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ARTICLE

Valuation with share repurchases and personal taxes

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Abstract

We derive a consistent valuation approach that integrates the interdependent effects of cash dividends, share repurchases and active debt management while considering personal taxes. The valuation approach is based on the assumption that a predetermined proportion of the flow to equity is used for share repurchases instead of cash dividends. Additionally, we examine the effects of share repurchases on the cost of equity by deriving appropriate adjustment formulae. Furthermore, we run simulations to investigate the valuation differences caused by the distribution of excess cash via cash dividends or share repurchases. The results show that share repurchases have a significant positive effect on equity market value.

KEYWORDS

active debt management, cash dividends, cost of equity, equity market value, personal taxes, share repurchases, simulations, valuation

JEL CLASSIFICATION

G32, H20, M41

1 | INTRODUCTION

Firms can use excess cash to pay dividends or repurchase shares. Share repurchases have become increasingly important since the early 1980s and, currently, have nearly the same magnitude as cash dividends (Brealey et al., 2020; Grullon and Michaely, 2002; Skinner, 2008). The reasons for this are manifold: perceived stock undervaluation, signaling effects, maintenance of financial flexibility, management of the “earnings per share” ratio, tax considerations and so on (e.g., Brav et al., 2005; Skinner, 2008). Among these reasons, tax considerations are of particular importance to the

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firm's choice about the distribution of excess cash to shareholders (Bierman and West, 1966; Jacob and Jacob, 2013). Share repurchases lead to stock price appreciation and subsequently to capital gains, which are taxed differently from cash dividends. In the past, the tax rate on capital gains used to be lower than that on cash dividends (e.g., Bierman and West, 1966, 1968; Elton and Gruber, 1968a, 1968b). This still holds for some countries, such as the US, but other countries, such as Germany, now use the same tax rate for cash dividends and capital gains. However, as shares represent long-term investments, capital gains are typically not immediately realized. Therefore, capital gains can be deferred, which leads to a tax advantage (Berk and DeMarzo, 2020; Brealey et al., 2020). Consequently, the effective tax rate on capital gains is lower than the tax rate on dividends. Thus, the distribution of excess cash via dividends or share repurchases is relevant to the market value of equity.¹

In this study, we examine the effects of cash dividends and share repurchases on the equity market value of a firm. Our contribution to the literature is threefold. First, we derive the valuation model for a firm that allows for simultaneous distribution of cash dividends and share repurchases while pursuing active debt management. The value associated with share repurchases affects the capital structure related to different parts of the valuation model. Clubb and Doran (1992) also present a valuation model with personal taxes, active debt management and share repurchases. However, in their model, the amount of share repurchases is always equal to the change in debt market value. We overcome this limitation by defining the amount of share repurchases and, accordingly, cash dividends as the ratio of the flow to equity. Insofar, we derive an extended valuation model for the flexible consideration of share repurchases independent of the financing policy. Second, the effects of the tax advantage of share repurchases on the cost of equity are disclosed by deriving appropriate adjustment formulae for active debt management according to Miles and Ezzell (1980, 1985) and Harris and Pringle (1985). The explicit forecast period and the steady state phase are analyzed. The resulting formulae have the same structure as the common adjustment formulae. Third, we compute the valuation difference resulting from a valuation assuming only cash dividends, as compared with a valuation considering both cash dividends and share repurchases. Under otherwise identical assumptions, the equity market value is always lower if only cash dividends are paid. The average valuation difference amounts to 5.2% in the Miles/Ezzell case and 9% in the Harris/Pringle case, depending on the percentage proportion of dividends and share repurchases. Furthermore, we show that the Harris/Pringle-type adjustment formula for the cost of equity is a good approximation of the Miles/Ezzell-type adjustment formula in the case of a high proportion of share repurchases.

The remainder of this study is organized as follows. In Section 2, we describe the empirical relevance and drivers of a payout policy with share repurchases, emphasizing the effect of differences in tax rates for dividends and capital gains. Furthermore, we provide a review of relevant valuation research. In Section 3, we present the basic valuation model for an unlevered firm that distributes excess cash via cash dividends and share repurchases. In Section 4, we develop a valuation model for the levered firm and highlight the interdependent effects of cash dividends, share repurchases and active debt management on equity market value. In Section 5, we derive adjustment formulae for the cost of equity of the levered firm under Miles/Ezzell and Harris/Pringle settings. In Sections 4 and 5, we also clarify the relationship between our valuation approach and the closest related model of Clubb and Doran (1992). Finally, we present the simulation results for the valuation differences under different cash distribution strategies (Section 6). The study concludes by summarizing the most important results.

2 | LITERATURE REVIEW

2.1 | Relevance and drivers of a payout policy with share repurchases

In 1967, Guthart found that share repurchases increased for firms listed on the New York Stock Exchange (Guthart, 1967). Subsequently, the changing balance between dividends and share repurchases has been analyzed in many

¹ The optimal dividend policy would imply that a firm pays no cash dividends at all. However, cash dividends are still made for signaling purposes and several other reasons (Black, 1976).

studies. Medury et al. (1992), Dittmar (2000), Grullon and Michaely (2002), von Eije and Megginson (2008) and Skinner (2008) showed that for US and European firms, excess financial funds are more frequently used for share repurchases rather than cash dividends. These empirical findings support the hypothesis that share repurchases are increasingly substituting dividends.

Fama and French (2001) also confirmed the increasing relevance of share repurchases for capital markets in many countries, but they concluded that share repurchases are a complement rather than a substitute for dividends. Furthermore, they identified firms with low earnings, strong investments and small sizes as chronic non-dividend firms. Additional empirical evidence of the complementary character of share repurchases was provided by Guay and Harford (2000), Jagannathan et al. (2000), Lee and Rui (2007) and Armitage and Gallagher (2021). They showed that share repurchases are associated with temporary components of earnings, whereas dividends are connected to permanent earnings, which makes total payouts more responsive to earnings.

The relevance of share repurchases and dividends for US industrial firms and banks during the financial crisis was analyzed by Floyd et al. (2015). In contrast to the increase in share repurchases before the crisis, share repurchases decreased at the beginning of the financial crisis. They showed that banks had a higher and more stable propensity to pay dividends and resisted cutting dividends as the financial crisis began. In the case of industrial firms, dividends are increasingly concentrated in firms that also repurchase shares, supporting the complementary theory of dividends and share repurchases.

Vermaelen (1981) empirically examined stock repurchases and market signaling. He found that, on average, firms with share repurchases experience a permanent increase in stock prices. Ofer and Thakor (1987) also analyzed the announcement effects of dividends and stock repurchases to evaluate the positive value effects of share repurchases compared with cash dividends. Grullon and Michaely (2004) showed that the announcement of share repurchases is not followed by an increase in operating performance but a significant reduction in systematic risk and cost of capital relative to nonrepurchasing firms. Furthermore, they found a more positive market reaction among those firms that are more likely to overinvest. Another argument for share repurchases is the ability of managers to identify and exploit the undervaluation of shares (Ikenberry et al., 1995).

The importance of tax considerations for the firm's choice about the distribution of excess cash to shareholders was first analyzed by Bierman and West (1966, 1968). The relevance of tax considerations for the payout policy is confirmed in Lie and Lie (1999), Grullon and Michaely (2004), Brockman et al. (2008), Alzahrani and Lasfer (2012) and Jacob and Jacob (2013). They found that the tax penalty on dividends versus capital gains is related, among other factors, to firms' propensity to pay dividends and repurchase shares. To analyze the tax effects of payout policies, it is important to consider that capital gains are not taxed immediately and can be deferred. Therefore, the effective capital gain tax rate is lower than the capital gain tax rate (Berk and DeMarzo, 2020; Brealey et al., 2020). This leads to a tax advantage for share repurchases in countries with equal tax rates, and possibly even in countries with lower dividend tax rates.

2.2 | Previous valuation research

Since debt financing provides a corporate tax advantage, a firm's financing strategy (i.e., passive or active debt management) affects the value of tax shields and, thus, the equity market value (Modigliani and Miller, 1958, 1963; Miles and Ezzell, 1980, 1985; Harris and Pringle, 1985).² Passive debt management is characterized by predetermined debt levels, whereas active debt management presumes predetermined targets for the capital structure. In this analysis, we assume active debt management. According to Miles and Ezzell, it is possible to adjust the capital structure only at the beginning of a period, which offers a sound theoretical basis in a discrete-time valuation model. In contrast, Harris and Pringle allow for continuous adjustments of the capital structure, which should be interpreted as a heuristic in this

² Note that Miller and Modigliani (1958, 1963), Miles and Ezzell (1980, 1985) and Harris and Pringle (1985) abstract from personal taxes.

setting. In addition, there are alternative financing strategies with a mixture of active and passive debt management (i.e. Clubb and Doran, 1995; Dierkes and Schäfer, 2017; Dierkes and de Maeyer, 2022), but so far they are of minor relevance for valuation.

The tax advantage of share repurchases over cash dividends was first addressed by Bierman and West (1966), Brigham (1964), Elton and Gruber (1968a) and Robichek and Myers (1965). Bierman and West (1966) assume – as we do in our study – that a predetermined cash dividend ratio is used to distribute excess cash among cash dividends and share repurchases. Unlike our analysis, the authors do not make any assumptions about the financing strategy and do not specify the underlying cost of equity. Consequently, they do not account for additional financing effects resulting from active debt management nor derive an adjustment formula for the cost of equity. Rashid and Amoako-Adu (1987, 1995) also address the effect of share repurchases on equity market value. They assume that excess cash is distributed to equity investors according to a predetermined dividend payout ratio based on earnings. The retained cash is used for share repurchases to ensure that investment and financing decisions remain independent. As these studies assume passive debt management, they are only partially comparable with the present study.

In a recent study, Dempsey (2019) develops different discounting techniques for various Discounted Cash Flow (DCF) models with personal taxes. Specifically, he derives the weighted average cost of capital and cost of equity under both passive and active debt management according to Harris and Pringle. Moreover, he shows that different DCF models yield the same equity market value in an explicit forecast period. Concerning the personal taxation of equity investors, he assumes a blended personal tax rate on cash dividends and capital gains (see also Sick, 1990; Taggart, 1991). The advantage of valuation models with a blended tax rate is lower complexity. Still, they are of limited practical use because it remains an open question how to determine the blended personal tax rate and, consequently, how to apply these valuation models.

Clubb and Doran (1992) analyzed a valuation model with active debt management according to Miles and Ezzell and different tax rates for dividends, capital gains and interest. This model is most closely related to our study, but it has one limitation. In contrast to our approach, they assume that the amount of share repurchases is always equal to the change in debt market value. Therefore, share repurchases are linked to the financing policy and the model cannot account for a different distribution of dividends and share repurchases. In the following section, we derive an extended valuation model with personal taxes, where share repurchases comprise a fixed fraction of the flow to equity and can be determined independently of the financing policy.

3 | VALUATION MODEL FOR THE UNLEVERED FIRM

In this section, we assume that the firm is all-equity-financed. The firm's expected free cash flows $E[\widetilde{FCF}_t]$ in periods $t = 1, 2, \dots$ are given, and the unlevered cost of equity after personal taxes ke^u is constant over time.³ Cash dividends and effective capital gains are taxed differently with tax rates τ_d and τ_g . Tax rates do not vary across investors and time. Capital gains correspond to changes in market value at the end of each period. The firm distributes excess cash via cash dividends and share repurchases. As the latter leads to stock price appreciation, share repurchases are subject to the effective capital gains tax rate τ_g (Clubb and Doran, 1992; Rashid and Amoako-Adu, 1995). Regarding the magnitudes of the cash dividend tax rate and effective capital gains tax rate, we expect $\tau_d > \tau_g$. Finally, we assume that the forecasting period is divided into an explicit forecast period and a steady state phase. In other words, the valuation object reaches a steady state at the end of the explicit forecast period, in which the free cash flow and expected values of all other relevant variables (e.g., earnings before interest, taxes and capital expenditures) increase at a uniform and constant growth rate g . This nominal growth rate can include both inflation-based and real growth (Penman, 2013; Koller et al., 2015).

³ For the assumption of a constant cost of equity see Appendix A.

Specifically, in period t , the firm distributes the cash dividend ratio $0 \leq r_t \leq 1$ of the available free cash flow as cash dividends and uses the residual cash flow for share repurchases. We assume the cash dividend ratio r_t to be a predetermined corporate policy variable (Bierman and West, 1966; Rashid and Amoako-Adu, 1995). Consequently, the shareholders' total surplus comprises two elements. The first element is the cash dividend $r_t \cdot E[\widetilde{FCF}_t]$ taxed at the dividend tax rate τ_d . The second element is the amount of share repurchases $(1 - r_t) \cdot E[\widetilde{FCF}_t]$, which leads to a corresponding increase in the stock price and is, therefore, taxed at the effective capital gain tax rate τ_g . Thus, we obtain the shareholders' total surplus as⁴

$$r_t \cdot E[\widetilde{FCF}_t] \cdot (1 - \tau_d) + (1 - r_t) \cdot E[\widetilde{FCF}_t] \cdot (1 - \tau_g), \quad \text{for } t = 1, \dots, T, \quad (1)$$

where T denotes the end of the explicit forecast period. By definition, the expected equity market value of the unlevered firm $E[\tilde{V}_{t-1}^u]$ at time $t - 1$ corresponds to the total surplus after personal taxes; change in market value ($E[\tilde{V}_t^u] - E[\tilde{V}_{t-1}^u]$), which is taxed by τ_g ; and equity market value $E[\tilde{V}_t^u]$ at time t discounted by the cost of equity ke^u after personal taxes. The cost of equity ke^u is dependent on the cost of equity for discounting the uncertain free cash flow before personal taxes and the risk-free interest rate because the market value at the beginning of a period is an element of the tax base of the capital gains tax.⁵ A recursive approach leads to the following:

$$E[\tilde{V}_{t-1}^u] = \frac{\overbrace{r_t \cdot E[\widetilde{FCF}_t] \cdot (1 - \tau_d)}^{\text{cash dividends}} + \overbrace{(1 - r_t) \cdot E[\widetilde{FCF}_t] \cdot (1 - \tau_g)}^{\text{share repurchases}} - \overbrace{\tau_g \cdot (E[\tilde{V}_t^u] - E[\tilde{V}_{t-1}^u])}^{\text{change in market value}} + E[\tilde{V}_t^u]}{1 + ke^u}, \quad (2)$$

for $t = 1, \dots, T$.

The taxation of changes in market values leads to a circularity problem because the equity market value at time $t - 1$ affects the tax base of personal taxes on capital gains in period t . This circularity problem can be easily overcome by solving equation (2) for the equity market value at time $t - 1$:

$$E[\tilde{V}_{t-1}^u] = \frac{E[\widetilde{FCF}_t] \cdot (1 - r_t \cdot \tau_{d^*}) + E[\tilde{V}_t^u]}{1 + ke^{u^*}}, \quad \text{for } t = 1, \dots, T, \quad (3)$$

where $\tau_{d^*} = (\tau_d - \tau_g)/(1 - \tau_g)$ indicates a modified personal tax rate and $ke^{u^*} = ke^u/(1 - \tau_g)$ denotes the modified cost of equity of the unlevered firm. τ_{d^*} can be interpreted as a dividend tax penalty for equity investors or the personal tax disadvantage of cash dividends over capital gains (Berk and DeMarzo, 2020; Dhaliwal et al., 2005; Dempsey, 2001; Naranjo et al., 1998; Poterba and Summers, 1985). To identify the value effect associated with the tax shield of share repurchases, we rearrange the terms in equation (3):

$$E[\tilde{V}_{t-1}^u] = \frac{\overbrace{E[\widetilde{FCF}_t] \cdot (1 - \tau_{d^*}) + E[\tilde{V}_t^{u,c}]}^{\text{market value without tax shields from share repurchases}}}{1 + ke^{u^*}} + \frac{\overbrace{(1 - r_t) \cdot E[\widetilde{FCF}_t] \cdot \tau_{d^*} + E[\tilde{V}_t^{u,\Delta}]}^{\text{added market value of tax shields from share repurchases}}}{1 + ke^{u^*}} = E[\tilde{V}_{t-1}^{u,c}] + E[\tilde{V}_{t-1}^{u,\Delta}], \quad (4)$$

for $t = 1, \dots, T$.

In equation (4), the first term depicts the expected market value without tax shields from share repurchases $E[\tilde{V}_{t-1}^{u,c}]$, whereas the second term denotes the added market value of tax shields from share repurchases $E[\tilde{V}_{t-1}^{u,\Delta}]$.

⁴ All uncertain variables are denoted by a tilde.

⁵ An alternative derivation of the expected market value of the unlevered firm according to Miles and Ezzell (1980) with differentiated discount rates for the uncertain and certain elements of the overall expected flow to equity is presented in Appendix A.

Here, the tax advantage of share repurchases over cash dividends becomes apparent. The superscripts c and Δ denote corresponding variables.⁶ Note that for $r = 1$, and consequently only considering free cash flow distributions as cash dividends, equations (3) and (4) correspond to equations (9) and (11) in Clubb and Doran (1992), assuming an unlevered firm. Accordingly, equations (3) and (4) extend Clubb and Doran's analysis by additionally accounting for share repurchases as an alternative channel for excess cash distribution to shareholders for unlevered firms. Note that the effective capital gains tax rate τ_g is relevant even if share repurchases are not considered, as the change in equity market value is subject to the effective capital gains tax rate.

In the steady state, all relevant quantities increase at the nominal growth rate g . Consequently, inserting $E[\tilde{V}_t^u] = E[\tilde{V}_{t-1}^u] \cdot (1 + g)$ in (3) and solving for $E[\tilde{V}_{t-1}^u]$, we obtain the expected terminal value $E[\tilde{V}_T^u]$ in period T as follows:

$$E[\tilde{V}_T^u] = \frac{E[\widetilde{FCF}_{T+1}] \cdot (1 - r_t \cdot \tau_{d^*})}{ke^{u^*} - g}, \quad (5)$$

which can be rearranged to

$$E[\tilde{V}_T^u] = \frac{E[\widetilde{FCF}_{T+1}] \cdot (1 - \tau_d)}{ke^u - g \cdot (1 - \tau_g)} + \frac{(1 - r) \cdot E[\widetilde{FCF}_{T+1}] \cdot (\tau_d - \tau_g)}{ke^u - g \cdot (1 - \tau_g)} = E[\tilde{V}_T^{u,c}] + E[\tilde{V}_T^{u,\Delta}]. \quad (6)$$

In equation (6), the taxation of capital gains leads to a reduced growth rate $g \cdot (1 - \tau_g)$. Equations (4) and (6) indicate that a firm's market value increases as cash dividend ratios (r_t and r) decrease due to different taxation of cash dividends and capital gains.⁷ An increasing use of share repurchases as a means of distribution of cash flows to shareholders leads to decreasing personal taxes and, correspondingly, to an increasing equity market value. Therefore, the added market value of tax shields from share repurchases in equations (4) and (6) stems only from the difference in the corresponding tax rates. If $\tau_d = \tau_g$ holds, the added market value of tax shields from share repurchases becomes zero, and the two equations translate into a valuation calculus without personal taxes corresponding to the result of dividend irrelevancy in Miller and Modigliani (1961).⁸

Overall, the effect of the added market value of tax shields from share repurchases on the market value of an unlevered firm emerges as a relatively straightforward adjustment. However, if we consider a levered firm with predetermined capital structure targets, the value-enhancing effect generates additional financing effects. The next section addresses this issue.

4 | VALUATION MODEL FOR THE LEVERED FIRM

We now assume that the firm is financed by both equity and debt. With respect to the previous setting, we add a few assumptions: As creditors do not bear any risk, the cost of debt kd corresponds to the risk-free interest rate and is constant over time. Furthermore, the debt book value is assumed to be equal to the debt market value. Interest on debt is fully deductible from taxable firm income (as in Modigliani and Miller, 1963 and Miles and Ezzell, 1980, among many others)⁹, and the corporate tax rate τ is independent of the amount of this income. Concerning debt investors' personal taxation, we introduce the tax rate τ_b for interest income (for the tax advantages of debt financing with corporate

⁶ If a variable has no superscript c or Δ , it refers to the overall values.

⁷ This statement can be verified by computing the corresponding partial derivatives in equations (4) and (6) for $\tau_d > \tau_b$.

⁸ If the cash dividend tax rate equals the effective capital gains tax rate, the cost of equity without personal taxes is obtained by dividing the cost of equity with personal taxes ke^u through one minus the uniform tax rate.

⁹ If interest on debt is only partially deductible, the appropriate tax rate of this tax base is used.

and personal taxes, see Miller, 1977). Thus, we consider three different personal tax rates for cash dividends, interest income and capital gains.¹⁰

As for the financing strategy of the valuation object, we assume active debt management characterized by predetermined leverage L_t in period t . Leverage is defined as follows:

$$L_t = \frac{\overbrace{L_t \cdot E[\tilde{V}_t^{\ell,c}]}^{\text{debt related to market value without tax shields from share repurchases}}}{E[\tilde{V}_t^{\ell,c}] + E[\tilde{V}_t^{\ell,\Delta}]} + \frac{\overbrace{L_t \cdot E[\tilde{V}_t^{\ell,\Delta}]}^{\text{additional debt related to added market value of tax shields from share repurchases}}}{E[\tilde{V}_t^{\ell,c}] + E[\tilde{V}_t^{\ell,\Delta}]} = \frac{E[\tilde{D}_t]}{E[\tilde{V}_t^{\ell}]}, \text{ for } t = 0, \dots, T-1, \quad (7)$$

where $\tilde{V}_t^{\ell,c}$ is the market value of equity without tax shields from share repurchases, and $\tilde{V}_t^{\ell,\Delta}$ is the additional market value of equity related to tax shields from share repurchases. From equation (7), it is evident that in the case of active debt management, additional debt $L_t \cdot \tilde{V}_t^{\ell,\Delta}$ must be issued to adhere to the predetermined leverage. If the firm only issued debt related to the equity market value without tax shields from share repurchases, the leverage would be lower than the predetermined one. Note that issuing additional debt implies additional interest and tax shields, which, in turn, affect different parts of the flow to equity valuation calculus. In the end, the total amount of debt issued becomes $\bar{D}_t = \bar{D}_t^c + \bar{D}_t^{\Delta}$, while the market value of equity is $\tilde{V}_t^{\ell} = \tilde{V}_t^{\ell,c} + \tilde{V}_t^{\ell,\Delta}$.

By considering only the debt that relates to the equity market value without tax shields from share repurchases, the expected flow to equity $E[\widetilde{FtE}_t^c]$ is computed as follows:

$$E[\widetilde{FtE}_t^c] = E[\widetilde{FCF}_t] - kd \cdot E[\bar{D}_{t-1}^c] + \tau \cdot kd \cdot E[\bar{D}_{t-1}^c] + E[\bar{D}_t^c] - E[\bar{D}_{t-1}^c], \text{ for } t = 1, \dots, T, \quad (8)$$

where $kd \cdot E[\bar{D}_{t-1}^c]$ is the expected interest paid relative to the equity market value without tax shields from share repurchases in period t and τ is the corporate tax rate. The term $\tau \cdot kd \cdot E[\bar{D}_{t-1}^c]$ depicts the tax shield resulting from the tax deductibility of interest. The change in debt in period t is $E[\bar{D}_t^c] - E[\bar{D}_{t-1}^c]$. As the amount of debt depends on the equity market value at time t ($E[\bar{D}_t^c] = L_t \cdot E[\tilde{V}_t^{\ell,c}]$), it is unknown at the time of valuation (active debt management).

Once additional debt is issued to maintain the predetermined leverage, we obtain the expected flow to equity $E[\widetilde{FtE}_t]$:

$$E[\widetilde{FtE}_t] = E[\widetilde{FtE}_t^c] + E[\widetilde{FtE}_t^{\Delta}] = E[\widetilde{FtE}_t^c] - kd \cdot E[\bar{D}_{t-1}^{\Delta}] + \tau \cdot kd \cdot E[\bar{D}_{t-1}^{\Delta}] + E[\bar{D}_t^{\Delta}] - E[\bar{D}_{t-1}^{\Delta}], \quad (9)$$

for $t = 1, \dots, T$.

It is the sum of \widetilde{FtE}_t^c , the flow to equity without the effect of additional debt related to tax shields from share repurchases, and $\widetilde{FtE}_t^{\Delta}$, the additional flow to equity due to the effect of additional debt related to share repurchases, $\bar{D}_t^{\Delta} = L_t \cdot \tilde{V}_t^{\ell,\Delta}$. Equation (9) shows that $\widetilde{FtE}_t^{\Delta}$ comprises additional interest paid and additional tax shields received. In addition, $\widetilde{FtE}_t^{\Delta}$ also considers changes in additional debt. Given the cash dividend ratio r_t , we assume that the proportion $r_t \cdot \widetilde{FtE}_t$ is used for cash dividends and $(1 - r_t) \cdot \widetilde{FtE}_t$ is used for share repurchases. Accordingly, shareholders' total surplus of the levered firm can be disaggregated into two parts:¹¹

$$r_t \cdot \left(E[\widetilde{FtE}_t^c] + E[\widetilde{FtE}_t^{\Delta}] \right) \cdot (1 - \tau_d) + (1 - r_t) \cdot \left(E[\widetilde{FtE}_t^c] + E[\widetilde{FtE}_t^{\Delta}] \right) \cdot (1 - \tau_g), \text{ for } t = 1, \dots, T. \quad (10)$$

¹⁰ In many European countries, the tax rate for cash dividends and interest is the same and thus $\tau_d = \tau_b$. Hence, the model can be easily specified to different tax systems.

¹¹ We assume that the cash dividend ratios r_t and r are identical for the unlevered and the levered firm.

Thus, the valuation calculus for the levered firm is:

$$E[\tilde{V}_{t-1}^{\ell}] = \frac{\overbrace{r_t \cdot (E[\tilde{FtE}_t^c] + E[\tilde{FtE}_t^{\Delta}]) \cdot (1-\tau_d) + (1-r_t) \cdot (E[\tilde{FtE}_t^c] + E[\tilde{FtE}_t^{\Delta}]) \cdot (1-\tau_g)}^{\text{cash dividends} \quad \text{share repurchases}}}{1+ke_t^{\ell,r}} + \frac{\overbrace{(E[\tilde{V}_t^{\ell}] - E[\tilde{V}_{t-1}^{\ell}])}^{\text{change in equity market value}}}{1+ke_t^{\ell,r}} + E[\tilde{V}_t^{\ell}], \text{ for } t = 1, \dots, T. \quad (11)$$

The total surplus, change in equity market value and equity market value in period t in equation (11) are discounted at the risk-adjusted cost of equity $ke_t^{\ell,r}$. By solving the circularity problem and rearranging the terms, we obtain:

$$E[\tilde{V}_{t-1}^{\ell}] = \frac{\overbrace{E[\tilde{FtE}_t^c] \cdot (1-\tau_d) + E[\tilde{V}_t^{\ell,c}]}^{\text{market value without tax shields from share repurchases}}}{1+ke_t^{\ell*,r}} + \frac{\overbrace{(1-r_t) \cdot E[\tilde{FtE}_t^c] \cdot \tau_d + E[\tilde{FtE}_t^{\Delta}] \cdot (1-r_t \cdot \tau_d) + E[\tilde{V}_t^{\ell,\Delta}]}^{\text{added market value of tax shields from share repurchases} \quad \text{market value of additional debt effects}}}{1+ke_t^{\ell*,r}} + E[\tilde{V}_{t-1}^{\ell,c}] + E[\tilde{V}_{t-1}^{\ell,\Delta}], \text{ for } t = 1, \dots, T, \quad (12)$$

with $ke_t^{\ell*,r} = ke_t^{\ell,r}/(1-\tau_g)$. In equation (12), $\tilde{V}_{t-1}^{\ell,\Delta}$ is the sum of the added market value of tax shields from share repurchases and the market value of additional debt effects. The relevant cost of equity is the modified cost of equity $ke_t^{\ell*,r}$.

In the steady state, all relevant values increase at the growth rate g . Thus, the expected terminal value $E[\tilde{V}_T^{\ell}]$ is as follows:

$$E[\tilde{V}_T^{\ell}] = \frac{E[\tilde{FtE}_{T+1}^c] \cdot (1-\tau_d)}{ke^{\ell,r} - g \cdot (1-\tau_g)} + \frac{(1-r) \cdot E[\tilde{FtE}_{T+1}^c] \cdot (\tau_d - \tau_g) + E[\tilde{FtE}_{T+1}^{\Delta}] \cdot (1-r \cdot \tau_d - (1-r) \cdot \tau_g)}{ke^{\ell,r} - g \cdot (1-\tau_g)} = E[\tilde{V}_T^{\ell,c}] + E[\tilde{V}_T^{\ell,\Delta}] \quad (13)$$

Both leverage and cost of equity are constant here.

Equations (12) and (13) resemble equations (4) and (6), but they exhibit increased complexity due to the effects of debt. Moreover, we face further circularity problems, as \tilde{FtE}_t^c and \tilde{FtE}_t^{Δ} are affected by tax shields, interest and debt changes according to equations (8) and (9). In the following, we solve these circularity problems successively for $E[\tilde{V}_{t-1}^{\ell,c}]$ and $E[\tilde{V}_{t-1}^{\ell,\Delta}]$.

A. Equity Market Value without Tax Shields from Share Repurchases

According to equation (12), we have for $E \left[\tilde{V}_{t-1}^{\ell,c} \right]$:

$$E \left[\tilde{V}_{t-1}^{\ell,c} \right] = \frac{E \left[\widetilde{FtE}_t^c \right] \cdot (1 - \tau_{d^*}) + E \left[\tilde{V}_t^{\ell,c} \right]}{1 + ke_t^{\ell^*,r}}, \text{ for } t = 1, \dots, T \quad (14)$$

Solving equation (14) for $E \left[\tilde{V}_{t-1}^{\ell,c} \right]$ in consideration of equation (8) and $E \left[\tilde{D}_t^c \right] = L_t \cdot \left[\tilde{V}_t^{\ell,c} \right]$ yields

$$E \left[\tilde{V}_{t-1}^{\ell,c} \right] = \frac{E \left[\widetilde{FCF}_t \right] \cdot (1 - \tau_{d^*}) + E \left[\tilde{V}_t^{\ell,c} \right] \cdot (1 + L_t \cdot (1 - \tau_{d^*}))}{1 + ke_t^{\ell^*,r} + (kd \cdot (1 - \tau) \cdot L_{t-1} + L_{t-1}) \cdot (1 - \tau_{d^*})}, \text{ for } t = 1, \dots, T. \quad (15)$$

Note that equation (15) relates to equation (10) in the Clubb and Doran (1992) analysis.¹² In contrast to our analysis, they assume a constant leverage ratio and changes in debt market values are not used for cash dividends but share repurchases. Therefore, changes in debt market values are taxed at the effective capital gains tax rate, which leads to a different valuation approach. In equation (15), we assume in the first step that this debt component is distributed to shareholders as cash dividends and taxed at the cash dividend tax rate. In the next step, we consider the value effects of share repurchases according to the cash dividend ratio. Therefore, in our model, the amount of share repurchases is not restricted to changes in debt market values but is determined by the cash dividend ratio, independent of the financing policy.

Inserting $E \left[\tilde{V}_t^{\ell,c} \right] = E \left[\tilde{V}_{t-1}^{\ell,c} \right] \cdot (1 + g)$ in equation (15), keeping leverage L constant and solving for $E \left[\tilde{V}_{t-1}^{\ell,c} \right]$ yields the terminal value without tax shields from share repurchases $E \left[\tilde{V}_T^{\ell,c} \right]$:

$$E \left[\tilde{V}_T^{\ell,c} \right] = \frac{E \left[\widetilde{FCF}_{T+1} \right] \cdot (1 - \tau_d)}{ke_t^{\ell^*,r} - g \cdot (1 - \tau_g) + (kd \cdot (1 - \tau) - g) \cdot L \cdot (1 - \tau_d)} \quad (16)$$

The term $kd \cdot (1 - \tau) \cdot L \cdot (1 - \tau_d)$ in the denominator of equation (16) embodies interest paid and tax shields received adapted to a situation without share repurchases. $g \cdot L \cdot (1 - \tau_d)$ takes into account the expected increase in debt according to the growth rate g .

B. Additional Market Value from Share Repurchases

To determine the additional market value $E \left[\tilde{V}_{t-1}^{\ell,\Delta} \right]$, we substitute the additional debt effects on the flow to equity $\widetilde{FtE}_t^\Delta = \tau \cdot kd \cdot \tilde{D}_{t-1}^\Delta - kd \cdot \tilde{D}_{t-1}^\Delta + \tilde{D}_t^\Delta - \tilde{D}_{t-1}^\Delta$ in equation (12):

$$E \left[\tilde{V}_{t-1}^{\ell,\Delta} \right] = \frac{(1 - r_t) \cdot E \left[\widetilde{FtE}_t^c \right] \cdot \tau_{d^*}}{1 + ke_t^{\ell^*,r}} + \frac{\overbrace{(\tau \cdot kd \cdot E \left[\tilde{D}_{t-1}^\Delta \right])}^{\text{additional tax shields}} - \overbrace{kd \cdot E \left[\tilde{D}_{t-1}^\Delta \right]}^{\text{additional interests}} + \overbrace{E \left[\tilde{D}_t^\Delta \right] - E \left[\tilde{D}_{t-1}^\Delta \right]}^{\text{additional change in debt}} \cdot (1 - r_t \cdot \tau_{d^*}) + E \left[\tilde{V}_t^{\ell,\Delta} \right]}{1 + ke_t^{\ell^*,r}}, \quad (17)$$

for $t = 1, \dots, T$.

¹² See Appendix B for a comparison of equation (15) with the valuation approach of Clubb and Doran (1992).

Solving equation (17) for $E[\tilde{V}_{t-1}^{\ell,\Delta}]$ with $E[\tilde{D}_t^\Delta] = L_t \cdot E[\tilde{V}_t^{\ell,\Delta}]$ yields

$$E[\tilde{V}_{t-1}^{\ell,\Delta}] = \frac{(1-r_t) \cdot E[\widetilde{\text{FtE}}_t^c] \cdot \tau_{d^*} + E[\tilde{V}_t^{\ell,\Delta}] \cdot (1+L_t \cdot (1-r_t \cdot \tau_{d^*}))}{1 + ke_t^{\ell^*,r} + (kd \cdot (1-\tau) \cdot L_{t-1} + L_{t-1}) \cdot (1-r_t \cdot \tau_{d^*})}, \text{ for } t = 1, \dots, T. \quad (18)$$

Consequently, we obtain for the terminal value $E[\tilde{V}_T^{\ell,\Delta}]$:

$$E[\tilde{V}_T^{\ell,\Delta}] = \frac{(1-r) \cdot E[\widetilde{\text{FtE}}_{T+1}^c] \cdot (\tau_d - \tau_g)}{ke_t^{\ell^*,r} - g \cdot (1-\tau_g) + (kd \cdot (1-\tau) - g) \cdot L \cdot (1-r \cdot \tau_d - (1-r) \cdot \tau_g)}. \quad (19)$$

Note that after computing the equity market value according to equations (15) and (16), $\widetilde{\text{FtE}}^c$ can be determined and the application of equations (18) and (19) is not affected by circularity problems. The effect of an increasing use of share repurchases on equity market value is comparable to the case of valuation of an unlevered firm: a lower cash dividend ratio leads to decreasing personal taxes and, correspondingly, to an increasing equity market value. The additional market value from share repurchases in equation (19) stems from the difference in the corresponding tax rates. If τ_d equals τ_g , the additional market value from share repurchases becomes zero. However, the valuation calculus for the levered firm cannot be applied as long as the costs of equity ($ke_t^{\ell^*,r}$ and $ke_t^{\ell^*,r}$) are not known. We will address this issue in the next section.

5 | THE COST OF EQUITY

In this section, we derive adjustment formulae for the cost of equity by following Miles and Ezzell (1980, 1985) and Harris and Pringle (1985). The approaches differ in their assumptions on the temporal adjustment of debt to the pre-determined leverage. Miles and Ezzell assume that adjustment can occur only at the beginning of a period, whereas Harris and Pringle allow for continuous adjustments. Miles and Ezzell conclude that the tax shield is certain in the period of its emergence and thus discounts at the risk-free interest rate within this period. For all previous periods, however, the relevant discount rate is the cost of equity of the unlevered firm. According to Harris and Pringle, the unlevered cost of equity is used as the discount rate for all periods. Whereas active debt management according to Miles and Ezzell is a sound theoretical basis for a valuation model in a discrete-time setting, the possibility of continuous adjustment of debt according to Harris and Pringle does not fit into this setting. Therefore, Harris and Pringle's approach should be interpreted as an approximation of Miles and Ezzell's approach.

To investigate the relationship between the costs of equity of the unlevered and levered firms, we rearrange the terms in equations (3) and (11). After rearranging the terms in equation (3), we obtain:

$$E[\widetilde{\text{FCF}}_t] \cdot (1-r_t \cdot \tau_{d^*}) = E[\tilde{V}_{t-1}^u] \cdot (1+ke^{u^*}) - E[\tilde{V}_t^u], \text{ for } t = 1, \dots, T. \quad (20)$$

Furthermore, from (11), we have

$$E[\tilde{V}_{t-1}^\ell] = \frac{E[\widetilde{\text{FtE}}_t] \cdot (1-r_t \cdot \tau_{d^*}) + E[\tilde{V}_t^\ell]}{1 + ke_t^{\ell^*,r}}, \text{ for } t = 1, \dots, T, \quad (21)$$

where $\widetilde{\text{FtE}}_t = \widetilde{\text{FCF}}_t - kd \cdot \tilde{D}_{t-1} + \tau \cdot kd \cdot \tilde{D}_{t-1} + \tilde{D}_t - \tilde{D}_{t-1}$ holds with $\tilde{D}_t = \tilde{D}_t^c + \tilde{D}_t^\Delta$. Equation (21) cannot be used for valuation without knowledge of the cost of equity. To derive the adjustment formula for the cost of equity of the levered firm, equation (21) and the market value of tax shields in the Miles/Ezzell case according to equation (C.4) in

Appendix C¹³ are combined with equation (20) and the common relationship from value additivity:

$$E[\tilde{V}_t^u] = E[\tilde{V}_t^e] + E[\tilde{D}_t] - E[\widetilde{\text{VTS}}_t^{\text{ME}}], \text{ for } t = 0, \dots, T-1, \quad (22)$$

with $E[\widetilde{\text{VTS}}_t^{\text{ME}}]$ as the expected market value of tax shields and the superscript ME denoting variables in the Miles/Ezzell case.

Eventually, after some rearrangement, we obtain the adjustment formula for the cost of equity:¹⁴

$$ke_t^{\ell,r,\text{ME}} = ke^u + (ke^u - kd \cdot (1 - \tau_b)) \cdot \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g)}{1 - \tau_g + kd \cdot (1 - \tau_b)} \cdot L_{t-1}, \text{ for } t = 1, \dots, T. \quad (23)$$

In the steady state, the leverage and cash dividend ratio r are constant:

$$ke^{\ell,r,\text{ME}} = ke^u + (ke^u - kd \cdot (1 - \tau_b)) \cdot \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - r \cdot \tau_d - (1 - r) \cdot \tau_g)}{1 - \tau_g + kd \cdot (1 - \tau_b)} \cdot L. \quad (24)$$

The adjustment formulae in equations (23) and (24) resemble those developed by Modigliani and Miller (1963) and Miles and Ezzell (1980, 1985). Starting from the cost of equity ke^u , which depicts the operating risk of the valuation object, a risk premium is added to incorporate financial risk. The risk premium is affected by the dividend tax penalty, which reflects the tax advantage of share repurchases compared with cash dividends. Note that the lower the cash dividend ratios r_t and r , the higher $ke_t^{\ell,r,\text{ME}}$ and $ke^{\ell,r,\text{ME}}$ because the tax rate on cash dividends is higher than the effective tax rate on capital gains.¹⁵ Thus, the tax advantage of share repurchases comes along with increasing financial risk. As equations (23) and (24) refer to parameters that are known at the valuation date, the adjustment formulae are applicable without circularity problems. Clubb and Doran (1992) derive an adjustment formula in the case of share repurchases corresponding to changes in debt market value. Hence, we extend the analysis of Clubb and Doran regarding the adjustment formula, as in equations (23) and (24) the cost of equity is determined for a flexible amount of share repurchases according to the cash dividend ratio.¹⁶

Unlike Miles and Ezzell, Harris and Pringle (1985) assume that debt is continuously adjusted to predetermined leverage. In the same way as equations (23) and (24), the Harris/Pringle-type adjustment formula can be derived as follows:¹⁷

$$ke_t^{\ell,\text{HP}} = ke^u + (ke^u - kd \cdot (1 - \tau_b)) \cdot L_{t-1}, \text{ for } t = 1, \dots, T. \quad (25)$$

The superscript HP indicate variables in the Harris/Pringle case. If leverage is constant, we obtain

$$ke^{\ell,\text{HP}} = ke^u + (ke^u - kd \cdot (1 - \tau_b)) \cdot L. \quad (26)$$

As in the Miles/Ezzell case, the adjustment formulae are not subject to circularity problems. Apparently, the tax advantage of share repurchases has no effect on the cost of equity, following the assumptions of Harris and Pringle. This indicates an advantage, as these adjustment formulae are independent of the cash dividend ratio r . Consequently, it is not necessary to specify this ratio for the levering and unlevering of beta factors. However, only the Miles and

¹³ For a detailed derivation of the market value of tax shields in the Miles/Ezzell case and Harris/Pringle case see Appendix C.

¹⁴ See Appendix D.

¹⁵ This statement can be verified by computing the corresponding partial derivatives in equations (23) and (24).

¹⁶ For a comparison of the adjustment formula (24) with the one in Clubb and Doran (1992) see Appendix E.

¹⁷ The procedure follows Appendix D. Inserting equation (C.5) into (D.3) and collecting terms yields (25).

Ezzell setting provides a sound theoretical basis for valuation with active debt management in a discrete-time valuation model. This raises the question of whether the Harris/Pringle-type adjustment formulae are a good approximation to the Miles/Ezzell-type adjustment formulae.

A comparison of the adjustment formulae (23) and (25) shows that the cost of equity in the Harris/Pringle case is higher than the cost of equity in the Miles/Ezzell case if the coefficient ν_{r_t} is lower than one:

$$\nu_{r_t} = \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g)}{1 - \tau_g + kd \cdot (1 - \tau_b)} = \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - r_t \cdot \tau_{d^*})}{1 + kd \cdot (1 - \tau_{b^*})}, \text{ for } t = 1, \dots, T, \quad (27)$$

where $\tau_{b^*} = (\tau_b - \tau_g)/(1 - \tau_g)$ indicates a modified personal tax rate. In the case of a cash dividends only strategy with $r_t = 1$, we obtain the coefficient $\nu_{r_t=1}$:

$$\nu_{r_t=1} = \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - \tau_d)}{1 - \tau_g + kd \cdot (1 - \tau_b)} = \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - \tau_{d^*})}{1 + kd \cdot (1 - \tau_{b^*})}, \text{ for } t = 1, \dots, T. \quad (28)$$

According to equation (28), it is obvious for plausible tax rate assumptions that $\nu_{r_t=1}$ is significantly lower than one. Therefore, the difference between the cost of equity is high. Starting from the cash dividends only strategy, the cost of equity in the Miles/Ezzell case increases linearly with decreasing cash dividend ratio due to the positive difference between the tax rate on cash dividends τ_d and the effective tax rate on capital gains τ_g . Consequently, the difference between the cost of equity decreases linearly because of the constant cost of equity in the Harris/Pringle case. In the extreme case of a share repurchases only strategy with $r_t = 0$, the cost of equity in the Miles/Ezzell case is the highest. The coefficient $\nu_{r_t=0}$ is:

$$\nu_{r_t=0} = \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - \tau_g)}{1 - \tau_g + kd \cdot (1 - \tau_b)} = \frac{1 + kd \cdot (1 - \tau)}{1 + kd \cdot (1 - \tau_{b^*})}, \text{ for } t = 1, \dots, T. \quad (29)$$

Equation (29) shows that the coefficient $\nu_{r_t=0}$ is one when the corporate tax rate τ equals the modified personal tax rate τ_{b^*} , which leads to identical costs of equity. This can be traced back to two opposing effects: On the one hand, the corporate tax rate τ enters into the tax shield $\tau \cdot kd \cdot E [\bar{D}_{t-1}]$ taxed at the effective tax rate on capital gains τ_g , which has a lowering effect on financial risk. On the other hand, the interest income of the levered firm $kd \cdot E [\bar{D}_{t-1}]$ is taxed at the tax rate τ_b . In the case of an unlevered firm with a share repurchases only strategy, the non-paid interest income implies an increase in the stock price and is taxed at the effective tax rate for capital gains τ_g . When $\tau_b > \tau_g$, it leads to a reduction in the tax shield and, therefore, to a higher financial risk. Thus, the modified personal tax rate τ_{b^*} can be interpreted as a tax disadvantage of interest income over capital gains. If τ equals τ_{b^*} , the two effects balance each other, so that the cost of equity in the Miles/Ezzell case is identical to the cost of equity in the Harris/Pringle case.¹⁸ Overall, we can conclude that the coefficient ν_{r_t} is close to one at low cash dividend ratios. Hence, the Harris/Pringle-type adjustment formulae are a useful approximation of the Miles/Ezzell-type adjustment formulae, especially for low cash dividend ratios.

By deriving the adjustment formulae for both financing policies, we provide valuation models with personal taxes for a firm repurchasing shares according to the cash dividend ratio. Finally, note that the common adjustment formulae of Miles and Ezzell (1980, 1985) and Harris and Pringle (1985) without personal taxes are obtained if $\tau_d = \tau_g = \tau_b$ is assumed.

¹⁸ For a share repurchase only strategy in each period ($\nu_{r_t} = 0$), the expected tax shields according to equation (C.2) in Appendix C are zero in all periods if $\tau = \tau_{b^*}$. Therefore, the financing policy in this case is irrelevant for the market value of the firm, even under consideration of corporate and personal taxes. As a consequence, the cost of equity is identical under the assumptions in the Miles/Ezzell case and the Harris/Pringle case.

6 | SIMULATION OF VALUATION DIFFERENCES

In this section, we examine how the valuation results vary depending on the distribution strategy. We compare the cash dividends only strategy with $r = 1$ and the cash dividends and share repurchases strategy with $r < 1$, and determine the valuation differences via simulations. For simplicity, we assume that the valuation object has reached a steady state. For $r = 1$ the equity market value $V_{r=1}^{\ell,ME}$ in the Miles/Ezzell case reduces to

$$V_{r=1}^{\ell,ME} = \frac{E[\widetilde{FCF}_1] \cdot (1 - \tau_d)}{ke_{r=1}^{\ell,ME} - g \cdot (1 - \tau_g) + (kd \cdot (1 - \tau) - g) \cdot L \cdot (1 - \tau_d)}, \quad (30)$$

with¹⁹

$$ke_{r=1}^{\ell,ME} = ke^u + (ke^u - kd \cdot (1 - \tau_b)) \cdot \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - \tau_d)}{1 - \tau_g + kd \cdot (1 - \tau_b)} \cdot L. \quad (31)$$

In the Harris/Pringle case, the equity market value, $V_{r=1}^{\ell,HP}$, is

$$V_{r=1}^{\ell,HP} = \frac{E[\widetilde{FCF}_1] \cdot (1 - \tau_d)}{ke_{r=1}^{\ell,HP} - g \cdot (1 - \tau_g) + (kd \cdot (1 - \tau) - g) \cdot L \cdot (1 - \tau_d)}. \quad (32)$$

As the Harris/Pringle-type adjustment formula (equation (26)) is independent of the cash dividend ratio r , it is also applicable if excess cash is partially distributed as cash dividends.

We determine the percentage valuation difference in the Miles/Ezzell case, p^{ME} , as follows:

$$p^{ME} = \frac{V_{r=1}^{\ell,ME} - V^{\ell,ME}}{V^{\ell,ME}}. \quad (33)$$

To illustrate the average percentage valuation difference, we simulated 1,000,000 valuation cases differing with regard to the cash dividend ratio r , corporate tax rate τ , cost of debt kd , growth rate g , leverage L and cost of equity ke^u .²⁰ We assumed that these valuation parameters are independent of each other and are uniformly distributed over the intervals listed in Figure 1. The cash dividend tax rate and the effective capital gains tax rate are assumed to be 25% and 12.5%, respectively. The interest tax rate equals the cash dividend tax rate. Additionally, Figure 1 includes the formulae for determining the percentage valuation difference p^{ME} in equation (33), the statistical characteristics of the simulation, and the frequency distribution of the percentage valuation difference in the Miles/Ezzell case.

Evidently, determining the equity market value under the cash dividends only strategy produces an underestimation of the equity market value in the case of share repurchases. The average valuation difference amounts to -5.2% . A sensitivity analysis showed that the cash dividend ratio and financial leverage explain 54 and 45.8% of the valuation difference, respectively. The lower the leverage and cash dividend ratio are, the higher is the valuation difference. Overall, if the firm distributes its excess cash mainly via share repurchases, and financial leverage is low, the percentage valuation difference becomes severe.

The percentage valuation difference in the Harris/Pringle case, p^{HP} , follows from

$$p^{HP} = \frac{V_{r=1}^{\ell,HP} - V^{\ell,HP}}{V^{\ell,HP}}. \quad (34)$$

¹⁹ Note that for $r = 1$ no additional debt must be issued and hence $\widetilde{FtE}_t^\Delta = 0$ holds.

²⁰ Note that the free cash flow is independent of debt effects and hence cancels out with the percentage value difference p^{ME} in equation (33) and p^{HP} in equation (34).

<i>Simulation assumptions (uniform distribution, no correlation between valuation parameters)</i>	
Cash dividend ratio	[10%;60%]
Corporate tax rate	[25%;35%]
Nominal growth rate	[0.5%;1.5%]
Unlevered cost of equity	[5%;10%]
Cost of debt	[2%;4%]
Leverage	[40%;200%]
Cash dividend tax rate	25%
Interest tax rate	25%
Effective capital gains tax rate	12.5%
<i>Valuation equations for determining percentage valuation difference p^{ME}</i>	
<i>Cash dividends only strategy $V_{r=1}^{I,ME}$</i>	
Equity market value	Equation (30)
Adjustment formula	Equation (31)
<i>Cash dividends and share repurchases strategy $V^{I,ME}$</i>	
Equity market value without tax shields from share repurchases	Equation (16)
Added market value of tax shields from share repurchases	Equation (19)
Adjustment formula	Equation (24)
<i>Valuation difference between cash dividends only and cash dividends and share repurchases strategy</i>	
Average	-5.2%
Minimum	-10.1%
Maximum	-2.4%
Standard Deviation	1.5%

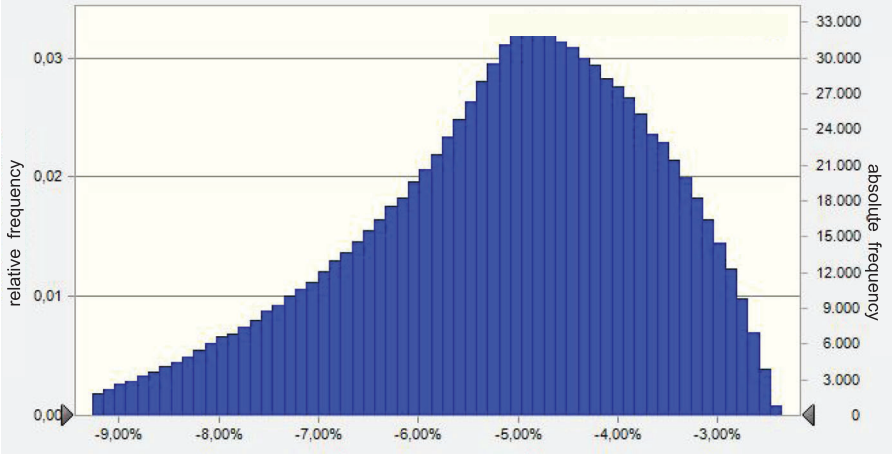


FIGURE 1 Approach and summary of the simulation in the Miles/Ezzell case

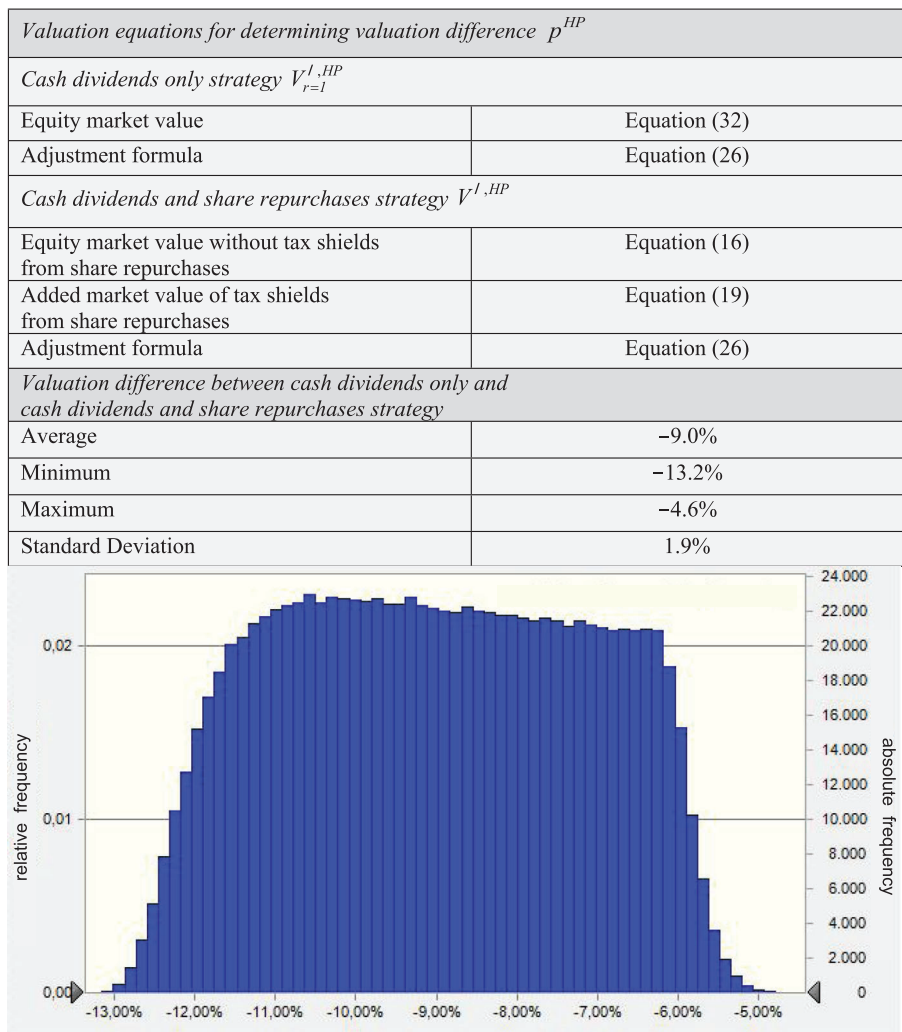


FIGURE 2 Approach and summary of simulation in the Harris/Pringle case

For all valuation parameters, the same assumptions apply as in the Miles/Ezzell case. The simulation results are shown in Figure 2.

In the Harris/Pringle case, the cash dividends only strategy also leads to an underestimation of equity market value, but the average valuation difference is with -9% higher. A sensitivity analysis showed that 96% of the valuation difference is explained by the cash dividend ratio, whereas financial leverage has a negligible effect. This is due to the independence of the cost of equity in the Harris/Pringle case of the cash dividend ratio r and hence of the distribution strategy. The valuation difference tends to be even higher than in the Miles/Ezzell case as the cost of equity does not increase with share repurchases.

From the two simulations, it is evident that the distribution strategy and the level of the cash dividend ratio r can have a significant impact on valuation results. This emphasizes the relevance of consistent valuation models in the case of share repurchases. Finally, in the third simulation, we analyze the quality of the Harris/Pringle-type adjustment formula as an approximation for the Miles/Ezzell-type adjustment formula. Therefore, we calculate the percentage

difference in the cost of equity $k^{\text{HP/ME}}$ and equity market value $p^{\text{HP/ME}}$:

$$k^{\text{HP/ME}} = \frac{ke^{\ell, \text{HP}} - ke^{\ell, r, \text{ME}}}{ke^{\ell, r, \text{ME}}} \quad (35)$$

$$p^{\text{HP/ME}} = \frac{V^{\ell, \text{HP}} - V^{\ell, \text{ME}}}{V^{\ell, \text{ME}}}. \quad (36)$$

We assume the same valuation parameters as considered in the other two simulations. The simulation results are shown in Figure 3.

The use of the Harris/Pringle-type adjustment formula leads in comparison with the Miles/Ezzell-type adjustment formula in all cases to an overestimation of the cost of equity with an average percentage valuation difference of 2.4%. Consequently, the use of the Harris/Pringle-adjustment formula results in an average underestimation of the equity market value of -2.3%. Sensitivity analysis showed that the cash dividend ratio and financial leverage explain 76% and 20% of the percentage valuation difference in the equity market value, respectively. Consequently, the simulation confirms that the Harris/Pringle-type adjustment formulae are more suitable as approximations to the Miles/Ezzell-type adjustment formulae for lower cash dividend ratios.

7 | CONCLUSIONS

Share repurchases have become an important alternative to distribute excess cash to shareholders, not least due to the personal tax advantage they provide in comparison with cash dividends. If both cash dividends and share repurchases are used, the equity market value increases with increasing share repurchases. In the case of active debt management, this leads to the issuance of additional debt to adhere to the predetermined capital structure. Consequently, additional interest and tax shields arise, which in turn affect the flow to equity and, thereby, the equity market value.

The major contribution of this study is a valuation model with three different personal tax rates for dividends, capital gains and interest that accounts for the interdependencies between cash dividends, share repurchases and active debt management. The main characteristic of this model is the flexible distribution of excess cash via share repurchases and cash dividends dependent on a prespecified cash dividend ratio. This flexibility is the essential extension compared with the valuation model in Clubb and Doran (1992) because, in their model, the amount of share repurchases always equals the change in debt market value and is thus linked to the financing strategy. Furthermore, Clubb and Doran only analyzed active management according to Miles and Ezzell (1980, 1985), whereas we also considered the setting of Harris and Pringle (1985). We determine the equity market value as the sum of the equity market value without tax shields from share repurchases and the added market value due to tax shields from share repurchases and additional debt effects. Additionally, we reveal the effects of share repurchases on the cost of equity by deriving the necessary adjustment formulae. In the Miles/Ezzell case, the adjustment formula is dependent on the cash dividend ratio and, hence, accounts for the tax advantage of share repurchases. Financial risk increases not only for higher financial leverage but also for lower cash dividend ratios leading to higher costs of equity. In contrast, the cost of equity is independent of the cash dividend ratio in the Harris/Pringle case.

Our valuation model accounts for an explicit forecast period and a steady state phase and can be applied in valuation practice without circularity problems in the Miles/Ezzell case as well as in the Harris/Pringle case. This opens the opportunity for a differentiated valuation approach for the distribution of excess cash. Our simulations show that the value contribution of share repurchases is far from negligible. The valuation model in the Harris/Pringle case might be more attractive for practitioners because the adjustment formula for the cost of equity is simple and independent of the cash dividend ratio. Furthermore, the independence of the cash dividend ratio can be particularly beneficial for the

Equations for determining the percentage differences $k^{HP/ME}$ and $p^{HP/ME}$	
Valuation with the Miles/Ezzell-type adjustment formula	
Equity market value without tax shields from share repurchases	Equation (16)
Added market value of tax shields from share repurchases	Equation (19)
Adjustment formula	Equation (24)
Valuation with the Harris/Pringle-type adjustment formula	
Equity market value without tax shields from share repurchases	Equation (16)
Added market value of tax shields from share repurchases	Equation (19)
Adjustment formula	Equation (26)
Percentage difference between the cost of equity $k^{HP/ME}$	
Average	2.4%
Minimum	0.3%
Maximum	5.9%
Standard Deviation	1.1%
Percentage difference between equity market value $p^{HP/ME}$	
Average	-2.3%
Minimum	-5.8%
Maximum	0.3
Standard Deviation	1.1%

FIGURE 3 Simulation of the Harris/Pringle approach as an approximation of the Miles/Ezzell approach

unlevering and relevering of beta factors. However, practitioners should note that in the Harris/Pringle case, the equity market value increases more severely with decreasing cash dividend ratios. Moreover, using the more straightforward Harris/Pringle-type adjustment formulae as an approximation to the more complex but theoretically consistent Miles/Ezzell-type adjustment formulae is more suitable for low cash dividend ratios.

Further theoretical research on valuation with personal taxes could focus on different assumptions regarding the firm's financing strategy (e.g., passive debt management) and its dividend strategy (e.g., an earnings-based dividend strategy). Also of interest is the transformation of the developed DCF model with personal taxes and share repurchases into a residual income valuation model. Finally, another continuative field of research could be the incorporation of financial distress into the valuation model.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

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APPENDIX

A. Determination of the unlevered cost of equity

According to (2), we use a constant unlevered cost of equity after personal taxes ke^u to discount the overall expected flow to equity of the unlevered firm. Considering that the tax base of the capital gains taxes in period t includes the market value of equity at the beginning of the period, we can alternatively discount this part of the flow to equity with the risk-free interest rate after personal taxes $kd \cdot (1 - \tau_b)$. All the other elements of the flow to equity are uncertain, so that these elements have to be discounted according to Miles and Ezzell (1980) with the cost of equity ke^u that

relates to the risk of the uncertain free cash flow. This yields the following recursive valuation approach:

$$E \left[\tilde{V}_{t-1}^u \right] = \frac{E \left[\widetilde{FCF}_t \right] \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g)}{1 + ke^{u'}} + \frac{E \left[\tilde{V}_t^u \right] \cdot (1 - \tau_g)}{1 + ke^{u'}} + \frac{E \left[\tilde{V}_{t-1}^u \right] \cdot \tau_g}{1 + kd \cdot (1 - \tau_b)}. \quad (\text{A.1})$$

Solving (A.1) for the equity market value $E \left[\tilde{V}_{t-1}^u \right]$ leads to:

$$E \left[\tilde{V}_{t-1}^u \right] = \frac{E \left[\widetilde{FCF}_t \right] \cdot (1 - r_t \cdot \tau_{d^*}) + E \left[\tilde{V}_t^u \right]}{(1 + ke^{u'}) \cdot \left(1 - \frac{\tau_g}{1 + kd \cdot (1 - \tau_b)} \right) \cdot \frac{1}{1 - \tau_g}}. \quad (\text{A.2})$$

Equating (A.2) and (3) and solving for the cost of equity $ke^{u'}$ yields the relationship between the costs of equity, corresponding to equation (14) in Clubb and Doran (1992):

$$ke^{u'} = \frac{ke^u \cdot (1 + kd \cdot (1 - \tau_b)) - kd \cdot \tau_g \cdot (1 - \tau_b)}{1 + kd \cdot (1 - \tau_b) - \tau_g}. \quad (\text{A.3})$$

If one assumes a periodic-specific cost of equity $ke^{u'}$ or risk-free interest rate, we obtain according to (A.3) a periodic-specific cost of equity ke^u . This could easily be incorporated into our valuation approach, but to keep the analysis simple, we assume a constant unlevered cost of equity as in Clubb and Doran (1992).

B. Comparison with valuation approach in Clubb and Doran (1992)

In Clubb and Doran (1992), changes in debt market value equal share repurchases. Accordingly, in their valuation approach, the changes in debt market value and the corresponding share repurchases are taxed at the capital gains tax rate:

$$E \left[\tilde{V}_{t-1}^{\ell, c} \right] = \frac{\overbrace{E \left[\widetilde{FCF}_t \right] - (kd \cdot (1 - \tau) \cdot L_{t-1} \cdot E \left[\tilde{V}_t^{\ell, c} \right])}^{\text{cash dividends}} \cdot (1 - \tau_d)}{1 + ke^{\ell, CD}} + \frac{\overbrace{-(L_t \cdot E \left[\tilde{V}_t^{\ell, c} \right] - L_{t-1} \cdot E \left[\tilde{V}_{t-1}^{\ell, c} \right]) \cdot (1 - \tau_g) - \tau_g \cdot (E \left[\tilde{V}_t^{\ell, c} \right] - E \left[\tilde{V}_t^{\ell, c} \right]) + E \left[\tilde{V}_t^{\ell, c} \right]}^{\text{share repurchases}}}{1 + ke^{\ell, CD}}, \quad (\text{B.1})$$

with $ke^{\ell, CD}$ as the risk-adjusted cost of equity. Note that Clubb and Doran assume a constant leverage ratio and use the symbol L for the debt ratio. Solving (B.1) for $E \left[\tilde{V}_{t-1}^{\ell, c} \right]$ leads to the valuation approach of Clubb and Doran:

$$E \left[\tilde{V}_{t-1}^{\ell, c} \right] = \frac{E \left[\widetilde{FCF}_t \right] \cdot (1 - \tau_{d^*}) + E \left[\tilde{V}_t^{\ell, c} \right] \cdot (1 + L_t)}{1 + ke^{\ell, CD} + (1 + kd \cdot (1 - \tau) \cdot (1 - \tau_{d^*})) \cdot L_{t-1}}, \quad (\text{B.2})$$

where $ke^{\ell, CD} = ke^{\ell, CD} / (1 - \tau_g)$.

C. Derivation of the market value of tax shields

To derive the market value of tax shields, we start with the expected next-period tax shield flow $E[\widetilde{\text{TS}}_t]$ as the sum of the flow to equity and the flow to debt minus the unlevered cash flow:

$$\begin{aligned}
 E[\widetilde{\text{TS}}_t] = & \overbrace{(E[\widetilde{\text{FCF}}_t] + \tau \cdot kd \cdot E[\tilde{D}_{t-1}] - kd \cdot E[\tilde{D}_{t-1}] + E[\tilde{D}_t] - E[\tilde{D}_{t-1}]) \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g) - \tau_g \cdot (E[\tilde{V}_t^\ell] - E[\tilde{V}_{t-1}^\ell])}^{\text{flow to equity}} \\
 & + \overbrace{(kd \cdot E[\tilde{D}_{t-1}]) \cdot (1 - \tau_b) - (E[\tilde{D}_t] - E[\tilde{D}_{t-1}])}^{\text{flow to debt}} \\
 & - \overbrace{(E[\widetilde{\text{FCF}}_t] \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g) - \tau_g \cdot (E[\tilde{V}_t^u] - E[\tilde{V}_{t-1}^u]))}^{\text{unlevered cash flow}}. \quad (\text{C.1})
 \end{aligned}$$

Since $E[\widetilde{\text{VTS}}_t] = E[\tilde{V}_t^\ell] + E[\tilde{D}_t] - E[\tilde{V}_t^u]$, where $E[\widetilde{\text{VTS}}_t]$ is the value of expected future tax shields at date t , we obtain

$$\begin{aligned}
 E[\widetilde{\text{TS}}_t] = & \tau \cdot kd \cdot E[\tilde{D}_{t-1}] \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g) - kd \cdot E[\tilde{D}_{t-1}] \cdot (\tau_b - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g) \\
 & - (E[\tilde{D}_t] - E[\tilde{D}_{t-1}]) \cdot r_t \cdot (\tau_d - \tau_g) - \tau_g \cdot (E[\widetilde{\text{VTS}}_t] - E[\widetilde{\text{VTS}}_{t-1}]). \quad (\text{C.2})
 \end{aligned}$$

According to Miles and Ezzell (1980), each element in (C.2) concerning the period $t - 1$ is discounted at the risk-free interest rate after personal taxes $kd \cdot (1 - \tau_b)$ because it is not subject to any risk in that period. For all elements concerning the period t , $ke^{u'}$ is the appropriate risk-adjusted discount rate (see Appendix A). Therefore, we obtain the expected market value of the tax shields $E[\widetilde{\text{VTS}}_{t-1}^{\text{ME}}]$:

$$\begin{aligned}
 E[\widetilde{\text{VTS}}_{t-1}^{\text{ME}}] = & \frac{\tau \cdot kd \cdot E[\tilde{D}_{t-1}] \cdot (1 - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g) - kd \cdot E[\tilde{D}_{t-1}] \cdot (\tau_b - r_t \cdot \tau_d - (1 - r_t) \cdot \tau_g)}{1 + kd \cdot (1 - \tau_b)} \\
 & - \left((\tau_d - \tau_g) \cdot r_t \cdot \frac{E[\tilde{D}_t]}{1 + ke^{u'}} - (\tau_d - \tau_g) \cdot r_t \cdot \frac{E[\tilde{D}_{t-1}]}{1 + kd \cdot (1 - \tau_b)} \right) \\
 & + \frac{\tau_g \cdot E[\widetilde{\text{VTS}}_{t-1}^{\text{ME}}]}{1 + kd \cdot (1 - \tau_b)} + \frac{E[\widetilde{\text{VTS}}_t^{\text{ME}}] \cdot (1 - \tau_g)}{1 + ke^{u'}}. \quad (\text{C.3})
 \end{aligned}$$

Solving equation (C.3) for $E[\widetilde{\text{VTS}}_{t-1}^{\text{ME}}]$, substituting $ke^{u'}$ according to (A.3) and dividing the numerator and denominator by $(1 - \tau_g)$ yields:

$$\begin{aligned}
 E[\widetilde{\text{VTS}}_{t-1}^{\text{ME}}] = & \frac{\tau \cdot kd \cdot E[\tilde{D}_{t-1}] \cdot (1 - r_t \cdot \tau_{d^*}) - kd \cdot E[\tilde{D}_{t-1}] \cdot (\tau_{b^*} - r_t \cdot \tau_{d^*})}{1 + kd \cdot (1 - \tau_{b^*})} \\
 & - \left(\tau_{d^*} \cdot r_t \cdot \frac{E[\tilde{D}_t]}{1 + ke^{u^*}} - \tau_{d^*} \cdot r_t \cdot \frac{E[\tilde{D}_{t-1}]}{1 + kd \cdot (1 - \tau_{b^*})} \right) + \frac{E[\widetilde{\text{VTS}}_t^{\text{ME}}]}{1 + ke^{u^*}}, \quad (\text{C.4})
 \end{aligned}$$

where $\tau_{b^*} = (\tau_b - \tau_g)/(1 - \tau_g)$. Note that τ_{b^*} depicts a modified personal tax rate resulting from the difference in personal tax rates on interest and capital gains. Equation (C.4) depicts the market value of the tax shields in the Miles/Ezzell case.

In the Harris/Pingle case, the relevant discount rate for all parts of the tax shield in equation (C.2) is the cost of equity of the unlevered firm $ke^{u'}$. This leads to the following equation for the expected market value of tax shields $E[\widetilde{VTS}_{t-1}^{HP}]$:

$$E[\widetilde{VTS}_{t-1}^{HP}] = \frac{\tau \cdot kd \cdot E[\tilde{D}_{t-1}] \cdot (1 - r_t \cdot \tau_{d^*}) - kd \cdot E[\tilde{D}_{t-1}] \cdot (\tau_{b^*} - r_t \cdot \tau_{d^*})}{1 + ke^{u^*}} - \left(\tau_{d^*} \cdot r_t \cdot \frac{E[\tilde{D}_t] - E[\tilde{D}_{t-1}]}{1 + ke^{u^*}} \right) + \frac{E[\widetilde{VTS}_t^{HP}]}{1 + ke^{u^*}}. \quad (C.5)$$

D. Derivation of the adjustment formula for the cost of equity in the Miles/Ezzell case

Plugging equation (20) in equation (21) and solving for $ke_t^{\ell^*, r, ME}$ yields:

$$ke_t^{\ell^*, r, ME} = \frac{E[\tilde{V}_{t-1}^u] \cdot (1 + ke^{u^*}) - E[\tilde{V}_t^u]}{E[\tilde{V}_{t-1}^\ell]} + \frac{(\tau \cdot kd \cdot E[\tilde{D}_{t-1}] - kd \cdot E[\tilde{D}_{t-1}] + E[\tilde{D}_t] - E[\tilde{D}_{t-1}]) \cdot (1 - r_t \cdot \tau_{d^*}) + E[\tilde{V}_t^\ell] - E[\tilde{V}_{t-1}^\ell]}{E[\tilde{V}_{t-1}^\ell]} \quad (D.1)$$

Furthermore, by plugging equation (22) in equation (D.1) and collecting terms, we obtain

$$ke_t^{\ell^*, r, ME} = \frac{(E[\tilde{V}_{t-1}^\ell] + E[\tilde{D}_{t-1}] - E[\widetilde{VTS}_{t-1}^{ME}]) \cdot (1 + ke^{u^*}) - E[\tilde{D}_t] \cdot r_t \cdot \tau_{d^*}}{E[\tilde{V}_{t-1}^\ell]} + \frac{(\tau \cdot kd \cdot E[\tilde{D}_{t-1}] - kd \cdot E[\tilde{D}_{t-1}] - E[\tilde{D}_{t-1}]) \cdot (1 - r_t \cdot \tau_{d^*}) + E[\widetilde{VTS}_t^{ME}] - E[\tilde{V}_{t-1}^\ell]}{E[\tilde{V}_{t-1}^\ell]} \quad (D.2)$$

Rearranging terms in equation (D.2) yields:

$$ke_t^{\ell^*, r, ME} = ke^{u^*} + \frac{E[\tilde{D}_{t-1}] \cdot (1 + ke^{u^*}) - E[\widetilde{VTS}_{t-1}^{ME}] \cdot (1 + ke^{u^*}) - E[\tilde{D}_t] \cdot r_t \cdot \tau_{d^*}}{E[\tilde{V}_{t-1}^\ell]} + \frac{(\tau \cdot kd \cdot E[\tilde{D}_{t-1}] - kd \cdot E[\tilde{D}_{t-1}] - E[\tilde{D}_{t-1}]) \cdot (1 - r_t \cdot \tau_{d^*}) + E[\widetilde{VTS}_t^{ME}]}{E[\tilde{V}_{t-1}^\ell]} \quad (D.3)$$

Inserting equation (C.4) in equation (D.3) leads to the cost of equity of the levered firm:

$$ke_t^{\ell^*, r, ME} = ke^{u^*} + (ke^{u^*} - kd \cdot (1 - \tau_{b^*})) \cdot \frac{(1 + kd \cdot (1 - \tau)) \cdot (1 - r_t \cdot \tau_{d^*})}{1 + kd \cdot (1 - \tau_{b^*})} \cdot L_{t-1} \quad (D.4)$$

Further simplifications yield equation (23).

E. Comparison of the cost of equity in the Miles/Ezzell case with Clubb and Doran (1992)

Clubb and Doran (1992) also assume active debt management according to Miles and Ezzell (1980, 1985) in their valuation approach with personal taxes. In contrast to our analysis, they do not consider the cash dividend ratio for share repurchases but assume share repurchases in the amount of changes in debt market value. Therefore, the market value of equity follows from (B.2). Furthermore, the tax shield must be calculated considering the taxation of changes in debt market values with the capital gains tax rate:

$$\begin{aligned}
 E \left[\widetilde{TS}_t \right] = & \overbrace{\left(E \left[\widetilde{FCF}_t \right] + \tau \cdot kd \cdot E \left[\widetilde{D}_{t-1} \right] - kd \cdot E \left[\widetilde{D}_{t-1} \right] \right) \cdot (1 - \tau_d)}^{\text{flow to equity}} + \overbrace{\left(E \left[\widetilde{D}_t \right] - E \left[\widetilde{D}_{t-1} \right] \right) \cdot (1 - \tau_g) - \tau_g \cdot \left(E \left[\widetilde{V}_t^\ell \right] - E \left[\widetilde{V}_{t-1}^\ell \right] \right)}^{\text{free cash flow}} \\
 & + \overbrace{kd \cdot E \left[\widetilde{D}_{t-1} \right] \cdot (1 - \tau_b) - \left(E \left[\widetilde{D}_t \right] - E \left[\widetilde{D}_{t-1} \right] \right)}^{\text{flow to debt}} - \overbrace{E \left[\widetilde{FCF}_t \right] \cdot (1 - \tau_d) - \tau_g \cdot \left(E \left[\widetilde{V}_t^u \right] - E \left[\widetilde{V}_{t-1}^u \right] \right)}^{\text{free cash flow}}.
 \end{aligned} \quad (E.1)$$

Following the procedure in Appendices C and D, we can derive the following adjustment formula:

$$ke_t^{\ell, CD} = ke^u + (ke^u - kd \cdot (1 - \tau_b)) \cdot \frac{(1 - \tau_g) + kd \cdot (1 - \tau_d) \cdot (1 - \tau)}{1 - \tau_g + kd \cdot (1 - \tau_b)} \cdot L_{t-1}. \quad (E.2)$$

In the case of a constant leverage ratio, this adjustment formula leads to the same cost of equity as the (more complex) adjustment formula (15) in Clubb and Doran (1992). In comparison with formula (23) in the case of no share repurchases ($r = 1$), the adjustment formula (E.2) leads due to share repurchases in the amount of the changes in debt market value for a given leverage ratio to a higher cost of equity.