heterogeneity across regimes for the representative firm, providing insights into the state-contingent and asymmetric effects of dividend tax reforms all within a tractable and familiar business cycle framework.

2023; McGrattan 2023). While some of these papers go a step further by examining the implications of a richer set of corporate business taxes rather than merely dividend distribution taxes, they all abstract from investment spending limits. These models thus do not directly capture the distortions arising from the wedge between the internal and external valuations of capital, nor the tight link between τ^D, ϕ, q, and I. Such elements are important in bridging the gap between the different standpoints of dividend taxation and understanding the real effects of dividend tax shocks in a representative-agent business cycle model. Atesagaoglu (2012) examines the consequences of permanent dividend tax reductions on U.S. corporate debt in a dynamic general equilibrium setup where the firm's collateral constraint is always binding. Complementary to this article, we study the macroeconomic impact of both permanent and temporary dividend tax reforms while allowing for credit regime switching.

The outline of the paper is as follows. Section 2 describes the model with a detailed description of the firm's investment decision and how it is influenced by the presence of the capital investment borrowing limit and dividend taxation. Section 3 presents the analytical and quantitative long- and short-run general equilibrium results, along with their applications to the 1981, 1986, and 2003 Tax Acts. Section 4 concludes. Finally, an Appendix part provides technical proofs to some of the main propositions presented throughout the paper.

2 The Model

Consider an infinite-horizon discrete-time economy populated by a continuum of measure one of identical households-shareholders, perfectly-competitive corporate firms, and a government.

2.1 Households

The representative household derives utility from consumption (C_t) and experiences disutility associated with labor (N_t) according to the following separable utility function:

$$U\left(C_t, N_t\right) = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left[\ln\left(C_t\right) - hN_t\right], \tag{1}$$

where $\mathbb{E}_t$ represents the expectation operator, $\beta \in (0, 1)$ is the discount factor, and $h > 0$ is the weight attached to the disutility from labor.

Each household supplies labor N_t to a firm and receives its wage bill $W_t N_t$, where W_t is the current wage rate. Households own all the initial corporate shares S_t, with the price per stock (equity wealth) given by p_t. The equity price describes the market valuation of assets outside the firm and is synonymous to the firm's value. Ownership of the firm's stocks entitles the household to earn an after-tax dividend per share of $\bar{D}_t \equiv \left(1-\tau_t^D\right) D_t^a$, with τ_t^D standing for the dividend tax rate and D_t^a the dividend payment net of corporate profit taxes. At the beginning of the period, the household also lends B_t to the firm at an intraperiod gross rate of R_t.[11] The household's budget constraint is:

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

with T_t denoting lump-sum transfers from the government.

For $S_t > 0$, and taking taxes, dividends, equity prices, loan interest rate, and the wage rate as given, maximization of (1) subject to (2) yields the respective first-order conditions with respect to C_t, S_{t+1}, B_t, and N_t:

$$U_{C,t} \equiv \Lambda_t = C_t^{-1}, \tag{3}$$

$$p_t = \beta \mathbb{E}_t \frac{C_{t+1}^{-1}}{C_t^{-1}} \left[\left(1-\tau_{t+1}^D\right) D_{t+1}^a + p_{t+1}\right], \tag{4}$$

$$R_t = 1, \tag{5}$$

$$C_t^{-1} W_t = h, \tag{6}$$

where Λ_t is the Lagrange multiplier on the household's budget constraint or the marginal utility of consumption. Equation (4) is a typical stock Euler equation, which shows that the firm's external value is equal to the present discounted value of the future share price and the dividend net of corporate income and dividend taxation. Equation (5) dictates the interest rate on lending to the firm, which is zero in net terms due to the intratemporal nature of corporate debt in this model. Condition (6) determines the optimal labor supply that varies along the extensive margin as in Hansen (1985).

Iterating forward on (4) and using the transversality condition yields the discounted share price equation only as a function of the after-tax dividend:

$$p_t = \mathbb{E}_t \sum_{j=1}^{\infty} \left\{ \left[\prod_{i=0}^{j-1} M_{t+i,t+i+1}\right] \left(1-\tau_{t+j}^D\right) D_{t+j}^a \right\}, \tag{7}$$

where $M_{t,t+1} = \beta\left(\Lambda_{t+1}/\Lambda_t\right)$ is the stochastic discount factor from period t to $t+1$.

[11] Our main results and insights would remain unaffected if the firm instead issued interperiod corporate debt to the household.

2.2 Firms: Production, q, and Investment Policy

A representative corporate firm owns the capital stock K_{t-1}, hires labor N_t, and combines these two inputs to produce output Y_t according to the following constant-returns-to-scale (CRS) technology:

$$F\left(K_{t-1}, N_t\right) = Y_t = K_{t-1}^{\alpha} N_t^{1-\alpha}, \tag{8}$$

with $\alpha \in (0,1)$ standing for the share of capital in production. The firm accumulates capital according to:

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

where $\delta \in (0,1)$ is the capital depreciation rate, and I_t is investment.

The firm's before-taxes dividend in period t is:

$$D_t^b = Y_t - W_t N_t - I_t - \Phi\left(\frac{I_t}{K_{t-1}}\right) + B_t - R_t B_t, \tag{10}$$

where corporate profits are defined as $\pi_t = Y_t - W_t N_t$ and B_t is total intratemporal debt. Following Hayashi (1982), and Poterba and Summers (1983, 1985), we introduce quadratic capital adjustment costs $\Phi\left(\frac{I_t}{K_{t-1}}\right) = \frac{\gamma}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}$ that are deducted directly from the firm's dividend payout. The parameter $\gamma > 0$ governs the magnitude of adjustment costs to capital accumulation. The firm must pay an increasing and convex cost of net investment, measured by deviations of I_t from the amount of investment required to replace depreciated capital. The functional form for $\Phi(\cdot)$ is chosen such that the steady-state equilibrium is unmodified.

Denoting τ^{π} as the corporate income (business profit) tax rate, τ^I as an investment tax (subsidy) if positive (negative), and using the intratemporal debt assumption with $R_t = 1$, the after-profit and investment tax dividend is:[12]

$$D_t^a = (1-\tau^{\pi})(Y_t - W_t N_t) - \left(1+\tau^I\right) I_t - \Phi\left(\frac{I_t}{K_{t-1}}\right). \tag{11}$$

From the expressions above and in line with Santoro and Wei (2011), net investment purchasing costs, adjustment costs, and debt are expensed out of total distributed capital income after profit taxes are levied. Moreover, while an investment tax-subsidy is indeed part of the U.S. tax code, our model's inclusion of τ^I aims to effectively account for any further disparities between the internal capital price q and its external value $\left(1-\tau^D\right)$, extending beyond the tightness of the financial

[12] Given our aim to exclusively analyze the macroeconomic effects of potentially time-varying dividend taxation in the presence of credit limits, we set the profit tax and investment tax-subsidy rates constant at τ^{π} and τ^I, respectively.

friction (see equation (16) below). The introduction of $\tau^I < 0$ can capture any depreciation allowances and investment tax credits, traditionally more applicable to tangible assets as explained in House, Mocanu, and Shapiro (2017) and McGrattan (2023), for example. Conversely, setting $\tau^I > 0$ may be viewed as a generic way to encapsulate additional financial frictions, investment wedges, capital gains taxes, and/or risk premiums that impact the price of capital, but which are not explicitly modelled within this current framework for the sake of keeping the analysis simple (see also Brinca, Chari, Kehoe, and McGrattan 2016). Thus, τ^I can be interpreted in our model as a proxy to the U.S. average capital gains tax minus investment subsidies. Either way, τ^I facilitates a more accurate steady-state calibration of both q and the tightness of the financial friction without any loss of generality.

Following Atesagaoglu (2012), Croce, Kung, Nguyen, and Schmid (2012), and Miao and Wang (2018), we assume that the total number of shares satisfies $S_t = 1$ for all t, with the firm having no access to issuing new stocks. To finance new capital investment, the firm can use internal funds (retained earnings) or external debt financing from the household.[13] In the case of the latter, the investment loan is tied to the liquidation value of the collateralized capital stock. Particularly, for $R_t = 1$ and $B_t \equiv I_t$ we consider the following occasionally-binding borrowing constraint:[14]

$$I_t \leq \theta q_t K_{t-1}, \tag{12}$$

where q_t is the market-based measure of Tobin's q (derived below), and $\theta \in (0,1)$ is the proportion of capital used as collateral in order to obtain the investment loan, or alternatively the loan-to-value (LTV) ratio. The above collateral constraint can be derived from a costly contract enforcement problem stating that if the firm cannot pay its debt, the creditor can take over the firm and seize its' physical assets (Kiyotaki and Moore 1997; Wang and Wen 2012; Miao and Wang 2018). As it is costly to liquidate capital after seizure, the lender retrieves only a fraction θ of the collateral asset value.

With a potentially time-varying dividend tax τ_t^D, the firm maximizes the following present discounted value of the after-tax dividend payout $\bar{D}_t$:

$$\max_{N_t, K_t, I_t} \mathbb{E}_t \sum_{t=0}^{\infty} M_{0,t} \left(1-\tau_t^D\right) \left[(1-\tau^\pi)(Y_t - W_t N_t) - \left(1+\tau^I\right) I_t - \Phi\left(\frac{I_t}{K_{t-1}}\right) \right], \tag{13}$$

[13] Debt and retained earnings are considered to be cheaper and thus more important sources of finance than new equity issuance (Sinn 1991; Atesagaoglu 2012).

[14] Incorporating the tax component into the overall investment bill, i.e., $B_t \equiv \left(1+\tau^I\right) I_t$, introduces complexity into the analytical solutions while keeping our findings virtually unaffected. Our conceptualization of corporate debt indicates that firms typically secure loans to address only a *portion* of their total investment spending. Following similar logic, adjustment costs are also financed from retained earnings.

subject to (8), (9), and (12). The term $M_{0,t} \equiv \beta^t (\Lambda_t/\Lambda_0)$ represents the firm's stochastic discount factor from time 0 to t, where Λ_t is derived in (3). Denoting q_t as the Lagrange multiplier on the capital accumulation constraint (9), and ϕ_t as the Lagrange multiplier on the borrowing constraint (12), the firm's first-order conditions with respect to the choice of input factors (N_t, K_t) and investment (I_t) are:

$$F_{N,t} = W_t, \tag{14}$$

$$q_t = \mathbb{E}_t M_{t,t+1} \left(1 - \tau_{t+1}^D\right) \left\{ (1 - \tau^\pi) F_{K,t+1} - \Phi_{K,t+1} + \frac{q_{t+1}}{\left(1 - \tau_{t+1}^D\right)} \left[(1 - \delta) + \theta \phi_{t+1}\right] \right\}, \tag{15}$$

$$q_t = \left(1 - \tau_t^D\right) \left[\left(1 + \tau^I\right) + \Phi_{I,t}\right] + \phi_t. \tag{16}$$

The corresponding complementary slackness condition is:

$$\phi_t \left(\theta q_t K_{t-1} - I_t\right) = 0; \quad \phi_t \geq 0. \tag{17}$$

Next, we shift our focus towards examining how dividend taxes impact physical capital formation. To achieve this, we utilize a q-theoretic investment function in conjunction with the implied capital-investment Euler equation. Additionally, we employ the dynamic user cost of capital approach to develop further intuition. For the rest of this section, we simplify the analytical presentation by assuming $\tau^I = 0$. However, the investment tax-subsidy is reintroduced when calibrating the model to match q and the financial friction tightness with their data counterparts later in the text. Prior to delving into the firm's optimal investment decision, we establish the equivalence between the marginal and average q in this setup. The use of q as an observable market-based measure facilitates the calibration and validation of the model using historical data in the main results section.

2.2.1 Marginal q and Average q

To characterize the relation between the unobservable marginal and the observable average q, we first substitute the value of after-corporate income tax dividends D_{t+1}^a from (11) into equation (4), use the specific formulations for the CRS production and quadratic adjustment cost functions, and divide the stock Euler equation (4) by K_t to obtain:

$$q_t^{av} = \mathbb{E}_t M_{t,t+1} \left\{ \left(1 - \tau_{t+1}^D\right) \left[(1 - \tau^\pi) \alpha \frac{Y_{t+1}}{K_t} - \frac{I_{t+1}}{K_t} - \frac{\gamma}{2} \left(\frac{I_{t+1}}{K_t} - \delta \right)^2 \right] + q_{t+1}^{av} \right\}, \tag{18}$$

where $p_t/K_t \equiv q_t^{av}$ is defined as the average q. From (8), (15), and (16) we have the capital-investment Euler equation written in terms of the marginal q:

$$q_t = \mathbb{E}_t M_{t,t+1}\left(1-\tau_{t+1}^D\right)\left\{\begin{array}{c}(1-\tau^\pi)\,\alpha\frac{Y_{t+1}}{K_t}+\frac{\gamma}{2}\left[\left(\frac{I_{t+1}}{K_t}\right)^2-\delta^2\right] \\ +\frac{q_{t+1}}{\left(1-\tau_{t+1}^D\right)}\left[(1-\delta)+\theta\phi_{t+1}\right]\end{array}\right\}. \tag{19}$$

Employing condition (9) for capital accumulation at period $t+1$, (12) to substitute for θ, and (16) for ϕ_{t+1}, we then subtract (19) from (18) which after some algebra yields:

$$q_t^{av} - q_t = \beta\mathbb{E}_t\frac{C_{t+1}^{-1}}{C_t^{-1}}\left(\frac{K_{t+1}}{K_t}\right)\left(q_{t+1}^{av}-q_{t+1}\right).$$

Forward iterations of $q_{t+j}^{av}-q_{t+j}$ for $j \geq 1$ and using $\frac{C_t}{K_t}\lim_{j\to\infty}\beta^j\left(q_{t+j}^{av}-q_{t+j}\right)\frac{K_{t+j}}{C_{t+j}}=0$ results in:

$$q_t^{av} = q_t. \tag{20}$$

Therefore, as long as Hayashi's (1982) homogeneity, proportionality, and CRS assumptions hold, introducing an investment borrowing constraint does *not* break the equivalence between the average and marginal q. Intuitively, the firm's fundamental value, as captured by q_t in (16), contains all the information about the marginal benefits and costs of investment, including the shadow cost of investment borrowing ϕ_t.[15] However, if a firm takes on external debt for purposes beyond productive investment, the two values of q differ.

Indeed, Hennessy, Levy, and Whited (2007) and Abel and Panageas (2022), among others, show that other financial constraints or a more comprehensive range of frictions create a wedge between the two values of q in partial equilibrium investment models. Our approach is different. We incorporate a specific meaningful constraint on investment loans motivated by Wang and Wen (2012) and Miao and Wang (2018) into a general equilibrium framework, and utilize the two Euler equations to establish the equality between q_t^{av} and q_t. By using such a constraint we derive a direct useful link between dividend taxes, shadow value of debt, investment, and q (see (16)), which when combined with (18) and (19), yields $q_t^{av} = q_t$. We will frequently refer to both values as simply q in the remainder of this paper.

[15] Introducing τ^I does not break this equivalence result, as the investment tax-subsidy is also integrated in the intrinsic value of the firm.

2.2.2 q-Theory

Given the quadratic form of the capital adjustment cost function, we rearrange equation (16) to obtain an explicit q-theoretic investment function augmented for the financial friction tightness and dividend taxes:

$$\frac{I_t}{K_{t-1}} = \frac{1}{\gamma}\left[\frac{q_t - \phi_t}{\left(1-\tau_t^D\right)} - 1\right] + \delta. \tag{21}$$

In a world with capital adjustment costs but without collateral constraints and dividend taxation, investment exceeds the depreciation rate when the shadow value of newly installed capital, as measured by Tobin's q, is greater than 1. If $\gamma > 0$ and the marginal source of investment is new borrowing, the q-theory equation implies that I_t is increasing in the shadow price for capital q_t, and decreasing in the tightness of the borrowing constraint ϕ_t. Intuitively, investment is determined at the point where the firm is indifferent between investing in an additional unit of capital with marginal value q_t, and paying out dividends to the household with value $\left(1-\tau_t^D\right)$. The presence of an occasionally-binding collateral constraint ($\phi_t \geq 0$) raises the marginal cost of investment, leading the firm to accelerate dividend distributions in order to maintain the equality between the return to investment inside and outside the firm. Put differently, to achieve a higher level of investment, the shadow value of capital must increase in line with the marginal cost of investment.

Proposition 1 *Suppose that* $q_t > \left(1-\tau_t^D\right)\left[1+\gamma\left(\frac{I_t}{K_{t-1}} - \delta\right)\right]$ *such that* $\phi_t > 0$*. The optimal investment level in the neighborhood of the credit-constrained steady-state is derived from (12) and (17) and is given by:*

$$I_t = \theta q_t K_{t-1}. \tag{22}$$

Moreover, imposing the transversality condition and the law of iterated expectations, the recursively forward solution to (19) yields:

$$q_t = \mathbb{E}_t \sum_{j=1}^{\infty}\left\{\left[\prod_{i=0}^{j-1} M_{t+i,t+i+1}\right]\left(1-\delta+\theta\phi_{t+j}\right)^{j-1} mpk_{t+j}\right\}, \tag{23}$$

where the marginal product of capital is defined as:

$$mpk_{t+j} = \left(1-\tau_{t+j}^D\right)\left\{\left(1-\tau^\pi\right)\alpha\frac{Y_{t+j}}{K_{t+j-1}} + \frac{\gamma}{2}\left[\left(\frac{I_{t+j+1}}{K_{t+j}}\right)^2 - \delta^2\right]\right\}. \tag{24}$$

This proposition states that marginal q reflects the firm's discounted marginal valuation, that, in turn, is directly influenced by the tightness of the credit friction and dividend taxes. A corporate payout tax relief raises the firm's value, relaxes the credit constraint (12), and expands investment up to the point where the adjustment cost-augmented q is equal the stock market valuation of the firm; i.e., $q_t \left[1+\gamma\left(\frac{I_t}{K_{t-1}}-\delta\right)\right]^{-1} = \left(1-\tau_t^D\right)$. Importantly, *large* tax cuts that push the economy towards a slack credit region only serve to raise the firm's valuation and dividend distributions, while inducing the firm to stop investing. The firm curtails production as a result, leading to a reduction in both employment and the marginal product of capital in equilibrium. Because of the potentially temporary nature of the policy change, the system eventually returns to its steady-state with a positive ϕ. The decision to invest or disinvest is inherently forward-looking and anchored by longer-term financial considerations.

Moreover, by substituting $I_t/K_{t-1} = \theta q_t$ for $\phi_t > 0$ in (24), the marginal product of capital itself is also altered by θ and q_t through the effect adjustment costs have on the cost of capital. Around the neighborhood of a credit-bound steady-state, θ and q modify investment decisions and therefore result in a higher $\Phi(\cdot)$ regardless of whether the government implements a tax hike or cut. Consequently, following distribution tax reforms, investment fluctuations are mitigated via a secondary forward-looking financially-augmented adjustment cost channel.

To further illuminate the intuition behind Proposition 1, combine (21) with (19) to derive the optimal capital-investment Euler equation:

$$\begin{aligned} & \left(1-\tau_t^D\right)\left[1+\gamma\left(\frac{I_t}{K_{t-1}}-\delta\right)+\frac{\phi_t}{\left(1-\tau_t^D\right)}\right] \\ = \; & \mathbb{E}_t M_{t,t+1}\left(1-\tau_{t+1}^D\right)\left\{\begin{array}{c} \left(1-\tau^\pi\right)\alpha\frac{Y_{t+1}}{K_t}+\frac{\gamma}{2}\left[\left(\frac{I_{t+1}}{K_t}\right)^2-\delta^2\right] \\ +\left[1+\gamma\left(\frac{I_{t+1}}{K_t}-\delta\right)+\frac{\phi_{t+1}}{\left(1-\tau_{t+1}^D\right)}\right]\left[(1-\delta)+\theta\phi_{t+1}\right] \end{array}\right\}. \end{aligned} \tag{25}$$

The left-hand side of (25) represents the current value of q_t that includes the after-dividend tax marginal adjustment and purchasing costs of period t investment, accounting for the marginal shadow cost of debt ϕ_t. The right-hand side measures the discounted value sum of the future marginal product of capital net of corporate income and dividend taxation, future adjustment costs, the reselling value of non-depreciated capital, and the option value of capital used as a collateral asset. Notably, for the credit-constrained firm, acquiring a marginal unit of investment via borrowing raises the anticipated value of capital and acts to relax the borrowing limit in the next period. The marginal benefit from a higher collateralized capital stock that can be used to secure future loans is represented by the term $q_{t+1}\theta\phi_{t+1}$. The firm equates between the marginal cost and the expected marginal gains from investment. Relative to Santoro and Wei (2011), our capital-investment Euler equation is directly augmented for the strength of the financial friction due to the inseparability of investment and debt, as well as for the inclusion of potentially distortionary dividend taxes.

To highlight the link between the 'traditional' and 'new' views of dividend taxation through the investment credit limit, observe from (25) that even a *constant* dividend tax rate ($\tau_t^D = \tau_{t+1}^D = \tau^D$) produces *asymmetric* effects on the marginal cost and benefit of investment when $\phi_t > 0$ and $\phi_{t+1} \geq 0$. Conversely, for $\phi_t = \phi_{t+1} = 0$ and $\tau_t^D = \tau_{t+1}^D = \tau^D$ for all t, the dividend tax drops out from (25), leaving the capital-investment outcome unchanged as implied from the 'new' view. Intuitively, the collateral constraint multiplier drives a wedge between the frictionless valuation of capital outside the firm, $\left(1 - \tau^D\right)$, and the adjustment cost-augmented q in the credit-constrained economy (see (16) for $\tau^I = 0$). When the marginal source of funds is determined by new external debt financing, a permanently lower dividend tax raises q and the return to investment, which, in turn, lifts I. This connection between investment financing via debt and dividend taxation is in the spirit of the 'traditional' view.[16] In Section 3 we derive the conditions under which the borrowing constraint is binding or slack in steady-state. Additionally, we show how the representative firm responds differently to dividend tax changes, contingent upon the value of θ, the initial steady-state dividend tax rate, and the magnitude of the reform.

2.2.3 User Cost of Capital

The impact of dividend taxation on investment can also be analyzed through the dynamic adjustment cost user cost of capital framework developed by Abel (1982) and generalized by Gourio and Miao (2010) in a heterogeneous-firm model featuring equity and dividend payment constraints. We define the user cost of capital as u_t, and set it equal to the after-corporate income tax marginal cash flow of an additional unit of capital corrected for the adjustment costs; i.e., $u_t = (1 - \tau^\pi)\, \pi_{K,t+1} - \Phi_{K,t+1}$. Using the specific formulations of the production, business profit, and adjustment cost functions we then have:

$$u_t = (1 - \tau^\pi)\, \alpha \frac{Y_{t+1}}{K_t} + \frac{\gamma}{2} \left[\left(\frac{I_{t+1}}{K_t} \right)^2 - \delta^2 \right]. \tag{26}$$

[16] Santoro and Wei (2011) show in their appendix that proportional dividend taxes obey the 'new' view even in the presence of constrained debt financing that takes a general form: $B_t \leq \theta_t q_t K_{t-1}$, where $q_t = 1$ in the absence of adjustment costs. In our model, debt is used to finance *new investment* which directly supports capital accumulation (i.e., $B_t \equiv I_t$ and $q_t \neq 1$ regardless of adjustment costs). A more explicit investment debt limit like in our paper restores the distortionary effects of proportional dividend taxes so long as $\phi_t > 0$. Introducing additional constrained debt for purposes beyond investment would simply result in an additional Euler equation for this secondary debt market and would not change any of our main results as long as investment is (also) financed by debt.

Considering the deterministic case only, we substitute (26) in (25) to derive:

$$u_t = M_{t,t+1}^{-1} \frac{\left(1-\tau_t^D\right)}{\left(1-\tau_{t+1}^D\right)} \left[1+\gamma\left(\frac{I_t}{K_{t-1}}-\delta\right)+\frac{\phi_t}{\left(1-\tau_t^D\right)}\right] - \left[1+\gamma\left(\frac{I_{t+1}}{K_t}-\delta\right)+\frac{\phi_{t+1}}{\left(1-\tau_{t+1}^D\right)}\right]\left[(1-\delta)+\theta\phi_{t+1}\right], \tag{27}$$

where $q_t/\left(1-\tau_t^D\right) = 1+\gamma\left(I_t/K_{t-1}-\delta\right)+\phi_t/\left(1-\tau_t^D\right)$ from (21). Notice that equations (25) and (27) are equivalent when the expectations operator is ignored. This facilitates the use of (27) in examining the macroeconomic effects of dividend taxation via the dynamic user cost of capital approach. Specifically, if the firm always faces a non-binding credit constraint and finances investment from retained earnings only ($\phi_t = 0$ for all t), then a permanently lower dividend tax rate does not change the user cost of capital, and therefore leaves capital and investment unchanged. Nevertheless, in the same constantly slack credit environment, a transitory tax reduction today relative to tomorrow, $\left(1-\tau_t^D\right)/\left(1-\tau_{t+1}^D\right) > 1$, raises the user cost of capital and lowers current investment. Put differently, in the frictionless framework, the anticipation of a reversal in the dividend tax cut policy leads the firm to engage in intertemporal tax arbitrage resulting in inflated dividend payouts today. We provide a quantitative demonstration of these short-run contractionary macroeconomic outcomes through the simulations in Section 3.

For $\phi_t > 0$ and $\phi_{t+1} \geq 0$, indefinite dividend tax changes have opposing effects on the user cost of capital. On the one hand, reducing τ^D lowers u_t by relaxing the tightness of the borrowing constraint as a fraction of the market value of capital, $\phi_t/\left(1-\tau^D\right)$. On the other, part of initial decline in u_t is counteracted by the heavier discounting of the borrowing constraint and the motivation to issue more dividends when the dividend tax rate remains persistently low and the borrowing friction occasionally-slack. These findings help in understanding the policy experiments presented throughout Section 3, which involve temporary and permanent tax shocks of varying magnitudes that directly affect the present and expected measure of the financial friction tightness.

Our key contribution relative to Gourio and Miao (2010, 2011) is that the financial regime may switch as a direct result of the dividend tax shock alone, without any reliance on large stochastic idiosyncratic productivity shocks that otherwise determine each firm's credit position at any point in time. Further, we focus on investment debt financing rather than on more expensive equity issuance. In fact, Gourio and Miao (2010) show that only a small number of firms use equity financing, arguably implying that an endogenous occasionally-binding debt limit may be more relevant when investigating the investment decision of the average representative firm.

2.3 Government

Total tax revenue from corporate profit, investment, and dividend tax rates finances lump-sum transfers to households according to the balanced budget constraint:[17]

$$T_t = \tau_t^D D_t^a + \tau^\pi (Y_t - W_t N_t) + \tau^I I_t. \tag{28}$$

2.4 Competitive Equilibrium

In a competitive equilibrium, the markets for labor, capital, dividends, debt, and stocks clear. For the goods market clearing condition, we combine (2), (8), (9), (11), and (28) to obtain the economy-wide resource constraint:

$$K_{t-1}^\alpha N_t^{1-\alpha} = Y_t = C_t + K_t - (1-\delta) K_{t-1} + \frac{\gamma}{2}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2 K_{t-1}. \tag{29}$$

Definition 1 *(Competitive Equilibrium) Given the initial capital stock (K_{-1}), a competitive equilibrium for the economy with an occasionally-binding credit constraint $\{\phi_t \geq 0\}_{t=0}^\infty$ is defined as a sequence of dividend tax policies $\{\tau_t^D\}_{t=0}^\infty$, prices $\{p_t, q_t, W_t, u_t\}_{t=0}^\infty$, and private sector allocations $\{Y_t, C_t, N_t, K_t, I_t, \bar{D}_t\}_{t=0}^\infty$, that satisfy (4), (6), (8), (9), (11), (14), (15), (16), (17), (27), and (29).*

3 Main Results

This section details the main findings of the paper. We first present the analytical and quantitative properties of the deterministic steady-state equilibrium, and analyze the long-run effects of the collateral constraint and dividend taxation on capital accumulation, asset prices, and dividend payouts. The model is then carefully calibrated to capture some salient features of the U.S. economy in 2002, the year preceding the significant 2003 JGTRRA legislation. We use this specific calibration to quantitatively examine the interactions between the occasionally-binding credit limit and key macroeconomic and financial variables following unexpected temporary dividend tax shocks that encompass a range of magnitudes, including 5, 8, and 10 percentage point reductions. The 8 percentage point tax cut replicates the observed difference in the effective dividend tax rate before and after the JGTRRA reform (McGrattan 2023). The 5 and 10 percentage point tax shocks are used to showcase counterfactual outcomes that bear important policy implications. Finally,

[17] Given the focus of our paper, we abstract from government spending financed by taxation.

we validate the model by comparing investment rate, q, and ϕ projected dynamics with their corresponding data values following the 1981, 1986, and 2003 tax reforms.

3.1 The Long-Run Effects of Collateral Constraints and Dividend Taxation

In the non-stochastic steady-state, all variables are constant and denoted without the time subscript. To produce the two figures in this subsection, we set $\beta = 0.96$, $\alpha = 0.3$, $N = 0.3$, and $\delta = 0.11$.[18] The capital depreciation rate δ is drawn from the aggregate nonresidential investment-to-capital ratio found in the data in over the period 1960-2020.[19] We also fix $\tau^{\pi} = 0.40$, which approximately corresponds with the average long-run effective U.S. corporate income tax rate, and initially pick $\tau^{I} = 0$ yet keep it throughout the derivations of the steady-state expressions below. The exact value of τ^{I} is not crucial for our quantitative steady-state results presented in Figures 1 and 2. However, we will employ different values for τ^{I} when matching the financial friction tightness with the credit spread and validating the model against the data.

Proposition 2 *The dividend tax rate τ^{D} and the borrowing limit θ determine whether an economy is subject to a constrained or a slack equilibrium. In particular:*

(i) If

$$0 < \theta_B < \frac{\delta}{\left(1-\tau^{D}\right)\left(1+\tau^{I}\right)}, \tag{30}$$

then there exists a unique steady-state constrained equilibrium (denoted by subscript B for 'binding') with

$$\phi = \frac{\delta}{\theta_B} - \left(1-\tau^{D}\right)\left(1+\tau^{I}\right) > 0. \tag{31}$$

(ii) If

$$\theta_{NB} \geq \frac{\delta}{\left(1-\tau^{D}\right)\left(1+\tau^{I}\right)}, \tag{32}$$

then there exists a unique steady-state unconstrained equilibrium (denoted by subscript NB for 'non-binding') with $\phi = 0$.

Proof 2. *See Appendix* ■

[18] We choose h such that $N = 0.3$ in the deterministic steady-state. This is consistent with the average fraction spent on market work (Gourio and Miao 2011). The values chosen for the discount factor β and the share of capital in production α are standard in the business cycle literature.

[19] Average aggregate U.S. statistics are extracted from the Federal Reserve Economic Database (FRED) of the Federal Reserve Bank of St. Louis.

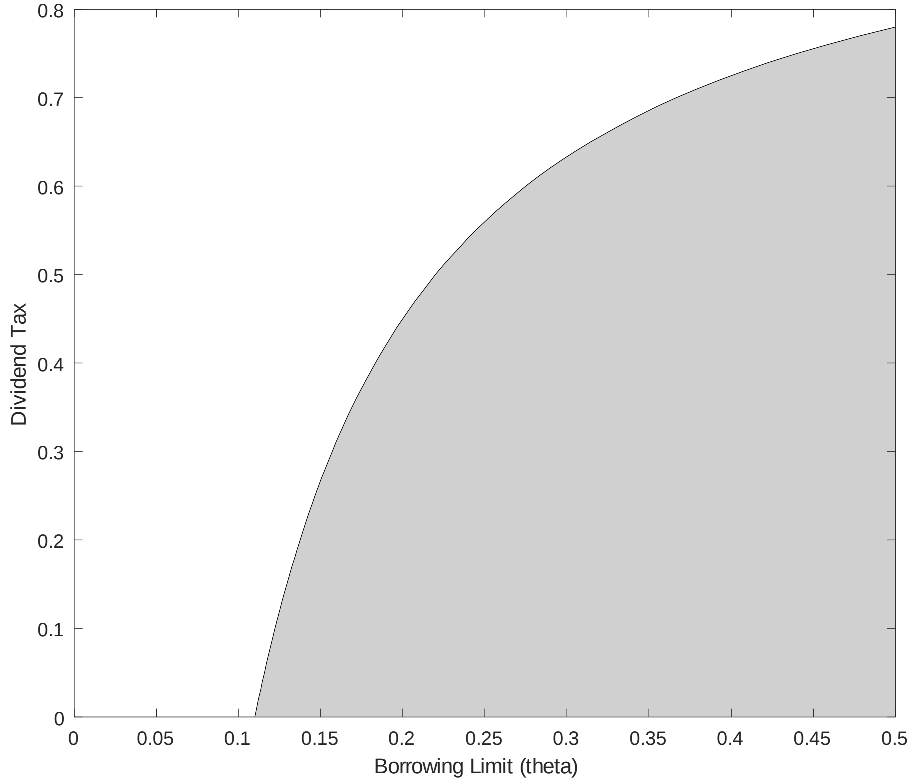

Figure 1: Constrained (white) and unconstrained (grey) equilibrium regions.

Figure 1 provides a visual representation of Proposition 2. The threshold between the constrained and the unconstrained equilibria lies in the region of empirically-plausible values of τ^D and θ.[20] The debt shadow cost ϕ is decreasing in the fraction of the value of capital that can be borrowed against, as a rise in θ makes the borrowing constraint less binding. Without dividend taxation, we must set $\theta_{NB} < \delta\left(1+\tau^I\right)^{-1}$ for the collateral constraint to bind.[21] Introducing dividend taxation breaks down this relationship by lowering the market valuation of capital, and reducing the value of the collateralized capital stock, both of which result in the tightening of the borrowing constraint. In other words, a hike in the dividend tax rate and/or a fall in the LTV ratio can move the long-run unconstrained equilibrium regime to a constrained one. The two regions create two different steady-states that yield distinct values of the capital stock, Tobin's q, equity

[20] Covas and Den Haan (2011) document that θ ranged from 0.1 to 0.4 for various sizes of firms over the period 1980-2006. Wang and Wen (2012) calibrate $\theta = 0.08$, while Miao, Wang, and Xu (2015) estimate $\theta = 0.30$.

[21] Our steady-state conditions without taxation essentially boil down to the 'bubbleless' steady-state equilibrium described in Miao and Wang (2018).

prices, and dividends. This is formally expressed in the following proposition.

Proposition 3 *The steady-state values of the capital stock, Tobin's q, equity prices, and dividend payouts depend on the value of ϕ and therefore on whether the economy faces a constrained or an unconstrained credit regime. Specifically:*

(i) If $\phi > 0$ (i.e., binding region), the capital stock, Tobin's q, equity prices, and dividends are given by:

$$\left(\frac{K}{N}\right)_B = \left\{\frac{\alpha\left(1-\tau^{\pi}\right)}{\left[\left(1+\tau^I+\frac{\phi}{(1-\tau^D)}\right)\left(\beta^{-1}-1\right)+\left(1+\tau^I\right)\delta\right]}\right\}^{\frac{1}{1-\alpha}}, \tag{33}$$

$$q_B = \left(1-\tau^D\right)\left(1+\tau^I\right)+\phi = \frac{\delta}{\theta_B}, \tag{34}$$

$$p_B = \frac{\delta}{\theta_B}K_B, \tag{35}$$

$$\bar{D}_B = \left(1-\tau^D\right)\left[\left(1-\tau^{\pi}\right)\alpha\left(\frac{K}{N}\right)_B^{\alpha} - \delta\left(1+\tau^I\right)\left(\frac{K}{N}\right)_B\right]N. \tag{36}$$

(ii) If $\phi = 0$ (i.e., slack region), the capital stock, Tobin's q, equity prices, and dividends are determined by:

$$\left(\frac{K}{N}\right)_{NB} = \left[\frac{\alpha\left(1-\tau^{\pi}\right)}{\left(1+\tau^I\right)\left(\beta^{-1}-1+\delta\right)}\right]^{\frac{1}{1-\alpha}}, \tag{37}$$

$$q_{NB} = \left(1-\tau^D\right)\left(1+\tau^I\right), \tag{38}$$

$$p_{NB} = \left(1-\tau^D\right)\left(1+\tau^I\right)K_{NB}, \tag{39}$$

$$\bar{D}_{NB} = \left(1-\tau^D\right)\left[\left(1-\tau^{\pi}\right)\alpha\left(\frac{K}{N}\right)_{NB}^{\alpha} - \delta\left(1+\tau^I\right)\left(\frac{K}{N}\right)_{NB}\right]N. \tag{40}$$

Proof 3. *See Appendix* ■

The credit constraint ϕ acts to raise the firm's marginal cost and q by lifting borrowing costs, and driving a wedge between the internal and external valuations of capital. In order to maintain the same level of wealth, the shareholder requires an equity premium as reflected by the *effective* augmented rate of return on stocks $\left(1+\tau^I+\frac{\phi}{(1-\tau^D)}\right)\left(\beta^{-1}-1\right)$, that is increasing in ϕ. In the binding steady-state environment, a higher ϕ raises the spread between the frictionless share return, equal to the household's rate of time preference $\left(\beta^{-1}-1\right)$, and the stock return in the credit-constrained economy. As a result, the firm reduces the capital stock and investment when financial frictions become more prevalent; i.e., $\left(\frac{K}{N}\right)_B < \left(\frac{K}{N}\right)_{NB}$ for $\phi > 0$. Note also that the denominator on the right hand side of (33) is precisely the steady-state value of the user cost of capital u, which is derived directly from (27) after suppressing the time subscripts, reinstating τ^I, and applying the long-run conditions $I/K = \delta$ and (34).

In the frictionless economy, the wedge between the market valuation of capital and the physical capital stock is determined by the dividend and investment taxes only as seen from (39). A cut in τ^D raises the stock price proportionally and increases the value of the household's wealth. The household is willing to hold more wealth as long as the rate of return is equal to the time preference rate. As a consequence, share prices and dividend distributions rise, while the capital stock, investment, and output remain the same. This conforms with the 'new' view of dividend taxation, wherein a change in the dividend tax rate impacts the firm's sources and uses of funds symmetrically, as also shown by McGrattan and Prescott (2005) and Santoro and Wei (2011).

However, when the collateral constraint binds, a change in τ^D alters the effective rate of return on stocks required by the household, thereby resulting in a direct impact on the firm's capital and investment decisions. Here, the capital-investment Euler equation (25), with the inclusion of τ^I, and its steady-state representation in (33) are distorted by the combination of $\phi > 0$ and τ^D. A dividend tax cut that, *ceteris paribus,* raises asset prices, reduces the user cost of capital, and stimulates K and consequently I. The dividend tax relief relaxes the borrowing constraint and facilitates additional lending for investment purposes. Furthermore, the upward pressure on q stemming from a positive ϕ is offset by any decrease in τ^D such that q_B remains unchanged at δ/θ_B following a tax reform in the binding long-run equilibrium (observe (34)). Equity prices, on the other hand, rise in response to the payout tax reduction due to the positive relationship between p and K (see (35)).

Our model therefore produces distortionary steady-state effects of dividend taxation without the assumptions of internally growing firms over the life-cycle and/or heterogeneous firms facing different finance regimes as in Korinek and Stiglitz (2009), Gourio and Miao (2010), and Erosa and González (2019). The steady-state values of δ, θ, τ^I, and τ^D determine whether the representative firm is subject to a binding or slack credit constraint, which, in turn, dictates to what extent dividend tax adjustments affect the macroeconomy. Examining the time-series of the investment rate, q, dividend taxes, and $\phi = \max\left(0, q - \left(1 - \tau^D\right)\left(1 + \tau^I\right)\right)$ from 1960 to 2020, and using our steady-state propositions, we find that θ over the sample term ranges from a minimum value of 0.06 to a maximum value of 0.34 with an average of 0.15 and a median of 0.122. These estimates lie well within range of Covas and Den Haan (2011), Wang and Wen (2012), Miao, Wang, and Xu (2015), and Miao and Wang (2018), and are used to illustrate the following proposition.

Proposition 4 *A cut (hike) in the dividend tax rate increases (lowers) the stock of capital and welfare when the economy is credit-constrained, conforming to the 'traditional' view of dividend* *taxation. In an unconstrained economy, dividend taxes are irrelevant for the marginal investment decisions and welfare, as hypothesized by the 'new' view of dividend taxation.*

Figure 2 visualizes the changes in the steady-state values of the capital-to-labor ratio, Tobin's q, equity prices, dividend payouts, and welfare when the tax rate is varied between 0 and 50 percent under three distinct borrowing scenarios linked to the minimum, maximum, and average values of θ mentioned above.

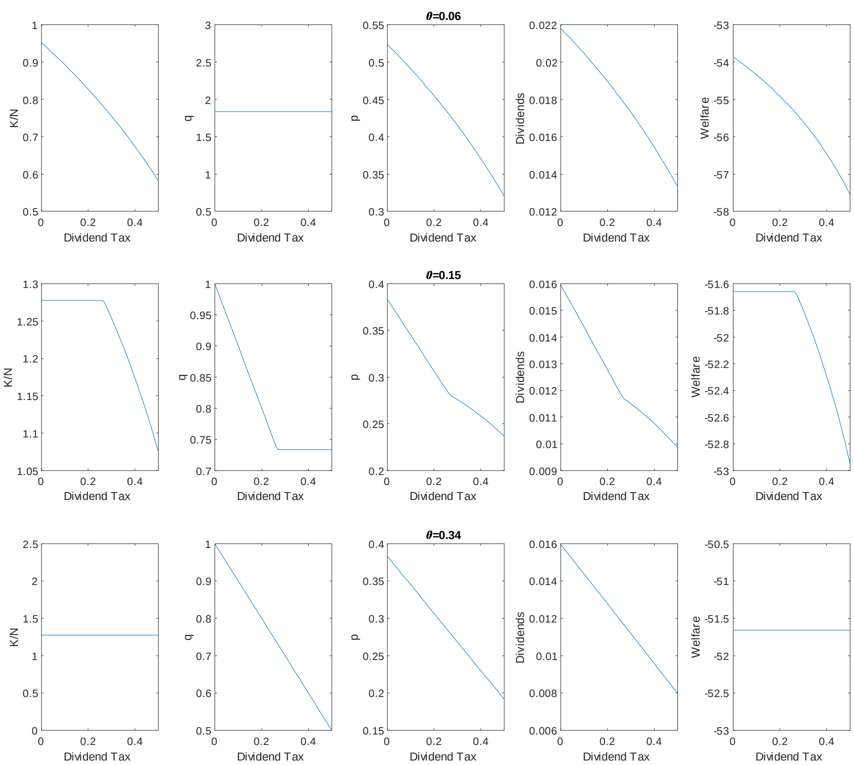

Figure 2: Steady-state values of the capital-to-labor ratio, Tobin's q, equity prices, dividend payouts, and welfare when the dividend tax rate is varied between 0 and 50 percent under three different borrowing regimes.

In the constrained equilibrium ($\theta = 0.06$), a fall in the dividend tax elevates the capital stock, share prices, and dividends but leaves q unchanged (see the first row of Figure 2). As capital is the main driver of output and welfare in neoclassical production economies, tax reductions are thus welfare enhancing in the binding regime.[22] By contrast, in the slack equilibrium ($\theta = 0.34$), where the firm finances investment purchases via retained earnings, a tax on dividends only influences q, p, and $\bar{D}$, leaving capital, investment, and welfare unchanged (see the third row of Figure 2). For the intermediate case ($\theta = 0.15$) and as observed from the second row of Figure 2, the economy finds itself in a constrained equilibrium when the dividend tax rate is greater than 27%. If tax cuts occur from those initially relatively higher tax rates, K/N and steady-state welfare increase until reaching their levels in the slack regime and remain unchanged thereafter (as also postulated from Propositions 2 and 3). At the same time, equity prices and dividends increase at a faster rate as soon as the the economy enters the slack credit region. In all credit regimes and from a qualitative perspective, the capital-to-labor ratio and welfare respond in an identical fashion to dividend tax adjustments. In summary, our results suggest that once credit distortions resulting from initially higher tax rates have been eliminated, further permanent reductions in τ^D below a certain threshold rate are unlikely to stimulate the economy and boost welfare.

In the next subsection, we employ calibrated values to match tax rates, credit spreads, and specific macroeconomic ratios in 2002. Specifically, we fix $\theta_B = 0.1298$, $\delta = 0.1125$, $\tau^D = 0.17$, and $\tau^I = -0.007$ such that the benchmark model economy confronts a constrained steady-state equilibrium with $\phi = 0.0425$ (observe condition (31)). A dividend tax rate of 17% is consistent with the average effective tax rate on dividend payouts in the U.S. prior to the JGTRRA (McGrattan 2023). Given $\delta = 0.1125$ and (34), the value for θ_B is chosen to yield $q_{2002} = 0.8667$. Furthermore, to proxy the borrowing constraint in our model, we utilize the average of two primary corporate credit spreads available in the data. These spreads represent the differences between Moody's Seasoned Baa Corporate Bond Yield and both the Yield on a 10-Year Treasury Constant Maturity and the Yield on a 3-Month Treasury Bill. A benchmark $\phi = 0.0425$ is in line with the 2002 data average of the two considered credit spreads.

Our parameterization implies a steady-state nonresidential investment-to-GDP ratio of 0.13, a nonresidential capital stock-to-GDP ratio of 1.16, and an average net dividend-to-GDP ratio of 0.042. All these statistics are pretty close to their data counterparts in 2002 based on FRED (see also Figures 3 and 5 in McGrattan 2023 for remarkably similar average values in 2002). To examine the state-contingent dynamic responses following temporary dividend tax changes, we compare the case where the initial position of the economy is in a binding steady-state equilibrium to the situation in which the long-run collateral constraint is slack. In the latter and for $\delta = 0.1125$, $\tau^D = 0.17$, and $\tau^I = -0.007$, we can choose any value $\theta_{NB} \geq 0.1365$ so that $\phi = 0$ corresponding with condition (32).

[22] The steady-state welfare measure is given by: $\left(\ln(C) - hN\right) / (1-\beta)$, where $C = \frac{(1-\alpha)}{h}\left(\frac{K}{N}\right)^{\alpha}$ from (6), (8), and (14).

3.2 Temporary Dividend Tax Shocks

Before performing our simulation analysis on the macroeconomic effects of temporary and permanent dividend tax shocks, we also need to calibrate the adjustment cost parameter γ. Values of γ vary significantly in the empirical literature that estimate homogeneity-based neoclassical production economies à la Hayashi (1982). For the purpose of estimating γ, we introduce a technology shock A_t to the model that follows an $AR(1)$ process with a persistence parameter $\rho_A = 0.90$ and a standard deviation of $\sigma_A = 0.013$ (e.g., Guerrieri and Iacoviello 2015). These moments imply a logarithmic output standard deviation of approximately 4.1%. At the same time, we choose a value for the adjustment cost parameter to match the standard deviation of logarithmic nonresidential investment in the data, which is around 6%. Our estimation of the *occasionally-binding* stochastic model yields $\gamma = 0.80$, a strikingly close value to the one reported by Gourio and Miao (2011). To solve the model with an occasionally-binding collateral constraint, we employ the OccBin and DynareOBC algorithms developed by Guerrieri and Iacoviello (2015) and Holden (2016), respectively, both of which generate identical results.

Let's now delve into the policy experiments. We start by comparing the behavior of two economic models: the permanently unconstrained economy model and the occasionally credit-constrained model. This comparison follows a 5 percentage point dividend tax rate reduction, taking it from the initial 17% down to 12%. Next, we undertake a similar experiment, but this time with a more significant tax reduction, moving from 17% to 9%. Our choice of an 8 percentage point tax cut aligns with the magnitude of change observed in effective dividend tax rates following the JGTRRA, as calculated by McGrattan (2023). The tax adjustment in all scenarios occurs in period 1, is assumed to be temporary, and lasts for 8 periods. After the 8 periods, τ^D reverts to its previous long-run level. Suppose the tax policies are unanticipated initially, but once they occur, the agents have perfect foresight about their future paths. For instance, the 2003 JGTRRA was originally scheduled to expire in 2009, despite being extended in 2010 and then again in early 2013. This highlights the transient yet persistent nature of such fiscal reform that motivates the examination of the immediate- and medium-term effects of temporary dividend tax shocks. Additionally, previous studies on the JGTRRA have analyzed tax changes of varying degrees based on the specific income bracket considered and the methodology utilized for computing dividend taxes.[23] This could account for some of the inconsistencies in the results regarding the overall

[23] For instance, Poterba (2004) considers the weighted average household dividend tax rate, which dropped from 32.1% in 2002 to 18.5% in 2003. Yagan (2015), on the other hand, focuses on the highest combined federal plus state marginal tax rate that fell from 44.7% percent to 20.8% following the JGTRRA. Gourio and Miao (2010, 2011) analyze a maximum 10 percentage point dividend tax reduction in their experiments. In any case, our analysis encompasses tax changes of varying magnitudes, revealing that the shock size and anticipated time horizon of the reform significantly influence the direction and responses of key macroeconomic variables.

impact of dividend tax reductions on the macroeconomy. The simulations presented in the following two subsections shed light on the distinctly contrasting and non-linear outcomes arising from transitional, permanent, and different sized payout tax shocks.

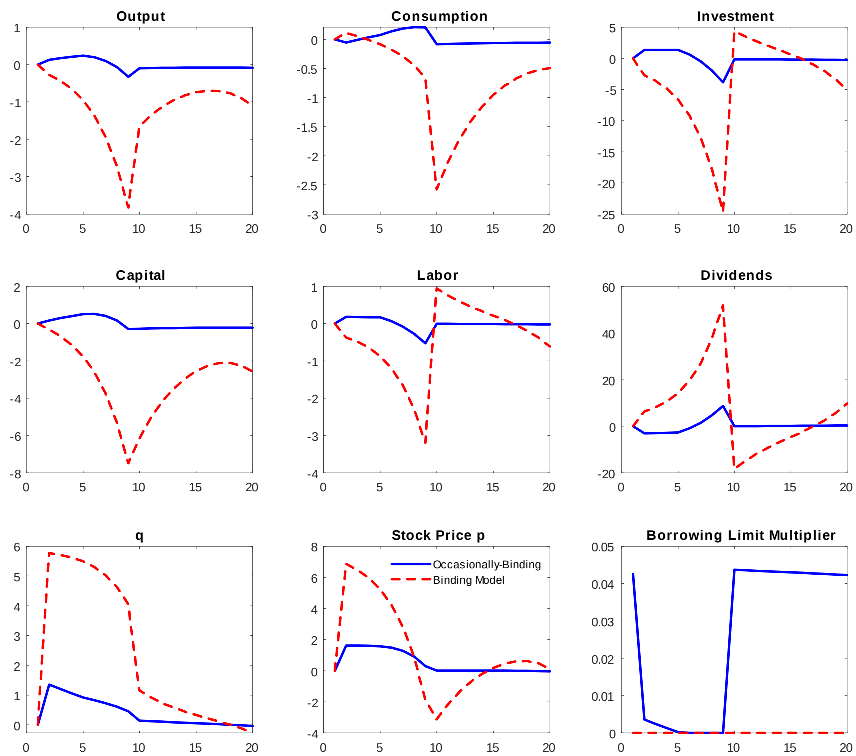

Figure 3: Dynamic responses following an unexpected temporary 5 percentage point dividend tax cut in the occasionally-binding and permanently slack models. Except for the borrowing limit multiplier that is calculated in levels, all other variables are measured in percentage deviations from the different steady-states corresponding with the different credit regimes.

The dynamics of key variables following the 5 percentage point temporary tax shock are shown in Figure 3. In the permanently unconstrained credit regime, a transitional dividend tax cut generates a collapse in investment and therefore in capital accumulation and output. These results are largely in line with the findings of Gourio and Miao (2011), who also show that firms distribute large dividends and cut back on capital investment in response to a transitory lower dividend tax rate. Furthermore, from equations (21), (25), and (27) with $\phi_t = 0$ for all t, Tobin's q initially rises upon the impact of the tax reduction, thereby lowering the user cost of capital, and placing some upward pressure on I in period 1. However, q starts to decrease until period 8 and then slowly converges to its steady-state because τ^D rises back permanently to its original rate at the start of period 9. Investment follows an opposite path to q as the effect of increasing dividends in response to the tax cut dominates the otherwise positive relationship between investment and its shadow price. In view of the anticipated tax policy reversal from period 9, the firm responds by sharply cutting dividends and accelerating investment in period 8. This leads to a slower rate of decline in q in the following year.

Due to the sharp rise in stock prices and an intertemporal substitution mechanism, consumption experiences a slight uptick during the initial tax implementation period in the frictionless setup. Furthermore, despite the Ricardian nature of the model and the absence of government spending, a tax cut today is financed by reducing lump-sum transfers required to maintain a balanced intertemporal household budget.[24] The combination of this small negative wealth effect and the large fall in capital accumulation, as explained above, leads to a situation where consumption remains below its steady-state level for a considerable amount of time. Given conditions (6), (8), and (14), together with capital being predetermined at the start date of the tax reform, employment shrinks, which, in turn, amplifies the decrease in output.[25] To summarize, lower temporary dividend taxes have an overall *strong* short- and medium-term *contractionary* impact on the real economy in a model without financial frictions.

On the other hand, when the credit regime is only occasionally binding, the same dividend tax cut results in a moderate investment, capital, and output rise by 1.36%, 0.53%, and 0.24%, respectively. The aforementioned large dividend payout prevailing in the unconstrained model is counteracted by the relaxation in the tightness of the collateral constraint that is directly impacted by the fall in τ^D. Intuitively, the reduced dividend tax raises q by increasing the value of the firm's collateralized capital stock. With an initially binding steady-state collateral constraint, the firm can engage in additional borrowing and raise its investment in physical capital. The temporary 5 percentage point tax cut relaxes the credit constraint from periods 1 to 8 with the constraint turning slack during periods 5 to 8. Subsequently, in period 9, there is an immediate jump to the originally positive long-run level of ϕ. The firm takes advantage of the interim relaxed credit environment to make further investments and to limit dividend payments in the first period. However, from periods 2 to 8 and as the capital stock is expected to improve, which allows the firm to borrow

[24] The model dynamics are independent of the timing of the adjustment in T.

[25] Gourio and Miao (2011) find that employment and investment move in the opposite direction of output in the immediate periods following the tax shock.

against future earnings, dividend distributions increase while investment gradually declines. Once the tax relief expires, both these variables slowly return to their steady-states.

The behavior of consumption in the frictional model can be explained as follows. In the first period, households postpone consumption due to an intertemporal substitution effect linked to the instantaneous rise in investment and in the marginal product of capital. Moreover, a reduction in distortionary dividend taxes is met with a fall in lump-sum transfers that produce a small negative wealth effect and an immediate increase in the labor supply. However, under the assumption that the tax cut policy sunsets together with the slightly higher than average investment level in the years of the reform, consumption overall exhibits lumpiness and remains above its long-run level throughout most of the duration of the tax reform and beyond. Altogether, easing the tightness of the investment credit limit in relation to the binding steady-state results in dividend taxes inducing *modest* short- and medium-term *expansionary* effects on the real economic activity.

Unlike our paper, Gourio and Miao (2011) in their extended model with debt financing do not predict that investment rises in the period when the dividend tax cut occurs. In fact, their model suggests that the transitional dynamics of real variables with and without debt are very similar. When the debt limit applies directly to investment in capital like in our framework, the short-term macroeconomic effects of small to moderate temporary dividend tax reforms become more consistent with the 'traditional' view of dividend taxation. As in House and Shapiro (2006), output, labor, and investment also exhibit a procyclical relationship on impact, irrespective of the economy's initial credit position.

To illustrate the state-contingent and non-linear effects caused by tax cuts of different magnitudes, consider now the more relevant scenario of an 8 percentage point tax reduction within the context of the JGTRRA. The results are presented in Figure 4. In contrast to a small tax reform scenario, a larger tax cut leads to overall *contractionary* macroeconomic effects, even in the occasionally-binding model. While investment, labor, and output initially experience some relatively muted growth during the first period, they quickly decline below their steady-state values just as dividends begin to rise. This outcome raises the user cost of capital, dilutes the value of capital as a collateral asset for securing investment loans, and consequently leads to a cutback in capital accumulation (see also equations (25) and (27)). Furthermore, a tax relief of 8 percentage points raises the attractiveness of dividend payouts against investments within the firm, and triggers an approximate fourfold increase in q compared to the case of a 5 percentage point tax stimulus (compare the solid blue lines in Figures 3 and 4). Both the borrowing constraint expectations channel and the greater incentive to distribute dividends following the bigger tax cut contribute to the slowdown in economic activity. Hence, the upshot of implementing a larger tax relief is that it negates the medium-term expansionary effects stemming from smaller tax decreases and the temporary slack credit regime.[26] The presence of the financial friction also considerably dampens the dynamics of the model in comparison to the frictionless setup, resulting in much more realistic investment reactions to dividend tax reforms.

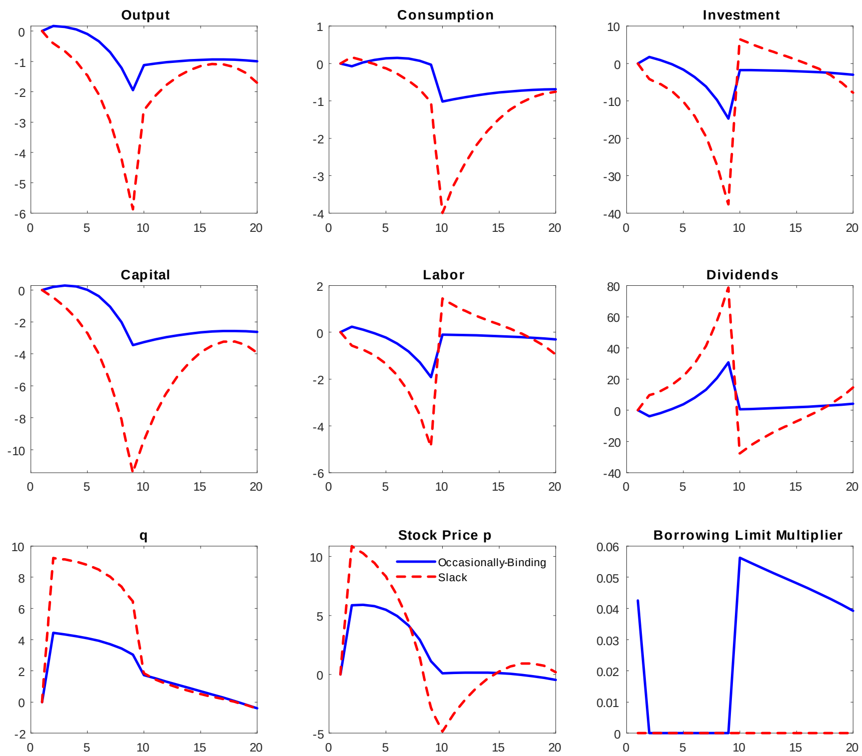

Figure 4: Dynamic responses following an unexpected temporary 8 percentage point dividend tax cut in the occasionally-binding and permanently slack models. Except for the borrowing limit multiplier that is calculated in levels, all other variables are measured in percentage deviations from the different steady-states corresponding with the different credit regimes.

Taking stock, we present an alternative theoretical explanation for why the substantial 2003 U.S. dividend tax cut may have had a muted or negative impact on aggregate investment according to

[26]Based on our model's analysis, implementing larger temporary tax cuts, resulting in a looser credit constraint, would lead to a mitigated rise or even a decline in investment from period 1 onwards. Moreover, in this scenario, the rise in q is amplified, as illustrated in Figure 5 below with a 10 percentage point tax cut. The direct investment rate-q relationship is impeded when the value of $\phi / \left(1 - \tau^D\right)$ is further reduced, as previously explained.

some studies (Desai and Goolsbee 2004; Chetty and Saez 2005; Anagnostopoulos, Cárceles-Poveda, and Lin 2012; Yagan 2015), and why smaller tax adjustments, like those implemented in Sweden and South Korea, had a more positive effect on the economic activity (Jacob 2021; Moon 2022). In addition, the model offers another justification for the documented rise in short-term corporate investment among firms facing tighter financial constraints and relying on external funding for investment, as evidenced in Auerbach and Hassett's (2006) and Campbell, Chyz, Dhaliwal, and Schwartz's (2013) analysis of the 2003 JGTRRA. Indeed, a central argument of this paper is that the magnitude and direction of macroeconomic and financial variables following temporary dividend tax cuts are determined by *both* the degree of financial market imperfections *and* the size of the tax shock.

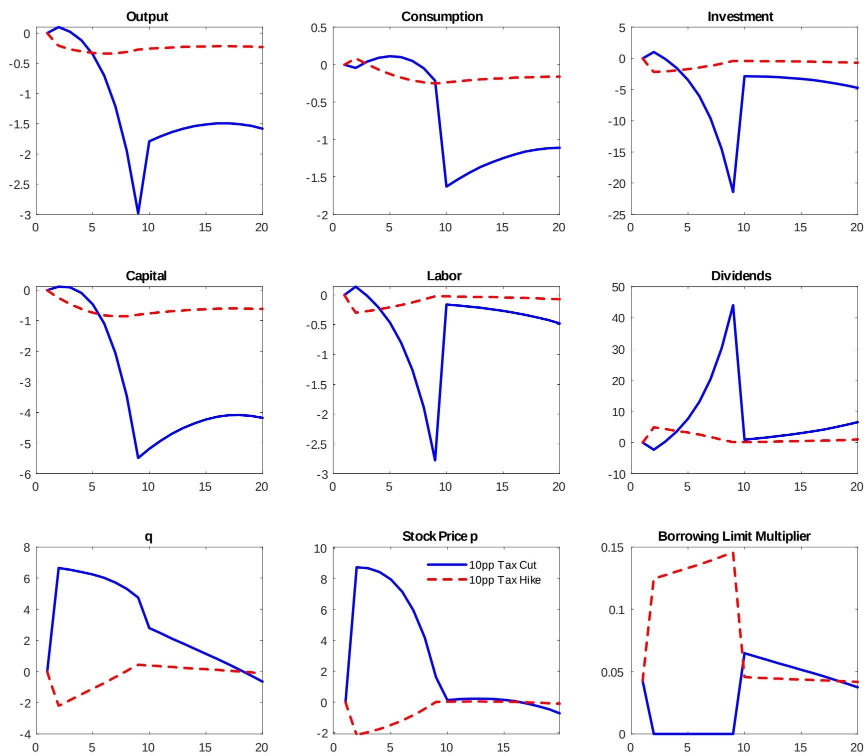

Figure 5: Dynamic responses following an unexpected temporary 10 percentage point dividend tax cut and hike. Except for the borrowing limit multiplier that is calculated in levels, all other variables are measured in percentage deviations from the common credit-bound steady-state equilibrium.

The current framework also sheds light on the asymmetrical macroeconomic effects caused by the interplay between dividend taxes and the occasionally-binding investment debt friction. This is a unique feature that is not present in previous dividend tax literature that either lack contractual financial frictions or assume frictions to be always binding. Figure 5 shows the dynamic responses resulting from a 10 percentage point tax cut and hike relative to a steady-state equilibrium with a binding constraint. Both tax reforms are expected to remain in place for 8 periods. The tax increase leads to a tighter credit constraint, causing an initial amplified decline in investment, labor, and output compared to the dynamics originating from a mirror-image tax cut that temporarily transitions the credit regime from binding to slack. Specifically, after the tax cut (hike), investment reaches its peak (trough) at $+1.03\%$ (-2.17%). Nonetheless, as explained through the previous experiments, the credit limit continues to operate only in terms of expectations when the constraint is slack. During the lax credit period, the firm discounts the significance of the borrowing constraint channel. Thus, in comparison to an equally-sized tax hike, the effects of a tax reduction on real variables are virtually muted in the first two periods, but grow considerably stronger and negative as the slack regime persists. We effectively capture the potentially asymmetric responses of investment to unexpected temporary dividend tax changes, a point also made by Jacob (2021) and Bilicka, Guceri, and Koumanakos (2023).[27] These asymmetrical and non-linear outcomes become even more dramatic with larger tax changes.

A final important insight from the simulations above is that when the investment debt friction is taken into account and for an initially binding steady-state equilibrium, there is a strong positive (negative) correlation between I and q after temporary moderate (large) payout tax reductions (see Figures 3 and 4). The otherwise positive link between these two variables following more modest tax reforms is weakened and may even break down when the the credit multiplier, expressed as a fraction of the stock market valuation $\phi/\left(1-\tau^{D}\right)$, remains persistently and significantly low. At the same time, investment and q always follow an opposite path in response to lower dividend taxes when the financial constraint is permanently slack. Unlike the state-contingent correlations arising from tax cuts, a dividend tax hike that raises the shadow cost of investment borrowing consistently produces a tight relationship between I and q (as shown in Proposition 1 and Figure 5). We conclude that the short-term connection between investment and q is also determined by the degree of financial market imperfections, as well as by the magnitude and direction of payout tax reforms.

[27] Although not shown in the figures above, a tax increase in a frictionless model ($\phi_t = 0$ for all t) generates expansionary effects, supporting the empirical findings of Bilicka, Guceri, and Koumanakos (2023). By contrast, a higher dividend tax rate reduces investment in the occasionally-binding model as shown in Figure 5 (see also Black, Legoria, and Sellers 2000; Becker, Jacob, and Jacob 2013). In other words, the investment spending friction can also account for state-dependent macroeconomic dynamics following payout tax *hikes*.

3.3 Model Validation

This subsection aims to assess if state-contingent and non-linear investment rate and q dynamics in the U.S. may be ascribed to the interaction between historical dividend tax reductions, their expected duration, and financial frictions. We confine our attention to three major tax reform episodes that corresponded with significant reductions in the effective marginal dividend tax rate. These episodes include the tax cuts that occurred around the 1981 Economic Recovery Tax Act (ERTA), the 1986 Tax Reform Act (TRA), and the 2003 Job Growth and Taxpayer Relief Reconciliation Act (JGTRRA). According to McGrattan (2023), around the years of the reform legislations and up to their final implementations, the effective distribution tax rate exhibited the following trends: between 1981 to 1982-1983, it decreased on average from 37% to 29%; from the period 1984-1986 to 1987-1989, it fell from around 25% to 17%; and from 2002 to 2003, it dropped from 17% to 9%.[28] All reforms were implemented with comparable magnitudes on effective tax rates, enabling a more insightful analysis of the financial friction's influence on investment rate dynamics.

The tax reforms of the 1980s were unanticipated and presented as permanent. We therefore focus on the model predictions with the movements of the selected variables in the data assuming tax shocks last for 100 periods. Simultaneously, we present counterfactual trajectories that envision the tax cuts as anticipated to last merely 10 periods. Moreover, we assume that the 2003 tax reform is projected to persist for a decade, in line with the evidence that the tax reduction was partially rolled back in 2013 and the notion that certain market participants might have anticipated tax cuts to extend beyond their initial intent. In fact, Gourio and Miao (2010, 2011) and Anagnostopoulos, Cárceles-Poveda, and Lin (2012) even contemplate the permanence of the JGTRRA in some of their policy experiments. In line with the counterfactual approach outlined in these papers, we also consider the scenario wherein the JGTRRA was alternatively perceived as a permanent measure.

Table 1: Aggregate Statistics before the 1980s and 2003 Tax Reforms.

	1981	1984-1986	2002
τ^D	0.37	0.25	0.17
I/K	0.105	0.112	0.1125
q	0.316	0.467	0.8667
ϕ	0.043	0.036	0.0425
τ^I	-0.567	-0.425	-0.007

To carry out this experiment, we first recalibrate the model to match the dividend tax rate,

[28] According to McGrattan (2023), the effective tax rate on dividends exhibited slight fluctuations between the reform years. For the sake of simplicity in our analysis, we posit that the effective dividend tax rate in the year following each reform remains constant.

nonresidential investment rate, and q observed during the years prior to the announcement of each of the 1980s tax reforms. The calibration before the 2003 JGTRRA is the same as in the previous subsection. Then, using Propositions 2 and 3, and importantly altering the value of τ^I to target the average corporate spread in the data, we can determine the degree of the financial constraint ϕ. All the other structural parameters $(\beta, \alpha, h, \gamma)$ and the business profit tax rate (τ^π) are set to the estimates used in the previous subsections. Table 1 displays the calculated targeted values for τ^D, I/K, q, and ϕ based on the aggregate data for 1981, 1984-1986, and 2002 as well as the resulting estimate in these years for τ^I.

According to our calculations, the U.S. economy was prone to a binding credit equilibrium in the years before the 1980s Tax Acts. However, during the 1984-1986 period, the financial constraint was relatively looser compared to 1981. We employ the initial credit spread values prior to the different tax regimes as the initial reference points for the model's quantitative predictions in the post-reform years. Note that the negative values for τ^I calculated for the 1980s are not inconsistent with the average investment subsidies across industries found in House, Mocanu, and Shapiro (2017).

As per the analysis of House and Shapiro (2006) and Gourio and Miao (2011), we now compare the simulated dynamics of the investment rate, q, and the borrowing friction multiplier with their corresponding data representations subsequent to the historical tax legislations. The results are presented in Figure 6.

Our framework successfully captures the fact that the 1981 ERTA produced a relatively stronger impact on the investment rate and q compared to the 1986 TRA. The tax reform of 1986 had a smaller short-term effect on the investment rate and mainly resulted in a sharp rise in asset prices, as also illustrated in Figure 6. These findings are largely consistent with McGrattan and Prescott (2005), who show that the capital-to-output ratio remained virtually unchanged during the mid-1980s despite significant increases in corporate equity values.

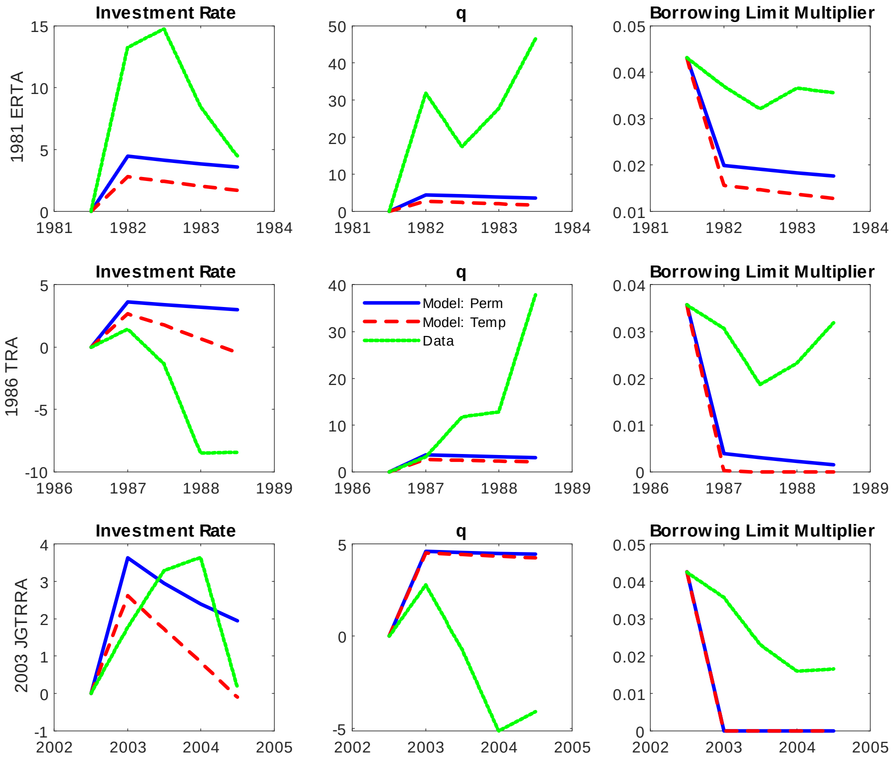

Figure 6: Comparison of the simulated results with the actual data following the 1981, 1986, and 2003 Tax Acts. The investment rate and q are measured in percentage deviations from steady-state, while the multiplier (spread) is measured in levels. We normalize the actual data and simulated data by their pre-reform values detailed in Table 1.

The current model proposes that the relatively modest expansionary real effects observed after the 1986 reform might be attributed to the pre-existing credit friction tightness, which was already relatively lax before the 1986 tax cut. As our argument unfolds, the stimulative potential of dividend tax reliefs tends to be limited when the economy starts from a less restrictive credit environment characterized by lower credit spreads. The reason why the 1981 ERTA was more effective in raising the investment rate upon impact, by around 4.5%, compared to the approximate 3.6% increase following the 1986 TRA, can be attributed to the idea that tighter financial conditions preceding the 1981 reform created a greater scope for tax cuts to exert a positive impact on real variables. This observation suggests that the effectiveness of tax reductions in boosting investment is influenced by the initial tightness of the investment credit constraint.

It is worth noting that when considering a *temporary* tax cut, the resulting investment rate and q dynamics tend to be subdued due to the anticipation of a forthcoming reversal in the tax policy. In the context of the 1986 reform, the investment rate fluctuations predicted by the model immediately after the shock align more closely with the modest increase observed in the actual data. This suggests that the 1986 TRA may not have been perceived as entirely permanent.

The model's predictions regarding the (initially) temporary 2003 JGTRRA are also generally consistent with the actual data movements. The financial constraint, proxied by the average credit spread, eased after the implementation of the tax reform, but remained positive in the subsequent years. This outcome can partly account for the overall elevated investment-to-capital ratio observed in the immediate periods following the reform and the relatively sharp decline in the medium-term. To a certain extent, the immediate fluctuations in the model-implied investment rate show greater similarity to the data when assuming a permanent tax reduction. Finally, while the simulated investment rate follows a similar path as the data, the peak point of this variable is delayed by one period compared to the model's projections.

Admittedly, the present analysis does not account for aggregate uncertainty, business cycle, and monetary policy effects that most likely contributed to heightened fluctuations in the years before and after the tax reforms. Therefore, we cannot fully accredit the overall changes in aggregate investment rates to the various Tax Acts. Notwithstanding, our framework offers a novel perspective on the short-term implications of historical dividend tax cuts. The model effectively captures the trends observed in the data and provides a satisfactory fit in measuring the instantaneous impacts of the tax reforms on investment rates.

4 Conclusions

We have devised a general equilibrium business cycle framework that connects the various views on the macroeconomic effects of dividend taxation by introducing an occasionally-binding investment credit limit. The impact of changes in dividend tax policies on the economic activity can be varied and contradictory, depending on the size of the reforms, their expected time span, and the permanent and temporary financial conditions faced by the average firm. The interplay between dividend taxation and the LTV ratio determines the effectiveness of tax cuts in stimulating real variables in the deterministic steady-state. In the short- and medium-run, the occasionally-binding debt constraint can explain why dividend tax changes produce state-dependent and non-linear dynamics as well as asymmetric macroeconomic outcomes, consistent with empirical evidence.

Overall, our findings suggest that existing theoretical and empirical work examining the impact of dividend taxation on the real economy and asset prices might be incomplete without analyzing the tight interaction between corporate distribution taxes and borrowing frictions on productive investment. Considering policy implications and assuming more accurate assessments of the economy's credit position, altering the dividend tax rate in a state-contingent fashion can induce non-negligible macroeconomic effects in the short- and long-run, thereby serving as a potential policy instrument to counteract business cycle fluctuations and promote real growth up to a certain limit.

We see three important directions for future research. First, despite the relative simplicity and familiarity of the stylized dynamic general equilibrium setup presented in this article, incorporating household and firm heterogeneity would allow us to understand the distributional effects of dividend taxation from both positive and normative perspectives. A heterogeneous-agent model, for example, could elucidate the potential trade-offs between mitigating inequality through the implementation of elevated dividend taxes on wealthier households, and the aggregate macroeconomic and financial market repercussions. Second, our model focuses merely on dividend taxes and their interactions with occasionally-binding credit limits. A warranted extension would be to enable firms to finance investment through both risky debt and equity, with occasionally-binding restrictions applied to both forms of funding. Then, the model could be used to understand the conditions under which one or both of the constraints become binding or slack, and how these frictions are affected by a richer set of business taxes. Third, by excluding lump-sum transfers, we can consider how collection of dividend taxes finances public expenditures and debt in times of persistently large government deficits. In this regard, analyzing the linkages between financial frictions, various corporation taxes, fiscal deficits, and the economic activity should be high on the research agenda.

Appendix

This appendix provides proofs to Propositions 2 and 3 that are presented in the main text.

Proof of Proposition 2

From the steady-state versions of (9), (12), (16), and $\phi > 0$ we have:

$$I = \delta K = \theta \left[\left(1 - \tau^D\right) \left(1 + \tau^I\right) + \phi \right] K,$$

or after re-arranging $\phi = \frac{\delta}{\theta} - \left(1 + \tau^I\right)\left(1 - \tau^D\right)$. It is straightforward to verify that $\phi > 0$ if and only if $\theta < \frac{\delta}{(1-\tau^D)(1+\tau^I)}$, while $\phi = 0$ if and only if $\theta \geq \frac{\delta}{(1+\tau^I)(1-\tau^D)}$.

Proof of Proposition 3

i) As shown in Proposition 2, the borrowing constraint binds when $\phi > 0$ or $\theta < \frac{\delta}{(1+\tau^I)(1-\tau^D)}$. For $\phi > 0$, combining equations (4), (8), (9), (11), (14), (15), (16), and the after-tax dividend payout $\bar{D}$ in steady-state yields:

$$\frac{(1-\beta)}{\beta} p = \bar{D}, \tag{A1}$$

$$q = \frac{\beta}{\{1-\beta[(1-\delta)+\phi\theta]\}} \left(1-\tau^D\right)(1-\tau^\pi)\,\alpha \frac{N^{1-\alpha}}{K^{1-\alpha}}, \tag{A2}$$

$$q = \left(1-\tau^D\right)\left(1+\tau^I\right) + \phi_t, \tag{A3}$$

$$\bar{D} = \left(1-\tau^D\right)\left[(1-\tau^\pi)\left(\frac{K^\alpha}{N^\alpha} - (1-\alpha)\frac{K^\alpha}{N^\alpha}\right)N - \delta\left(1+\tau^I\right)K\right]. \tag{A4}$$

Substituting $\phi = \frac{\delta}{\theta} - \left(1+\tau^I\right)\left(1-\tau^D\right) > 0$ or $\theta\phi = \delta - \theta\left(1+\tau^I\right)\left(1-\tau^D\right)$ in (A1)-(A4) and re-arranging produces conditions (33)-(36).

ii) The borrowing constraint is slack when $\phi = \frac{\delta}{\theta} - \left(1-\tau^D\right)\left(1+\tau^I\right) = 0$ or $\theta = \frac{\delta}{(1-\tau^D)(1+\tau^I)}$. Moreover, from the complementary slackness condition, the collateral constraint is slack when $I < \theta q K$. Applying $I = \delta K$, $\phi = 0$, and $q = \phi + \left(1-\tau^D\right)\left(1+\tau^I\right)$ we obtain $\theta \geq \frac{\delta}{(1+\tau^I)(1-\tau^D)}$. Substituting $\phi = 0$ in (A1)-(A4) then yields (37)-(40).

References

[1] Abel, Andrew B. 1982. "Dynamic Effects of Permanent and Temporary Tax Policies in a q Model of Investment." *Journal of Monetary Economics*. 9(3): 353-373.

[2] Abel, Andrew B. and Stavros Panageas. 2022. "An Analytic Framework for Interpreting Investment Regressions in the Presence of Financial Constraints." *Review of Financial Studies*. 35(9): 4055-4104.

[3] Anagnostopoulos, Alexis, Orhan Erem Atesagaoglu, and Eva Cárceles-Poveda. 2022. "Financing Corporate Tax Cuts with Shareholder Taxes." *Quantitative Economics*. 13(1): 315-354.

[4] Anagnostopoulos, Alexis, Eva Cárceles-Poveda, and Danmo Lin. 2012. "Dividend and Capital Gains Taxation under Incomplete Markets." *Journal of Monetary Economics*. 59(7): 599-611.

[5] Atesagaoglu, Orhan Erem. 2012. "Taxes, Regulations, and the Corporate Debt Market." *International Economic Review*. 53 (3): 979-1004.

[6] Auerbach, Alan J. 1979. "Wealth Maximization and the Cost of Capital." *Quarterly Journal of Economics.* 93: 433–446.

[7] Auerbach, Alan J. 2002. "Taxation and Corporate Financial Policy." *Handbook of Public Economics.* 3: 1251-1292.

[8] Auerbach, Alan J. and Kevin A. Hassett. 2003. "On the Marginal Source of Investment Funds." *Journal of Public Economics.* 87(1): 205-232.

[9] Auerbach, Alan J. and Kevin A. Hassett. 2006. "Dividend Taxes and Firm Valuation: New Evidence." *American Economic Review.* 96(2): 119–123.

[10] Barro, Robert J. and Jason Furman. 2018. "Macroeconomic Effects of the 2017 Tax Reform." *Brookings Papers on Economic Activity.* 1: 257-345.

[11] Becker, Bo, Marcus Jacob, and Martin Jacob. 2013. "Payout Taxes and the Allocation of Investment." *Journal of Financial Economics.* 107(1): 1-24.

[12] Bilicka, Katarzyna A., Irem Guceri, and Evangelos Koumanakos. 2023. "Dividend Taxation and Firm Performance with Heterogeneous Payout Responses." *National Bureau of Economic Research (NBER) Working Paper No. 30808*

[13] Black, Ervin L., Joseph Legoria, and Keith F. Sellers. 2000. "Capital Investment Effects of Dividend Imputation." *Journal of the American Taxation Association.* 22(2): 40-59.

[14] Bradford, David F. 1981. "The Incidence and Allocation Effects of a Tax on Corporate Distributions." *Journal of Public Economics*, 15: 1–22.

[15] Brinca, Pedro, Varadarajan V. Chari, Patrick J. Kehoe, and Ellen McGrattan. 2016. "Accounting for Business Cycles." *Handbook of Macroeconomics.* 2: 1013-1063.

[16] Campbell, John L., James A. Chyz, Dan S. Dhaliwal, and William C. Schwartz Jr. 2013. "Did the 2003 Tax Act Increase Capital Investments by Corporations?." *Journal of the American Taxation Association.* 35(2): 33-63.

[17] Chetty, Raj and Emmanuel Saez. 2005. "Dividend Taxes and Corporate Behavior: Evidence from the 2003 Dividend Tax Cut." *Quarterly Journal of Economics.* 120(3): 791-833.

[18] Chetty, Raj and Emmanuel Saez. 2010. "Dividend and Corporate Taxation in an Agency Model of the Firm." *American Economic Journal: Economic Policy.* 2(3): 1-31.

[19] Covas, Francisco and Wouter J. Den Haan. 2011. "The Cyclical Behavior of Debt and Equity Finance." *American Economic Review*. 101(2): 877-899.

[20] Croce, M. Max, Howard Kung, Thien T. Nguyen, and Lukas Schmid. 2012. "Fiscal Policies and Asset Prices." *Review of Financial Studies*. 25(9): 2635-2672.

[21] Desai, Mihir A. and Austan Goolsbee. 2004. "Investment, Overhang, and Tax Policy." *Brookings Papers on Economic Activity*. 2: 285-355.

[22] Erosa, Andrés and Beatriz González. 2019. "Taxation and the Life Cycle of Firms." *Journal of Monetary Economics*. 105: 114-130.

[23] Feldstein, Martin S. 1970. "Corporate Taxation and Dividend Behaviour." *Review of Economic Studies*. 37: 57–72.

[24] Gertler, Mark, and Peter Karadi. 2011. "A Model of Unconventional Monetary Policy." *Journal of Monetary Economics*. 58(1): 17-34.

[25] Gourio, Francois and Jianjun Miao. 2010. "Firm Heterogeneity and the Long-Run Effects of Dividend Tax Reform." *American Economic Journal: Macroeconomics*. 2(1): 131-168.

[26] Gourio, Francois and Jianjun Miao. 2011. "Transitional Dynamics of Dividend and Capital Gains Tax Cuts." *Review of Economic Dynamics*. 14(2): 368-383.

[27] Guerrieri, Luca, and Matteo Iacoviello. 2015. "OccBin: A Toolkit for Solving Dynamic Models with Occasionally Binding Constraints Easily." *Journal of Monetary Economics*. 70: 22-38.

[28] Hansen, Gary D. 1985. "Indivisible Labor and the Business Cycle." *Journal of Monetary Economics*. 16(3): 309-327.

[29] Harberger, Arnold C. 1962. "The Incidence of the Corporation Income Tax." *Journal of Political Economy*. 70: 215–240.

[30] Hayashi, Fumio. 1982. "Tobin's Marginal q and Average q: A Neoclassical Interpretation." *Econometrica*. 50(1): 213-224.

[31] Hennessy, Christopher A., Amnon Levy, and Toni M. Whited. 2007. "Testing Q Theory with Financing Frictions." *Journal of Financial Economics*. 83(3): 691-717.

[32] Holden, Thomas D. 2016. "Computation of Solutions to Dynamic Models with Occasionally Binding Constraints." Working Paper.

[33] House, Christopher L. and Matthew D. Shapiro. 2006. "Phased in Tax Cuts and Economic Activity." *American Economic Review*. 96(5): 1835–1849.

[34] House, Christopher L., Ana-Maria Mocanu, and Matthew D. Shapiro. 2017. "Stimulus Effects of Investment Tax Incentives: Production versus Purchases." *National Bureau of Economic Research (NBER) Working Paper No. w23391.*

[35] Isakov, Dušan, Christophe Pérignon, and Jean-Philippe Weisskopf. 2021. "What if Dividends were Tax-Exempt? Evidence from a Natural Experiment." *Review of Financial Studies*. 34(12): 5756-5795.

[36] Jacob, Martin. 2021. "Dividend Taxes, Employment, and Firm Productivity." *Journal of Corporate Finance*. 69: 102040.

[37] King, Mervyn A. 1977. "*Public Policy and the Corporation*." Chapman and Hall, London.

[38] Kiyotaki, Nobuhiro and John Moore. 1997. "Credit Cycles." *Journal of Political Economy*. 105(2): 211–248.

[39] Korinek, Anton and Joseph E. Stiglitz. 2009. "Dividend Taxation and Intertemporal Tax Arbitrage." *Journal of Public Economics*. 93(1): 142-159.

[40] McGrattan, Ellen R. 2023. "Taxes, Regulations, and the Value of U.S. Corporations: A Reassessment." *Review of Economic Dynamics*. forthcoming.

[41] McGrattan, Ellen R. and Edward C. Prescott. 2005. "Taxes, Regulations, and the Value of U.S. and U.K. Corporations." *Review of Economic Studies*. 72(3): 767-796.

[42] Miao, Jianjun and Pengfei Wang. 2014. "Lumpy Investment and Corporate Tax Policy." *Journal of Money, Credit and Banking*. 46(6): 1171-1203.

[43] Miao, Jianjun, and Pengfei Wang. 2018. "Asset Bubbles and Credit Constraints." *American Economic Review*. 108(9): 2590-2628.

[44] Miao, Jianjun, Pengfei Wang, and Zhiwei Xu. 2015. "A Bayesian Dynamic Stochastic General Equilibrium Model of Stock Market Bubbles and Business Cycles." *Quantitative Economics*. 6(3): 599-635.

[45] Moon, Terry S. 2022. "Capital Gains Taxes and Real Corporate Investment: Evidence from Korea." *American Economic Review*. 112(8): 2669–2700.

[46] Occhino, Filippo. 2023. "The Macroeconomic Effects of the Tax Cuts and Jobs Act." *Macroeconomic Dynamics.* 27(6): 1495-1527.

[47] Poterba, James M. 2004. "Taxation and Corporate Payout Policy." *American Economic Review.* 94(2): 171-175.

[48] Poterba, James M. and Lawrence H. Summers. 1983. "Dividend Taxes, Corporate Investment, and 'Q'." *Journal of Public Economics.* 22(2): 135-167.

[49] Poterba, James M. and Lawrence H. Summers. 1985. "The Economic Effects of Dividend Taxation." In: *Recent Advances in Corporate Finance*, Edward I. Altman and Marti G. Subrahmanyam (Editors), 227-284. Homewood, IL: Dow Jones-Irwin Publishing.

[50] Santoro, Marika and Chao Wei. 2011. "Taxation, Investment, and Asset Pricing." *Review of Economic Dynamics.* 14(3): 443-454.

[51] Sinn, Hans-Werner. 1991. "The Vanishing Harberger Triangle." *Journal of Public Economics.* 45(3): 271-300.

[52] Stojanović, Danilo. 2022. "The 2003 Tax Reform and Corporate Payout Policy in the U.S." CERGE-EI Working Paper Series 727.

[53] Tobin, James. 1969. "A General Equilibrium Approach to Monetary Theory." *Journal of Money, Credit and Banking.* 1(1): 15-29.

[54] Wang, Pengfei and Yi Wen. 2012. "Hayashi meets Kiyotaki and Moore: A Theory of Capital Adjustment Costs." *Review of Economic Dynamics.* 15(2): 207-225.

[55] Yagan, Danny. 2015. "Capital Tax Reform and the Real Economy: The Effects of the 2003 Dividend Tax Cut." *American Economic Review.* 105(12): 3531–3563.

[56] Zwick, Eric, and James Mahon. 2017. "Tax Policy and Heterogeneous Investment Behavior." *American Economic Review.* 107(1): 217-248.