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ABSTRACT

We analyze the effects of changes in dividend tax policy using a life-cycle model of the firm, in which new firms first access equity markets, then grow internally, and finally pay dividends when they have reached steady state.

In accordance with the traditional view of dividend taxation, new firms raise less equity and invest less the higher the level of dividend taxes. However, as postulated by the new view of dividend taxation, the dividend tax rate is irrelevant for the investment decisions of internally growing and mature firms. Since aggregate investment is dominated by these latter two categories, the level of dividend taxation as well as unanticipated changes in tax rates have only small effects on aggregate investment.

Anticipated dividend tax changes, on the other hand, allow firms to engage in inter-temporal tax arbitrage so as to reduce investors' tax burden. This can significantly distort aggregate investment. Anticipated tax cuts (increases) delay (accelerate) firms' dividend payments, which leads them to hold higher (lower) cash balances and, for capital constrained firms, can significantly increase (decrease) aggregate investment for periods after the tax change.

The analysis of dividend taxation in a contestable democracy thus has to take into account future policy changes as well as expectations thereof. This can significantly alter the evaluation of any given dividend tax policy.

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1 Introduction

The economic effects of dividend taxation have been at the center of a fierce academic debate for decades. Proponents of the 'traditional view' of dividend taxation (as discussed e.g. in Poterba and Summers, 1985) stress that it raises the cost of equity finance. Hence, they argue, it distorts firms' investment decisions, and higher dividend taxes decrease the long-run capital intensity of an economy. The 'new' or 'tax capitalization view,' by contrast, which was developed in King (1977) and Auerbach (1979), extending an earlier argument of Stiglitz (1973),[1] assumes that firms use retained earnings as the marginal source of finance; the level of dividend taxation is thus irrelevant for their investment decisions.

In this paper, we explicitly take this controversy into account by modeling the life cycle of firms. Following the discussion in Stiglitz (1973, 1976) and Sinn (1991), firms in our model go through three stages: When they are started, their marginal source of finance is equity markets, i.e. they issue new equity. As predicted by the traditional view, dividend taxation is distortionary for such firms. In the second stage, firms grow internally by retaining all their earnings until they reach their optimal size. In the final stage, or steady state, they pay out their earnings in the form of dividends. In Sinn (1991), the only way for firms to carry resources from one period to the next is by first investing into physical capital, which exhibits strictly decreasing returns, and then liquidating the investment the following period. This severely limits firms' ability to engage in intertemporal tax arbitrage.

By contrast, this paper emphasizes that firms routinely hold cash or cash equivalents to carry resources into the future, without being subject to the decreasing returns exhibited by physical capital. This enables them to better arbitrage between different tax regimes, with important efficiency implications.

In our model, firms' steady state cash holdings are determined as a tradeoff between two considerations, imperfect access to capital markets and agency costs of holding cash: We capture the first consideration by assuming that investment opportunities arrive randomly, yet that firms cannot raise new funds in capital markets instantaneously; they need to carry cash on their balance sheets in order to take advantage of investment opportunities. The second consideration is that because of agency problems, investors discount future cash flows from firms at a higher rate than the returns of cash on hand. This assumption captures a wide variety of models of agency concerns; a specific example that motivates this discrepancy in discount rates from managerial myopia is given in appendix A. The equilibrium level of cash balances trades off the expected benefit of holding cash

[1] Stiglitz (1973) demonstrated that it was more tax-efficient to distribute funds to shareholders by buying back shares than by paying dividends, with effective tax rates that are markedly lower than the dividend tax rate (or even than the capital gains tax rate if the pay-out is treated as a return of principal). The fact that so much money is nonetheless distributed through dividends has subsequently come to be called the 'dividend puzzle' (see Black, 1976).

We do not address this puzzle here – we simply assume that all payouts from the firm are subject to the dividend tax, as if there were no stock repurchases. The results of our analysis are valid so long as firms engage – at the margin – in intertemporal arbitrage. Even if they irrationally distribute funds in the form of dividends, they can be and should be sensitive to the fact that by distributing dividends in low-tax periods they increase shareholder value.

for investment against the cost of holding cash balances; this implies that firms are capital constrained in equilibrium.

As postulated by the traditional view of dividend taxation, we show that dividend taxation is distortionary for young firms that need to issue new equity.[2] Let us capture the logic of this in the simplest possible model, where i represents the amount invested, r is investors' required return and τ the dividend tax rate. We can then define a firm's optimum amount of investment as the point where the investors' opportunity cost of funds equals the marginal net return of funds.

$$1 + r = (1 - \tau) f'(i)$$

The higher the dividend tax rate, the lower the return of firm investment to the shareholder, and therefore the higher the required marginal gross product of capital and the lower the amount of investment.

On the other hand, an internally growing or mature firm that finances investment out of its cash reserves has to reduce its dividend in the current period, which entails a marginal cost to shareholders of $(1 - \tau)(1 + r)$, and can distribute the payoff of the investment next period. The resulting equilibrium condition is

$$(1 - \tau)(1 + r) = (1 - \tau) f'(i)$$

The tax rate cancels out of firms' optimality condition; a constant level of dividend taxation therefore does not affect the investment decisions of internally growing or mature firms that do not access equity markets. Since these two categories of firms dominate aggregate investment, the effect of the level of dividend taxation on investment is low at a macroeconomic level.

We employ the outlined model to investigate the effects of *changes* in the dividend tax rate on macroeconomic variables such as aggregate investment. The impact of unanticipated tax changes is generally small, since they affect only young firms that raise new equity.

By contrast, anticipated tax changes entail effects that can be an order of a magnitude higher: they allow mature firms to engage in inter-temporal tax arbitrage by shifting dividend payments from high-tax periods to low-tax periods. This involves significant deviations from firms' optimal steady state levels of cash holdings, and since firms are capital constrained, changes in their cash holdings can significantly distort aggregate investment and output.

An anticipated dividend tax cut allows firms to reduce investors' tax bill by postponing dividend payments to the period in which the tax cut takes place. This implies that firms carry larger cash balances in the meantime, which allows them to make larger investments when an investment opportunity arrives.

By the same token, an anticipated dividend tax increase creates an incentive for firms to accelerate their dividend payments, i.e. to take advantage of the low tax rate while it

[2]Implicitly, much of the literature on corporate taxation and investment has assumed the existence of capital constraints; for in the absence of capital constraints, firms could always finance their investment at the margin by debt; with interest payments tax deductible, there would be no marginal distortion. See Stiglitz (1973, 1976). As we note later, our analysis is consistent with partial debt financing at the margin.

lasts by paying out a special dividend before the increase takes place. This leads to lower cash balances and in turn lower investment in the following periods. Using the simplified notation from above, an increase in the tax rate from τ_L to τ_H implies that paying out dividends becomes comparatively cheaper than investing and distributing the payoff under a higher tax rate. The equilibrium level of investment i is then given by

$$(1 - \tau_L)(1 + r) = (1 - \tau_H)f'(i)$$

When dividend taxes are expected to change, the tax terms no longer cancel; instead it is easy to see that the required return for an investment is higher and the firm will invest less:[3]

$$f'(i) = (1 + r)\frac{1 - \tau_L}{1 - \tau_H} > 1 + r$$

A temporary dividend tax change can be viewed as an unanticipated change followed by a second anticipated change in the opposite direction. As we argued, the effects of this second anticipated change are likely to far outweigh any effects of the first unanticipated change. A temporary dividend tax cut, for example, is thus likely to have an overall negative effect on aggregate investment and output. Similarly, uncertainty about an impending dividend tax increase can lead firms to reduce their cash holdings, with the corresponding negative macroeconomic effects.

Lastly, we discuss the political economy implications of dividend taxation in a contestable democracy with two parties (denoted as conservatives and social democrats) that have different preferences regarding dividend taxation and adjust the tax rate accordingly when they come to power. Paradoxically, aggregate investment is higher under social democratic rule, since firms expect a tax cut when that party loses power and hold higher cash reserves in anticipation. Under a conservative regime, firms fear that dividend taxes will go up when the party loses power; they thus pay out a larger amount of dividends, which depresses their cash holdings and reduces aggregate investment.

Aside from providing new insights into the consequences of the temporary dividend tax cuts that were introduced in the United States in 2003 and extended in 2006, this paper also makes a point about the political economy of government policies of more general import: in contestable democracies, the effects of policies have to be analyzed in the context of an environment in which economic agents expect (stochastically) a change in decision makers and in government policies. It is wrong simply to assume, as much of the political economy literature has done heretofore, that government policies can be altered permanently. Policy instability affects the behavior of economic agents, and decision makers have to rationally take this into account in formulating their policies.

1.1 US Dividend Tax Policy in the Current Decade

In analyzing the implications of dividend tax policy on firm behavior and the macroeconomy, it is important to take account of both implemented tax changes and expectations

[3]Note that for simplicity, this simple two-period example of a tax increase abstracts from the difference between a firm's cash holdings and physical capital – as much of the existing literature does. For tax cuts, a thorough analysis necessitates that cash holdings are explicitly taken into account, as we do in the full model in section 2.

thereof. In the United States dividends used to be taxed at the personal income tax rate of up to 38.6% until 2003. CBO (2003) estimated the resultant average effective tax rate on dividends to be around 19%, since many savings vehicles and shareholders were exempt from dividend taxation. In his campaign for the 2000 presidential election, George W. Bush ran on a platform of lowering taxes so as to reduce the high predicted fiscal surplus over the coming decade, yet he never specifically addressed the possibility of a reduction in dividend taxation. Still rational, forward-looking firms must have assigned a small, but positive probability to such a policy. In late December 2002, a plan to cut dividend taxes was first announced.[4] Finally, in May 2003, the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) was passed: the personal income tax on corporate dividends was reduced to a nominal rate of up to 15% (or an estimated effective rate of 5%, see CBO, 2003) with a retroactive start at the beginning of 2003 and an expiration date of 2008.

While many conservatives argued that the tax cut should be made permanent, an increasing number of critics called for an early repeal, especially after the anticipated fiscal surplus quickly disappeared and the country was confronted with enormous fiscal deficits. The critics included Senator Kerry who ran against President Bush in the 2004 presidential elections. During the election campaigns of 2004, firms must thus have assigned a positive probability to all three events – the scheduled expiration of the tax cuts in 2008 as well as an extension or an early repeal. This latter possibility made it optimal to pay out large dividends in 2004, as exemplified by a $32bn special dividend by Microsoft.

When Bush won re-election in 2004, expectations adjusted again: an early repeal of the tax cut no longer seemed likely. Instead, a special budget reconciliation bill in May 2006 extended the dividend tax cuts to the end of 2010. At least partly as a result of these policies, the fraction of dividends in national income jumped from 4.4% in 2003 to almost 6% in 2006 – a level not seen since 1936.[5]

President Bush continues to call for making the dividend tax reductions permanent, where "permanent" has to be understood in the context of a political economy in which future governments are likely to change course again, as we discuss in section 5. However, after the Democrat gained control of both Houses of Congress in the 2006 mid-term elections, a permanent extension appears unlikely.

1.2 The Current Debate on Dividend Taxation

A number of researchers have investigated the impact of this policy change on firms' payout behavior empirically. There is evidence that the tax cut has led to a significant increase in both special and regular dividend payouts (see e.g. Blouin et al., 2004; Chetty and Saez, 2005), consistent with our view that the policy change induced firms to engage in intertemporal tax arbitrage.[6]

[4]For a detailed overview of the relevant events see table 1 in Auerbach and Hassett (2007).

[5]Data from the webpage of the Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.gov, table 1.12.

[6]It is also likely that part of the observed increase in dividends was due to cyclical and secular increases in firm profits and due to substitution between share repurchases and dividends, as suggested e.g. by Brown et al. (2007). However, according to Chetty and Saez (2006), the existing data is not yet sufficient to provide a definite answer to this question. In our analysis, the distinction between regular and special

Chetty and Saez (2005) and Brown et al. (2007) also document that firm responses to the dividend tax cut differed depending on the specific incentives faced by executives and shareholders. For example, firms with large inside ownership or a large and influential outside shareholder that is subject to dividend taxation were more likely to raise dividends in response to the tax cut; managers holding options (with a strike price that is typically not adjusted for dividend payments) were less inclined to pay out dividends. Our model describes the behavior of representative firms, where managers maximize the present discounted value of the net (after tax) dividends, given a discount rate that reflects agency considerations. With different ownership structures, different agency problems, different tax incentives, and different potential investment opportunities, firms will pursue differnt policies.[7] While we could capture this by varying the set of parameters that we use to describe the representative firm, our basic insights, that the first order effects of a (temporary) dividend tax cut arise from the intertemporal arbitrage to which it gives rise, would be unaffected.

Amromin et al. (2006) and Auerbach and Hassett (2006, 2007) find that the tax cut also had a significantly positive effect on the share prices of high dividend-paying stocks, which suggests that their marginal cost of equity finance was reduced. In popular opinion, such findings have often been interpreted as an indication that the dividend tax cut had a positive effect on aggregate investment.

Our paper argues that this view is incomplete, if not incorrect. Indeed, there may be little relationship between share prices and investment. We discussed earlier (and show more rigorously below) that temporary dividend tax reductions can be associated with an increase in share prices but a lowering of investment. When firms anticipate a dividend tax increase, they have an incentive to pay out higher dividends under the current low tax regime. If they are already cash constrained in equilibrium, then inducing them to decrease their cash holdings even further because of intertemporal tax arbitrage decreases aggregate investment and reduces welfare.

Some of the proponents of the dividend tax cut, by contrast, have argued that the net marginal return to investment in certain firms with large cash holdings is actually negative, i.e. that they engage in socially wasteful investments.[8] If such firms are encouraged to pay

dividends is immaterial: just as tax policies are never "permanent," so are firms' payout policies: for signaling or intertemporal smoothing reasons (which we do not incorporate into our model – doing so would not alter the qualitative results but would add greatly to the complexity of the analysis), firms might prefer to gradually lower their cash balances for the duration of the low dividend tax rate by raising regular dividends. Also, they might rationally anticipate that a future tax increase could allow them to cut regular dividends with only small adverse signaling effects.

[7]For a firm such as Microsoft, for example, where large stakes are held by influential insiders, agency problems might be less severe, implying a relatively low discount rate, and potential investment opportunities, including takeovers, might be large due to the fast-changing nature of its industry. (An acquisition through a cash purchase would in fact provide an avenue for distributing funds from the corporate sector to the household sector subject to the more favorable capital gains treatment.) This can explain both the large cash holdings of the firm and the strong response to the tax arbitrage opportunity presented in 2003, which took the form of a $32bn special dividend. Furthermore, the recent Microsoft offer for Yahoo is consistent with the presence of large investment opportunities.

[8]Jensen (1986), for example, emphasized the potential agency costs of free cash flow. Gordon and Dietz (2006) and Chetty and Saez (2007) build these considerations into their models of dividend taxation.

out dividends, economic efficiency could be increased for two potential reasons: first, cash-abundant firms would no longer engage in as much wasteful investment; secondly, their cash distributions could get reshuffled to cash-constrained firms with a higher marginal product of capital.

First, the view that there was over-investment and that it would have been a good thing for investment to be reduced in some firms runs at least counter to the professed argument for the 2003 temporary dividend tax cut, which was introduced to stimulate the economy in the belief that aggregate investment was too low at the time. There may have been some firms, where agency problems were so severe that managers made inefficient investments at the margin[9] and for which a temporary reduction in dividend taxes that reduced investment may have been welfare increasing. However, at least the average product of capital inside firms seems to be significantly larger than the risk-free rate.[10] This casts doubt on the claim that a large number of firms exhibit a negative marginal product of investment. If shareholders believe that the marginal returns to keeping funds inside the firm are less than their (outside) opportunity costs, they can and presumably would demand larger cash distributions (either in the form of dividends or share repurchases).[11]

Secondly, for the tax cuts to raise the efficiency of the capital allocation in the economy, payouts must be reinvested in new investment projects. However, it is generally much easier for government policies to get money out of the corporate sector than to put it back in. An important factor that inhibits this 'recycling of capital' is asymmetric information (see e.g. Stiglitz and Weiss, 1981; Greewald et al., 1984). Another factor can be international capital flows that break the link between domestic saving and investment (see e.g. Slemrod, 1988) and that have become a major force in driving US interest rates in recent years.

Chetty and Saez (2007) argue that the increases in dividend payments that could be observed after the 2003 tax cut stem from a shift from wasteful towards productive investments, implying large welfare gains from the dividend tax cuts. As our paper shows, there may be other explanations for increases in dividend payments – with opposite welfare impacts, especially in the context of temporary tax changes.[12]

[9]This assumes that take-over mechanisms do not work well – for reasons suggested by e.g. Stiglitz (1972), Grossman and Hart (1980) and Edlin and Stiglitz (1995).

[10]This is e.g. one of the findings of the literature on the equity premium puzzle, which asserts that the large part of the equity premium cannot be satisfactorily explained by risk aversion (Mehra and Prescott, 1985; Kocherlakota, 1996).

[11]Indeed, a standard response to "excess cash holdings" by firms and the associated agency problems is what Hall (1988) termed the "backs-to-the-wall" approach of corporate finance: shareholders demand large pay-outs from managers, leaving firms equity-constrained, as we model in this paper. This not only removes the scope for excess investment, but the increased probability of bankruptcy to which it gives rise enhances managerial incentives (see Greenwald and Stiglitz, 2003). Theories of excess corporate liquidity presume not only that shareholders cannot control managerial misbehavior, but also that they cannot effectively control dividend distributions to mitigate such behavior.

[12]Our analysis focuses on intertemporal arbitrage, but there are other possible effects, e.g. related to substitutions from share repurchases, or cyclical factors such as a temporary rise in firm profits or a reduction in investment opportunities. If the effects identified by Chetty and Saez were dominant, one would expect to see a lowering of investment in mature firms and a corresponding increase in investment in firms that were formerly equity constrained. In fact, comparing investment in the late 1990s with post-2003 suggests the opposite; the major increase in investment occurred in real estate – in what appeared at the time to be a response to a real estate bubble. Though there may be other factors accounting for

There are several other dimensions of heterogeneity that may determine a firm's responses to dividend taxes. If markets are rational, a temporary dividend tax cut will affect only firms that are expected to pay dividends while the low tax rate is in effect. However, among the more dynamic sectors of the economy are the 'new economy' sectors, where any payouts are largely in forms that are subjected to capital gains taxation.[13] Capital market imperfections (such as the absence of good risk markets, etc.) mean that there may be underinvestment in this part of the economy, relative to the 'old' and mature dividend paying firms. This is true without agency problems, but even more so with agency problems. Lowering dividend taxes advantages the old economy, as opposed to firms in the new economy, and thus may exacerbate the inefficiency of capital allocation.[14]

Those firms that pay out dividends and whose share prices should therefore benefit from temporary dividend tax cuts are mostly mature firms that do not issue equity and have little to gain from a lower cost of equity. Share prices and the cost of equity for new firms that do issue equity should be hardly affected by a temporary tax cut, since they are unlikely to pay dividends while the low tax rate is in effect.[15]

Our analysis does not take into account the budget deficits/revenue shortfalls created by the dividend tax cut. In the absence of lump-sum taxation, any replacement taxes that make up for the lost revenue will introduce further distortions. If taxes are not raised, a higher stock of public debt may increase interest rates at the margin and thereby discourage investment. (It is a more complicated matter to assess whether, at the margin, welfare is increased by lowering dividend/capital taxation. That depends on the deviation of the current tax structure from the "optimal"[16] tax structure.)[17]

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these investment patterns, there is little support for the view that the higher dividend payout led to overall productive gains.

[13]These 'smart' sectors are not only smart in innovation; they have also figured out the dividend puzzle.

[14]This provides support for one of the political criticisms of the temporary dividend tax cuts, that they benefitted the interests of old and stagnant industries rather than those of young and dynamic industries. It is perhaps no accident that the Secretaries of Treasury in office at the time of both tax cuts had been CEO's of "old economy" firms; and that the sway of "new economy" firms was markedly lower in the Bush Administration than in the Clinton Administration.

[15]Empirically, there is a controversy regarding the impact of the tax cut on the share prices of non-dividend paying firms: Auerbach and Hassett (2006, 2007) find that the share prices of firms that are likely to issue new equity increased significantly as a result of the tax cut; Amromin et al. (2006) argue that the same effect can be found for REITs and European stocks that are not affected by US dividend tax policy and should therefore be attributed to other market factors. As we show in this paper, some of the ambiguity might be due to the fact that in 2003, investors assigned a positive probability to a more permanent extension of the temporary tax cuts.

[16]Whether, and to what extent, capital should be taxed is a complicated and contentious issue (see for instance Stiglitz, 1998).

[17]In the theoretical literature, Gourio and Miao (2007) perform a similar analysis, though mostly for the case of mature firms. As in Sinn (1991), firms in their model engage in intertemporal tax arbitrage by adjusting the physical capital stock, which is subject to both decreasing returns to scale and adjustment costs. By contrast, this paper explicitly allows firms to accumulate cash holdings, which better accounts for the behavior of firms that experience tax arbitrage opportunities (a clear example being Microsoft). For a detailed empirical analysis of firms' saving behavior as a response to both uncertainty and imperfect access to external capital markets see e.g. Riddick and Whited (2007). Furthermore, we aggregate over firms of all three stages of development so as to analyze the behavior of macroeconomic variables.

In section 2 we develop our basic life-cycle model of capital constrained firms with random investment opportunities that are subject to dividend taxation. Section 3 investigates the effects of unanticipated and anticipated dividend tax changes on firm behavior. Section 4 analyzes how dividend tax policy affects macroeconomic variables such as aggregate investment. Section 5 briefly discusses a simple model of the political economy of dividend taxation. Section 6 concludes.

2 Model

Underlying the model developed here are two key economic considerations:

First, it is costly for firms to hold cash. Cash holdings within firms are discounted at a higher rate than cash holdings outside, because of agency concerns (including managerial myopia) and because of imperfections in risk markets, which may result in households being even more credit rationed than firms. Analytically, we assume that the discount factor β on firms' future distributions is lower than the risk-free discount factor $\frac{1}{1+r}$, where r is the risk-free interest rate.[18]

Secondly, because of capital market imperfections, firms cannot instantaneously raise new capital for investment purposes – they have to rely on their working capital. In our model, these constraints become particularly important because we assume that investment opportunities arrive at random.[19] If firms do not have cash on hand, these investment opportunities have to be forgone.

As a result, firms have an incentive to hold working capital – to give them the resources to take advantage of new opportunities as they arrive – even though the rate of interest that they earn on cash is lower than the discount rate they face.

Our model allows us to analyze precisely these intertemporal trade-offs. Suppose that the amount of cash a firm has on hand at the beginning of period t is M_t. The firm decides how much to pay in dividends D_t and keeps its remaining cash holdings $M_t - D_t$ on the balance sheet.

To capture the random arrival of investment opportunities, we assume that a Bernoulli variable $\tilde{\lambda}_t$ indicates every period whether a firm has an investment project. $\tilde{\lambda}_t$ takes on the value of 1 with probability p, which indicates that the firm can invest, and 0 with probability $(1-p)$. If a firm has a project, then investing I_t dollars yields a pay-off of $F(I_t)$ at the end of period t, with $F(\cdot)$ being a neoclassical production function, e.g. of the form $F(I_t) = AI_t^{\alpha}$. For notational convenience we also define a corresponding net production function, or net profits $G(I_t) = F(I_t) - (1+r)I_t$.

Reflecting imperfect capital markets, investment is limited by the amount of cash that

[18] For simplicity, there is no aggregate market risk in our model; therefore the risk-free rate would be the appropriate discount rate in the absence of the discussed market imperfection. See appendix A for a motivation of the discount factor $\beta < \frac{1}{1+r}$ from micro fundamentals based on a model of managerial myopia.

[19] Theories of asymmetric information, such as Stiglitz and Weiss (1981) and Myers and Majluf (1984), have explained why firms may face credit and equity constraints. Our analysis does not depend on the particular explanation for the constraints, only on the fact that such constraints exist.

a firm keeps on its balance sheet

$$I_t \leq M_t - D_t \tag{1}$$

If a firm does not have an investment project, it keeps the amount of $M_t - D_t$ on its bank account and earns interest at rate r on it.[20] And thus

$$\tilde{M}_{t+1} = (1+r)\left[M_t - D_t\right] + \tilde{\lambda}_t G\left(I_t\right) \tag{2}$$

This is the basic law of motion for cash holdings. Investment is limited to cash on hand as given in equation (1). We we will show that normally, the constraint is binding, i.e. the full amount of cash available is invested when an investment opportunity arises. This means that the key decision variable is D_t. Given the structure of our model, D_t depends simply on M_t, i.e. it is a function $D(M_t)$. Technically, this section analyzes the optimal dividend policy of the firm, $D^*(M_t)$, and, in particular, how it is affected by dividend taxation.

Before proceeding to the analytical part of the paper, let us note that our assumptions regarding investment opportunities, capital stock, access to capital markets, and incentives for dividend payments have been made mainly for analytical simplicity. There are the following four dimensions along which the presented model could be generalized without significantly affecting the predictions of the paper:

Firstly, instead of a binary Bernoulli variable determining an investment opportunity, we could allow for opportunities of different magnitudes, e.g. that firms face a production function of the form $\tilde{\eta}_t F(I_t)$, where $\tilde{\eta}_t \in [0, \infty)$ is a random variable. Alternatively, we could allow firms to carry unused opportunities into future periods at some cost. The assumption that postponing investment is costly corresponds to the real world, since firms are subject to e.g. changing competition, including competition from abroad, and evolving consumer tastes. As long as there is at least some cost associated with not fully seizing an investment opportunity in the period in which it is optimal to do so, then changes in firms' cash balances induced by changes in dividend taxation can have real effects.[21]

Secondly, we could easily add a state variable for firms' long-term capital holdings to our analysis. In the current paper we have focused on holdings of cash rather than long-term capital since cash or other liquid short-term assets are the most convenient tools for short-term intertemporal tax arbitrage. This should not be understood as suggesting that firms' long-term capital holdings are unimportant in other economic questions, but for the purpose of analyzing intertemporal tax arbitrage it keeps our model more tractable.

Thirdly, the extreme case of having no access to capital markets once an investment opportunity has materialized could easily be relaxed. We could for example assume that firms are subject to a maximum debt equity ratio (which they would in equilibrium always exhaust, since debt is cheaper than equity), and that this is already built into the production function $F(\cdot)$ given above. Alternatively, if firms changed their debt equity ratio in response to tax changes, the discussed results could be attenuated, but in general they will

[20] In our model, we assume that the rate of interest is fixed, e.g. as would be the case in a small open economy. As discussed e.g. in Sinn (1991), qualitative results would be similar if the interest adjusted as firms paid out higher dividends.

[21] Obviously, the magnitude of the welfare loss is smaller the smaller the diminution in value as a result of postponement.

not disappear. Our results hold as long as internal finance and external finance are not or not always perfect substitutes, e.g. because there are costs to accessing capital markets. This is certainly true in the real world.[22]

Fourthly, regarding firms' payout policy, the assumption that future dividend payments are discounted at a higher rate than the risk-free interest rate can be replaced by any other theory of why firms make dividend payments without changing the implications of tax changes for firm investment. The only requirement is that changes in tax rates over time affect firms' marginal incentive to pay out dividends.[23] An example for a theory of dividend payments other than agency costs is e.g. the accumulated retained earnings tax, which punishes firms for holdings excessive cash balances. As long as future changes in tax rates lead firms to alter their payout behavior at the margin, firms' cash balances and thus their investment and output will be affected.

Our model is compatible with share repurchases as long as there is at least some role left to dividends, e.g. if share repurchases are capped because of IRS rules that would subject excessive repurchases to dividend taxation.

We begin our formal analysis by looking at firms' payout policy under a constant dividend tax rate. Following the arguments of Stiglitz (1973, 1976) and Sinn (1991), we show that the behavior of firms can be analyzed by looking at three stages: (a) new firms that access equity markets; (b) young firms: there exists a threshold M^* such that for $M_t \leq M^*$, firms retain all their earnings and $D_t = 0$; and (c) mature firms, which distribute all excess cash beyond M^*, i.e. $D_t = M_t - M^*$. The amount M^* can be derived as the optimal amount of cash balances that firms hold for investment purposes in steady state.

2.1 Model Setup

Managers maximize the stock market value of the representative firm, i.e. the stream of dividend payments discounted by the factor β that reflects the agency problem, and

[22] Even if we allowed firms to access equity markets again in case a very large investment opportunity $\tilde{\eta}_t$ arrives, firms' cost of equity would be $1 + \kappa$ as opposed to $1 - \tau$ for the cost of retained earnings, so there would be a real cost involved with being capital constrained.

[23] Normally, this will be the case, so long as firms are concerned about the present discounted value of dividends. Our analysis is, in particular, consistent with the signaling theory of dividends, if we allow that, when tax arbitrage opportunities arise, investors consider special dividends differently from regular dividend payments. In particular, rational investors should realize (i) a change in tax rates implies a change in the optimal holdings of cash; (ii) the most tax efficient way of distributing the excess is through a one time share repurchase; (iii) a reduction of distributions from that level should not be viewed as a negative signal – and indeed, a firm that fails to distribute its excess cash holdings in a tax efficient way is signaling its incompetency.

diminished by the dividend tax rate τ:

$$V(M_0) = \max_{\{D_t, I_t, M_{t+1}\}_{t=0}^{\infty}} E\left\{\sum_{t=0}^{\infty} \beta^t (1-\tau) D_t\right\} \tag{3}$$

$$\text{s.t. } M_{t+1} = (1+r)[M_t - D_t] + \tilde{\lambda}_t G(I_t) \tag{4}$$

$$M_t \geq I_t + D_t \tag{5}$$

$$D_t \geq 0 \tag{6}$$

$$\text{with } M_0 > 0 \text{ given.}$$

Constraint (4) describes the law of motion for cash holdings; constraint (5) captures the fact that dividend payments plus investment cannot exceed the firm's cash holdings. (6) is the dividend non-negativity constraint.[24]

Substituting the law of motion for cash holdings (4) we can re-write the maximization problem (3) in recursive form:

$$V(M_t) = \max_{D_t, I_t} (1-\tau) D_t + \beta E V\left\{(1+r)[M_t - D_t] + \tilde{\lambda}_t G(I_t)\right\} \text{ s.t. (5), (6)} \tag{7}$$

The firm chooses every period how much to pay out in dividends D_t (which simultaneously determines the amount of cash left on its balance sheet) and how much to invest in case an investment opportunity arises. In the following, let us briefly sketch the solution strategy to problem (7).[25]

Lemma 1 *Under constant dividend taxes, a firm always invests its entire cash holdings when an investment opportunity arises. Therefore constraint (5) on the maximum amount of investment is always binding:* $I_t = M_t - D_t$.

The intuition for this result is that holding cash is costly and the only purpose of cash is to be invested; therefore the firm would never hold more than what would be used if an investment opportunity arises.

Proposition 1 (Steady state cash holdings) *In steady state, the firm retains an equilibrium level of cash balances* M^**, which is defined by*

$$\beta[pF'(M^*) + (1-p)(1+r)] = 1 \tag{8}$$

The term in square brackets represents the expected gross return of cash; it consists of two parts, the return if an investment opportunity arises (with probability p) and the return if cash is kept in T-bills (with probability $1-p$). Equilibrium is reached when the

[24] This constraint is needed since firms could otherwise issue new equity through negative dividend payments at a cost of only $(1-\tau)D_t$, i.e. with a government subsidy of τD_t. This clearly needs to be ruled out. We discuss the dynamics of raising equity below.

[25] A more detailed analytical derivation of the Lagrangian problem corresponding to (7) and of the following lemmas and propositions is available from the authors upon request.

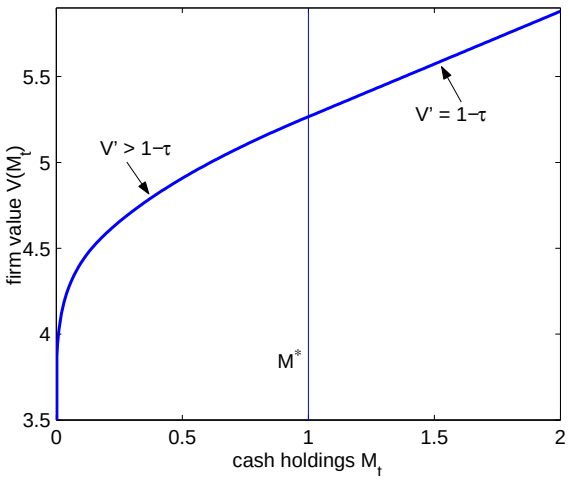

Figure 1: The value function $V(M_t)$ can be determined iteratively from firms' maximization problem (7). Parameter values: $\alpha = 1/2$, $\beta = 0.93$, $r = 0.01$, $p = 1/2$, $\tau = 38.6\%$, A calibrated so that $M^* = 1$.

expected return discounted by β is unity.[26] If $I_t < M^*$, then firm value could be increased by increasing cash holdings; if $I_t > M^*$, then value is being destroyed and it would be optimal to reduce the firm's cash holdings.

The equilibrium condition above implies that $F'(M^*) < 1 + r$, i.e. firm investment is always constrained in steady state – agency concerns lead firms to pay out cash because of managerial myopia or because this reduces the amount of 'free cash' that managers might abuse.Inducing firms to reduce cash holdings further, e.g. because of intertemporal tax arbitrage, entails a first-order cost.

It is noteworthy that condition (8) is independent of the level of dividend taxes – the behavior of mature firms is unaffected by dividend taxation. Pre-multiplying both sides of the equation by $(1 - \tau)$, the left side of (8) can be interpreted as the marginal payoff to investors of keeping one dollar of cash in the firm and the right hand side as the marginal payoff of paying out one dollar in dividends, i.e. $1 - \tau$. For firms in steady state, the two sides have to equal.

Proposition 2 (Payout policy) *A firm retains all of its earnings and pays no dividends as long as its cash holdings are below the steady state level, i.e. $M_t < M^*$. It pays out dividends if its cash holdings are in excess of M^*:*

$$D_t = \max\{M_t - M^*, 0\}$$

This result follows directly from lemma 1. A firm would never keep more cash than it would invest since holding excess cash is costly.

[26]The corresponding equilibrium condition in standard models of physical capital is $\frac{1}{1+r}E[f'(K)] = 1$; the optimal capital stock is at the point where the cost of capital equals the marginal return on physical capital. We focus on cash holdings here, which can be more easily adjusted when tax rates change and firms want to engage in intertemporal tax arbitrage.

Proposition 3 (Value function) *The firm's value function is strictly concave and increases at a rate $V'(M_t) > 1 - \tau$ for growing firms with $M_t < M^*$. It is linear with slope $V'(M_t) = 1 - \tau$ for mature firms with $M_t \geq M^*$.*

Beyond M^*, the value function is linear since any excess cash holdings $M_t - M^*$ are immediately paid out and taxed at rate τ. Below M^*, the value function inherits its concavity from the production function: the lower investment, the higher the marginal product and therefore the higher the increase in the value of the firm from raising its cash holdings. The value function does not have an explicit algebraic representation, but figure 1 shows an example for typical parameter values.

Let us next define $V(M_t; \tau)$ as the value of a firm with cash holdings M_t, given the tax rate τ as an argument. We can then find that dividend taxation simply scales the value of an untaxed firm by the factor $1 - \tau$:

Proposition 4 (Effect of dividend taxes on firm value) *The value of a firm with cash holdings M_t under a constant dividend tax rate of τ can be expressed as $V(M_t; \tau) = (1 - \tau)V(M_t; 0)$, where $V(M_t; 0)$ is the value function under zero dividend taxation.*

2.2 Raising Equity

Let us next analyze the behavior of new firms that raise equity. Suppose that an entrepreneur develops a new business idea and starts a firm that needs an initial injection of equity. We also allow for the case that issuing new equity is costly. For every dollar that the firm receives in funding, the investor has to pay an additional premium of $\kappa \geq 0$ in transactions costs. This can include e.g. underwriting fees (see Chen and Ritter, 2000) as well as underpricing because of agency problems (see e.g. Asquith and Mullins, 1986). The optimum amount of new equity N^* that the firm raises is then determined by the following no-arbitrage consideration:

Proposition 5 (Equity issuance) *(i) For a new firm the optimal amount of equity $N^*(\tau)$ to raise satisfies the condition $V'(N^*(\tau); \tau) = 1 + \kappa$. (ii) $N^*(\tau)$ is decreasing in the dividend tax rate τ and in the cost of raising equity κ.*

In the graph in figure 2, we have indicated the points where the slope of the value function reaches $1 + \kappa$ and where it reaches 1, the latter being the case without transactions costs, which enables the entrepreneur to raise a higher amount of cash.

In short, the life-cycle of a firm in our model can be split into three distinct regions:

External financing region: For $M_t < N^*(\tau)$ the firm's marginal value of cash is higher than its external financing costs $1 + \kappa$. The firm thus raises cash from equity markets up to the point $N^*(\tau)$.[27]

[27] In our analysis, firms only issue equity once. In practice, young firms often issue equity in several tranches because of asymmetries of information: insiders may know (or believe) that information will become available that will reveal that the true value of the company is higher than currently believed; current owners thus want to minimize the dilution required by postponing raising funds from the market.

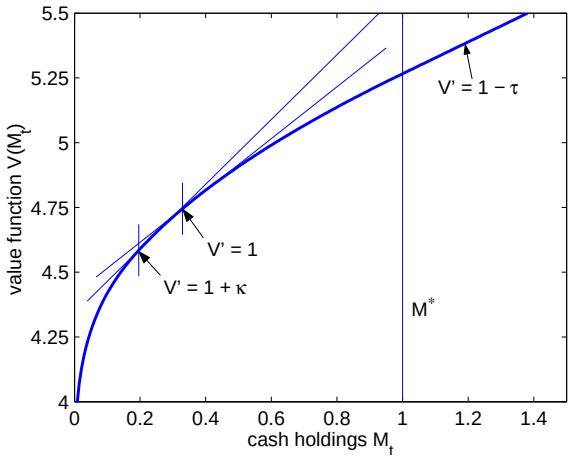

Figure 2: New equity issues: For a new firm, it is optimal to raise equity N^* up to the point where $V'(N^*;\tau) = 1 + \kappa$, or 1 if there are no costs to issuing equity. Parameter values used: $\kappa = 25\%$, $\tau = 36.8\%$.

Internal growth region: For $M_t \in [N^*(\tau), M^*)$ the firm's marginal value of funds is too low to raise new equity, but too high to pay out dividends. In this region, the firm grows internally by investing and retaining its earnings until it reaches the steady state with $M_t = M^*$. Also, the firm does not pay dividends in the internal growth region.

Steady state: For $M_t \geq M^*$ the firm is in its steady state. Every period, it pays out its cash holdings in excess of the optimal holdings M^* in the form of dividends. If an investment opportunity arises, then the firm invests M^* and earns $F(M^*)$. Next period the firm distributes all but the amount of cash required for new investments, i.e. it pays a dividend $D_{t+1} = F(M^*) - M^*$. Otherwise, if no investment opportunity arises, it earns interest of rM^*, which it pays out at the beginning of the next period.[28] As a consequence, note that once the firm has reached the threshold M^*, its cash holdings will never again fall below this value, given constant parameters values.

Since the arrival of investment opportunities is random, the path along this life-cycle will differ from firm to firm. However, to give an example we have depicted the average cash balances of a new firm over its first 15 periods in figure 3. As can be seen, almost all

Sometimes firms return to equity markets at later stages in their development. This can be modeled as a simple extension of the model presented here when firms face a positive (publicly observable) shift in their production function. If that shift is large enough, it may pay the firm to raise new equity in the market (in spite of the high cost of doing so), because the opportunities forgone otherwise would simply be too great. However, even without asymmetries of information, even if the shift in the production function were perfectly anticipated, and even if there were fixed costs to entering the equity market, firms might not want to raise all of their equity at one time, because of agency costs.

[28]This yields the result that dividends are variable. In practice, dividends often show a high degree of stability related to their signaling role, as discussed e.g. in Ross (1977) or Bhattacharya (1979) and evidenced in DeAngelo and DeAngelo (1990). Note that in this model, dividends perform no signaling role. Including a coherent model in which dividends might perform such a role would greatly complicate the analysis, e.g. by requiring random shifts in the production function of the firm.

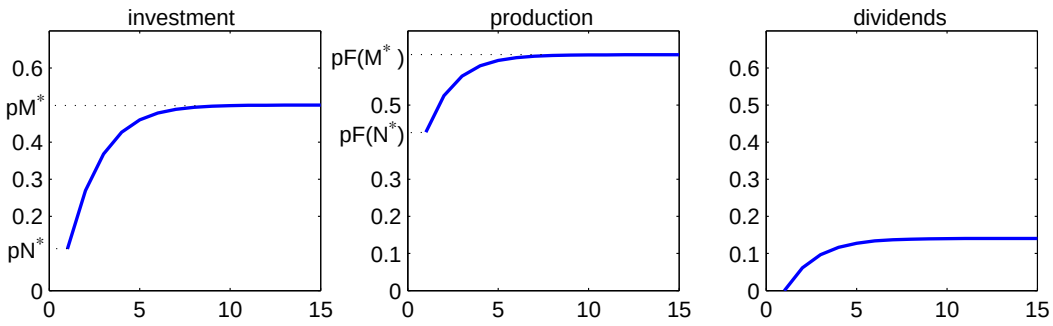

Figure 3: Average Evolution of Firm: The figure shows how investment, production, and dividend payments for a new firm evolve on average over the first 15 periods. In the first period, the firm raises $N^*(\tau)$ where we chose $\tau = 38.6\%$. It invests on average pN^* and produces $pF(N^*)$. In the 15th period, its expected investment and production are almost indistinguishable from the steady state values pM^* and $pF(M^*)$.

new firms in our example have reached the mature stage with $M_t = M^*$ after 10 periods under our choice of parameters.

3 Changes in the Dividend Tax Rate

The model developed in the previous section now allows us to analyze how capital constrained firms react to changes in the dividend tax rate. As we discussed before, unanticipated tax changes are likely to have only a small impact on aggregate investment, since they affect only young firms issuing equity. On the other hand, in the case of anticipated tax changes, firms engage in tax arbitrage, which affects their optimal level of cash balances and hence has potentially strong implications for aggregate investment.

3.1 Unanticipated Dividend Tax Changes

Unanticipated cuts and increases in the dividend tax rate affect the value function of firms in a similar fashion:

Proposition 6 *An unanticipated permanent dividend tax cut (increase) from τ_1 to τ_2 scales firms' value function $V(M_t;\tau_1)$ proportionally upwards (downwards) to $V(M_t;\tau_2)$. The optimal investment and payout policy of mature firms is not affected by an unanticipated change in dividend taxation.*

These results are easy to see from the fact that dividend taxes do not affect the maximization problem of mature firms, but only scale firms' value function by the constant $1-\tau$:

$$\underset{\{D_t,I_t,M_{t+1}\}}{\arg\max}\ E\left\{\sum_{t=0}^{\infty}\beta^t\left(1-\tau\right)D_t\right\} = \underset{\{D_t,I_t,M_{t+1}\}}{\arg\max}\ E\left\{\sum_{t=0}^{\infty}\beta^t D_t\right\}$$

For the investment decisions of mature firms a change in the dividend tax rate in either direction is neutral. This is typical for models that follow the 'new view' of dividend

taxation. However, the amount of equity that new firms raise is affected by permanent dividend tax changes, which reflect the 'traditional view' elements of our model.

Proposition 7 *An unanticipated permanent cut (increase) in dividend taxes from τ_1 to τ_2 increases (decreases) the amount of funds that new firms raise in equity markets from $N^*(\tau_1)$ to $N^*(\tau_2)$.*

As already noted in proposition (5), the amount of equity that new firms raise is decreasing in the dividend tax rate. In addition, in the case of a tax cut, there might be some young firms for which cash holdings $M_t < N^*(\tau_2)$, i.e. for which one marginal dollar of new equity raises firm value by more than the cost of issuing equity ($V'(M_t;\tau_2) > 1+\kappa$). These firms issue new equity up to the point where $M_t = N^*(\tau_2)$. No similar effect occurs in the case of unanticipated tax increases. This asymmetry reflects the asymmetry between lowering and raising equity (distributing funds to shareholders is subject to the dividend tax, raising equity is not).[29]

3.2 Anticipated Dividend Tax Increase

These results contrast strongly with the case of anticipated changes in dividend taxes. Let us first analyze the effect of such a policy on young firms issuing equity; then on growing and mature firms. Throughout the discussion, we denote by $V_s(M_t;\tau_L,\tau_H)$ the value function of a firm that expects a dividend tax increase after s periods, i.e. that is subject to a low dividend tax rate τ_L for s periods and then to a higher rate τ_H for all following periods. Similarly, we denote by $M_s^*(\tau_L,\tau_H)$ the firm's optimal cash balances s periods before the tax increase. (Note that $V_0(M_t;\tau_L,\tau_H) \equiv V(M_t;\tau_H)$ and $M_0^*(\tau_L,\tau_H) = M^*$.)

For young firms, the cost of equity rises immediately in anticipation of a dividend tax increase, because investors are forward-looking and expect that much of the payoff of their equity investment will occur in the future when dividend taxes are increased. In the period directly before the tax increase, new firms raise the same (low) amount of new equity as if the higher tax rate was already in effect, i.e. $N_1^*(\tau_L,\tau_H) = N^*(\tau_H)$. This is because all dividends that will be paid out by these firms will be subject to the high tax.

To see what happens to new equity issuance in earlier periods, we need to analyze the value functions of firms in those periods. If a dividend tax hike is anticipated for time t, then firms' value function in period $t-s$ can be denoted iteratively as

$$V_s(M_{t-s};\tau_L,\tau_H) = \max(1-\tau_L)D_{t-s} + \beta E\left\{V_{s-1}\left(\tilde{M}_{t-s+1};\tau_L,\tau_H\right)\right\} \tag{9}$$

for any $s > 0$, where $V_0(M_t;\tau_L,\tau_H) = V(M_t,\tau_H)$, as discussed above.

We have depicted the value functions V_1 to V_{15} for the 15 periods preceding an anticipated dividend tax hike in figure 4. The upmost value function in the figure represents firms that are permanently subject to the old (low) tax rate τ_L; the lowest curve represents firms that are subject to the new (high) tax rate τ_H forever. If an increase in the dividend

[29]The marginal value of dividends to shareholders is $1-\tau$; the marginal cost to issuing equity is $1+\kappa$. Both the dividend tax and the cost involved in issuing equity thus increase the wedge between the cost of new equity and the cost of capital in the form of retained earnings.

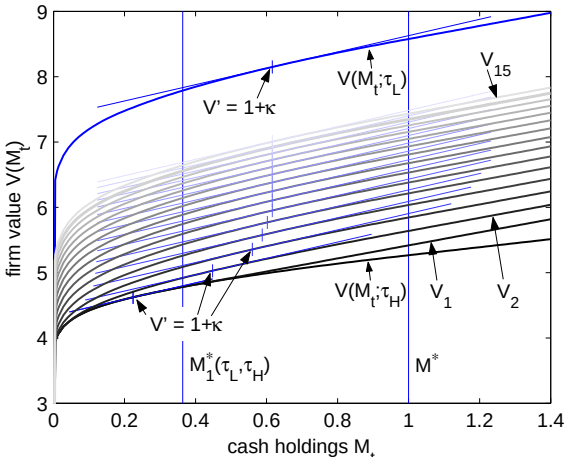

Figure 4: Anticipated Dividend Tax Increase, Value Functions: This figure shows the value functions $\{V_{15}, ..., V_1\}$ of firms in the 15 periods prior to an anticipated dividend tax increase from $\tau_L = 0\%$ to $\tau_H = 38.6\%$. When the future tax increase is announced, the value function jumps immediately from the top curve $V(M_t; \tau_L)$ down to V_{15}. Firms' value functions then move in small steps period-by-period closer to $V(M_t; \tau_H)$.

tax rate is announced s periods ahead, this implies that firms' value function immediately jumps from the upmost curve down to $V_s(\tau_L, \tau_H)$. As can be seen in the figure, the series of value functions $V_k(\tau_L, \tau_H)$, $k = s, s-1, \ldots, 1$ moves every period a little closer to the final value function $V(M_t; \tau_H)$, which will come into effect under the new dividend tax rate. The amount of equity $N_s^*(\tau_L, \tau_H)$ that new firms would issue in a given year $t - s$ is depicted as the tangent with slope $1 + \kappa$ to the value function $V_s(\cdot)$. Analytically it can be determined by the condition $V_s'(N_s^*(\cdot); \tau_L, \tau_H) = 1 + \kappa$. Clearly, $N_s^*(\cdot)$ decreases the closer the economy comes to the dividend tax increase. Let us summarize this in the following:

Proposition 8 *When a dividend tax increase from τ_L to τ_H is anticipated in $s > 1$ periods, new firms issue an amount of equity $N_s^*(\tau_L, \tau_H)$, which lies in between $N^*(\tau_L)$ and $N^*(\tau_H)$ and falls the closer the increase, i.e. $N_s^* > N_{s-1}^*$. In the period immediately preceding the tax hike, firms issue the same (low) amount of equity $N^*(\tau_H)$ as if the high tax rate was already in effect.*

The effects of an anticipated tax increase on new firms thus follow what is predicted by the traditional view of dividend taxation, since the marginal source of funds for new firms is equity markets. For this category of firms, our findings are also consistent with Alvarez et al. (1998) who discuss how firm investment reacts to the anticipation of tax policy changes.

An important implication of this finding is that a temporary tax cut that is scheduled to expire after a few periods does not raise the amount of investment by much and has a significantly smaller impact on the cost of equity of new firms than what would be predicted from analyzing a permanent tax cut of identical magnitude.

Let us next turn our attention to firms that no longer access equity markets, i.e. internally growing and mature firms. These are the firms that have an incentive to engage in

tax arbitrage: shareholders can save taxes if firms pay out a higher amount of dividends in the period preceding a tax increase. However, this tax arbitrage is limited by the fact that firms need cash in order to take advantage of random investment opportunity. The optimal amount of cash balances $M_1^*(\tau_L, \tau_H)$ balances these two factors off against each other.

Proposition 9 *An anticipated increase in dividend taxes from τ_L to τ_H induces firms with cash holdings $M_{t-1} > M_1^*(\tau_L, \tau_H)$ to pay out a special dividend in the period $t-1$ immediately prior to the tax increase. They reduce their cash holdings to $M_1^*(\tau_L, \tau_H) < M^*$, which is defined implicitly by the equation*

$$V'\left(M_1^*; \tau_H\right) = 1 - \tau_L$$

This depresses investment and lowers dividends in the period t of the tax increase and in the following periods, until firms have restored their optimal level of cash balances M^* through internal savings.

Under a constant dividend tax rate τ_L, steady-state cash holdings are defined by the condition $V'(M^*; \tau_L) = 1 - \tau_L$, i.e. the marginal value of keeping one dollar inside the firm is the after-tax value of a one dollar dividend. The period before a tax increase, this intertemporal tradeoff changes: keeping one dollar inside the firm will raise firm value in the future only by $V'(M_t; \tau_H) < V'(M_t; \tau_L)$ since the tax rate is expected to go up, while current dividends still yield the after-tax value $1 - \tau_L$. Firms thus pay out a special dividend up to the point $M_1^*(\tau_L, \tau_H) < M^*$ where marginal benefit and cost of keeping cash are equalized. In figure 5, this is the point where the slope of the high-tax value function $V'(M_t; \tau_H) = 1 - \tau_L$, which is indicated by the vertical line labeled $M_1^*(\tau_L, \tau_H)$. Beyond this M_1^*, firms' value function $V_1(M_{t-1}; \tau_L, \tau_H)$ is linear and increasing at rate $1 - \tau_L$, since all cash in excess is paid out and taxed at the rate τ_L.

Note that in earlier periods before the tax cut, i.e. $t-2$, $t-3$ etc., internally growing and mature firms do not alter their behavior in response to an impending dividend tax increase: they accumulate cash balances up to M^* and pay out any excess, because there aren't any tax arbitrage opportunities yet. However, firm value still falls in anticipation of the higher tax rate (see again the value functions in figure 4).

3.3 Probabilistic Dividend Tax Increase

Firms react in a similar way if there is uncertainty about whether a dividend tax increase will occur in a future period. Such a situation can arise for example if a dividend tax cut has been implemented in the past and firms expect (e.g. for political economy reasons or because of large fiscal deficits) that the tax cut will be undone in a future period.

Proposition 10 *Suppose that in every time period, there is a probability π that the prevailing dividend tax rate τ_L will rise to τ_H. Then mature firms reduce their cash balances to $M_\pi^*(\tau_L, \tau_H) < M^*$ while the low tax rate is in effect.*

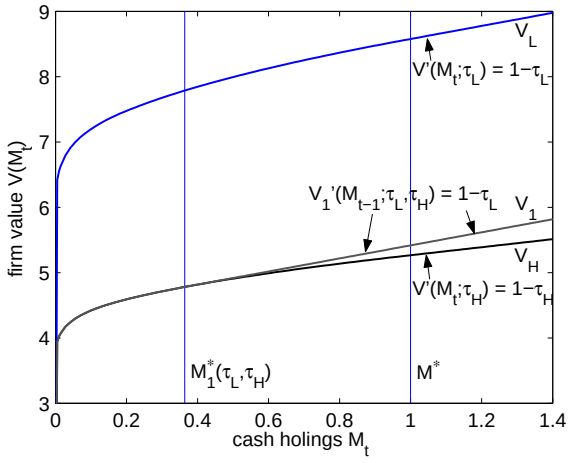

Figure 5: Anticipated Dividend Tax Increase, 1 Period Ahead: In the period preceding a dividend tax increase from $\tau_L = 0\%$ to $\tau_H = 38.6\%$, firms pay out all their cash holdings above $M_1^*(\tau_L, \tau_H)$ in the form of a special dividend. Their value function $V_1(M_t; \tau_L, \tau_H)$ coincides with the new value function V_H up to that point and increases at the constant slope $1 - \tau_L$ (steeper than the new value function) thereafter.

M_π^* is the point at which the expected stochastic tax savings from paying out a higher dividend now (left-hand side) equal the cost of forgoing a potential investment opportunity next period because of cash constraints (right-hand side):

$$1 - \tau_L = \pi V'(M_\pi^*; \tau_H) + \beta(1-\pi)(1-\tau_L)\left[pF'\left(M_\pi^*\right) + (1-p)(1+r)\right]$$

Naturally, mature firms depress their cash balances more the greater the probability of the tax increase and the larger the expected difference in tax rates. For young firms raising cash, the implications are similar to what we discussed in the previous subsection. A direct implication of the observation that $M_\pi^*(\tau_L, \tau_H) < M^*$ is the following:

Corollary 1 *If there is uncertainty about a future dividend tax increase, investment by mature firms can be increased by raising dividend taxes immediately.*

What is perhaps even more striking is that whether the government raises or leaves the tax rate (permanently) unchanged, firm investment and tax revenues will increase. Once the uncertainty about a possible dividend tax increase is resolved (in either direction), mature firms increase their cash holdings back to M^*.

3.4 Anticipated Dividend Tax Cut

We next investigate a dividend tax cut from τ_H to τ_L that is anticipated in s periods. The general idea is that for new firms, the cost of capital falls in anticipation of the tax cut; for mature firms the anticipated tax cut enables firms to engage in intertemporal tax arbitrage by postponing dividend payments. Let us focus on each category of firms in some detail.

Similar to our discussion in subsection 3.2, investors expect that much of the dividend payments of new firms will occur after the tax cut; therefore firms' valuation rises immediately, as depicted in figure 6 for the 15 periods preceding an anticipated tax cut. The

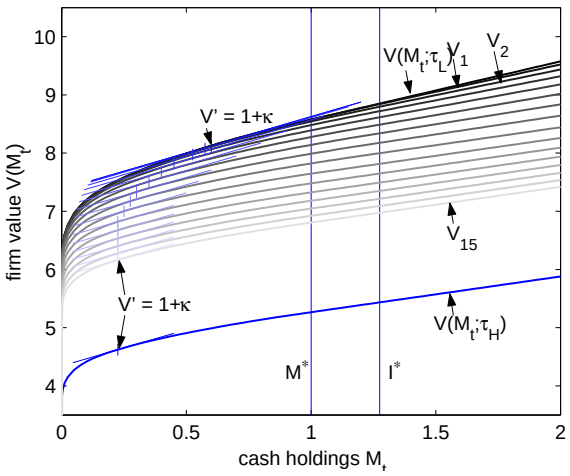

Figure 6: Anticipated Dividend Tax Cut, Value Functions: The value functions $\{V_{15}, ..., V_1\}$ of firms in the 15 periods prior to an anticipated dividend tax cut move closer and closer to the value function $V(M_t; \tau_L)$ prevailing under the new dividend tax rate. The amount of equity that new firms issue, indicated by the tangent with slope $1 + \kappa$ to each value function, rises.

bottom line depicts firms' value function under the old high-tax regime; the top line represents the value function after the tax cut was enacted. The curves in between illustrate how firms' valuation gradually approaches the after-tax cut valuation.

The tangents with slope $1 + \kappa$ to the various value functions V_{15}, V_{14}, etc. (marked with a vertical tick) indicate the amounts of new equity that young firms issue in the respective periods. In the periods immediately preceding a tax cut, firms issue the same amount of equity $N_1^*(\tau_H, \tau_L) = N^*(\tau_L)$ as if the cut was already enacted, since all their future dividends will be taxed at the lower rate. In earlier periods, the optimal amount of new equity continually rises, i.e. $N_{s-1}^* > N_s^*$. Young firms with low cash holdings $M_{t-s} < N_s^*(\tau_H, \tau_L)$ thus have an incentive to access equity markets again, and possibly multiple times, since their internal cost of capital is higher than the new cost of equity, given the impending dividend tax cut.[30]

Mature and internally growing firms can delay dividend payments to later periods and thereby save on dividend taxes by temporarily increasing their cash holdings above M^*. The extent to which they are willing to do so depends on the magnitude of the expected tax cut.

Proposition 11 *Let k be the largest integer such that $1 - \tau_H < (1 - \tau_L)[\beta(1 + r)]^k$. Then mature firms keep all their cash earnings on the balance sheet for the k periods preceding a tax cut, i.e. $M_s = \infty$ for $s = 1, ..., k$. In period $k + 1$ before the tax cut, firms accumulate cash balances up to $M_{k+1}^* > M^*$, which is defined by*

$$\beta \left[pF'(M_{k+1}^*) + (1 - p)(1 + r) \right] = \frac{1 - \tau_H}{1 - \tau_L} \cdot \frac{1}{[\beta(1 + r)]^k}$$

[30]This is an important asymmetry to anticipated tax increases as discussed in subsection 3.2, where firms could not undo equity issues when the cost of equity rose in reaction to an anticipated tax increase.

Firms pay out all their cash holdings in excess of M^* as a special dividend after the tax cut has been implemented.

For the first k periods, paying dividends in the future at the lower tax rate is – despite the high discount rate – more favorable to investors than paying out immediately under the high tax rate, and therefore firms pay zero dividends and retain all earnings.[31] We noted earlier that, because of agency considerations, firms' equilibrium cash holdings M^* and by implication firms' investment are below the optimum investment I^* in a neoclassical world without capital constraints (defined by $F'(I^*) = 1 + r$). Postponing dividends raises firm cash holdings and enables firms to more fully take advantage of investment opportunities. Specifically, arbitraging firms invest all their cash holdings up to $I^* > M^*$ when an investment opportunity arrives and keep the rest in cash, i.e. they are subject to constant returns to scale above I^*, earning the risk-free return r.

In period $k+1$ before the tax cut, optimal cash holdings are $M^* < M^*_{k+1} < I^*$ – firms increase cash holdings above the long-run steady state, but are still cash-constrained in equilibrium because the incentives for tax arbitrage are only weak. They pay out any cash earnings in excess of M^*_{k+1}. After that, no further dividend payment is made until after the tax cut, when all the accumulated excess cash holdings $M_t - M^*$ are distributed to shareholders in the form of a special dividend.

If a dividend tax cut is expected to occur in more than $k+1$ periods in the future, the payout and investment policies of existing firms are unaltered. However, share prices rise immediately in anticipation of the tax cut.

In summary, an anticipated dividend tax cut leads to a permanent increase in investment by new firms and a temporary increase in investment by internally growing and mature firms engaging in tax arbitrage.

3.5 Probabilistic Dividend Tax Cut

If there is uncertainty about whether a dividend tax cut will occur in a future period, similar conclusions hold. An example for this situation occurred in 2002, when political parties were discussing the possibility of a reduction in the dividend tax rate.

Proposition 12 *If firms expect a dividend tax cut from τ_H to τ_L with a probability of π in every time period until the tax cut is realized, they accumulate cash balances up to a level of $M^*_\pi(\tau_H, \tau_L) > M^*$ while the higher tax rate is in effect, which is defined by*

$$\begin{aligned} \beta(1 - E\tau_{t+1})[pF'(M^*_\pi) + (1-p)(1+r)] = 1 - \tau_H \quad &\text{if} \quad 1 - \tau_H > \beta(1+r)(1 - E\tau_{t+1}) \\ M^*_\pi = \infty \quad &\text{if} \quad 1 - \tau_H \leq \beta(1+r)(1 - E\tau_{t+1}) \end{aligned}$$

where $E\tau_{t+1} = (1-\pi)\tau_H + \pi\tau_L$ is the expected dividend tax rate next period.

In other words, firms reduce their dividend payments and increase their cash holdings in order to take advantage of the expected lower dividend tax in the future. If the tax cut is likely or large enough, as described by the second inequality, firms will not pay any

[31] For dividend tax cuts that are small in comparison to the equity premium, it is possible that $k = 0$.

dividends until the tax cut has materialized. Instead, they would be willing to accumulate arbitrarily large cash balances.

Corollary 2 *If there is uncertainty about whether there will be a tax decrease, it pays the government to postpone resolving that uncertainty (either way). In the interim, tax revenues are higher and output is higher.*

3.6 Temporary Dividend Tax Changes

Essentially, an unanticipated temporary change in dividend taxes is equivalent to an unanticipated change in one direction followed by an anticipated change in the reverse direction at a later point in time.

Let us first focus on temporary dividend tax cuts. Assume that a high dividend tax rate of τ_H is unexpectedly reduced to τ_L for k periods, after which it returns to τ_H. As discussed before, the unanticipated reduction in the tax rate increases the value of all firms. For new firms, this increases the amount of equity that they raise, but it does not have any effects on the behavior of mature firms.

However, note that both the increase in stock prices and in the amount of equity that new firms issue is strongly mitigated by the fact that a dividend tax rise after k periods is anticipated. Figure 4 reveals that firms' value functions for the periods preceding a typical tax hike are actually much closer to $V(M_t; \tau_H)$, i.e. the lowest line in the figure, than to $V(M_t; \tau_L)$, the highest line that would correspond to a permanent tax cut. In other words, the positive effects of lower dividend taxes in terms of a lower cost of equity is strongly reduced by the fact that a dividend tax hike in a future period is impending. The reason is that young firms usually do not pay out dividends in the first few years of their existence, but only once they have accumulated their steady state holdings of cash M^*. We can thus conclude that temporary dividend tax cuts reduce the marginal cost of equity $V'(M_t)$ mostly for those firms that do not need it (mature firms), but hardly affect the marginal cost of equity for new firms that need to access capital markets. In the extreme case of a one-period temporary tax cut, this leads to the following result.

Proposition 13 *The effects of an unanticipated one-period dividend tax cut on aggregate investment are unambiguously negative.*

New firms do not raise more equity than if the tax rate had been kept at τ_H, since taxes will be back at their earlier level when they make their first distributions. At the same time, because of arbitrage considerations, internally growing and mature firms pay out a special dividend to reduce their cash holdings to $M_1^*(\tau_L, \tau_H)$, and their cash balances will be lower for a number of periods until firms have recovered their optimum, M^*.

The opposite conclusions hold for a temporary dividend tax increase. While the amount of equity that new firms issue during the high tax period would fall, firms hold higher cash balances than M^* in anticipation of the impending dividend tax cut, and this allows them to invest higher amounts. Again, the extreme case of an unanticipated one-period increase would have unambiguously positive effects on aggregate investment, though only for one period.

4 Aggregate Investment and Output

This section investigates the effects of dividend tax policy on aggregate investment, summing up across all firms in the economy. For a firm that was started a periods ago, i.e. of age a, we define average investment as $\bar{I}_a := pE[I_a]$, the probability of receiving an investment opportunity times the amount that would be invested. Evidently, this entails that $\bar{I}_0 = pN^*$ and $\bar{I}_a = pM^*$ for all $a \geq T$, where T is the number of years after which all firms of vintage a have reached their steady state cash holdings M^*. Similarly, we define expected net output and expected dividend payments by a firm of age a as $\bar{Y}_a := pE\left[G(I_a)\right]$ and $\bar{D}_a := E[D_a]$.

Assume that at any given time t the economy consists of a mass z_{t-1} of existing firms, and a mass $\Delta z_t = \gamma z_{t-1}$ of new firms is started, yielding a total of $z_t = (1+\gamma)z_{t-1}$. Firms are indexed by i and follow the maximization problem and the resulting rules described in the previous sections. The arrival of investment opportunities is independent among firms, yielding deterministic values for all macroeconomic variables.

In steady state the fraction of firms at a given stage of development, say age a, is then constant at $\frac{\gamma}{(1+\gamma)^{a+1}}$. However, the total mass of firms is increasing, reflecting growth in the economy. At time t the total mass of firms of age a is $\frac{\gamma}{(1+\gamma)^{a+1}} z_t$. Aggregate investment AI_t at time t can then be expressed as

$$AI_t = \int_0^{z_t} pI_{t,z}dz = z_{t-T}\bar{I}_T + \cdots + \Delta z_t \bar{I}_0 = z_t \left[\frac{\bar{I}_T}{(1+\gamma)^T} + \sum_{a=0}^{T-1} \frac{\gamma \bar{I}_a}{(1+\gamma)^{a+1}} \right]$$

By the same token, aggregate output AY_t and aggregate dividend payments AD_t are

$$AY_t = z_t \left[\frac{\bar{Y}_T}{(1+\gamma)^T} + \sum_{a=0}^{T-1} \frac{\gamma \bar{Y}_a}{(1+\gamma)^{a+1}} \right] \quad \text{and} \quad AD_t = z_t \left[\frac{\bar{D}_T}{(1+\gamma)^T} + \sum_{a=0}^{T-1} \frac{\gamma \bar{D}_a}{(1+\gamma)^{a+1}} \right]$$

Let us use this setup to simulate the impact of dividend tax policy on aggregate variables. Note that our analysis is partial equilibrium in the sense that we take the interest rate as given and do not allow for e.g. offsetting monetary policy actions.[32] As we argued earlier, this may be justified if the economy is open to international capital flows, which break the link between domestic saving and investment and determine interest rates exogenously. In reality, some of the dividends paid out may be re-invested in the domestic economy. But empirically, there is some question about the extent to which this may be so.[33] Since dividend taxes are only a small part of government revenue, we furthermore disregard the effects of dividend taxation on the government's budget position.

[32] Even if there is a feedback effect on interest rates (see e.g. the reasoning in section 3.2. of Sinn, 1991), all the effects that we discuss are still present, though they are mitigated by endogenous adjustments in the interest rate.

[33] For example, if we assume that the Fed sets interest rates so as to maintain a given level of GDP, then if there are some individuals who are cash constrained (à la Stiglitz-Weiss), and if these individuals spend some of the dividends which they receive, then consumption will be higher and investment lower: in equilibrium, not all of the money will have "re-circulated" back into investment.

Furthermore, dividends may be re-invested in the stock market and drive up the price of shares – but for mature firms, the marginal source of capital is not equity markets, and therefore the response of investment

Following Mehra and Prescott (1985, 2003) we chose $\beta = 0.93$ and $r = 1\%$. In order to replicate a typical growth rate of the economy we calibrated $\gamma = 3\%$.[34] For the other structural parameters we used values of $\alpha = 1/2$ and $p = 1/2$, and A was chosen so that $M^* = 1$. However, our results are robust to alternative calibrations.

4.1 Aggregate Effects of Unanticipated Dividend Tax Changes

We showed in the previous section that the behavior of internally growing and mature firms (and hence their contribution to investment) is unaffected by dividend taxes. However, new firms issue less equity the higher the dividend tax rate and therefore take longer to reach the mature stage. This reduces aggregate investment, but since only a small fraction of investment in the economy is performed by new firms that access equity markets, the aggregate effect of unanticipated dividend tax changes is small.

We depict an example of an unanticipated reduction of a $\tau_H = 38.6\%$ dividend tax to $\tau_L = 15\%$ in figure 7.[35] The tax cut occurs unexpectedly in period 4 and immediately raises the amount of new equity N^* that new firms issue. Since the optimal amount of cash balances M^* for mature firms remains unchanged, the average firm in the economy has only slightly higher cash balances, as a result of the higher N^*. As a result, aggregate investment AI, production AY, and gross dividend payments AD increase very modestly. However, the distribution of firms' dividends changes significantly: shareholders net dividend receipts $(1-\tau)AD$ increase steeply; the government's revenue from dividend taxation τAD falls sharply. Thus the redistributory effect of changes in dividend taxation is an order of magnitudes stronger than any efficiency effects.[36] In our simulation model, the described cut of a 38.6% dividend tax increased aggregate investment, output, and dividends only by 1.3%, 0.9% and 2% respectively. Recall in this context that due to various tax deductions, the estimated effective dividend tax rate in the US economy is actually much lower than the nominal rate.

4.2 Aggregate Effects of an Anticipated Tax Increase

As discussed in the previous section, the results for an anticipated tax change differ substantially. In figure 8 we have depicted an example of a tax increase from $\tau_L = 15\%$ to $\tau_H = 38.6\%$ that is anticipated to occur in period 8. The effects on aggregate macroeconomic variables are twofold: Firstly, new firms issue less and less equity both in the periods leading up to the increase and under the new tax rate, reducing their investment

to increases in equity prices is limited, slow, and uncertain. Our qualitative results hold as long as the marginal propensity to invest (directly or indirectly) of the recipients of dividends is lower than had the money remained inside the firm.

[34] Empirically, the value of new equity issued fluctuates wildly from year to year, but $\gamma = 3\%$ is a reasonable approximation to the average long-run amount of equity issuance.

[35] We have normalized all aggregate variables in this figure as well as in the following figures by z_t in order to distinguish the effect of tax policy from the general growth of the economy.

[36] If the lower government revenue forces a reduction in public spending and if there is a multiplier associated with government expenditure, then the dividend tax cut would potentially have a strongly negative effect on output.

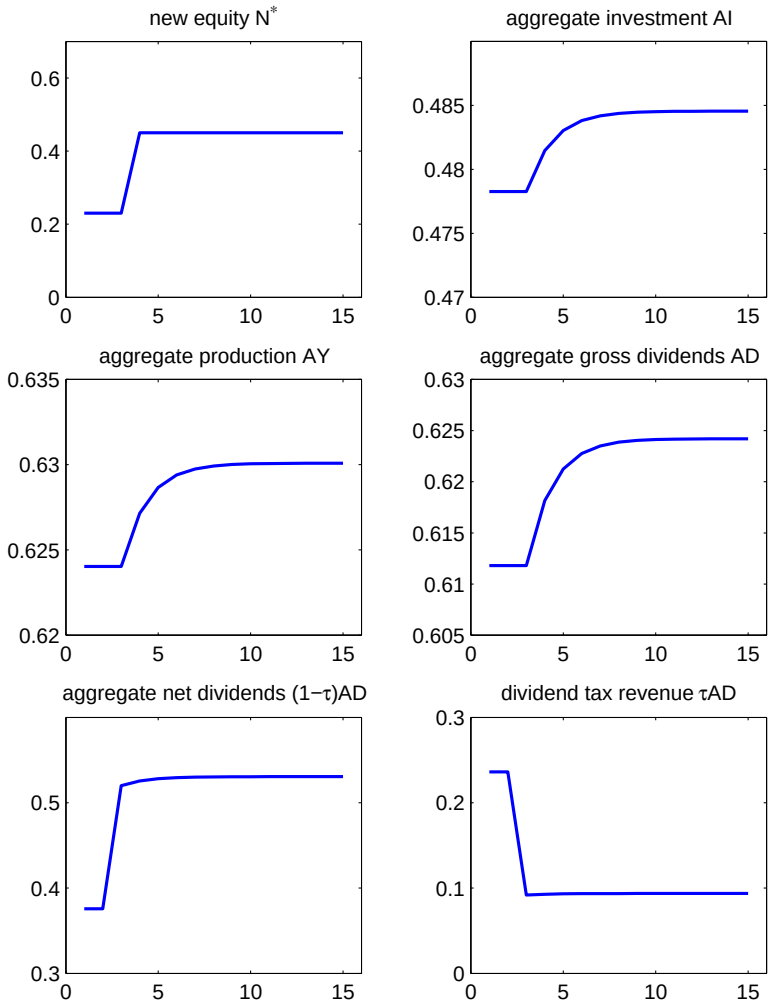

Figure 7: Unanticipated Dividend Tax Cut: After an unanticipated dividend tax cut from 38.6% to 15% in period 4, the amount of new equity N^* that new firms issue rises significantly. However, aggregate investment AI, production AY, and gross dividend payments AD increase only modestly. The redistributory effect of the tax change, on the other hand, is very strong.

and prolonging the time for them to reach the steady state. Secondly, all mature firms pay out a special dividend in the period immediately preceding the tax increase, reducing their investment for periods to come. Since most firms in the economy are mature, this second effect is much more pronounced than the first one. However, as can be seen from the two graphs at the bottom, the redistributory effects of the tax increase are even stronger than the direct effects on investment.

Let us also analyze the case of firms that expect a dividend tax increase from τ_L to τ_H to happen any period with a constant probability of arrival π. This encourages internally growing and mature firms to hold less cash. As a result, aggregate investment is depressed below the point where it would be if the high tax rate was already in effect – investment will increase once the dividend tax increase has been enacted, since mature firms will restore their steady state cash holdings of M^*.

An example of this is given in figure 9. In the first three periods of the figure, firms anticipate that there is a 25% risk of a dividend tax increase in each of the next periods. This reduces their optimal cash balances to M^*_π. In period 4, the tax increase is enacted, and firms' optimal level of cash holdings reverts to $M^* > M^*_\pi$, which increases investment activity in the economy. Note, however, that the amount of equity that new firms issue decreases in period 4 because of the higher dividend tax rate.

4.3 Aggregate Effects of an Anticipated Tax Cut

An example of firms' reaction to an anticipated dividend tax cut is given in figure 10: Starting from period 1 agents foresee that dividend taxes will fall from $\tau_H = 38.6\%$ to $\tau_L = 0\%$ in period $t = 11$. The amount of equity that new firms issue slowly increases between periods 1 and 11.

Mature firms' payout policy is unchanged up to period 5, in which they reduce their dividend payments. From period 6 to period 10, firms make no dividend payments and accumulate an increasing amount of cash on their balance sheets. This allows them to invest more in case an investment opportunity arises, but only up to a maximum of I^*, since the marginal product of capital turns below the risk-free interest rate after this point. Aggregate investment AI and output AY are thus significantly above their long-run equilibrium value.

In period 11, when the tax cut is enacted, mature firms pay a special dividend, which returns them to the steady state. New firms can now issue a slightly larger amount of equity, but as the figure illustrates, aggregate investment and output are lower once the anticipated dividend tax cut has materialized than during the periods when it was expected.

In comparing this example with the case of the unanticipated tax increase of figure 7, we can see that the effects on all aggregate variables are by an order of a magnitude higher in the case of anticipated tax changes. This section thus has five very clear implications for policymakers:

1. Unanticipated changes in dividend taxes have only insignificant macroeconomic effects, but strong redistributory consequences.

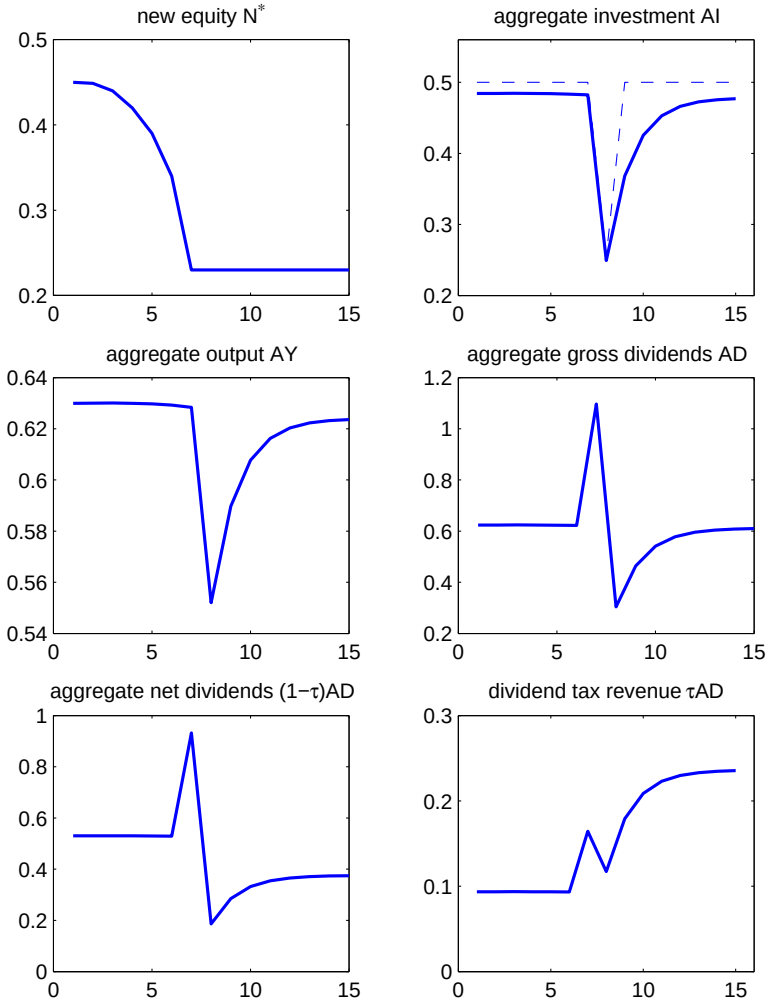

Figure 8: Anticipated Dividend Tax Increase: The amount of equity N^* that new firms issue starts falling when the tax increase is announced, causing a small decline in aggregate investment, output, and dividend payments. In the period preceding the tax increase (period 7), firms pay out a special dividend, reducing aggregate investment AI_t, output AY_t and dividends AD_t for periods to come. (The dotted line in the graph for investment represents the path of firms' optimal cash holdings M^*. It always lies above AI since not all firms are in steady state.)

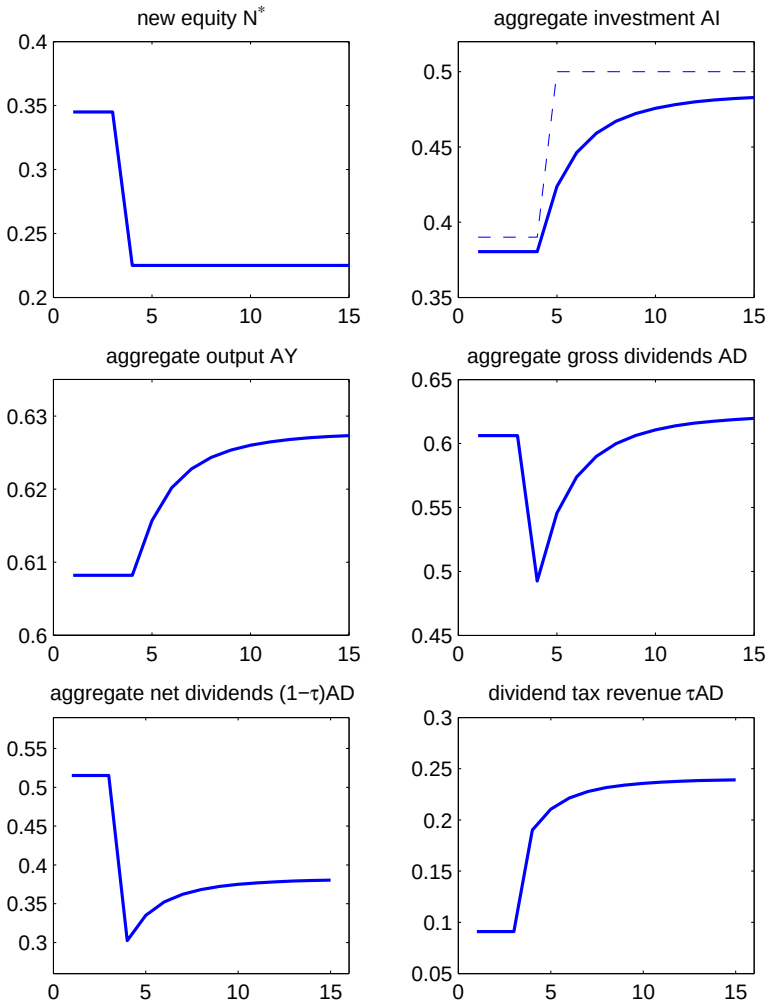

Figure 9: Risk of Dividend Tax Increase: In periods 1 to 3 firms anticipate that there is a $\pi = 25\%$ risk of a dividend tax hike from 15% to 38.6%. This reduces mature firms' cash reserves and depresses aggregate investment. The tax increase is enacted in period 4, and firms' optimal cash reserves (the dotted line in the upper right pane) revert to M^*. Aggregate investment increases even though new firms issue less equity N^* under the higher dividend tax rate.

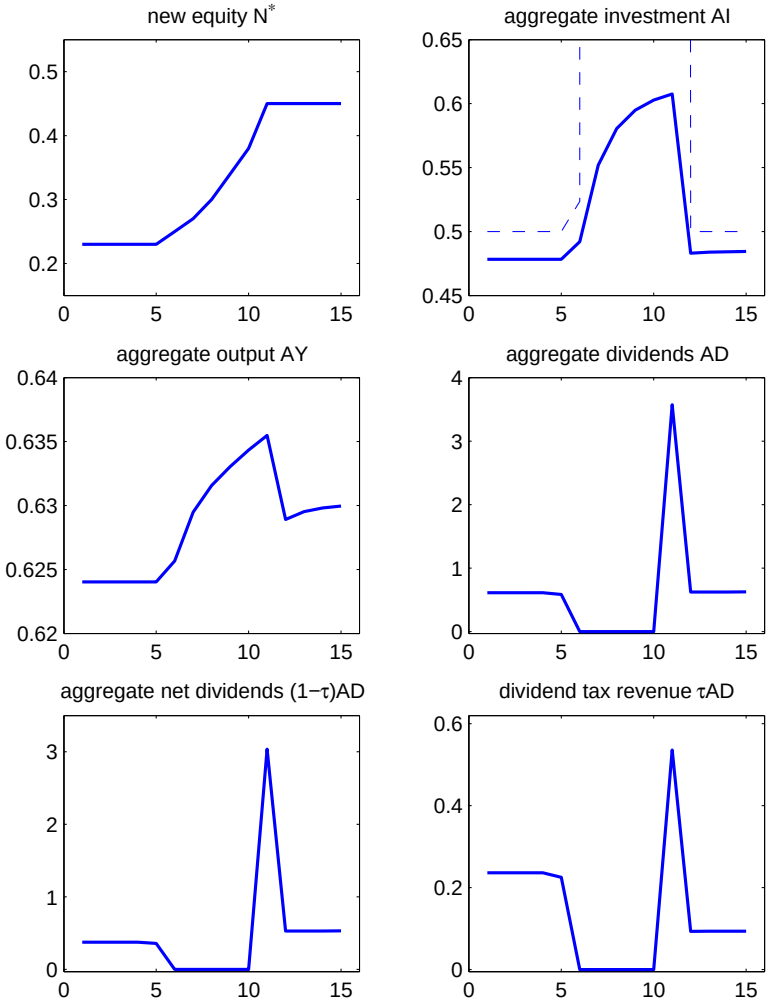

Figure 10: Anticipated Dividend Tax Cut: At $k = 5$ periods before an anticipated dividend tax cut from 38.6% to 15%, firms stop paying dividends AD and accumulate cash instead. This increases the aggregate amounts of investment AI and production AY that firms can engage in. After the tax cut is enacted, here in period 11, firms pay out all their excess cash and return to the steady state. The amount of equity that new firms issue, N^*, increases as a result of the tax cut, but the overall effect on aggregate investment once the cut has materialized is lower than in the periods of anticipation.

2. If policymakers want to increase dividend taxes *or* if firms expect an increase in the future, it is better to enact it immediately.

3. If policymakers want to reduce dividend taxes *or* if firms expect a reduction in the future, back-load the tax cut and keep firms waiting.

4. Unanticipated temporary dividend tax cuts are equivalent to an immediate unanticipated tax cut followed by an anticipated tax increase at a later time; they have an overall negative effect on investment and output.

5. Conversely, unanticipated temporary dividend tax increases have an overall positive effect on investment and output.

5 Political Economy of Dividend Tax Changes

In democratic societies, there are frequent changes in party rule, and parties often adjust the levels of tax rates when they come to power. The effect of any dividend tax policy thus has to be analyzed in a dynamic context that explicitly takes the possibility of regime changes and future changes in tax policy into account. This is of even greater importance, since we have shown in the previous sections that the level of dividend taxation itself does not have strong macroeconomic effects, but that anticipated changes in the tax rate can introduce significant distortions into the economy.

Even if the party in power succeeds in defining a "clear" policy [37], the governing party cannot, in a democracy, prevent the opposition from suggesting that, should they get elected, there will be a change in policy. Indeed, contestable politics focuses on changing policies and this is desirable. It is hard to envision a politics in which each party claims that it will simply continue with the policies of the opposition.

When a party comes to power, it can set the tax rate according to its preferences, but it rationally anticipates that it will lose power to a rival within finite time and that its rival will change the tax rate when it comes to power. Private agents rationally foresee this and adjust their behavior accordingly; and parties rationally anticipate private agents' behavior and their rivals' behavior.

Let us assume an economy with two parties that have different preferences over tax rates, e.g. conservatives and social democrats. When conservatives are in power, private agents anticipate that tax rates will rise as soon as social democrats will come to power. Under the hypothesis that the switching of parties is governed by a Markovian process, this is precisely the model that we formulated in section 3.3, where we have shown that firms pay out higher dividends now and hold lower cash balances. As a result, they are comparatively constrained in their investment behavior when an investment opportunity arises. These effects of tax arbitrage are stronger, the larger the expected dividend tax *increase*.

[37] And many have failed to do so – as an extreme example, there were three major tax "reforms" under Reagan in five years.

In our analysis so far, we have taken tax rates as given. But it is easy to derive the non-cooperative Nash equilibrium in the game between two political parties. For each level of taxation of the social democrats, there is an optimal tax rate for the conservatives: $\tau_C = \tau_C(\tau_S)$. Because of their different preferences, the social democrats impose higher tax rates than the conservatives. It is easy to see that this fact leads the conservatives to adjust the optimal tax rate that they impose: The larger the expected tax increase when conservatives lose power, the more incentive firms have to engage in intertemporal arbitrage and make large payouts during conservative rule, which make firms relatively cash constrained and contract their investment and output under the conservative regime. If conservatives put a high weight on investment and output under their regime, they will therefore implement a higher tax rate than what would be optimal if they could legislate tax rates permanently. This raises investment under their regime relative to the opposition's regime.

When social democrats are in power, on the other hand, investors anticipate a tax cut the next time that conservatives enter government. As shown in section 3.5, they pay out lower dividends and accumulate higher cash balances than under conservative rule, which allows them to invest more when an investment opportunity arises. This effect is stronger the larger the expected tax cut. Again, we can endogenize social democrats' choice of a tax rate. For each level of taxation of the conservatives, there is an optimal tax rate for the social democrats: $\tau_S = \tau_S(\tau_C)$. The social democrats know that (firms know that) when the conservatives seize power, taxes will be lower. If social democrats also place a large weight on investment and output in their preferences, they also have an incentive to raise dividend taxes so as to maximize the expected tax cut. As a result, both parties exhibit a bias towards "excessive" dividend taxation.[38]

The Nash equilibrium between the two parties is simply defined as $\tau_C = \tau_C(\tau_S(\tau_C))$, and it is easy to show that this equilibrium is Pareto inefficient. If the discount rate is low enough, Pareto efficient equilibria can be sustained in a repeated game. We present a more detailed analysis of this political game as well as a set of more general implications for the analysis of public policies in contestable democracies in Korinek and Stiglitz (2008).

6 Conclusions

This paper has investigated the dynamic effects of dividend taxation on macroeconomic variables such as investment and output using a life cycle model of capital constrained firms. Similar to Sinn (1991), firms in our model start out by issuing equity, then they accumulate more funds through retaining their earnings, i.e. internal saving, and when they reach the mature stage, they pay out dividends.

The arguments of the traditional view of dividend taxation apply to firms that are in the first stage: since the level of the dividend tax rate affects the valuation of firms, it

[38]By contrast, if parties place a large weight on dividend payouts under their regime, e.g. because they value the government revenue derived from dividend taxation or the resulting income stream to investors, both parties exhibit a bias towards inefficiently low tax rates: each party lowers tax rates competitively so as to induce firms to pay out dividends under its regime.

has an impact on how much equity new firms issue. On the other hand, the new view of dividend taxation applies to firms in the second and third stage. Their corporate saving and investment decisions are not distorted by dividend taxes, so long as the rate is constant, even though their (after tax) value to shareholders decreases proportional to $1 - \tau$. Since only a small fraction of firms in a typical economy are in the first stage, we have argued that the level of dividend taxation has only a minor impact on aggregate investment and output.

We then used the model to investigate the effects of changes in the dividend tax rate through quantitative simulations. Unanticipated tax changes have a small impact on aggregate investment, since they only affect how much equity new firms issue. However, anticipated dividend tax changes create opportunities for inter-temporal tax arbitrage, and this can distort firms' cash balances and investment decisions significantly. An anticipated dividend tax cut makes mature firms delay their dividend distributions to the period when the tax rate is reduced, which implies that they have more cash on hand for investment purposes when an investment opportunity arises. At the same time, anticipated tax cuts increase the value of firms already in the periods ahead, which raises the amount of equity that new firms issue. Overall, anticipated tax cuts strongly raise aggregate investment in the periods prior to the cut.

Similarly, an anticipated dividend tax increase causes mature firms to pay out excessive dividends, which reduce aggregate investment for a number of periods after the tax hike until firms have recovered their optimal level of cash holdings. Anticipated tax hikes also depress the stock price of all firms for several periods before they come into effect, which reduces the amount of equity that new firms can raise. In total, anticipated increases in the dividend tax rate reduce aggregate investment before and after the increase comes into effect.

An unanticipated temporary dividend tax cut, such as the one enacted in the United States in 2003 and extended in 2006, can be seen as an unanticipated tax cut, followed by an anticipated tax increase at the expiration of the law.Such a temporary reduction in the dividend tax rate has a large positive price effect on mature firms, but a negative effect on their investment, and a small positive price and investment effect on new firms. In the limiting case of a one period temporary dividend tax cut, the investment effect on mature firms is negative and that on new firms is zero.

By the same token, uncertainty about whether or how long a government will keep a low dividend tax rate in place can lead to a phenomenon similar to the peso problem: firms assign a certain probability to a dividend tax increase, which leads them to pay out more cash than optimal in every period until the expectations of the tax increase have realized. In such a situation, it would be optimal to bring the tax increase forward – this would increase aggregate investment starting in the following period.

Incumbent governments, unfortunately, can only control what they do: they cannot control what the opposition promises, or what firms and investors believe the opposition might do. Governments that ignore these dynamic effects do so at their peril.

This paper has explored an important set of dynamic interactions. These are pervasive in many other arenas of policy. This paper thus has broader implications for the conduct of policy analysis and political economy in contestable democracies. The question should

not be, what is the best "permanent" policy, but rather, given the policy preferences of the opposition, and the responses of agents within the economy, what is the best policy each party can pursue, when it is in office; and what kind of deals can be struck between the parties to achieve efficient cooperative outcomes.

A Model of Managerial Myopia

The model presented in section 2 of this paper emphasizes that there are agency problems between the owners and managers of firms. We assumed that as a result, firm managers maximize the expected discounted value of future dividend flows using a discount rate that includes a premium reflecting these agency factors, i.e. that managers of firms are myopic. This appendix illustrates how such a discrepancy in discount rates can be motivated.

The underlying market imperfection is that there exist informational asymmetries between shareholders and managers. As a result, a manager's effort is not perfectly observable to shareholders. In order to motivate managers to exert effort, their compensation is performance-based, as discussed by e.g. Baker et al. (1988).

Specifically, we follow Chetty and Saez (2007) in assuming that managers hold a fraction α of their company's stocks to capture the effects of incentive pay. However, managers do not serve in their job forever. For simplicity, we assume that there is an exogenous separation probability s every period for managers to lose their jobs, and that they no longer participate in the company's earnings and dividends after their departure. (In a more realistic setting, a manager's probability to keep his job would increase the higher earnings he achieves, which could make him focus even more on short-term performance and could re-inforce the myopia effect (Stein, 1988). Furthermore, a manager's future job opportunities could strongly depend on his observed short-run performance at the old firm, exacerbating the bias.) As a result, managers discount dividend payments every period by a factor of $\frac{1-s}{1+r}$. Their objective function is therefore

$$\max \ \alpha E \left\{ \sum_{t=0}^{\infty} \left(\frac{1-s}{1+r} \right)^t (1-\tau) D_t \right\}$$

Denoting $\beta = \frac{1-s}{1+r}$ we can see that this maximization problem is isomorphic to the setup in our main model (3).

References

Alvarez, Luis H. R., Vesa Kanniainen and Jan Södersten (1998), "Tax policy uncertainty and corporate investment: A theory of tax-induced investment spurts," *Journal of Public Economics* 69(1), pp. 17 – 48.

Amromin, Gene, Paul Harrison and Steven Sharpe (2006), "How Did the 2003 Dividend Tax Cut Affect Stock Prices?" *FRB Finance and Economics Discussion Series* 2005-61.

Asquith, Paul and David Mullins (1986), "Equity Issues and Offering Dilution," *Journal of Financial Economics*, 15(1/2), pp. 61 - 89.

Auerbach, Alan J. (1979), "Wealth maximization and the cost of capital," *Quarterly Journal of Economics*, 93(3), pp. 433 – 446.

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

Auerbach, Alan J. and Kevin A. Hassett (2007), "The 2003 Dividend Tax Cuts and the Value of the Firm: An Event Study," in A. Auerbach, J. Hines, and J. Slemrod (eds.), *Taxing Corporate Income in the 21st Century*, Cambridge, MA: Cambridge University Press.

Baker, George P., Michael C. Jensen and Kevin J. Murphy (1988), "Compensation and incentives: practice vs. theory," *Journal of Finance* 43(3), pp. 593 - 616.

Bhattacharya, Sudipto (1979), "Imperfect Information, Dividend Policy, and 'The Bird in the Hand' Fallacy," *Bell Journal of Economics* 10(1), pp. 259 – 270.

Black, Fischer (1976), "The Dividend Puzzle," *Journal of Portfolio Management* 2(2), pp. 5 – 8.

Blouin, Jennifer L., Jana S. Raedy and Douglas A. Shackelford (2004), "Did Dividends Increase Immediately After the 2003 Reduction in Tax Rates?" NBER Working Paper w10301.

Brown, Jeffrey R., Nellie Liang and Scott Weisbenner (2007), "Executive Financial Incentives and Payout Policy: Evidence from the 2003 Dividend Tax Cut," forthcoming in the *Journal of Finance*.

Congressional Budget Office (2003), "How CBO Analyzed the Macroeconomic Effects of the President's Budget," Washington DC.

Chen, Hsuan-Chi and Jay R. Ritter (2000), "The Seven Percent Solution," *Journal of Finance* 55(2), pp. 1105 – 1131.

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

Chetty, Raj and Emmanuel Saez (2006), "The Effects of the 2003 Dividend Tax Cut on Corporate Behavior: Interpreting the Evidence," *American Economic Review Papers and Proceedings* 96, pp. 124 – 129.

Chetty, Raj and Emmanuel Saez (2007), "An Agency Theory of Dividend Taxation," *NBER Working Paper* w13538.

DeAngelo, Harry and Linda DeAngelo (1990), "Dividend Policy and Financial Distress: An Empirical Investigation of Troubled NYSE Firms," *Journal of Finance* 45(5), pp. 1415 – 1431.

Edlin, Aaron and Joseph E. Stiglitz (1995), "Discouraging Rivals: Managerial Rent-Seeking and Economic Inefficiencies," *American Economic Review* 85(5), pp. 1301 – 1312.

Gordon, Roger and Martin Dietz (2006), "Dividends and Taxes," *NBER Working Paper* 12292.

Gourio, François and Jianjun Miao (2007), "Dynamic Effects of Permanent and Temporary Dividend Tax Policies on Corporate Investment and Financial Policies," Boston University, mimeo.

Greenwald, Bruce C., Joseph E. Stiglitz and Andrew Weiss (1984), "Informational Imperfections in the Capital Market and Macroeconomic Fluctuations," *American Economic Review* 74(2), pp. 194 – 199.

Greenwald, Bruce C. and Joseph E. Stiglitz (2003), *Towards a New Paradigm in Monetary Economics*, Cambridge University Press.

Grossman, Sanford J. and Oliver D. Hart (1980), "Takeover Bids, The Free-Rider Problem, and the Theory of the Corporation," *Bell Journal of Economics* 11(1), pp. 42 – 64.

Hall, Robert E. (1988), Commentary on "Financial Factors in Business Fluctuations," Proceedings, Federal Reserve Bank of Kansas City.

Jensen, Michael C. (1986), "Agency costs of free cash flow, corporate finance, and takeovers," *American Economic Review* 76, pp. 323 – 329.

Jensen, Michael C. and Kevin J. Murphy (1990), "Performance pay and top-management incentives," *Journal of Political Economy* 98, pp. 225 - 284.

Jensen, Michael C. (2001), *A Theory of the Firm: Governance, Residual Claims, and Organizational Forms*, Harvard University Press.

King, Mervyn (1977), *Public Policy and the Corporation*, Chapman and Hall, London.

Kocherlakota, Narayana R. (1996), "The Equity Premium: It's Still a Puzzle," *Journal of Economic Literature* 34, pp. 42 – 71.

Korinek, Anton and Joseph E. Stiglitz (2008a), "Political Economy in a Contestable Democracy: The Case of Dividend Taxation," Columbia University, mimeo.

Mehra, Rajnish and Edward C. Prescott (1985), "The Equity Premium: A Puzzle," *Journal of Monetary Economics* 15, pp. 145 - 161.

Mehra, Rajnish and Edward C. Prescott (2003), "The Equity Premium in Retrospect," in George M. Constantinides, Milton Harris, and Rene M. Stulz (eds.), *Handbook of the Economics of Finance*, Amsterdam, Netherlands: North-Holland.

Myers, Stewart C. and Nicholas S. Majluf (1984), "Corporate financing and investment decisions when firms have information that investors do not have," *Journal of Financial Economics* 12, pp. 187 – 221.

Poterba, James and Lawrence Summers (1985), "The Economic Effects of Dividend Taxation," in Edward Altman and Marti Subrahmanyam (eds.), *Recent Advances in Corporate Finance*, Homewood, IL: Richard D. Irwin Publishers, pp. 227 – 284.

Ross, Stephen (1977), "The Determination of Financial Structure: An Incentive-Signalling Approach," *Bell Journal of Economics* 8(1), pp. 23 – 40.

Riddick, Leigh A. and Toni M. Whited (2007), "The Corporate Propensity to Save," University of Wisconsin, mimeo.

Sinn, Hans-Werner (1991), "The vanishing Harberger triangle," *Journal of Public Economics* 45, pp. 271 – 300.

Slemrod, Joel (1988), "Effect of Taxation with International Capital Mobility," in *Uneasy Compromise: Problems of a Hybrid Income-Consumption Tax*, edited by Henry Aaron, Harvey Galper, and Joseph A. Pechman, Washington, DC: Brookings, pp. 115 – 155.

Stein, Jeremy C. (1988), "Takeover Threats and Managerial Myopia," *Journal of Political Economy* 96(1), pp. 61 – 80.

Stiglitz, Joseph E. (1972), "Some Aspects of the Pure Theory of Corporate Finance: Bankruptcies and Take-Overs," *Bell Journal of Economics* 3(2), pp. 458 – 482.

Stiglitz, Joseph E. (1973), "Taxation, Corporate Financial Policy, and the Cost of Capital," *Journal of Public Economics* 2, pp. 1 – 34.

Stiglitz, Joseph E. (1976), "The Corporation Tax," *Journal of Public Economics* 5(3-4), pp. 303 – 311.

Stiglitz, Joseph E. (1998), "Pareto Efficient Taxation and Expenditure Policies, With Applications to the Taxation of Capital, Public Investment, and Externalities," presented at a conference in honor of Agnar Sandmo, January 1998.

Stiglitz, Joseph E., and Andrew Weiss (1981), "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71, pp. 393 – 410.