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Abstract

Dividends and share repurchases are taxed, but raising funds does not offer a symmetric tax advantage. Hence, it is preferable for the firm to retain cash if the funds may be needed later. The paper formalizes this cash accumulation motive in a corporate finance model that trades off the advantages of saved personal taxes against agency and corporate tax costs of keeping cash inside the firm. Calibration of the model reveals an optimal average cash level of 24% of net asset value, about half of which is explained by the tax asymmetry motive. We present empirical evidence for the tax asymmetry motive by verifying a positive relation between the effective dividend tax rate and corporate cash holdings. We also show theoretically and empirically that this motive is more important for firms with high volatility, low agency cost, and low corporate tax rates.

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1. Introduction

U.S. firms hold large amounts of cash on their balance sheets. For instance, the cash holdings of AT&T, Facebook, and Johnson & Johnson in 2017 exceeded 50, 41, and 18 billion USD, respectively.[1] Not only are corporate cash holdings large in absolute dollar terms, but also when compared to assets. The average ratio of cash-to-assets of all U.S. Compustat firms over the years 2001–2014 amounted to 22.64% (Graham and Leary, 2018), with a ratio of 20.54% in 2011 (Pinkowitz, Stulz, and Williamson, 2016). This paper explores a motive for holding cash that has been overlooked in the literature, namely, the tax asymmetry motive. The tax asymmetry motive to hold cash stems from the fact that dividends are taxed, but raising funds does not offer the symmetric tax rebate. Thus, there is a tax-saving motive to retain cash, if the funds are potentially needed later.

To explore the quantitative importance of the tax asymmetry motive, we develop a corporate finance model. In this model, firms trade off saved taxes against the agency and tax costs of accumulating cash. Firms optimally choose capital structure, the liquidity and payout policy, and whether to inject funds or default in case the firm runs out of cash. Injecting funds is subject to financing cost, and default entails the loss of a fraction of the going-concern firm value. For a large range of realistic parameter values, we find that firms optimally inject new funds instead of defaulting when corporate liquidity is exhausted. In this case, the model features both the tax asymmetry motive to hold cash and also a standard transaction motive. The transaction motive occurs because injecting funds is costly and, hence, there is a motive to hold cash to avoid these costs.

While the tax asymmetry motive to hold cash is intuitive, its actual importance is less clear. We therefore start by investigating the quantitative importance of the tax asymmetry motive in isolation. Our model permits us to distinguish the tax asymmetry motive from the transaction motive by setting injection costs to zero. In this case, the tax asymmetry motive is the only motive to hold cash in the model. The implied average cash level for a firm with only the tax asymmetry motive exceeds 19% of asset value. This result indicates that the tax asymmetry

[1] Source: Compustat, variable cash and marketable securities (CHE), fiscal year 2017.

motive is a key driver of corporate cash holdings. Next, we consider the base case, in which we have both the tax asymmetry and the transaction motive to hold cash. In this case, the implied average cash level exceeds 24% of asset value. This result is of the same order of magnitude reported by Graham and Leary (2018), who find an average cash-to-asset ratio of 22.64% in 2001–2014 (16.73% in 1991–2000). Bates, Kahle, and Stulz (2009) report average ratios of cash to assets ranging between 10% and 24%. To quantify the impact of the tax asymmetry motive in the presence of the transaction motive, we focus on the tax asymmetry contribution (TAC). TAC is defined as the percentage increase in cash when both the tax asymmetry and transaction motives are present compared to the case in which only the transaction motive is present. In the base case, TAC amounts to 41%. That is, average cash levels increase more than 40% due to the tax asymmetry motive. The results are robust to parameter variations and suggest that the tax asymmetry motive is a key determinant of corporate cash holdings.

Our results have implications for tax policies. Specifically, the tax asymmetry motive suggests that increasing dividend taxes incentivizes firms to hold more cash. The model allows us to quantify this effect. We find that, for realistic parameter values, a one percentage point increase in the dividend tax rate augments both the average cash level and the average ratio of cash to net assets by more than 3%.

While dividend taxes have a first order impact on cash holdings, the analysis reveals that they have only a minor effect on average dividend payouts. On the one hand, a higher dividend tax rate has a direct negative effect on expected dividends by way of increasing the payout boundary. On the other hand, it has an indirect positive effect as the higher dividend tax lowers the value of equity and, therefore, firms also issue less debt, which, in turn, results in firms distributing more dividends to equity. We find that these two forces are of similar quantitative importance and, overall, entail only a minor impact on expected dividends. The empirical evidence on the impact of dividend taxes on dividends and total payout is mixed. Papers documenting a small or no impact include Brown, Liang, and Weisbenner (2007), Edgerton (2013), Alstadsæter, Jacob, and Michaely (2017), and Jacob and Michaely (2017), while studies documenting an important impact include Chetty and Saez (2005), Blouin, Raedy, and Shackelford (2011), and Isakov, Pérignon, and Weisskopf (2018). In addition, survey evidence of Brav, Graham, Harvey, and

Michaely (2008) suggests that the impact of the 2003 dividend tax cut on dividend payments and initiation was small to moderate.

The main empirical prediction from the model is that there should be a positive relation between the effective dividend tax rate and corporate cash holdings. This relationship is confirmed using two different empirical measures of effective dividend tax rates derived from Poterba (2004) and Sialm (2009). The results indicate that from 1980 to 2000 firms on average build up 1.4% more cash holdings to assets each year because of the relative decrease in the dividend tax rate.

Finally, we test a set of additional empirical predictions from the model regarding which types of firms should be the most sensitive towards the tax asymmetry motive. These predictions separate the firms based on their cash flow volatility, agency costs, bankruptcy costs, and effective corporate tax rates. Specifically, the model predicts that the tax asymmetry motive is more important for more volatile firms as a higher cash flow volatility increases the probability of running out of cash. In addition, the tax asymmetry motive should be more important for firms with lower agency cost and firms with lower corporate tax rate. For both variables, the reason is the decreased cost of holding cash, which renders the tax asymmetry motive more important. We find that the model predictions for these variables are all confirmed in the data.

Literature. The paper belongs to the literature studying the motives to hold cash. Bates, Kahle, and Stulz (2009) detail the four motives proposed so far: The transaction motive, the precautionary motive, the repatriation tax motive, and the agency motive. The transaction motive refers to the idea that a firm incurs transaction costs when converting a noncash financial asset into cash (Keynes, 1936; Baumol, 1952; Miller and Orr, 1966). The precautionary motive is that firms hold cash in anticipation of adverse shocks when accessing capital markets exhibits frictions (Keynes, 1936). The repatriation tax motive occurs because U.S. corporations repatriating foreign income incur a tax obligation when doing so (Foley, Hartzell, Titman, and Twite, 2007). The agency motive arises because entrenched managers can be reluctant to pay out cash to shareholders and have a preference for free cash flow instead (Jensen, 1986).[2] Our

[2]A number of papers investigate empirical evidence for these motives. Examples of testing predictions from the transaction and precautionary motives include Mulligan (1997), Opler, Pinkowitz, Stulz, and Williamson

paper highlights a fifth motive related to the tax asymmetry.

Our paper also contributes to the literature examining the impact of taxation on corporate policies, in particular corporate liquidity management. Classical papers on personal taxes and corporate liquidity management include Auerbach (1983) and Poterba (1987). More recently, Hennessy and Whited (2005) and Hennessy and Whited (2007) explore the implication of a tax environment on the corporate and personal level in a dynamic model. Their analysis includes investment, financing, and financing costs, and focuses on implications of corporate taxation on cash holdings, but not on the tax asymmetry motive. Bolton, Chen, and Wang (2014) also analyze how the tax environment impacts corporate liquidity management, but their model does not include the tax asymmetry motive. In particular, in their model, variations in the dividend tax rate do not alter the payout boundary or average implied cash levels. Our paper contributes to this literature by recognizing and quantifying the impact of the dividend tax asymmetry on corporate cash holdings.

The paper is also related to the literature on the impact of taxes on other corporate policies such as capital structure (e.g., Miller, 1977, DeAngelo and Masulis, 1980, MacKie-Mason, 1990, Graham, 1996, and Faccio and Xu, 2015). Two long-standing theories of corporate taxation include the neoclassical, "old view" of dividends (Harberger, 1962, Feldstein, 1970, and Poterba and Summers, 1985) and the "new view" (King, 1970, Auerbach, 1979, and Bradford, 1981). Both views analyse dividend payments and investment jointly. More recent contributions on the impact of dividend taxes on investment include Auerbach (1986), Becker, Jacob, and Jacob (2013), and Yagan (2015), while, e.g., Desai and Jin (2011) and Jacob and Michaely (2017) investigate the impact of dividend taxes on dividend payments.

2. The model

We first present the model assumptions and subsequently present its solution.

(1999), Almeida, Campello, and Weisbach (2004), Han and Qiu (2007), and Acharya, Bharath, and Srinivasan (2007b). For further evidence on the repatriation tax motive, see Harford, Wang, and Zhang (forthcoming) and references cited therein. Examples of papers providing evidence regarding the agency motive of cash are Dittmar, Mahrt-Smith, and Servaes (2003), Pinkowitz, Stulz, and Williamson (2006), Dittmar and Mahrt-Smith (2007), and Harford, Mansi, and Maxwell (2008). In addition, Pinkowitz, Stulz, and Williamson (2016) show that U.S. firms hold more cash on average than foreign firms do, and that this effect is driven by U.S. R&D-intensive firms.

2.1. Assumptions

A firm generates cash flows, $\mathrm{d}X_t$, which are the increments of an arithmetic Brownian motion, X, following the dynamics

$$\mathrm{d}X_t = \mu \mathrm{d}t + \sigma \mathrm{d}Z_t. \tag{1}$$

Z is a standard Brownian motion under $\mathbb{Q}$. μ and σ denote the drift and volatility of the cash flow process, respectively. This setup allows for positive and negative cash flows. Shocks to cash flows are purely transitory.[3]

The firm is financed by issuing infinite maturity debt and equity. As in Bolton, Chen, and Wang (2014), equity issuances involve a fixed cost ϕ and a proportional cost γ. Debt is issued with a fixed promised coupon rate b. The firm can default on its debt obligation, which leads to costly restructuring. The restructuring cost is $1 - \alpha$ of firm value.

The firm is subject to corporate taxes at the rate τ_c. Payments to debt holders are shielded from this taxation. The firm chooses its capital structure to maximize firm value. The optimal capital structure is implemented initially and at potential restructurings. To our knowledge, we are the first to allow for repeated optimal restructurings upon default in a model of cash holdings. In existing models, defaults trigger liquidation either at a fixed liquidation value (e.g., Bolton, Chen, and Wang, 2014 or Hugonnier, Malamud, and Morellec, 2015) or at a fraction of the unlevered firm value (Gryglewicz, 2011).

At any time (including time zero), equity holders can inject cash into the firm, retain cash, or pay out cash. To inject cash, equity holders issue new equity. The firm's cash level must be nonnegative at all times. Equity holders have limited liability and control cash injections. This setup can entail either risky or riskless debt. Both cases occur endogenously depending on parameters. Equity holders pay out cash as dividends (as in Morellec and Schürhoff, 2010). In

[3]This setup follows Jeanblanc-Picqué and Shiryaev (1995), Bolton, Chen, and Wang (2011), Décamps, Mariotti, Rochet, and Villeneuve (2011), Gryglewicz (2011), Hugonnier, Malamud, and Morellec (2015), and others. It provides a tractable framework to explore the tax asymmetry motive. In particular, this one-state-variable model entails closed-form solutions to the value of corporate securities. The implications of models with both permanent and transitory shocks, but without either leverage or cash, are analyzed in Gorbenko and Strebulaev (2000) (leverage, but no cash) and Décamps, Gryglewicz, Morellec, and Villeneuve (forthcoming) (cash, but no leverage). None of these models focus on the dividend tax asymmetry.

addition, we analyze share repurchases as an alternative.[4] We define the process D as cumulative payouts and the process I as cumulative injections of cash. We assume both processes are nondecreasing.

The firm's cash level, C, is the only state variable of the model. The dynamics of C are given by

$$\begin{aligned} \mathrm{d}C_t &= (1-\tau_c)(r-\lambda)C_t\mathrm{d}t + (1-\tau_c)(\mathrm{d}X_t - b\mathrm{d}t) - \mathrm{d}D_t + \mathrm{d}I_t \\ &= (1-\tau_c)\big((r-\lambda)C_t + \mu - b\big)\mathrm{d}t - \mathrm{d}D_t + \mathrm{d}I_t + (1-\tau_c)\sigma\mathrm{d}Z_t. \end{aligned} \quad (2)$$

At each time, changes in cash holdings are given by after-tax interest on cash as well as cash flows net of coupon payments, corporate taxes, dividends, and injections. The first term on the right-hand side shows the after-tax interest on cash, which is determined by the two disadvantages of cash in the model, namely, the tax disadvantage and agency cost (as in, e.g., Kim, Mauer, and Sherman, 1998; Bolton, Chen, and Wang, 2011, 2013). Specifically, the firm earns a before-tax interest rate r and is subject to a cash-carry cost λ on the cash balance. The parameter λ is a reduced form way of modeling agency issues of holding cash inside the firm. In addition, cash holdings are tax disadvantaged as the corporate tax rate applies to interest on cash holdings and typically exceeds the personal tax rate on interest income (Graham, 2000; Faulkender and Wang, 2006). As in Riddick and Whited (2009), the tax disadvantage is modeled explicitly in our paper. In contrast, Kim, Mauer, and Sherman (1998), Bolton, Chen, and Wang (2011), and Bolton, Chen, and Wang (2013) simplify these two mechanisms to one joint cost parameter.

On the investor level, we consider taxes on interest payments, on dividends, and on capital gains. τ_i denotes the tax rate on interest payments. Formally, net costs of holding cash must be positive to avoid optimal infinite cash injections (as in Bolton, Chen, and Wang, 2014):

$$(1-\tau_c)(r-\lambda) < (1-\tau_i)r. \quad (3)$$

[4] For simplicity, our model does not contain an endogenous choice between dividends and share repurchases. A reduced-form way of modeling this choice is presented in Hennessy and Whited (2007), who propose an increasing and convex tax function to capture a progressive tax scheme for payouts.

Eq. (3) reflects both the agency cost and the tax disadvantage to hold cash.

We model a capital gains tax on realized capital gains and losses, denoted by τ_g. This setup resembles the common tax structure in most countries, including the US.[5]

In the context of realized capital gains taxation, investors can defer capital gains and offset them with capital losses.[6] We assume that investors have full use of capital losses. Morellec and Schürhoff (2010) show that the optimal trading strategy entails deferring capital gains and immediately realizing capital losses. However, this approach requires a second state variable capturing the investors' tax base. For tractability, we simplify investors' behavior by assuming that they realize their losses only when the share price is at its lowest value, i.e., when equity holders inject new funds or the firm defaults. Our simplified timing of realizing capital losses can be justified by transaction costs or by taking into account the unfavorable tax treatment of net short-term capital gains.

The tax rate on dividends is τ_d. We focus on an asymmetry in the tax system. Specifically, investors pay dividend tax on positive dividend payouts, but injecting funds into the firm does not offer a symmetric tax rebate. Hence, this tax asymmetry entails a motive for the firm to hold a cash cushion.[7] This mechanism is at the heart of our analysis. To the best of our knowledge, we are the first to explicitly model the tax asymmetry and explore its implications. While Bolton, Chen, and Wang (2014) present a similar tax structure, their setup does not consider a re-injection of funds and therefore precludes analysis of the tax asymmetry motive on cash holdings.

Equity holders maximize the present value of their future after-tax dividends net of capital gains taxes

$$\max_{D,I} \mathbb{E}^{\mathbb{Q}}\left[\int_0^T e^{-r(1-\tau_i)s}\big((1-\tau_d)\mathrm{d}D_s - \mathrm{d}I_s - \mathrm{d}G_s\big)\right].$$

[5] The model can also be solved with a tax on both realized and unrealized capital gains and losses on a continuous basis. Such a capital gains tax is implemented in Denmark, although on an annual basis. In this alternative model, the main insights on the tax asymmetry motive to hold cash remain valid. The model setup and solution are available upon request.

[6] To calculate realized capital gains and losses, we deduct the purchase price from the sales price (Stiglitz, 1973; Hennessy and Whited, 2007).

[7] The motive also exists in case of share repurchases instead of dividends. When the firm buys back shares, it requires that some equity holders tender shares and are hence forced to realize a taxable capital gain. This capital gains tax entails the tax asymmetry motive.

dG denotes the capital gains tax payments and T denotes the stopping time when the firm defaults. After debt has been issued, equity holders choose the payout policy and whether to inject or default. The optimal injection and payout policies are of threshold type.[8] The payout threshold is denoted by $\bar{C}$. Default or injection occurs when the cash level hits the threshold zero because equity holders have no incentive to act earlier. In case equity holders inject new funds, they also choose the amount of cash to inject, denoted C_0.

2.2. Model solution

We start by deriving the value of debt and equity for a given coupon rate, b, and a given initial cash injection, C_0. In the main text, we consider the case in which equity holders inject new funds (injection case). The case in which the firm defaults (default case) is presented in Appendix A. We proceed by showing how to determine the optimal policies including capital structure, injection and payout policies.

The value of equity. The value of equity is denoted by $E(C)$. An application of Ito's lemma to the no-arbitrage condition for equity shows that the value of equity in the continuation region $0 < C < \bar{C}$ solves the ordinary differential equation (ODE):

$$(1-\tau_i)\, rE(C) = (1-\tau_c)(\rho C + \mu - b)\, E'(C) + \frac{1}{2}(1-\tau_c)^2 \sigma^2 E''(C). \tag{4}$$

The right hand side of the ODE is the expected capital gains to equity in the continuation region. Expected capital gains must be equal to the required return on equity as expressed on the left hand side. The ODE (4) reflects that equity holders do not receive any cash flows in the continuation region.

At the payout boundary, $\bar{C}$, the marginal value to equity holders of a dollar paid out must

[8] It is well-known that an affine injection cost structure implies that the optimal control is of threshold type. If fixed issuing costs are zero, equity holders could have an incentive to gradually realize their capital losses and inject continuously as the cash level declines. We assume this incentive away by restricting equity holders to realize losses at the lower threshold only. We expect that modeling this incentive would complicate the solution without any qualitative impact and with only minor quantitative effects.

be equal to the marginal value of keeping a dollar inside the firm:

$$E' \left(\bar{C} \right) = 1 - \tau_d. \tag{5}$$

To find the optimal boundary, we impose the super-contact condition

$$E'' \left(\bar{C} \right) = 0. \tag{6}$$

Plugging (5) and (6) into (4) yields the alternative boundary condition

$$E \left(\bar{C} \right) = \frac{1}{r} \frac{(1 - \tau_c)(1 - \tau_d)}{1 - \tau_i} \left(\rho \bar{C} + \mu - b \right). \tag{7}$$

The boundary condition at the lower bound, zero, depends on whether equity holders inject funds or let the firm default. In case of injections and if fixed equity issuance costs are strictly positive, i.e., $\phi > 0$, injections are lumpy. The corresponding boundary condition is

$$(1 - \gamma)(E(C_0) - E(0)) + \tau_g (E(C_0) - E(0)) = C_0 + \phi. \tag{8}$$

The left-hand side corresponds to the increase in the value of equity due to the injection (net of flotation cost) and the tax benefit of realizing the capital losses. Specifically, the second term reflects that the equity holders bought equity at the price $E(C_0)$ and realize their loss at $E(0)$. The right hand side shows the costs of injection and consists of the new cash level in the firm, C_0, and the fixed cost of injection. Simplifying the boundary condition yields

$$E(0) = \frac{C_0 + \phi}{1 - \gamma + \tau_g} + E(C_0). \tag{9}$$

If fixed equity issuance costs, ϕ, are zero, equity holders inject incrementally at $C = 0$ to prevent the cash holdings from becoming strictly negative. The associated boundary condition is

$$E'(0) = \frac{1}{1 - \gamma + \tau_g}. \tag{10}$$

The value of equity is calculated as the solution to the ODE (4) subject to boundary conditions Eqs. (5), (7), and either (9) (injection case with fixed issuance cost) or (10) (injection case with no fixed issuance cost). The value function for equity can be expressed in closed form with the help of confluent hypergeometric functions in both cases.

The value of debt. The value of debt is denoted by $D(C)$. $D(C)$ solves the ODE

$$(1-\tau_i)\, rD(C) = (1-\tau_i)\, b + (1-\tau_c)(\rho C + \mu - b)\, D'(C) + \frac{1}{2}(1-\tau_c)^2 \sigma^2 D''(C) \tag{11}$$

in the continuation region $0 < C < \bar{C}$. The interpretation of this ODE is similar to the ODE describing the price of equity, Eq. (4). In addition, the first term on the right hand side of Eq. (11) reflects the continuous coupon payments (after tax) to debt holders.

In the injection case, debt is risk free. Formally, the boundary conditions with positive equity issuance costs are

$$D(0) = D(C_0) \tag{12}$$

$$D'\left(\bar{C}\right) = 0 \tag{13}$$

In the injection case with no fixed issuance cost, the boundary condition Eq. (12) is replaced by

$$D'(0) = 0. \tag{14}$$

Hence, the value of debt in the injection case (with or without fixed issuance cost) is given by the trivial solution to the ODE (11)

$$D(C) = \frac{b}{r}.$$

The optimal capital structure and cash injection. We first consider the injection case with fixed equity issuance cost. Every time the cash holdings reach zero, equity holders inject cash. In particular, the firm never defaults. Hence, equity holders maximize the sum of the value of equity and the tax benefit of the capital loss, given the initially chosen coupon b:

$$\max_{C_0} (1+\tau_g)(E(C_0) - E(0)) + \frac{C_0 + \phi}{1-\gamma}. \tag{15}$$

Using the stationary solution requires that the initial cash injection is also determined by maximizing Eq. (15). In particular, the stationary solution assumes that the equity investor is able to realize a capital loss when injecting funds into the firm at time zero. While this capital loss does not exist literally, we expect only minor changes in corporate policies with no economic insights by disregarding this initial artificial capital loss.[9] In the injection case with zero fixed equity issuance costs, the optimal policy is to inject incrementally when the firm runs out of cash.

Initially, independent of whether equity issuance costs are zero or not, equity holders determine the optimal coupon by maximizing the enterprise value

$$\max_{b} Y(C_0). \tag{16}$$

The enterprise value $Y(C)$ is defined as

$$Y(C) = (1-\gamma)E(C) + D(C) - (C + \phi). \tag{17}$$

As debt is risk free and has a tax benefit, it is optimal to issue as much risk-free debt as possible. Due to limited liability, the maximum amount of risk-free debt is determined by the condition

$$E(0) = 0. \tag{18}$$

The optimal cash injection is determined by the first order condition of the Optimization problem (15):

$$E'(C_0) = \frac{1}{1+\tau_g}\frac{1}{1-\gamma}. \tag{19}$$

[9] Considering the initial optimization without the artificial tax benefit leads to a sequence of cash injections C_0^n. Specifically, each cash injection decision C_0^n depends on the previously injected amount C_0^{n-1} as the latter determines the tax benefit. The sequence converges to our stationary solution.

The endogenous decision to inject or default. The remaining choice variable is whether to setup the firm in the injection case or in the default case. This decision is determined by which of the two cases implies the higher value: Eq. (16) in the injection case or Eq. (26) (in Appendix A) in the default case.

3. Model analysis

We first show the calibration of our model and then proceed by discussing the tax asymmetry motive to hold cash in the model. Subsequently, we discuss implication for corporate policies and comparative statics. The final subsection derives two testable hypotheses from the model, which are then tested in the next section.

3.1. Parameter values and calibration

We choose the base case parameter values following the literature. We set the corporate tax rate to $\tau_c = 0.35$, as in Leland (1994) and Bolton, Chen, and Wang (2014), and the interest tax rate to $\tau_i = 0.30$ (cf. Graham, 2000). We choose the capital gains tax rate as $\tau_g = 0.26$ and the dividend tax rate as $\tau_d = 0.32$. These values are the corresponding average rates in our empirical sample.

Without loss of generality, we set the drift, μ, to one. As in Gryglewicz (2011), we choose the volatility of cumulated cash flows such that the coefficient of variation, $\frac{\sigma}{\mu}$, equals two, thereby reflecting the empirical findings of Irvine and Pontiff (2009). We set the before tax risk-free rate to $r = 5\%$ and the costs of carrying cash to $\lambda = 0.5\%$. We specify the recovery rate as $\alpha = 0.9$.

We set the proportional flotation cost to $\gamma = 6\%$. The fixed cost are $\phi = 0.002$, i.e, two permille of average annual cash flows. This parameter combination reflects the findings of both Altinkilic and Hansen (2000) and Hennessy and Whited (2005). Specifically, the proportional flotation cost is close to the estimate of 5.9% of Hennessy and Whited (2005). In addition, the parameter combination implies that the total fee spread in the base case is 5.4%, which is the number reported by Altinkilic and Hansen (2000). Table I summarizes our parameter choice.

3.2. The tax asymmetry motive to hold corporate cash

We first investigate the quantitative importance of the motive to hold corporate cash generated by tax asymmetry and compare it to that stemming from transaction costs of raising new capital. To do so, we consider the results of our model with and without the transaction motive as well as with and without tax asymmetry motive. Subsequently, we decompose the tax asymmetry motive into a timing motive and a rate difference motive.

Specifically, we eliminate the transaction motive by setting fixed and proportional issuance costs to zero ($\phi = \gamma = 0$). We represent the no tax asymmetry motive ("No TAM") by using a dividend tax rate and a capital gains tax rate of zero ($\tau_d = \tau_g = 0$). The base case tax asymmetry motive ("Base case TAM") is defined by using the base case parameters, in particular, the capital gains tax rate is 0.26 and the dividend tax rate 0.32. Finally, we specify the tax asymmetry timing motive ("TAM timing only") by setting both the dividend and the capital gains tax rate to $\tau_d = \tau_g = 0.26$, which corresponds to the base case capital gains tax rate. Table II shows corporate policies, values, and properties of the time-series distribution of the cash level. Statistics of the time-series distribution are obtained by simulation.

Panel A presents the results without transaction motive. In case there is no tax asymmetry motive either (first line), it is optimal to issue the maximum amount of debt with a coupon of $b = \mu$. The optimal liquidity policy is to pass any excess cash flow above the coupon rate to equity holders instantaneously and to raise new funds whenever cash flows are below the coupon obligations. In particular, there is no motive to hold cash.

With base case tax asymmetry motive (second line), the payout boundary corresponds to 5.88. Specifically, the tax asymmetry motive implies a payout boundary that is almost six times expected annual cash flows. (The expected annual cash flows are $\mu = 1$.) The result indicates that firms may hold high levels of cash, which raises the question of how much cash this firm holds on average over time. To answer this question, we report the average cash level and its standard deviation, which are 3.42 and 1.71, respectively. In particular, with base case tax asymmetry, the associated motive of holding cash alone entails an increase in the average cash level from zero to 3.42. The table also shows that the average ratio of cash to enterprise value R is 19.61%, with a standard deviation of 10.12. These results suggest that the tax asymmetry motive is a key driver of corporate cash holdings.

The tax asymmetry motive to hold cash can be decomposed into two mechanisms, namely, the timing effect and the rate difference effect. The rate difference effect arises in case the dividend tax rate exceeds the capital gains tax rate: Because the tax deadweight costs of payout are higher than the tax rebate of injections, the firm has an incentive to hold cash. The timing effect entails a motive to hold cash even if the dividend tax rate equals the capital gains tax rate. To see this effect, consider the payout decision of a firm in this environment. If the firm decides to pay out, it incurs the deadweight tax cost of dividends now. Even if future injections are subject to a rebate of the same rate, discounting to the present time reduce the value of this future rebate. Hence, the current value of the future rebate of an injection is lower than the current deadweight cost of paying dividends, resulting in an incentive to postpone payout, i.e., a motive to hold cash. Indeed, the model predicts that there is no timing effect in case the interest rate is zero (not reported in the table).

To decompose the tax asymmetry effect, we consider the case in which the dividend tax rate is set equal to the base case capital gains tax rate of 0.26. In this case, only the timing effect is present. Line three of Table II shows that the timing effect alone implies a substantial payout boundary of 4.25. The implied cash level is 2.29 and the implied ratio of cash to assets amounts to 12.44%. Subtracting the values in line three of the values in line two of Table II captures the rate difference effect. In the base case, the increase in payout boundary due to the rate difference effect is 5.88–4.25 = 1.58. The increase in average cash level is 3.42–2.29 = 1.13 and the increase in the cash-to-asset ratio is 19.61% – 12.44% = 7.17%. These results indicate that both the timing effect and the rate difference effects are quantitatively important.

In Panel B, we investigate the quantitative impact of the tax asymmetry motive in the presence of the transaction motive. The transaction motive alone implies a payout boundary of 4.33 and an average cash level of 2.43 (first line). The average ratio of cash to enterprise value R corresponds to 12.66%. These numbers are of somewhat lower magnitude as the ones implied by the tax asymmetry motive in isolation.

With the transaction and the base case tax asymmetry motive (second line), the optimal payout boundary is 6.73 and the average cash level is 4.14. The average ratio of cash to enterprise value is 24.42%. This number conforms to Graham and Leary (2018), who report average cash ratios of 22.64% in 2001–2014 and 16.73% in 1991–2000. It slightly exceeds the upper end of the range reported by Bates, Kahle, and Stulz (2009), which is 10.5%–24.0%. Comparing the first and second lines (no and base case tax asymmetry motive) shows that the marginal effect of the tax asymmetry motive remains substantial even in the presence of the transaction motive. Specifically, the payout boundary and the average cash level increase by more than one half, and the average ratio R almost doubles. To gauge the relative importance of the tax asymmetry motive, we focus on the percentage of the cash level C that stems from the tax asymmetry motive, which we call the tax asymmetry contribution ("TAC"). Table II shows that the tax asymmetry contribution to C corresponds to 41.30% ($= \frac{4.14-2.43}{4.14}$) in the base case. Similarly, the tax asymmetry contribution to R amounts to 48.15% ($= \frac{24.42-12-66}{24.42}$). These results confirm that ignoring the tax asymmetry motive can result in severe underestimation of cash holdings, even if other motives to hold cash are taken into account.

To decompose the tax asymmetry effect, the third line shows the TAM timing effect only. In the presence of the transaction motive, the TAM timing effect entails an increase of the payout boundary of 5.63–4.33 = 1.3 and an increase in the cash to enterprise ratio of 18.27%–12.66% = 5.61%. The remaining residual is due to the rate difference effect and amounts to an increase in payout boundary of 6.73–5.53=1.10 and an increase in the ratio of cash to assets of 24.42%–18.27% = 6.15%. About half of the tax asymmetry contribution to C is due to the timing effect (20.05% out of 41.30%). These results show that in the presence of the transaction motive, both the timing effect and the rate difference effect are quantitatively important.

Morellec, Nikolov, and Schürhoff (2012) show that equity holders optimally realize capital losses immediately. In contrast, our model assumes that capital losses are realized only when the firm runs out of cash. In the base case, this simplifying assumption means that capital losses are not realized as soon as the cash level falls below 0.12 (the optimal initial injection), but only once the cash level reaches zero. With earlier realization of capital losses, the tax asymmetry timing motive would be weakened by way of a higher present value of future tax losses. Hence, our model is likely to overestimate the tax asymmetry timing effect, but the relatively low value of initial injection of $C_0 = 0.12$ (compared to an average cash holding of 3.98) suggests that the bias is small.

We find that injection is optimal for a large range of parameters, including the base case and all cases considered later in the comparative statics. Hence, the analysis of the default case and the resulting precautionary motive to hold cash is relegated to Appendix A.

3.3. The tax asymmetry and corporate policies

Fig. 1 presents the implied payout boundaries and average cash levels for a range of dividend tax rates (upper graph). In addition, the lower graph shows the average ratios of cash to enterprise value for varying dividend tax rates. The figures confirm that the quantitative importance of the tax asymmetry motive increases with the dividend tax rate. For instance, a dividend tax rate of $\tau_d = 0.35$ (which corresponds to the dividend tax rate in 1984 and 1985; Sialm (2009)) further increases the payout boundary from 6.73 to 7.16 and also augments the average cash level from 4.14 to 4.85. Similarly, the average ratio of cash to enterprise value rises from 24.42% to 29.49%. Further, historically, dividend tax rates were substantially higher. For example, the top dividend tax rate in the years 1965–1981 was 70%. In our model, a dividend tax rate of 70% implies a payout boundary of 9.54, an average cash level of 7.63, and an average ratio of cash to enterprise value of 79.31%. In particular, the average cash level almost doubles relative to the base case, and the ratio of cash to enterprise value is more than three times as large as in the base case. These results confirm that the impact of the dividend tax rate on cash levels is of first order importance.

The figure also allows us to quantify the impact of tax policies on the corporate decision to save. Specifically, in the base case, increasing the dividend tax rate by one percentage point implies an increase in the average ratio of cash to assets of 3.2%. This number suggests that actual changes in personal tax rates, such as the 2003 Jobs and Growth Tax Relief Reconciliation Act (JGTRRA), can have an important impact on corporate liquidity management.

The final column in Table II suggests that the impact of the dividend tax rate on paid dividends is not extensive. The economic mechanisms of this result are as follows. On the one hand, an increase in dividend taxes should decrease expected dividends because the payout boundary increases due to the tax asymmetry motive (direct effect). However, an increase in dividend taxes also entails a lower coupon. This lower coupon increases the drift of free cash flow, thereby augmenting expected dividends. This mechanism constitutes an indirect channel through which dividend taxes impact dividends. For instance, comparing lines one and three of Panel B, yields that increasing both the capital gains and the dividend tax rate from 0 to 0.26 decreases dividends paid by 0.02 (from 0.25 to 0.23). The increase is due to the dominant direct effect, namely, the increase in payout boundary from 4.33 to 5.63. Increasing the dividend tax rate further to 0.32 (comparing line three and two) entails an increase in the dividends paid from 0.23 to 0.24. In this case, the indirect effect dominates, i.e., the decrease in coupon from 0.94 to 0.91. We conclude that in the base case the direct and the indirect effect of dividend taxes on expected dividends are approximately of equal importance and cancel out. The empirical evidence of the quantitative impact of the dividend tax rates on dividends paid is not conclusive. Studies finding an important impact are, e.g., Chetty and Saez (2005), Blouin, Raedy, and Shackelford (2011), and Isakov, Pérignon, and Weisskopf (2018). In contrast, Brown, Liang, and Weisbenner (2007), Edgerton (2013), Alstadsæter, Jacob, and Michaely (2017), and Jacob and Michaely (2017) find only a small to moderate impact, also consistent with survey evidence of Brav, Graham, Harvey, and Michaely (2008). Finally, our model is silent on how dividend taxes may impact investment. However, the result that the dividend tax policy has a first order impact on cash holdings but not on aggregate payout appears not inconsistent with the finding of Yagan (2015) that the 2003 dividend tax decrease had no effect on aggregate investment.

3.4. Comparative statics

Table III presents comparative statics with respect to the model parameters. Panel A shows the base case. To study the effects of parameter variation, we vary one parameter at a time in each Panel B–G.

Panel B reduces the volatility to $\sigma = 1$, which substantially decreases the payout boundary, the average cash level, and the average ratio of cash to enterprise value. The reason is that the lower volatility reduces both the transaction cost and the tax asymmetry motives. The tax asymmetry contribution to C remains substantial, at 39.63%. Doubling the agency cost parameter to $\lambda = 1\%$ in Panel C decreases these two motives to hold cash, while the tax asymmetry contribution to C remains of the same magnitude, at 41.30%. In Panel D, the lower corporate tax rate reduces the tax disadvantage of holding cash, thereby strengthening both the transaction cost and the tax asymmetry motive. Hence, cash levels increase. For instance, the average cash to enterprise ratio with base case tax asymmetry motive amounts to 33.05%. The tax asymmetry contribution to C remains stable, at 40.89%. Panel E reduces the interest rate tax, which, in turn, increases the opportunity cost of holding cash. Therefore, the motives to hold cash become weaker and the implied average ratio of cash to enterprise value declines to 20.70%. The tax asymmetry contribution to the cash level is again remarkably unchanged, at 41.28%.

In Panels G and H, we consider higher fixed and proportional issuance costs, respectively. Decreasing issuance costs weakens the transaction motive of holding cash relative to the tax asymmetry motive. Hence, the tax asymmetry contribution to C increases. In particular with respect to fixed issuance cost, the impact is quantitatively small: Considering only one half of the base case fixed issuance cost increases the tax asymmetry contribution to the cash level from 41.30% to 42.60%.

Overall, we find that the tax asymmetry motive is positively related to cash flow volatility, negatively related to financing cost, and relatively insensitive to agency cost, the corporate tax rate, and the interest tax rate. The tax asymmetry contribution to R is substantial in all considered cases, varying between 39% and 52%.

3.5. Testable hypotheses

Table II show that corporate cash holdings increase as the difference between the dividend tax rate and the capital gains tax rate rises (tax asymmetry rate difference effect) and as the level of the capital gains tax increases (tax asymmetry timing effect). Jointly, these two effects are the tax asymmetry motive to hold cash in the model. As corporate cash holdings are a cumulative variable and personal tax rates change frequently in practice, it is problematic to focus on the level of corporate cash holdings in the empirical analysis. Specifically, it could be the case that changes in the level of corporate cash holdings due to a change in personal tax rates materialize only after further changes in tax rates. To circumvent this challenge, we instead focus on changes in corporate cash holdings.

With respect to changes, the model implies that changes in cash holdings are larger when the rate difference effect is more important, that is, when the difference in dividend and capital gains tax rates is greater. For instance, Panel B of Table II documents that in case $\tau_g = 0.26$ and $\tau_d - \tau_g = 0$, the expected ratio of cash to enterprise value is 18.27% (third line) while the expected ratio is 24.42% in case $\tau_g = 0.26$, and $\tau_d - \tau_g = 0.06$ (second line). In practice, to increase the ratio from 18.27% to 24.42%, the firm is expected to increase the future contributions to the cash level, that is, the expected changes in cash holdings increase.

In addition, changes in cash holdings are larger when the timing effect is more important, that is, when the level of the capital gains tax rate is higher (everything else equal). For instance, Panel B of Table II shows that in case $\tau_g = 0$ and $\tau_d - \tau_g = 0$, the expected ratio of cash to enterprise value is 12.66% (first line). In case $\tau_g = 0.26$ and $\tau_d - \tau_g = 0$, the ratio amounts to 18.27%.

The analysis focuses on the effective dividend tax rate (EDTR) defined as $EDTR = \frac{\tau_d - \tau_g}{1 - \tau_g}$. $EDTR$ increases in both the tax asymmetry rate difference and timing effects. Therefore, the first and main prediction from the model is:

H1: There is a positive relation between changes in corporate cash holdings and the effective dividend tax rate.

We also derive predictions from the comparative statics presented in Table III. To do so, we consider the sensitivity of the expected ratio of cash to enterprise value to the dividend tax rate. Because the effective dividend tax rate is a linear function of the dividend tax rate, the sensitivity of cash to enterprise value to the effective tax rate is also a linear transformation, namely, to divide by $(1 - \tau_g)$.

Comparing Panels A and B yields that a lower volatility decreases the sensitivity of the expected ratio of cash to enterprise value to the dividend tax rate. For instance, the sensitivity decreases from 0.90 to 0.39 with base case tax asymmetry motive, lines 2 of Panels A and F. Hence, a decrease in the volatility entails a reduction in the quantitative impact of the effective dividend tax rate on cash holdings. This insight leads to the second testable prediction:

H2: The tax asymmetry motive to hold cash is stronger for more volatile firms.

The interpretation of H2 is that more volatile firms have a higher probability of running out of cash and having to inject funds, which means that the deadweight loss from a dividend tax is more likely to materialize. Thus, the tax asymmetry motive to hold cash is more important for more volatile firms. Again, this motive is different from the traditional transaction motive and arises even if injecting funds is costless.

The model features two costs of holding cash, namely, the tax disadvantage and agency cost. In case any cost of holding cash increases, the sensitivity of the expected ratio of cash to enterprise value to the dividend tax rate decreases because the higher costs of holding cash renders the tax asymmetry motive relatively less important. This mechanism can be seen in Panels C and D of Table III, which show that the sensitivity declines in case agency cost rise and increase in case the corporate tax rate decreases. For instance, doubling the agency cost of holding cash to $\lambda = 1\%$ entails a decline in the sensitivity of the expected ratio of cash to enterprise value to the dividend tax rate from 0.90 in the base case to 0.68. The corresponding testable predictions are:

H3: The tax asymmetry motive to hold cash is weaker for firms with more important cash-carry agency cost.

H4: The tax asymmetry motive to hold cash is weaker for firms subject to a higher corporate tax rate.

Finally, the injection case in the model is insensitive to default cost because default does not occur. In Appendix A, we argue that default costs should have only a small or no impact on the tax asymmetry effect in the default case. Hence, the fifth hypothesis to test is:

H5: The tax asymmetry motive to hold cash is insensitive to default cost.

Empirical Results

This section tests a set of empirical predictions from the model. We focus on the change in cash holdings to assets as the corporate decision variable. This change in cash holdings to assets can then be related to the effective dividend tax rate. This parameter is increasing in dividend taxes and decreasing in capital gains taxes. The model predicts that firms build up larger cash holdings when the effective dividend tax rate is high compared to when it is low (hypothesis H1). This main prediction is supported in the data along with other predictions from the static analysis of the model.

Data

The empirical methodology follows that from Opler, Pinkowitz, Stulz, and Williamson (1999) and Bates, Kahle, and Stulz (2009). The data sample runs from 1980 to 2003 and includes yearly observations of all US incorporated firms that appear at any time in the database. Financial firms (SIC codes 6000-6999) and utility firms (SIC codes 4900-4999) are excluded from the final sample as these firms are expected to be special with regards to their cash holdings. The analysis includes the same set of explanatory variables as in Bates, Kahle, and Stulz (2009). These are the market to book ratio, real firm size, cash flow to assets, net working capital to assets, capital expenditures to assets, leverage, industry cash flow risk (industry sigma), dividend payout dummy, R&D to sales, and acquisitions to assets. The computation of these variables are described in Appendix B, Table VII. Unique to this analysis is the inclusion of a measure of the effective dividend tax rate (EDTR). The measure is defined as:

$$\text{Effective dividend tax rate}_t = 1 - \theta_t \tag{20}$$

where t is the year and θ_t is the tax preference parameter taken from Poterba (2004). θ_t is the weighted average investor tax price, which is a weighted average of $(1 - \tau_{div})/(1 - \tau_{cg})$ where τ_{div} is the dividend tax and τ_{cg} is the long-term capital gains tax rate. The weighting is done by using holding information for various investor groups and matching the tax rates to the specific investor groups. The effective dividend tax rate is thus increasing in the dividend tax rate and decreasing in the capital gains tax. According to the model, firms build up larger cash holdings when the effective dividend tax rate is high compared to when it is low. The data from Poterba (2004) is available up to 2003, which then determines the end of the sample period.

As an alternative to the effective dividend tax rate derived from the data in Poterba (2004), another measure is calculated using data from Sialm (2009). There the interpretation is similar except that the weighting is done at the level of the tax rates and not the ratio. Figure 2 shows the evolution of the two effective dividend tax rates over time. The two different measures are highly correlated although the levels are different. As can also be seen in Table IV, the average effective dividend tax rate is around 0.18 on average. It is substantially higher in the beginning of the period and very low at the end after the 2002 tax reform.

Regression analysis

The main prediction of the theoretical model is the positive relationship between changes in cash holdings and the level of the effective dividend tax rate (hypothesis H1). Hence, when dividends are heavily taxed relative to capital gains firms hold back earnings and build up a larger cash buffer. The prediction can be tested empirically with a regression analysis:

$$
\begin{aligned}
\Delta\text{Cash holdings/ assets}_{i,t+1} &= \beta_1 \times \text{industry sigma}_{it} + \beta_2 \times \text{Market to book}_{it} + \beta_3 \times \text{Real size}_{it} \\
&+ \beta_4 \times \text{Cash flow/ assets}_{it} + \beta_5 \times \text{NWC/ assets}_{it} + \beta_6 \times \text{Capex}_{it} \\
&+ \beta_7 \times \text{Leverage}_{it} + \beta_8 \times \text{R\&D/ sales}_{it} + \beta_9 \times \text{Dividend dummy}_{it} \\
&+ \beta_{10} \times \text{Acquisition activity}_{it} + \beta_{11} \times \text{Effective dividend tax rate}_{t} \\
&+ \text{Firm fixed effects} + \epsilon_{i,t+1} \qquad (21)
\end{aligned}
$$

where t is the year and i is the firm. The regression is estimated with standard errors clustered by firm and year (see, e.g., Petersen, 2009). The explanatory variables are lagged one year compared to the change in cash holdings ratio, hence, a high effective dividend tax rate today would give a high build up in cash holding over the next year.

Table V shows the estimated coefficients. The first column is using the EDTR based on the data in Poterba (2004). The regression includes firm fixed effects so that it captures the behaviour inside the firm. Graham and Leary (2018) note that over the sample period used in the regression, aggregate corporate cash holdings have gone up on average but cash holdings within the individual companies have gone down over the same period. The aggregate increase is primarily driven by new firms entering the market with large cash holdings (see also Bates, Kahle, and Stulz, 2009). The entrance of new firms should not be an issue in our regression because of the fixed effects and because the dependent variable is changes in cash holdings and not levels.

Looking at the first regression specification, real size and the dividend dummy are both negative and statistically significant. Both variables are related to financing constrains in that large firms usually have better access to capital markets and the same for firms paying out dividends. These signs are in line with the precautionary and transaction motives for building up cash (Bates, Kahle, and Stulz, 2009). Also consistent with these motives is that firms with higher cash flow to assets are slower in building up cash and that firms with high leverage build up cash holdings (Acharya, Almeida, and Campello, 2007a). Firms with high levels of capital expenditures and acquisition activity tend to increase cash holdings, which is consistent with these firms having investment opportunities. Net working capital to assets are positively related to building up cash holdings, which is likely because cash holdings and working capital are similar instruments and the reasons for increasing one is the same as for the other.

The effective dividend tax rate is positive and significant, supporting hypothesis H1 derived from the model. It indicates that firms increase cash holdings when dividends are relatively more heavily taxed. Thus, the evidence is supportive of the existence of the tax asymmetry motive to hold cash. The effect of a one standard deviation decrease in the effective dividend tax rate decreases the change in cash holdings by $0.099 \times 0.043 = 42$basis points. This number can be compared to the average yearly decrease in cash holdings over the period from 1980-2000 as found in Graham and Leary (2018) which is 39 basis points. Between 1980 and 2000, the effective dividend tax rate decreases by 0.12 which translates into a 120 basis points less increase in cash holdings per year in 2000 compared to 1980. This is a substantial decrease in the willingness to build up cash holdings. As can be seen in column 2 of Table V, results are robust to using the alternative effective dividend tax rate.

In addition to hypothesis H1, we test the other static predictions. For hypothesis H2, we divide firms into two groups based on their cash flow volatility each year. In order to avoid outliers, we exclude firm-years with cash flow to assets below -1. We then test if the firms in the low cash flow volatility group respond differently to the tax asymmetry motive than the firms in the high cash flow volatility group. Hypothesis H2 predicts that the low cash flow volatility group should have a lower sensitivity towards the EDTR. This is also what we see in the data: in column 3 of the table, the interaction term for low cash flow volatility firms has a significant negative coefficient.

Hypothesis H3 predicts that firms with high agency costs should be less sensitive towards the EDTR. We take three different approaches from the literature to measure and rank firms based on agency costs. The first measure is sales to assets which proxy for asset utilization as used in Ang, Cole, and Lin (2000) and Singh and Davidson (2003). The idea is that it measures the management ability to employ assets efficiently without engaging in non-cash flow generating activities. Hence, a low sales to asset ratio signals high agency costs. The second measure is based on the accounting item selling, general, and administrative expenses (SG&A) to total sales as in Singh and Davidson (2003). SG&A reflect managerial discretion in spending company resources and, hence, a high level of SG&A to sales are likely associated with higher agency costs. The third measure is the R-spread used in Kim, Mauer, and Sherman (1998). The R-spread is defined as the asset return minus the Treasury bill return and it measures the attractiveness of investing in physical assets versus liquid assets. As with the sales to asset ratio, having a low R-spread indicates high agency costs. We do not subtract the return on the Treasury bills in our study because we rank firms by the R-spread within each year. From Table V we see that all three measures of agency costs give support to hypothesis H3. Firms with high agency costs are less sensitive to the tax asymmetry motive because high agency costs discourage building up cash inside the firm.

Next, we calculate the effective corporate tax rate for each company each year by the total income tax to total pretax income. Consistent with hypothesis H5, we see that firms with high effective corporate rates are less sensitive towards the EDTR. Similar to the interpretation of agency cost, a high corporate tax rate decrease the firm's incentive to hold cash, resulting in a lower sensitivity of cash to EDTR.

For hypothesis H5, we measure bankruptcy costs by the ratio of advertising and R&D expenses to total sales as in Graham (2000). The measure relates to the level of asset intangibility and is the fraction of firm value which would be lost in a liquidation. From Table V, we see that differences in bankruptcy costs does not affect the sensitivity towards the EDTR consistent with the prediction in hypothesis H5.

4. Conclusion

We describe a motive to accumulate corporate cash that has received little attention in the literature so far. We show that this motive is quantitatively and empirically important. For realistic parameter values, it constitutes about one half of the total motive for firms to hold cash. Our main testable empirical implication is the positive relation between the dividend tax rate and corporate cash holdings. In addition, we argue that the tax asymmetry motive to hold cash should be stronger for more volatile firms, firms with lower effective corporate tax rates, and firms with lower agency costs. We verify the main implication of the model as well as the additional predictions empirically using data from 1980 to 2003. We find support for our predictions.

Our results can be used to derive policy implications. Specifically, higher dividend taxes incentivize firms to hold more cash. Quantitatively we find that, for realistic parameter values, a one percentage point increase in the dividend tax rate increases the typical firm's average ratio of cash to assets by more than 3%.

Appendix

A. The default case

In this Appendix A, we solve analyze the default case. We first show how to solve the model in the default case and proceed by analyzing the tax asymmetry in the default case.

A.1. Model solution.

In the default case, equity holders enjoy limited liability and reclaim the tax value of their capital loss. Hence, the boundary condition of equity is given by

$$E(0) = \tau_g \left(E(C_0) - E(0)\right), \tag{22}$$

which replaces Condition (9) in the injection case. Condition (22) can be reduced to

$$E(0) = \frac{\tau_g}{1+\tau_g} E(C_0). \tag{23}$$

The value of equity is calculated as the solution to the ODE (4) subject to boundary conditions Eqs. (5), (7), and (23) in the default case. As in the injection case, the value function for equity can be expressed in closed form with the help of confluent hypergeometric functions.

In the default case, debt holders take over the firm when it runs out of cash. This transfer of ownership leads to the debt boundary condition at zero

$$D(0) = \alpha Y(C_0) + \tau_g \left(D(C_0) - D(0)\right), \tag{24}$$

replacing Condition (12) in case of injection. The first term on the right hand side of Eq. (24) reflects that upon default, debt holders reoptimize the firm with new equity, debt, and cash. The value of the firm in default equals that of an optimally capitalized firm net of the costs. The costs are those for reoptimizing the capital structure and for bankruptcy. The second term on the right hand side of Eq. (24) reflects that debt holders reclaim the tax value of their capital loss. Simplifying yields

$$D(0) = \frac{\alpha + \tau_g}{1 + \tau_g} D(C_0) - \frac{\alpha}{1 + \tau_g}(C_0 + \phi) + \frac{\alpha(1 - \gamma)}{1 + \tau_g} E(C_0). \tag{25}$$

The value of debt in the default case is a solution to the ODE (11) subject to the two boundary conditions Eq. (13) and Eq. (25). The value function for debt can also be expressed in closed form with the help of confluent hypergeometric functions.

Every time the firm's cash holdings reach zero, the firm defaults. As in the injection model, we consider the stationary solution. That is, at each default, incumbent debt holders become equity holders and issue the same amount of debt and inject the same amount of cash. The associated optimization problem is

$$\max_{b,C_0} Y(C_0) + \tau_g (D(C_0) - D(0)), \tag{26}$$

in which $Y(C_0)$ is the enterprise value defined in Eq. (17). The second term represents the realized tax shield due to the capital loss of incumbent debt.

A.2. The default case and the tax asymmetry

With the base case parameters, default is suboptimal and dominated by the injection case of our model. In case of default, previous debt holders take over the remaining assets and then issue new securities and inject cash. Between defaults, incumbent equity holders are in control and they never inject new funds. Hence, transaction costs are irrelevant to equity holders and there is no transaction motive to hold cash. Instead, equity holders have an incentive to hold cash to delay default and the resulting loss of their claim. This motive is a precautionary motive, as in the model by Bolton, Chen, and Wang (2014).

Table VI shows optimal policies and values in the default case. As in the injection case, we present three sets of results. In the first line, we set dividend and capital gains tax rates to zero ($\tau_g = \tau_d = 0$). The second line considers the base case with both the dividend and the capital gains tax rate equal to the base case values ($\tau_d = 0.32, \tau_g = 0.26$). In the third line, both the dividend tax and capital gains tax rate is set to the base case capital gains tax rate of 0.26. In addition, we also show the results when the dividend tax is equal to the base case, but the capital gains tax rate is zero ($\tau_d = 0.32, \tau_g = 0$).

In the base case, with precautionary motive only (line one of Table VI), the payout boundary is 8.42 and the average cash level is 6.40. This boundary is higher than the one in the injection case, in particular, higher than the ones implied by the transaction motive only and by the tax asymmetry motive only (see Table II).

The second line shows the results in the base case. The payout boundary falls to 7.00. The effect is primarily driven by the increase in the capital gains tax rate because it renders cash savings relatively less attractive. For instance, line four shows that with a capital gains tax rate or zero but the base case dividend tax rate of 0.26, the payout boundary is of the same order of magnitude as in the case that both tax rates are zero in line 1 (8.15 compared to 8.42). The minor decrease in payout boundary stems solely from the increase in coupon from $b = 0.85$ to $b = 0.86$ because the dividend tax rate renders debt relatively cheaper. Specifically, in case of zero capital gains tax and given a fixed coupon, changing the dividend tax rate leaves the payout boundary unaffected (as in Bolton, Chen, and Wang, 2014). This result relates to the new view of dividends, under which changes in the dividend tax rate should not alter dividend payments.

In our model, after a default, former debt holders inject funds. Thus, when equity holders decide whether to pay out or not, they do not balance the cost of payout against the rebate of potential injections, as they do in the injection case. Therefore, the tax asymmetry timing motive breaks down. Instead, equity holders consider the cost of default. The cost of default to equity holders are decreasing in the capital gains tax rate because they realize their capital loss in default. Hence, everything else equal, equity holders pay out earlier when capital gains tax rates are higher. Table VI shows this mechanism when comparing lines one and three: Increasing the capital gains tax rate from zero to 0.26 (and keeping $\tau_d - \tau_g$ constant at zero) entails a decrease in the payout boundary from 8.42 to 6.94.

The rate difference effect of the tax asymmetry also exists in the default case. Fixing the capital gains tax rate at $\tau_g = 0.26$, an increase in the dividend tax rate from 0.26 to 0.32

augments the payout boundary from 6.94 to 7.00 (compare lines three and two of Table VI). However, in the base case, the decrease due to higher capital gains tax of 8.42 – 6.94 = 1.48 clearly dominates the increase due to the tax asymmetry rate difference effect of 7.00 – 6.94 = 0.06. Overall, the tax asymmetry motive does not predict a unique directional effect as in the injection case.

In all cases in Table VI, default is suboptimal and dominated by injection. Indeed, the project value in the injection model substantially exceeds that in the default model (compare with Table II). For instance, in the base case (second line of Tables II and VI), the project value in the injection model is 18.25, while it is only 14.51 in the default model. In particular, the project value in the injection case is more than 25% higher than that in the default case.[10] This stark optimality of the injection model further emphasizes the importance of the tax asymmetry motive, which arises only in case fund injections are optimal.

In Panel B, we show the results in case of a lower recovery rate $\alpha = 0.75$. The precautionary motive becomes stronger and payouts boundaries rise. In particular, the relative change in payout boundaries is similar to the base case. For instance, comparing the first two lines of Panels A and B implies a decrease in payout boundary of about 20% in both Panels A and B. These considerations suggest that the impact of default costs on the tax asymmetry effect is minor.

B. Definition of variables.

Table VII shows the definition of variables based on Compustat data.

[10] In unreported results, we find optimality of the default case only when bankruptcy costs are close to zero and/or volatility is very high.

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Figures and tables

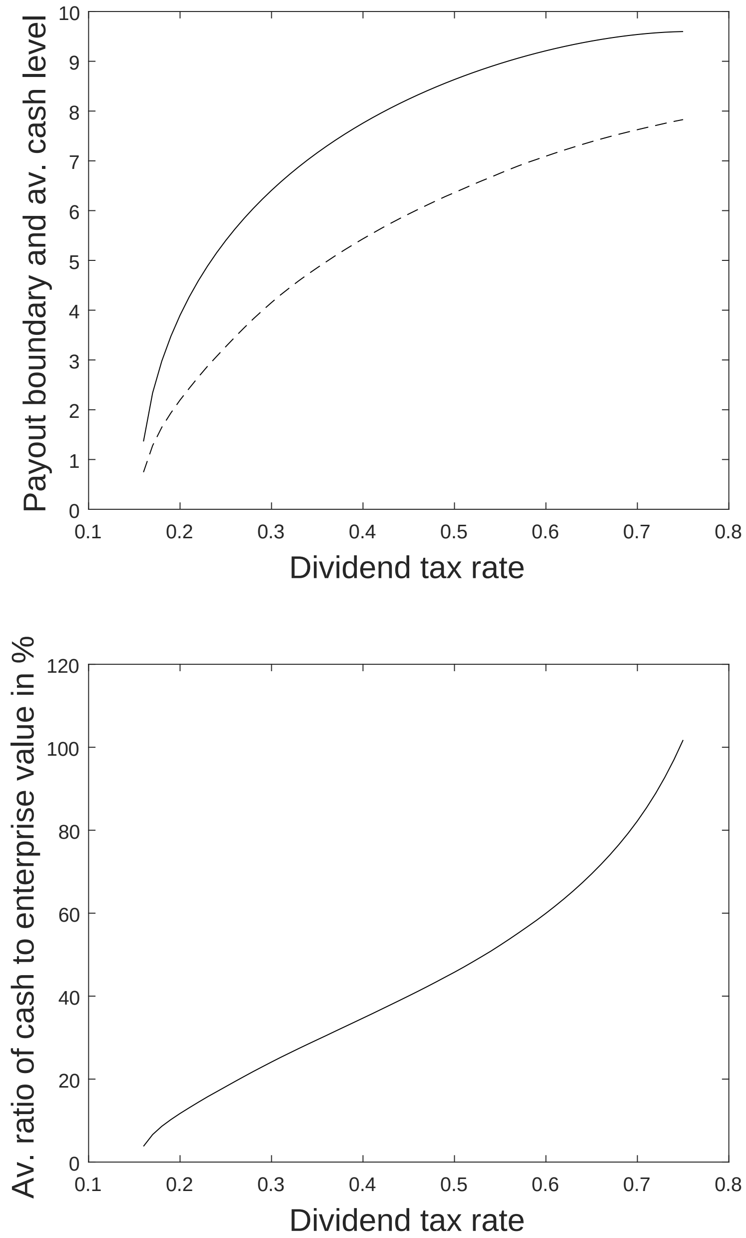

Figure 1. Payout boundary and average cash level (upper graph) and average ratio of cash to enterprise value in percent (lower graph) for varying dividend tax rates. The upper figure plots the payout boundary $\bar{C}$ (solid line) and the average cash level $\mathbb{E}[C]$ (dashed line) as a function of the dividend tax rate τ_d. The lower figure plots the average ratio of cash to enterprise value $mean\,(R_t) = mean\left(\frac{C_t}{Q_t}\right)$ as a function of the dividend tax rate τ_d. Parameters from Table I are used. Average cash levels are obtained by simulation.

Figure 2. Effective dividend tax rate. This figure shows the two effective dividend tax rates used in the regression analysis. The solid line is the effective dividend tax rate derived from data in Poterba (2004). The measure is increasing in the dividend tax rate and decreasing in the capital gains tax. The other line is the alternative effective dividend tax rate derived from data in Sialm (2009). The parameters are plotted from 1980 up to 2003 when the data in Poterba (2004) ends.

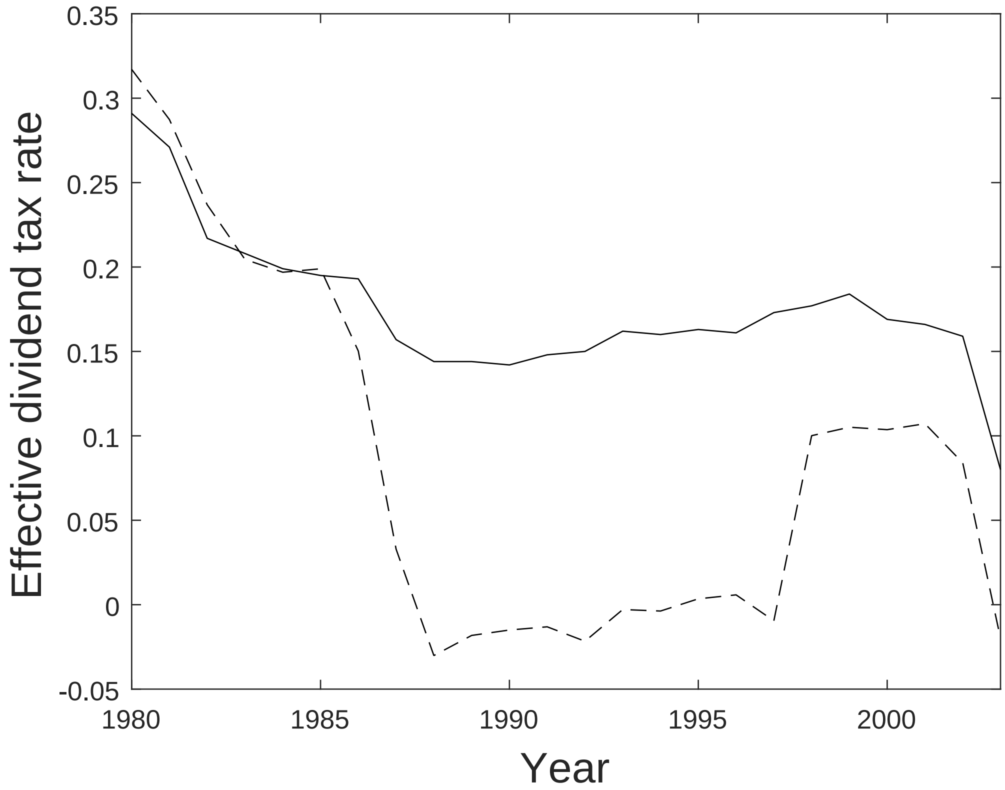

Table I
Parameters.

This table shows the base case parameter values.

Parameter	Variable	Base case value
Tax rate on corporate income	τ_c	0.35
Tax rate on interest income	τ_i	0.30
Tax rate on dividends	τ_d	0.32
Tax rate on realized capital gains	τ_g	0.26
Risk-free rate	r	0.05
Drift of cumulated cash flows	μ	1
Volatility of cumulated cash flows	σ	2
Cash carrying cost	ρ	0.005
Recovery rate	α	0.9
Fixed financing cost	ϕ	0.002
Proportional equity financing cost	γ	0.06

Table II: **Optimal capital structure, corporate policies and values.**

This table shows the optimal capital structure, corporate policies, values, and distributional properties in the injection case without equity issuance costs ($\phi = \gamma = 0$) in Panel A and with equity issuance costs (ϕ, γ as in Table I) in Panel B. Each Panel shows the results without tax asymmetry motive ($\tau_d = \tau_g = 0$, "No TAM") in the first line and with base case tax asymmetry motive (τ_d, τ_g as in Table I, "Base case TAM") in the second line. The third line in each panel shows the values when both the dividend and the capital gains tax rate is equal to the base case capital gains tax rate of 0.26, which allows to decompose the tax asymmetry effect into the timing effect (third line) and the rate difference effect (difference between second and third line). All remaining parameters are as in Table I. b is the promised coupon, C_0 denotes the initial cash injected in the firm, Y denotes project value (as given by the equity holders' objective function initially), and Q is the enterprise value defined as the sum of debt and equity less cash. lev is market leverage given as the value of initial debt divided by the sum of the values of initial debt and equity. R is the ratio of the cash level to enterprise value in percent, i.e., $R = 100\frac{C}{Q}$. Distributional properties and dividends are obtained by simulation. $TAC\,(C)$ denotes the tax asymmetry contribution, defined as relative difference between the ratio C with and without tax asymmetry, expressed as a percentage of C with tax asymmetry.

	Corporate policies				Values		Properties of the distribution					
	b	C_0	$\bar{C}$	$lev\,(0)$	$Y\,(0)$	$Q\,(0)$	$\mathbb{E}\,[C]$	$std\,[C]$	$\mathbb{E}\,[R]$	$std\,[R]$	$TAC\,[C]$	$\frac{\mathbb{E}[D]}{year}$
Panel A: No transaction motive												
No TAM	1.00	0.00	0.00	1.00	20.00	20.00	0.00	0.00	0.00	0.00		0.00
Base case TAM	0.93	0.00	5.88	1.00	18.63	18.63	3.42	1.71	19.61	10.12	100.00	0.23
TAM timing only	0.96	0.00	4.25	1.00	19.14	19.14	2.29	1.25	12.44	6.92	100.00	0.25
Panel B: With transaction motive												
No TAM	0.96	0.35	4.33	0.98	19.12	19.14	2.43	1.22	12.66	6.36	0.00	0.25
Base case TAM	0.91	0.12	6.73	0.99	18.23	18.23	4.14	1.90	24.42	11.67	41.30	0.24
TAM timing only	0.94	0.12	5.63	0.99	18.69	18.70	3.26	1.62	18.27	9.30	20.05	0.23

Table III: **Comparative statics.**

This table shows the optimal capital structure, corporate policies, values, and distributional properties in the injection case for different parameter combinations. In each Panel, we vary one parameter at a time and report the results without the tax asymmetry motive ($\tau_d = \tau_g = 0$, "No TAM," first line) and with base case tax asymmetry motive ("Base case TAM," second line). All remaining parameters are as in Table I. b is the promised coupon, C_0 denotes the initial cash injected in the firm, Y denotes project value (as given by the equity holders' objective function initially), and Q is the initial enterprise value defined as the sum of debt and equity less cash. lev is market leverage given as the value of initial debt divided by the sum of the values of initial debt and equity. R is the ratio of the cash level to enterprise value in percent, i.e., $R = 100\frac{C}{Q}$. Distributional properties and dividends are obtained by simulation. $TAC\,(C)$ denotes the tax asymmetry contribution, defined as relative difference between the cash level C with and without tax asymmetry, expressed as a percentage of C with tax asymmetry.

	Corporate policies				Values		Properties of the distribution						
	b	C_0	$\bar{C}$	$lev\,(0)$	$Y\,(0)$	$Q\,(0)$	$\mathbb{E}\,[C]$	$std\,[C]$	$\mathbb{E}\,[R]$	$std\,[R]$	$TAC\,[R]$	$\frac{\mathbb{E}[D]}{year}$	$\frac{\partial \mathbb{E}[\frac{R}{100}]}{\partial \tau_d}$
Panel A: Base case													
No TAM	0.96	0.35	4.33	0.98	19.12	19.14	2.43	1.22	12.66	6.36	0.00	0.25	0.80
Base case TAM	0.91	0.12	6.73	0.99	18.23	18.23	4.14	1.90	24.42	11.67	41.30	0.24	0.90
Panel B: Lower volatility $\sigma = 1$													
No TAM	0.98	0.25	2.23	0.99	19.54	19.56	1.27	0.62	6.48	3.16	0.00	0.13	0.46
Base case TAM	0.96	0.10	3.40	1.00	19.11	19.10	2.10	0.95	11.39	5.25	39.63	0.12	0.39
Panel C: Higher cash-carry agency cost $\lambda = 0.01$													
No TAM	0.95	0.32	3.57	0.98	18.91	18.94	1.97	1.01	10.39	5.30	0.00	0.29	0.82
Base case TAM	0.90	0.11	5.71	0.99	17.94	17.92	3.36	1.63	19.91	9.97	41.30	0.24	0.68
Panel D: Lower corporate tax rate $\tau_c = 0.30$													
No TAM	0.96	0.41	5.71	0.98	19.29	19.32	3.28	1.61	16.91	8.29	0.00	0.25	1.22
Base case TAM	0.95	0.12	8.53	0.99	18.51	18.49	5.56	2.36	33.05	14.76	40.89	0.27	1.18
Panel E: Lower interest tax rate $\tau_i = 0.25$													
No TAM	0.95	0.32	3.70	0.98	18.95	18.98	2.05	1.04	10.79	5.48	0.00	0.28	0.64
Base case TAM	0.90	0.11	5.85	0.99	17.99	17.97	3.50	1.66	20.70	10.19	41.28	0.25	0.78
Panel F: Lower fixed financing cost $\phi = 0.001$													
No TAM	0.96	0.25	4.24	0.99	19.14	19.16	2.35	1.21	12.24	6.29	0.00	0.25	0.83
Base case TAM	0.91	0.07	6.70	1.00	18.27	18.26	4.10	1.90	24.10	11.65	42.60	0.24	0.90
Panel G: Lower proportional issuance cost $\gamma = 0.03$													
No TAM	0.97	0.42	3.30	0.98	19.37	19.38	1.83	0.92	9.45	4.72	0.00	0.30	1.40
Base case TAM	0.92	0.17	6.42	0.99	18.40	18.37	3.89	1.81	22.66	10.99	52.78	0.24	0.95

Table IV
Summary statistics.

The table shows summary statistics for the variables used in the regression analysis. The sample is Compustat firm-years from 1980 to 2003. The Compustat derived variables are described in Table VII. The effective dividend tax rate (EDTR) is derived from data in Poterba (2004) and the alternative EDTR is derived from data in Sialm (2009) and goes to 2006.

Variable	N	Mean	Std	Q1	Median	Q3
Cash / assets	60,478	0.139	0.181	0.020	0.064	0.183
Δ Cash / assets	60,478	0.00004	0.097	-0.026	-0.0002	0.025
Industry sigma	60,478	0.077	0.068	0.047	0.068	0.099
Market to book	60,478	1.850	2.338	1.008	1.299	1.906
Real size	60,478	8.395	3.953	5.598	7.913	10.584
Cash flow / assets	60,478	0.025	0.223	0.017	0.065	0.104
NWC / assets	60,478	0.139	0.225	0.006	0.137	0.278
Capex	60,478	0.069	0.071	0.026	0.049	0.087
Leverage	60,478	0.242	0.216	0.073	0.216	0.358
R&D sales	60,478	0.683	30.638	0.000	0.000	0.037
Dividend dummy	60,478	0.387	0.487	0.000	0.000	1.000
Acquisition activity	60,478	0.019	0.060	0.000	0.000	0.003
Cash flow vol	60,264	0.073	0.143	0.021	0.037	0.073
Sales / assets	60,478	1.356	1.225	0.797	1.218	1.703
SGA / sales	60,478	0.448	13.454	0.115	0.213	0.337
Rspread	60,478	0.071	0.237	0.038	0.111	0.170
Bankruptcy costs	60,478	0.706	31.889	0.000	0.015	0.059
Eff. Corp. Tax rate	60,478	0.261	7.377	0.085	0.352	0.407
EDTR	24	0.176	0.043	0.154	0.165	0.194
Alt. EDTR	27	0.072	0.107	-0.018	0.006	0.150

Table V: **Changes in cash holdings and effective dividend tax rate.**

The table shows regression coefficients where firm-year changes in the cash holding ratio is the dependent variable. The sample goes from 1980 to 2003. The effective dividend tax rate (EDTR) is derived from data in Poterba (2004) and the alternative EDTR measure is derived from data in Sialm (2009) for 1980-2006. The indicator variable I(split) is 1 for the same sample indicated in the headline and zero otherwise. The split is done on a yearly basis separating into two equally sized groups. Agency cost 1 is based on the sales to asset ratio, agency costs 1 is based on the SGA costs to sales ratio, and agency costs 3 is based on the R-spread. Bankruptcy costs (BC) is R&D costs plus advertising costs divided by sales. The effective corporate tax rate is taxes divided by pre-tax income. All regressions are with firm fixed effects and standard errors are clustered over firm and year as in Petersen (2009). Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Split	All	All	Low CF vol	1- High Agency costs	2- High Agency costs	3- High Agency costs	High BC	High Eff. corp. tax
Industry sigma	-0.011	0.002	-0.106	-0.005	-0.002	-0.006	-0.006	-0.006
	(-1.637)	(0.337)	(-1.377)	(-1.056)	(-0.423)	(-1.153)	(-1.159)	(-1.158)
Market to book	0.000	0.001	0.000	0.000	-0.001*	0.000	0.000	0.000
	(0.406)	(1.087)	(0.329)	(0.244)	(-1.928)	(0.023)	(0.426)	(0.383)
Real size	-0.005***	-0.005***	-0.005***	-0.004***	-0.005***	-0.005***	-0.005***	-0.005***
	(-6.929)	(-8.578)	(-7.973)	(-6.327)	(-8.138)	(-6.871)	(-6.966)	(-7.04)
Cash flow/ assets	-0.046***	-0.048***	-0.019**	-0.051***	-0.030***	-0.053***	-0.046***	-0.048***
	(-5.338)	(-6.244)	(-2.102)	(-5.928)	(-3.845)	(-6.004)	(-5.184)	(-5.466)
NWC/ assets	0.103***	0.093***	0.112***	0.100***	0.108***	0.102***	0.102***	0.108***
	(9.492)	(9.298)	(10.354)	(10.189)	(11.537)	(10.278)	(10.168)	(11.443)
Capex	0.038***	0.037***	0.025**	0.042***	0.035***	0.037***	0.041***	0.041***
	(3.392)	(3.347)	(2.240)	(3.745)	(3.289)	(3.244)	(3.539)	(3.473)
Leverage	0.086***	0.079***	0.089***	0.087***	0.087***	0.087***	0.086***	0.088***
	(7.592)	(8.75)	(9.828)	(8.798)	(9.64)	(8.953)	(8.84)	(8.583)
R&D/ sales	0.000	0.000	0.000	0.000	-0.003**	0.000	0.000	0.000
	(-1.490)	(-0.960)	(-1.220)	(-1.510)	(-2.107)	(-1.530)	(-1.490)	(-1.500)
Dividend dummy	-0.004***	-0.006***	-0.004***	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***
	(-3.608)	(-4.628)	(-3.021)	(-3.902)	(-3.709)	(-4.505)	(-4.163)	(-3.974)
Acquisition activity	0.028***	0.035***	0.023**	0.039***	0.023***	0.028***	0.027***	0.028***
	(3.018)	(3.769)	(2.386)	(4.298)	(2.868)	(3.171)	(3.066)	(3.16)
EDTR	0.099**		0.082*	0.165***	0.118**	0.123***	0.099**	0.101***
	(2.115)		(1.939)	(3.854)	(2.463)	(2.737)	(2.154)	(2.297)
EDTR x I(split)			-0.013**	-0.144***	-0.042***	-0.055***	-0.005	-0.014***
			(-2.158)	(-9.837)	(-3.922)	(-7.013)	(-0.668)	(-2.746)
Alt. EDTR		0.058***						
		(4.626)						
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.146	0.134	0.142	0.151	0.153	0.147	0.146	0.147
N	60,482	67,717	58,234	60,482	60,482	60,482	60,482	60,482

Table VI
Default case.

This table shows the optimal capital structure, corporate policies and values in the default case. The results without dividend and capital gains taxes ($\tau_d = \tau_g = 0$) are shown in the first line. The second line displays the results with the base case dividend and capital gains tax rates ($\tau_d = 0.32, \tau_g = 0.26$), and the third line shows results in case the dividend and capital gains tax rates both equal the base case capital gains tax rate ($\tau_d = \tau_g = 0.26$). All remaining parameters are as in Table I. b is the promised coupon, C_0 denotes the initial cash injected in the firm, Y denotes project value (as given by the equity holders' objective function initially), and Q is the initial enterprise value defined as the sum of debt and equity less cash. lev is market leverage given as the value of initial debt divided by the sum of the values of initial debt and equity.

	Corporate policies				Values	
	b	C_0	$\bar{C}$	$lev\,(0)$	$Y\,(0)$	$Q\,(0)$
Panel A: Default case						
$\tau_g = \tau_d = 0$	0.85	5.88	8.42	0.70	15.95	18.17
$\tau_d = 0.32, \tau_g = 0.26$	0.85	3.08	7.00	0.84	14.51	15.92
$\tau_d = \tau_g = 0.26$	0.85	3.24	6.94	0.82	14.83	16.35
$\tau_d = 0.32, \tau_g = 0$	0.86	3.76	8.15	0.83	13.85	15.59
Panel B: Lower recovery rate $\alpha = 0.75$						
$\tau_g = \tau_d = 0$	0.77	7.04	9.25	0.61	12.96	17.87
$\tau_d = 0.32, \tau_g = 0.26$	0.81	4.16	7.59	0.77	11.82	15.00
$\tau_d = \tau_g = 0.26$	0.80	4.34	7.58	0.75	12.11	15.49
$\tau_d = 0.32, \tau_g = 0$	0.82	4.87	8.75	0.77	10.93	14.84

Table VII
Definition of financial variables.

This table shows that the descriptions of the financial variables derived from Compustat data. The description is supplemented with the Compustat specific item numbers in order to uniquely identify the variables and calculation.

Variable	Description	Compustat items
Market to book	Book value of assets minus book value of equity plus market value of equity with book value of assets as numerator.	((#6)-(#60)+(#199 x #25)) / #6
Real size	Logaritm of book value of assets in 2003 dollars.	Log(#6)
Cash flow/ assets	Earnings after interest dividends. and taxes but before depriciation with book value of assets as numerator.	(#13-#15-#16-#21)/#6
NWC / assets	Net working capital net of cash with book value of assets as numerator.	(#179-#1) / #6
Capex	Capital expenditures with book value of assets as numerator.	#128 / #6
Leverage	Long-term debt plus debt in current liabilities with book value of assets as numerator.	(#9 + #34) / #6
R&D/ sales	R&D with sales as numerator. Set to 0 if missing.	#46 / #12
Dividend dummy	Dummy is 1 if dividends are paid out and 0 otherwise.	If(#21 >0)
Acquisition activity	Acquisitions with book value of assets as numerator.	#129 / #6
Cash flow sigma	Standard deviation of cash flows / assets over the last 10 years.	Std((#13-#15-#16-#21)/#6)
SGA / sales	Selling, General and Administrative Expense with sales as numerator	#189 / #12
Sales / assets	Total sales with book value of assets as numerator	#12 / #6
Rspread	Asset return spread calculated as EDITDA minus non-operating expense with the book value of assets as numerator	(EDITDA - #61) / #6
Bankruptcy cost	R&D/ expense plus advertising expenses with sales as numerator	(#45 + #46) / #12
Eff. corp. tax rate	Income taxes with pre-tax income as numerator	#16 / #170