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The 2003 Tax Reform and Corporate Payout Policy in the US*

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Abstract

This study explores the hypothesis that the 2003 tax cuts on dividends and capital gains generated an increase in aggregate dividends and aggregate share repurchases in the US after 2003. I find that the 2003 tax reform leads to a rise in both types of payouts in the General Equilibrium setting with sticky wages after incorporating two financial frictions, including the adjustment costs on dividends and endogenous constraint on repurchases. Two motives lie behind the results. First, the 2003 tax reform generates a tax motive for dividends due to higher tax cuts on dividends than tax cuts on capital gains. Second, the 2003 tax reform activates a flexibility motive for repurchases because paying dividends in the current period induces a commitment of firms to future dividend payments. Since any deviation from such a commitment might be costly for firms, those with low excess cash prefer to choose repurchases as a buffer to protect against extra penalties related to higher dividend volatility. Sticky wages in the General Equilibrium aim to provide firms with excess cash.

JEL Classification: D21, E62, G35, H25, H32.

Keywords: payout flexibility, capital reallocation, tax reform, heterogeneous firms.

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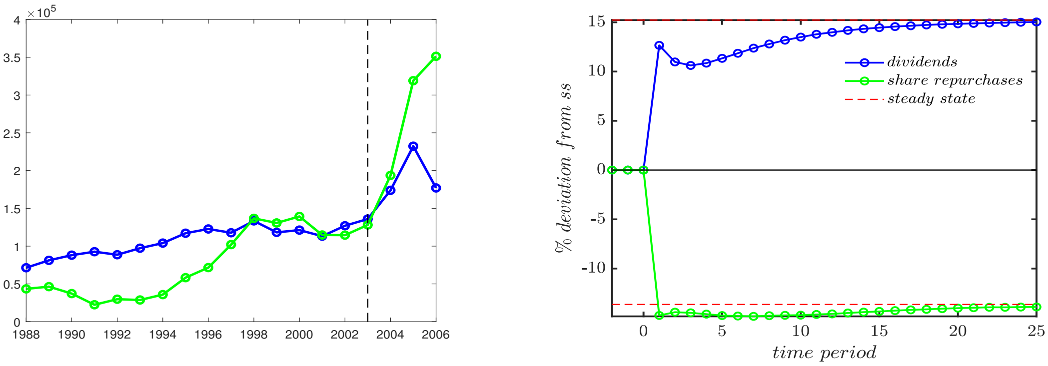
1. Introduction

In 2003, the Bush administration authorized a fiscal stimulus package, which lowered dividend taxes sharply and capital gains taxes modestly such that the wedge between these taxes was eliminated. The primary goal of the tax reform was to enhance economic growth through long-run capital accumulation, stimulated by lower costs of capital. Empirical evidence shows positive responses in aggregate capital investment and aggregate payouts to shareholders following the 2003 tax reform. Nevertheless, the previous quantitative frameworks do not capture the positive responses of both share repurchases and dividends after the tax reform because either payouts are treated as almost perfect substitutes (e.g., Gourio and Miao (2011, 2010)) or repurchase responses are ignored (e.g., Anagnostopoulos et al. (2012)). This study aims to make progress along this dimension by connecting the financial flexibility for repurchases and the tax motive for dividends.

Figure 1, panel (a) shows the aggregate US nominal dividends and share repurchases of all publicly traded corporations, as computed from the Compustat database. The data are in stark contrast with the findings of Gourio and Miao (2011). In Figure 1, panel (b), the 2003 tax reform induces almost a perfect substitution between aggregate dividends and aggregate share repurchases in the model economy. The rise in dividend tax preference parameter after the tax reform is the key reason that lies behind the strong substitution between dividends and repurchases.[1] After controlling for firm characteristics, empirical literature also suggests that the 2003 tax reform generated a rise in both aggregate dividends and repurchases by 20% and around 7%, respectively (see Section 4).

The central question of this study is: What motivated the US economy to increase

[1]The 2003 tax reform reduces taxes on dividends much more than taxes on capital gains, which forced the dividend preference parameter to rise. The relative price of dividends to share repurchases is a linear function of the dividend tax preference parameter. In addition, dividends and repurchases offset each other proportionally in the budget constraint. Hence, the 2003 tax cuts generate almost perfect substitution between aggregate dividends and repurchases.



(a) Compustat data: Gourio and Miao, 2010

(b) Model: Gourio and Miao, 2011

Figure 1: Aggregate payout responses

aggregate dividends and repurchases after the 2003 tax cuts? To answer the question, in addition to the tax motive for dividends, I incorporate financial flexibility for repurchases as an additional motive into the taxation framework of Gourio and Miao (2011) through two financial frictions: adjustment costs on dividends and endogenous constraint on share repurchases. Following the seminal survey study by Lintner (1956) on dividend distribution, an extensive empirical literature confirms that markets impose large costs on volatile dividends, which in turn induce a commitment to future dividend payments. Relative to dividends, Jagannathan et al. (2000) empirically show that share repurchases do not induce such a commitment to future payments. For example, firms may announce repurchases but fail to conduct repurchases. Even if firms perform repurchases, there is no obligation to start with new repurchases. Consequently, with repurchases firms could more flexibly vary an amount of return paid to their shareholders over time.[2] Hence, financial flexibility of repurchases implies that paying repurchases in the current period does not commit firms to continue repurchases in the future. In this study, I consider heterogeneous firms such that the tax motive for dividends is stronger for firms with high excess cash, while the flexibility motive for repurchases is stronger for firms with low excess cash.[3] At the aggregate level, the 2003 tax reform increases dividends and repurchases.

[2]Since 1982, when SEC Rule 10b-18 allowed firms to use share repurchases as an alternative method for payouts to shareholders in the US, firms have started to consider share repurchases as a flexible payout method.

[3]Excess cash in the model implies that internal funds of firms are larger than their investment needs.

In the model, firms are heterogeneous in capital stock and productivity, and divided into the the four finance regimes. The finance regimes are structured to acknowledge that share repurchases are more tax preferable and financially flexible than dividends before the tax reform. This implies that *transiting* firms must first exploit all opportunities for repurchases before reallocating capital to the regime with positive dividends.[4] Following the 2003 tax reform, transiting and dividend-paying firms repurchase their shares before initiating (increasing) dividends in order to control for the costly volatility in dividends. Moreover, adjustment costs on dividends keep the structure of finance regimes fixed even after the 2003 tax cuts, implying that the relative importance of the finance regimes only changes after the tax reform.[5]

The model predicts the large extensive and intensive margin effects of the 2003 tax cuts on payout decisions of transiting firms in the General Equilibrium. As for the extensive margin effects, depending on the level of investment opportunities, the 2003 tax cuts have asymmetric effects on investment and payout decisions. On the one hand, the tax cuts stimulate transiting firms with high investment opportunities to issue new equities, which reduces the number of firms with repurchases. On the other hand, the tax cuts encourage transiting firms with low investment opportunities to decrease capital investment and initiate dividends (tax motive). As for the intensive margin effects, quantitative results suggest that the 2003 tax cuts stimulate some transiting firms with low investment opportunities to increase repurchases through lower capital investment (flexibility motive). These firms choose repurchases to avoid a long-term commitment to future dividend payments to shareholders. Therefore, the firm heterogeneity has an important role in explaining the influence of taxes on the decisions of firms.

I find that the 2003 tax reform leads to a rise in both types of payouts in the General Equilibrium setting with sticky wages after incorporating the two financial frictions:

[4]Transiting firms in the model economy are firms with positive repurchases, but without equity issues and dividends.

[5]Gomes (2001) and Gourio and Miao (2011) introduce transaction costs on equity issues to make financial policy responses of firms determined after the tax changes.

adjustment costs on dividends and endogenous regularity constraint on repurchases. Two motives lie behind the results. First, the 2003 tax reform generates a tax motive for dividends due to higher tax cuts on dividends than tax cuts on capital gains. Second, paying dividends in the current period induces a commitment of firms to future dividend payments. Since any deviation from such a commitment might be costly for firms, firms with low excess cash and low investment opportunities prefer to choose repurchases as a buffer to protect against extra penalties related to higher dividend volatility.[6] Firms with high excess cash and low investment opportunities repurchase shares up to the regularity constraint, while the rest of excess cash is used for dividends. Sticky wages in the model aim to provide firms with additional excess cash such that transiting firms with relatively *high* investment opportunities decrease demand for new equity issues, which mitigates the extensive margin effects of the tax reform on reducing repurchases. In their transition to a regime with dividends over time, larger current capital expenditure opens the space for higher repurchases. In addition, sticky wages also affect transiting firms with *low* investment opportunities to increase demand for repurchases, which amplifies the intensive margin effects of the tax reform on increasing repurchases.

This study aims to capture the rise in aggregate dividends and share repurchases for two reasons: (1) to evaluate the efficiency and welfare gains of the 2003 tax cuts on dividends and capital gains; and (2) to perform counterfactual experiments. First, if the 2003 tax cuts induced an increase in aggregate dividends and a decrease in aggregate repurchases without changing total payouts, then the total amount of cash that could potentially recirculate in the economy would remain unchanged. Consequently, in the model with substitutable payouts, the 2003 tax cuts may generate low allocation efficiency and low

[6] Uncertainty of being unable to keep a long-term commitment to dividend payments emanates from lower capital investment in the current period, which reduces operating profit in the future. Quantitative results suggest that the 2003 tax cuts stimulate firms with low investment opportunities to decrease capital investment, which provides excess cash, and increase payouts. Paying dividends in the current period does not trigger additional costs if dividends are set to the dividend target. However, the influence of the adjustment costs on dividends becomes greater because of increased uncertainty in operating profit. Moreover, knowing that the constraint on repurchases becomes tighter in the future due to lower capital investment in the current period, which will reduce the space to control for the volatility in dividends, firms will be more stimulated to increase repurchases in the current period.

(consumption equivalent) welfare benefits. Second, in order to quantify the relative contribution of financial frictions to the payout dynamics of firms after 2003, I compute the counterfactual rise in payouts: How much would financial flexibility contribute to the rise in aggregate dividends and share repurchases if the 2003 tax reform had not occurred? Moreover, holding both the degree of financial frictions and capital taxes fixed to their pre-tax levels, I also compute how much aggregate productivity contributed to payout dynamics. The additional counterfactual scenario with aggregate productivity allows me to investigate to what extent the economic recovery from the 2001-2002 recession stimulated firms to distribute cash to shareholders.

This study highlights the following results. First, the payout flexibility and capital reallocation across firms generate limited substitution between aggregate payouts in the General Equilibrium setting. More specifically, the 2003 tax reform induces a rise in aggregate dividends by around 11% and a drop in aggregate share repurchases by around 3.5%. Once the sticky wages are incorporated in the model economy, the model generates an increase in aggregate dividends by around 18% and an increase in aggregate repurchases by around 4%. Second, this study provides empirical support for positive repurchase responses to the 2003 tax shock. After controlling for observable firm characteristics and dividend smoothing at the aggregate level, the simple OLS estimates show that the tax shock generates a rise in repurchases by around 7%. Third, the aggregate productivity gains, measured by Total Factor Productivity, increases by 0.35pp (0.05pp) in the General Equilibrium (General Equilibrium with sticky wages) model, respectively. In addition, the welfare benefits, measured by a rise in consumption for a fixed leisure, increase by 0.97% (7.92%) in the General Equilibrium (General Equilibrium with sticky wages) model, respectively. Forth, the effects of the tax cuts on payouts are stronger for firms that face lower adjustment costs on dividends and a more relaxed constraint on repurchases.[7] Fifth, economic recovery from the 2001-2002 dot-com

[7] A drop in dividend adjustment cost is expected for the post-2003 period due to the accounting scandals occurring in 2001-2002, which created distrust among shareholders, potentially stimulating shareholders to request large dividends even in the absence of the tax reform. In addition, in 2003 there were regularity changes related to increasing the volume limit on repurchases by the Securities and Exchange Commission (SEC).

crisis contributes to a slight increase in aggregate dividends and aggregate repurchases by 2.50% and 2.74%, respectively. Sixth, the quantitative results predict that the drop in taxes on capital gains has larger aggregate, efficiency and welfare effects than the drop in taxes on dividends.

The contributions of this study are as follows. First, in stark contrast to Gourio and Miao (2011, 2010) and Anagnostopoulos et al. (2012), this study quantitatively captures the empirically documented rise in aggregate dividends and capital investment and qualitatively captures the rise in repurchases after 2003. Second, I contribute to the empirical investigation of the 2003 tax reform and firm decisions. Prior studies find that the tax reform increases dividends by 20% (Chetty and Saez, 2006, 2005) and capital investment by around 10% (Campbell et al., 2013). Using the simple OLS, my study predicts a rise in aggregate repurchases by around 7%. Third, in traditional models of firm investment, investment responses to dividend tax changes depend on the marginal source and use of funds. This study predicts that investment responses to changes in dividend tax depend on the position of a firm in the finance regime and the degree of the constraint on repurchases. For instance, the endogenous constraint on repurchases amplifies the negative effects of a dividend tax cut on investment when reallocating capital to the regime with dividends. Forth, the influence of the degree of substitution between aggregate dividends and repurchases on aggregate productivity gains depends on the frictions in the model. In contrast to Gourio and Miao (2011), imposing the labor market friction through sticky wages, my model generates complementarity between dividends and repurchases, and generates positive Total Factor Productivity after the 2003 tax reform. A relaxed constraint on repurchases prevents reallocation inefficiency after the tax reform.

The paper is structured as follows. Section 2 provides the rationale for incorporating the payout flexibility in the model economy as an additional motive for repurchases. Section 3 includes related literature. Section 4 provides the empirical investigation of the relationship between the tax shock and share repurchases. Section 5 describes the model economy and discusses the quantitative results. Section 6 concludes.

2. Corporate Behaviour in the Data

This section provides support for incorporating frictions in the model economy, such as adjustment costs on dividends, endogenous constraint on repurchases and wage rigidity. Figure 2 shows how much profit firms pay out to shareholders at the aggregate level over the 1988-2006 period.[8] In the Compustat data, earnings before interest, taxes, depreciation and amortization EBITDA (data item `OIBDP`) as a measure of corporate earnings experienced an increase of 10.72% in the 2003-2006 period. In the data, it is possible that firms might simultaneously, within a year, issue new shares and buy back their old shares. For that reason, Figure 2 considers net repurchases. Positive net repurchases indicate higher repurchases over equity issuance, and vice-versa. The vertical line refers to the implementation of the 2003 tax reform. Relative to Figure 1, the dynamics of aggregate payouts are controlled for corporate earnings in Figure 2. Since both aggregate payouts rise after 2003, corporate earnings are not enough to explain all variations in aggregate payouts.

Figure 2 provides three messages. First, aggregate dividends are relatively smooth over the observed period, while aggregate share repurchases experience much larger volatility.[9] Second, the rise in dividends does not affect the fall in repurchases after 2003. This implies that repurchases and dividends are not substitutes. Even if repurchases lost their tax advantage over dividends after the 2003 reform, repurchases exhibited a rise after 2003, indicating that some factors other than tax changes are the reasons for large repurchases.[10] Third, dividends and net repurchases do not experience a fall just before 2003, indicating that the 2003 tax reform was unanticipated.[11]

[8] Note that the Compustat data on individual firm decisions is not publicly available. I borrow the Compustat data on aggregate firm responses from the official site of François Gourio: https://sites.google.com/site/fgourio.

[9] Lack of a commitment is the main reason for repurchases with much larger volatility than dividends. Since repurchases were illegal from 1934 to 1982, a much longer presence of dividends in the financial market was considered an indicator of overall firm performances. Hence, firms tend to continue with their commitment to dividend payments.

[10] Similar findings about the absence of substitution between dividends and repurchases after 2003 are documented in the empirical literature (see Floyd et al., 2015; Edgerton, 2013; and Chetty and Saez, 2005).

[11] Although President Bush announced lower tax rates in January 2003 for the first time, the tax cuts

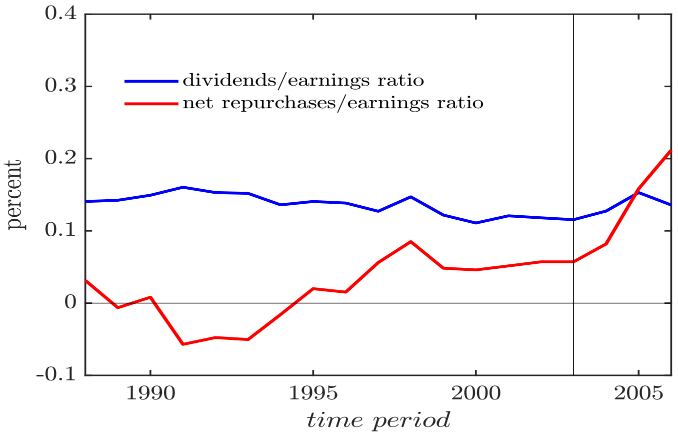


Figure 2: Payout dynamics of firms in the US, 1988-2006

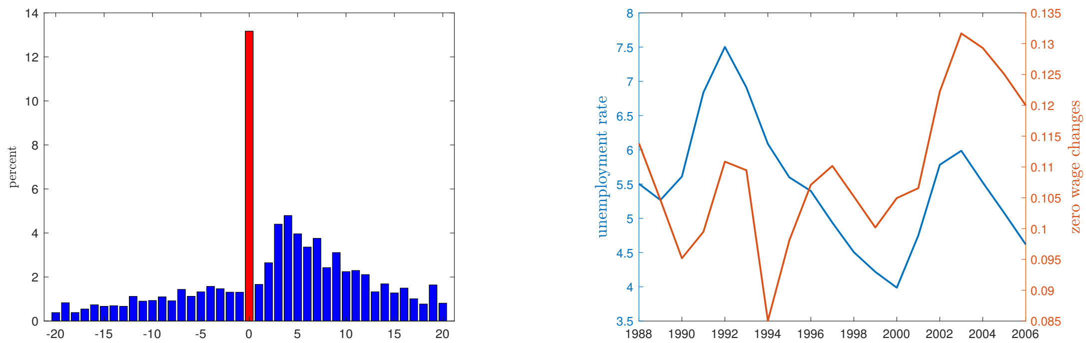
Strong persistence of dividend payments. On the one hand, since dividends may serve as an indicator of a firm's profitability, any negative deviation of current dividends from an average firm's dividends induces costs by market participants (see Lintner, 1956). Denis et al. (1994) show that an announcement of a cut in dividend payments generates a 6% decline in stock prices. Reluctance of firms to reduce dividends makes dividends a more expensive cash payout than share repurchases today if firms expect to reduce a cash payout tomorrow. On the other hand, large positive dividends may indicate a lack of investment opportunities. Therefore, aversion of firms to change dividends is rather important to account for low variability of dividends at the aggregate level. This fact is usually ignored in the General Equilibrium analysis of tax reforms. To capture firm's dividend smoothing behaviour observed in the Compustat data, I incorporate symmetric and convex dividend adjustment costs into the model economy.

Financial flexibility of share repurchases (see Ricardo, 2020; Farre-Mensa et al., 2014; Jermann and Quadrini, 2012; Brav et al., 2005; Fama and French (2001); Jagannathan et al., 2000 among many others). Since firms face costs to dividend volatility, firms consider an alternative payout method (repurchases) flexible. Moreover, there is neither an explicit nor implicit obligation that commits firms to continue future

were debated until May 2003. Since the 2003 tax reform narrowly passed the Senate with a 51-50 vote, this clearly shows how uncertain it was for the 2003 tax act to become law (see https://www.senate.gov/legislative/LIS/roll_call_lists/roll_call_vote_cfm.cfm?congress=108&session=1&vote=00196).

payouts in the form of repurchases. Consequently, thanks to repurchases, firms could more flexibly vary the amount of return intended for shareholders over time. Firms choose repurchases because of either a tendency to avoid a long-term commitment to future payments to shareholders or a need to absorb increased volatility in earnings. Figure 2 indicates that firms adjust their share repurchases much more significantly and more frequently than dividends relative to their operating profits. The survey analyses by Farre-Mensa et al. (2014) and Brav et al. (2005), which are updated versions of the survey by Lintner (1956), confirm the significance of the financial flexibility of share repurchases for payout decisions.

Nominal wage rigidity. Incorporating labor market frictions in the model economy through wage rigidity aims to increase the propagation of the tax shock to employment and higher aggregate payouts. That is, the wage rigidity rationalizes a (persistent) rise in employment and the substantial amount of excess cash for firms with low investment opportunities. I use Current Population Survey (CPS) to support the existence of nominal wages rigidity in the US for the 2003-2006 period.[12]



(a) wage change distribution (b) spike at zero and unemployment

Figure 3: Y-on-y nominal wage changes

Figure 3, panel (a) documents two observations. First, there is a large spike at zero (wage rigidity) such that around 13% of workers in the survey reported zero wage

[12]The distribution of 12-month log wage changes of individuals and unemployment rate come from Daly and Hobijn (2014). The spike at zero is also available from the Wage Rigidity Meter: https://www.frbsf.org/economic-research/indicators-data/nominal-wage-rigidity/.

changes in 2003 relative to 2002.[13] Second, there are fewer wage cuts than wage rises, indicating that frictions on wage cuts are stronger than frictions on wage rises. Hence, we might expect a larger rise in zero-wage changes than a drop in zero-wage changes, causing wage rigidity to remain at a high level even after the 2003 expansionary fiscal policy. Figure 3, panel (b) confirms that the rise in wage rigidity is stronger in the 2000-2001 recession than the drop in wage rigidity in the 2003-2006 recovery period. The modest growth rate of overall wages during the 2003-2006 period implies that labor market adjustments are more realized through employment than through nominal wages. More importantly, Figure 3, panel (b) documents a positive relationship between the size of spike at zero and unemployment rate around 2003, supporting the existence of nominal wage rigidity.

During the 2000-2001 recession, a large fraction of workers reports the increase in zero-wage changes instead of wage cuts, which imposes higher operational costs on firms and thus leads to an increase in unemployment rate. On the other hand, in spite of modest growth of overall wages during the 2003-2006 recovery period, still many workers who may have experienced an increase in wages would rather experience zero wage changes. Therefore, a large fraction of workers without wage increases implies the existence of some degree of friction in wage adjustment during the 2003-2006 period. Reduced nominal wage rigidity in the recovery period causes a lower wage growth than that in the flexible wage setting, which consequently leads to a drop in unemployment rate. High inflation rate could potentially confound the positive relationship between the spike at zero (wage rigidity) and unemployment rate during the 2003-2006 period. That is, high inflation may prevent real wages from rising, and consequently lead to lower unemployment even in the absence of wage rigidity. Moreover, high aggregate productivity growth could decrease unemployment. The influence of these potential confounding factors on unemployment is controlled by the fact that the 2003-2006 period is characterized by low inflation and low aggregate productivity growth.[14]

[13] Similar patterns are observed for each year from 2004 to 2006. These graphs are available upon request. The findings of wage rigidity present in the US are consistent with the literature (see Jo, 2019; Elsby et al., 2016; Daly and Hobijn, 2014 among others).

[14] According to the San Francisco Federal Reserve's database, aggregate productivity recorded a rise of 0.85pp. Based on U.S. Bureau of Labor Statistics, the average inflation rate was 2.8% for the 2003-2006.

3. Related Literature

This study is related to two strands of literature. The first is concerned with the effects of dividend taxes on stock market and capital accumulation. Santoro and Wei (2011) and McGrattan and Prescott (2005) indicate that constant dividend taxes have no influence on corporate investment and dividends, while share prices are affected in the model economy without heterogeneity.[15] If a representative firm is considered, Anagnostopoulos et al. (2012) prove that dividend taxes exert negative influence on corporate investment and positive influence on dividends when considering household heterogeneity and insurable labor income risks. On the other hand, Gourio and Miao (2011, 2010) show that if marginal source and use of funds are asymmetric across heterogeneous firms in two adjacent periods, then dividend taxes have real effects through the user cost of capital. In the setting of heterogeneous firms and a representative household, I predict that a dividend tax cut may have negative effects on investment in capital if a marginal source of funds is retained earnings and return on investment is used for repurchases in the next period. The reason is the presence of a constraint on repurchases that is endogenous with capital stock. The intuition is the following. If a firm uses a dollar of internal funds for investment, then the marginal cost of investment rises due to a dividend tax cut. However, the dividend tax cut does not change the marginal benefit of investment if return on investment is used for repurchases in the next period.

The second strand of literature studies the role of frictions in firm dynamics.[16] This

[15] According to the "new view", a firm uses retained earnings (internal funds) such that marginal incentives to invest are not changed after dividend tax policy changes. The reason is that the marginal unit of earnings faces the equal dividend tax burden, regardless of whether the firm pays dividends in the current period or invests and uses return on investment for dividends in the future. Hence, the relative price of investment to dividends is not affected by dividend tax, and consequently dividend taxation has no influence on investment (see Auerbach, 1985 and Bradford, 1981). Under the "old view", a firm uses new equity to finance investment, and thus dividend taxes affect capital investment (see Poterba and Summers, 1984).

[16] Parameters on frictions in the model economy are estimated by the Simulated Method of Moments. These frictions include constraint on repurchases and adjustment costs on dividends.

study differs from the second strand in three important dimensions. *The first dimension* relates to an upper bound on share repurchases. The literature imposes no limit on share repurchases, and thus circumvents the legal constraint under which frequent realizations of share repurchases begin to be treated as dividends by the Internal Revenue Service in the US (see Begenau and Salomao, 2019; Hennessy and Whited, 2007; Gomes, 2001). Even if the upper bound on share repurchases is imposed, it is limited by a fixed number (see Gourio and Miao, 2011). Since the constraint on equity transactions is independent of firm characteristics and decisions, and is insensitive to government fiscal policies, the above literature provides only a partial explanation for changes in cash payouts. Instead, I follow Karabarbounis and Neiman (2012), who endogenize a constraint of repurchases on physical capital. However, Karabarbounis and Neiman (2012) assume that repurchases are strictly tax preferable than dividends for the observed period 1977-2007, and thus any excess cash will be distributed as repurchases until reaching the upper bound of repurchases. Instead, my model has to incorporate additional nominal frictions in reallocation of capital among firms in order to steer cash distribution towards repurchases after the 2003 tax cuts.

The second dimension relates to payout frictions. There is a large literature that explains why firms prefer to have smooth dividends. In contrast to Ricardo (2020), but consistent with Jermann and Quadrini (2012), this study imposes symmetric and convex costs on a long-run level of dividends rather than on previous dividend choices to smooth dividends. The need for investigating dividend smoothing is consistent with the observation from Section 2 and with managers' preferences observed in the survey analyses of Farre-Mensa et al. (2014) and Brav et al. (2005). There are two distinctions to Jermann and Quadrini (2012). First, they treat dividend payments and share repurchases as equivalent payout choices. Consequently, their model cannot generate a realistic relationship between firm decisions and equity return, and thus suffers from meaningful predictions for equity transactions consistent with the Compustat data. Second, they impose multiple dividend targets on each firm in the model. In this way, they underestimate the role of adjustment costs on dividends.[17] Instead, this study imposes a single dividend target on all firms.

[17] Assume that a firm is hit by a positive productivity shock. The firm will tend to pay more dividends over time. However, the shock will also increase the dividend target, which decreases the cost of deviation

The third dimension relates to labor market friction. There is a large theoretical and empirical literature that confirms the (downward) nominal wage rigidity in the US (see Jo, 2019; Elsby et al., 2016; Daly and Hobijn, 2014 among others). Moreover, Hirata et al. (2020) show, on the example of Japan, that the downward nominal wage rigidity induces the upward wage rigidity during an economic recovery, causing a lower nominal wage growth than that under the flexible wage setting. In contrast to the above literature, this study incorporates the wage rigidity mainly to explain corporate payout responses of firms to the 2003 tax cuts. That is, the wage rigidity in my model economy mitigates the feedback dampening the effects of the wage growth after the tax reform, which further generates excess cash available for payouts and capital investment.

4. Empirical Evidence

The empirical analysis aims to provide *direct* evidence of the importance of tax changes for aggregate share repurchases. The null hypothesis is that the 2003 tax reform increases aggregate repurchases after controlling for dividend adjustment and aggregate firm characteristics. An empirical finding related to aggregate repurchases serves as a test for the economic relevance of the model prediction, i.e. how much a model-predicted rise in aggregate repurchases after the 2003 tax cuts is close to an empirical one.

The empirical analysis is based on the Compustat data. Since the Compustat data on individual firm decisions is not publicly available, I borrow the aggregate firm-level data from Gourio and Miao (2010). The sample period for the empirical analysis is from 1988 to 2006. Table 1 presents the summary statistics for the variables of interest. The average logarithm of aggregate repurchases as the dependent variable in the sample is 11.307. There is a significant variation in repurchases and unemployment rate. Since repurchases are very noisy in the data, I also consider the sample period from 1996 to 2006. Shortening the time series of repurchases for empirical analysis and controlling for

and increases variations in dividends. Consequently, the role of the adjustment costs on dividends as a volatility stabilizer is mitigated with multiple targets.

important firm characteristics make it possible to smooth the time series of repurchases, and thus obtain more reliable estimates.

Table 1: Descriptive statistics, 1988-2006

Variable	Compustat, data item	Mean	Median	Std Dev	Min	Max	Obs
log rep	`prstkc`	11.307	11.533	0.814	10.016	12.769	19
log excess cash	`oibdp - capxv`	0.668	0.629	0.166	0.445	0.937	19
log mkt	`prcc * csho`	15.645	15.835	0.541	14.646	16.246	19
log book	`at`	14.638	14.601	0.364	14.013	15.223	19
unemprate	-	5.463	5.400	0.975	3.900	7.400	19
log capital	`ppent`	14.655	14.701	0.236	14.114	14.999	19
log div	`dvp + dvc`	11.668	11.676	0.287	11.176	12.356	19
log equiss	`sstk`	10.951	10.970	0.309	10.221	11.397	19

Note: *Mkt, book, unemprate, equiss* stand for market value of shares, book value of assets, unemployment rate, new equity issuance. Unemployment rate comes from Daly and Hobijn (2014).

Aggregate time-series regression specification is

$$log(rep_t) = \beta_1 TP_t + \beta_2' log(X_t) + \epsilon_t, \ H_0 : \beta_1 = 0,$$

where rep_t is the aggregate repurchases, TP_t is tax policy, X_t denotes control variables, and t is year. Variable rep_t is the dollar amount repurchased in year t. A tax dummy is a proxy for the tax policy (TP_t), which takes one after 2002, and zero otherwise. Control variables include market value of shares, book value of assets, capital stock, dividend adjustment, equity issues, excess cash flow and unemployment rate. Excess cash flow equals a positive difference between earnings and capital expenditure. Dividend adjustment is computed as $(div_t - d^*)^2$, where div_t stands for aggregate dividends at time t, while d^* is the mean of dividends for the sample period. Variables are taken in natural log in order to control for effects of outliers and stabilize volatility in the observed variables.

Table 2 shows consistency in the influence of tax policy on repurchases across different regression specifications. Although the regression specifications are very simple, they are able to explain much of the variations in repurchases over time. All the coefficients have expected signs. Across different regression specifications, positive and high parameter values for dividend adjustment may indicate a high speed of adjustment of aggregate dividends towards a dividend target. More volatile dividends stimulate a demand for repurchases. Capital stock has positive and statistically significant effects on repurchases. Capital is a proxy for a size of firms, which determines the space for repurchases needed to control for volatility in dividends. The larger the size of firms, the more repurchases could be paid by firms. Unemployment rate is a proxy for the influence of macroeconomic conditions on repurchases. A negative parameter value of unemployment indicates that the economic recovery has a positive influence on repurchases.

Table 2: Time-series analysis of 2003 tax policy and repurchases

Dep Var	log repur	log repur	log repur	log repur	log repur
Sample period	1988-2006	1988-2006	1996-2006	1996-2006	1996-2006
Specification	(1)	(2)	(3)	(4)	(5)
TP	-	0.111 (0.245)	-	0.069***(0.014)	0.064 (2.022)
log excess cash	1.917***(0.265)	1.683***(0.261)	1.689***(0.048)	1.523***(0.064)	2.762 (2.365)
log mkt	-0.475**(0.212)	-0.457***(0.058)	-1.064***(0.070)	-1.068***(0.039)	-
log book	-	-	-	-	-1.074 (1.139)
unemprate	-0.392***(0.051)	-0.395***(0.017)	-0.726***(0.033)	-0.725***(0.032)	-0.696**(0.223)
log capital	0.245 (0.228)	0.283***(0.061)	2.005***(0.083)	2.021***(0.056)	2.286***(0.554)
log div_smooth	0.060***(0.012)	0.054***(0.010)	0.088***(0.005)	0.084***(0.006)	0.067 (0.087)
log equiss	-	-	-	-	-0.528 (0.981)
DW	1.83	1.91	2.09	1.84	1.55
Adj. R-square	0.95	0.96	0.97	0.97	0.94

Note: TP is the tax policy that takes 1 after 2002. Statistical significance: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Estimation method: OLS. Standard errors are robust to heteroskedasticity and are reported in parentheses next to the parameter estimates. *Mkt, book, unemprate, equiss* stand for market value of shares, book value of assets, unemployment rate, new equity issuance. DW refers to the Durbin-Watson statistic.

The estimated coefficients on excess cash across different specifications are positive and statistically significant. Column (1) of Table (2) indicates that firms buy back their shares to distribute excess cash. Larger excess cash-flow indicates poor growth opportunities. This funding is consistent with the excess cash flow theory of Jensen (1986). Although share repurchases lost its tax advantage over dividends after 2003, firms still distribute excess cash in the form of repurchases in order to avoid a long-term commitment to dividend payments, i.e. there is a flexibility motive for repurchases. Column (2) of Table (2) suggests that after controlling for the influence of tax policy on repurchases, the influence of excess cash on repurchases decreases. That is, the tax reform amplifies the flexibility motive for repurchases after 2003. Column (2) also shows that the influence of the 2003 tax cuts on repurchases is positive, but not statistically significant. Shortening the sample period from 1996 to 2006 allows for the statistically significant effects of the 2003 tax reform on repurchases. Therefore, the main regression specification is the specification (4) that has the estimated response in repurchases to the tax reform 7.14% ($=exp(0.069) \cdot 100\% - 100\%$). Apart from the statistical significance, the coefficient on the excess cash is also economically significant as the excess cash accounts for 13.47% (=1.523/11.307) of the mean value of aggregate repurchases.

The negative relationship between the market price of shares and repurchases indicates that firms use repurchases to increase the price of shares because it is lower than its true value. This result is consistent with the undervaluation theory of Vermaelen (1981). The economic significance of using repurchases to signal undervaluation from the specificaiton (4) is 9.44%(=1.068/11.307).

Using the Compustat data, Campbell et al. (2013) document a rise of 10.2% in capital expenditure as a measure of corporate investment after the 2003 tax cuts. Moreover, public firms from the Compustat data increase dividend payments by 20% (see Chetty and Saez, 2005). In contrast to this literature, I empirically find that repurchases are also responsive to the 2003 tax reform when firms have large excess cash at their disposal. The literature also reports a strong real annualized average growth rate of aggregate share repurchases in the two-year window around 2003 (see Floyd et al., 2015). In contrast to this literature, the empirical results of this study indicate that there are different motives for repurchasing shares, including a flexibility motive and undervalued prices. These motives for repurchases become amplified after the 2003 tax reform. Chetty and Saez (2006, 2005) focus on a subsample of firms and show that dividend-initiator firms increase both dividends and repurchases, leading the authors to the conclusion that there is no substitution between aggregate payouts after 2003. In addition, Floyd et al. (2015) and Edgerton (2013) document the absence of substitution between dividends and repurchases after 2003. My study suggests that the 2003 tax cuts do matter for increasing repurchases.

5. Model Economy

The model has two purposes: positive and normative. On the positive side, the model is necessary to explain why the 2003 tax cuts generate a rise in aggregate dividends and repurchases. Knowing firms' responses to capital taxation allows me to determine optimal taxation on dividends and capital gains. The key puzzle is, why do firms buyback their shares if the 2003 tax reform generates a strong tax motive for dividends? The model also aims to show what would have occurred to firms' payouts in the counterfactual scenario with different tax experiments other than the 2003 tax reform. Even in the absence of the tax cuts, financial frictions, such as adjustment costs on dividends and endogenous constraint on repurchases, help to explain why firms are reluctant to only distribute dividends to shareholders. On the normative side, the question is what are the efficiency and welfare effects of the 2003 tax cuts in the US? The reallocation of capital across firms has an important role in generating investment and payout dynamics documented by the empirical literature. This capital reallocation further affects output, wages and consumption.

Modifications to the benchmark model of Gourio and Miao (2011, 2010) are colored blue in the text below. The model economy consists of a representative household, heterogeneous firms and government. Time is discrete and the horizon is infinite.

5.1 Household

The representative household maximizes the lifetime utility, which is the sum of current and present discounted future utility:

$$\max_{\{C_t,N_t,B_{t+1},\theta_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - h\frac{N_t^{1+\varphi}}{1+\varphi} \right) \tag{1}$$

where $\beta \in (0,1)$ is the household's discount factor, C_t is consumption, N_t is labor supply, σ is the risk aversion parameter, h refers to disutility of labor, φ is the inverse of Frisch labor supply elasticity. The household earns labor income $w_t N_t$ in the competitive labor market.

The household trades firms' shares θ_t and risk-free government bonds B_t every period. Asset holdings allow the household to save for future consumption. There is a fixed continuum of firms $[0,1]$, represented by the cross-sectional distribution of firms $\mu(k_t, z_t)$.[18] Since the household owns firms, it receives a return on share that consists of dividends d_t and capital gains achieved on a positive transaction of firms' shares. Moreover, the household has an option to invest in risk-free one-period government bonds that provide interest rate r_t. Note that the household is required to pay (proportional) taxes to the government, such as taxes on labor and bond returns τ_i, tax on dividends τ_d, and tax on capital gains τ_{cg}. Capital gains are taxed on an accrual basis rather than upon realization. In addition, tax on capital gains is symmetric, which implies that capital losses are refunded.

The budget constraint of the household is given by

$$\begin{aligned} C_t + \int P_t \theta_{t+1} d\mu_t + B_{t+1} = \; & (1-\tau_i) w_t N_t + (1 + (1-\tau_i) r_t) B_t + \\ & + \int \Big((1-\tau_d) d_t + \frac{P_t}{1-\gamma_t} - \tau_{cg} \big(\frac{P_t}{1-\gamma_t} - P_{t-1} \big) \Big) \theta_t d\mu_t + T_t \; , \end{aligned}$$

where P_t is the ex-dividend share price of a firm during period t, θ_t denotes the number of firm's shares bought at time $t-1$, T_t is the lump-sum government transfer. Effects of share repurchases on capital gains are captured by changes in the fraction of repurchased

[18] There is a continuum of firms ℓ. Since firms are ex-ante identical, I drop the subscript ℓ for the rest of the analysis. Firms differ ex-post because of idiosyncratic productivity shocks and capital stocks.

equity at time t, which is denoted by γ_t. Share repurchases increase the ownership concentration, which generates capital gains for the remaining shareholders.

In order to explain the influence of investment and repurchases on market price of shares, let us consider the following example. If a firm invested in capital in the previous period $t-1$, then it increases the current market price of shares P_t. Based on shares θ_t, which are bought in the previous period, shareholders have a right to receive dividends d_t, price P_t and capital gains $P_t - P_{t-1} > 0$ during (ex-dividend) time t. The point is that capital investment generates capital gains for all shareholders. Next, suppose that a firm repurchases its old shares, and one of the shareholders sells all his shares because of better investment opportunity θ_{t+1}, B_{t+1}. Repurchases do not exert influence on capital gains of the shareholder if that shareholder has no shares in the firm any more after the equity transaction. Therefore, repurchases generate capital gains only for the remaining shareholders after that equity transaction. In this way, changes in the ownership of the shareholder match the equity policy of firms.

Throughout the text below, the market price of repurchased equity is denoted by $s_t < 0$, while $s_t \geq 0$ refers to the market price of new equity issue. If the total number of repurchased equity is $\gamma_t\theta_t$ and each of the remaining equities after repurchase is worth $P_t/(1-\gamma_t)\theta_t$, then the market price of repurchased equity becomes

$$-s_t = (\gamma_t\theta_t) \cdot \frac{P_t}{(1-\gamma_t)\theta_t}$$

The above expression derives the fraction of repurchased equity at time t:

$$\gamma_t = \frac{-s_t}{P_t - s_t},$$

and then plug γ_t in the budget constraint of the shareholder to obtain the market price of shares just before the repurchase program

$$\frac{P_t}{1-(-s_t/(P_t - s_t))} = P_t - s_t,$$

Alternatively, the sum of market price of repurchased equity $\gamma_t P_t/(1-\gamma_t) = -s_t$ and the market price of non-repurchased equity $(1-\gamma_t)P_t/(1-\gamma_t) = P_t$ equals the market price of shares just before the repurchase program $P_t - s_t$. The market price of repurchased and non-repurchased equities are identical. That is, equity before the repurchase program has the same rate of return as equity sold through the repurchase program.

Before we proceed with the optimality conditions of the household, the no-Ponzi game constraints on government bonds and firms' shares are also considered to prevent the case of rolling over debt in infinity:

$$\lim_{T\to\infty}\prod_{t=0}^{T}\Big(1+(1-\tau_i)r_t\Big)^{-1}B_{T+1}\geq 0$$

$$\lim_{T\to\infty}\prod_{t=0}^{T}\Big(1+(1-\tau_i)r_t\Big)^{-1}\theta_{T+1}\geq 0$$

The optimality conditions for $\{C_t, N_t, B_{t+1}, \theta_{t+1}\}$ of the household are

$$C_t:\ \lambda_t = C_t^{-\sigma}$$

$$N_t:\ h\cdot N_t^{\varphi} = \lambda_t(1-\tau_i)w_t$$

$$B_{t+1}:\ \lambda_t = \beta\cdot\mathbb{E}_t\Big[\lambda_{t+1}\Big(1+(1-\tau_i)r_{t+1}\Big)\Big]$$

$$\theta_{t+1}:\ \lambda_t = \frac{1}{P_t}\beta\cdot\mathbb{E}_t\Big[\lambda_{t+1}\Big((1-\tau_d)d_{t+1}+P_{t+1}-s_{t+1}-\tau_{cg}(P_{t+1}-s_{t+1}-P_t)\Big)\Big],$$

where λ_t is the Lagrange multiplier on the household's budget constraint. From $FOC[B_{t+1}]$ we can find the household's discount factor $\beta=\frac{1}{1+(1-\tau_i)r}$.

I consider the household's problem in stationary equilibrium, where prices (w_t, r_t), aggregate quantities and distribution of firms across states are constant over time. Since there is no aggregate uncertainty, investment wedge does not exist, which implies that return on firms' equity R_t has to be equal to after-tax risk-free interest rate $(1-\tau_i)r$ in equilibrium.

Combine $FOC[B_{t+1}]$ and $FOC[\theta_{t+1}]$ to determine required return on equity R_t:

$$1+\underbrace{(1-\tau_i)r}_{R_t} = \frac{1}{P_t}\cdot\mathbb{E}_t\Big[(1-\tau_d)d_{t+1}+P_{t+1}-s_{t+1}-\tau_{cg}(P_{t+1}-s_{t+1}-P_t)\Big]$$

$$\Leftrightarrow\ R_t = \frac{1}{P_t}\cdot\mathbb{E}_t\Big[(1-\tau_d)d_{t+1}+(1-\tau_{cg})(P_{t+1}-s_{t+1}-P_t)\tag{2}$$

Equation (2) indicates that the household invests in equity until the expected return to such investment is equal to return on government bonds, i.e. there is no risk premium. The no-arbitrage equation from (2) helps to determine the equity valuation of firms.

Rewrite equation (2) such that

$$(1-\tau_{cg}) + R_t = \frac{1}{P_t} \cdot \mathbb{E}_t\Big[(1-\tau_d)d_{t+1} + (1-\tau_{cg})(P_{t+1} - s_{t+1})\Big],$$

and divide the above expression by $(1-\tau_{cg})$ to obtain the ex-dividend price of shares

$$P_t = \frac{1}{1+\frac{(1-\tau_i)r}{1-\tau_{cg}}} \mathbb{E}_t \underbrace{\left[\frac{1-\tau_d}{1-\tau_{cg}} d_{t+1} - s_{t+1} + P_{t+1}\right]}_{V_{t+1}} \tag{3}$$

where V_{t+1} is the cum-dividend equity value of a firm. For $\tau_{cg} > 0$, managers of a firm anticipate future tax liability (deduction) on capital gain (loss) when they formulate payout policy in the future. The transversality condition on equity prices is also imposed

$$\lim_{T\to\infty} \prod_{t=0}^{T} \left(1 + \frac{(1-\tau_i)r_t}{1-\tau_{cg}}\right)^{-1} P_{T+1} = 0$$

Under the assumptions of no-aggregate uncertainty and no-bubbles, and iterating forward the price from (3) one can express the ex-dividend price as the present discounted sum of tax-adjusted payouts

$$P_t = \mathbb{E}_t \sum_{j=1}^{\infty} \left(\frac{1}{1+\frac{(1-\tau_i)r}{1-\tau_{cg}}}\right)^j \cdot \left(\frac{1-\tau_d}{1-\tau_{cg}} d_{t+j} - s_{t+j}\right) \tag{4}$$

The formulation of the firm's price (4) is consistent with Anagnostopoulos et al. (2022, 2012); Tran and Wende (2020); Gourio and Miao (2011, 2010), Poterba and Summers (1984), among many others.

In equilibrium, $\theta_{t+1} = \theta_t = 1$ because all households are equal, which further implies that the household obtains all proceeds from share repurchases and provides all new equity issues. Risk-free bond holdings equal net debt of firms in equilibrium, $B_t = 0$.

5.2 Firms

I assume that the household lends directly to firms, and thus the intermediation provided by banks is not necessary to provide funds to firms. Firms in the model economy are owned by the household (shareholder). The optimization problem of firms is consistent with the household's optimization problem, i.e. there is no agency problem.

5.2.1 Production Technology

Firms are heterogeneous at any time t in a level of capital stock and productivity.[19] Firms face idiosyncratic productivity shocks.[20] The next period firm-level productivity shocks z_{t+1} are generated by a Markov process with transition function $Q(z_{t+1}, z_t)$. I assume that $Pr\{z_{t+1} = z_j | z_t = z_i\} = Q_{ij} \geq 0$ and $\sum_j Q_{ij} = 1$ for each $i = 1, \ldots, n_z$. I also assume that productivity process follows AR(1) process:

$$lnz_{t+1} = \rho_z lnz_t + \sigma_z \epsilon_{t+1}, \quad \epsilon_{t+1} \stackrel{iid}{\sim} \mathcal{N}(0, 1) \tag{5}$$

where innovation ϵ_{t+1} has a normal distribution with mean zero and variance σ_z^2. The persistence parameter satisfies $\rho_z \in (0, 1)$. Firms are also subject to exogenous TFP shock A_t, which is common to all firms. The sequence of aggregate productivity shocks is known with perfect foresight. From now on, let us assume that $A_t = 1$. When the counterfactual analysis of economic recovery is conducted, then $A_t > 1$.

Firms use their capital (k_t) and labor rented from the labor market (n_t) to produce a single homogeneous output (y_t). I assume $DRTS$ production function $F_t(k_t, n_t; z_t)$ in order to make the firm size matter, i.e. make it possible for heterogeneity of firms to exist in equilibrium. Therefore, it is not possible that the most productive firms take control of the whole market. Since the competitive consumption goods market is considered, the price of output is the same for all firms and normalized to one. Operating profit function is defined as

$$\Pi_t(A_t, k_t, z_t; w_t) := \max_{n_t \geq 0} \; A_t F(k_t, n_t; z_t) - w_t n_t(k_t, z_t) \tag{6}$$

[19]Every period, a firm starts with the predetermined capital stock and the realization of firm-level productivity.

[20]The variable z_t refers to current shocks to productivity, demand and input prices.

Solutions to *static* problem of firms from (6) provide optimal labor demand, output and profit. Suppose that $y_t(k_t, z_t) := A_t F_t(k_t, n_t; z_t) = A_t z_t k_t^{\alpha_k} n_t^{\alpha_n}$ where $0 < \alpha_k + \alpha_n < 1$.

For a given capital stock, a firm decides optimally about the current level of labor demand after the realization of the productivity shock:

$$n_t : \; n_t(k_t, z_t) = (A_t z_t k_t^{\alpha_k})^{\frac{1}{1-\alpha_n}} \left(\frac{\alpha_n}{w_t}\right)^{\frac{1}{1-\alpha_n}}$$

Optimal output is

$$y_t(k_t, z_t) = (A_t z_t)^{\frac{1}{1-\alpha_n}} k_t^{\frac{\alpha_k}{1-\alpha_n}} \left(\frac{\alpha_n}{w_t}\right)^{\frac{\alpha_n}{1-\alpha_n}}$$

Optimal profit is

$$\Pi_t(A_t, k_t, z_t; w_t) = A_t^{\frac{1}{1-\alpha_n}} \underbrace{z_t k_t^{\alpha_k} (z_t k_t^{\alpha_k})^{\frac{\alpha_n}{1-\alpha_n}}}_{=\left(z_t k_t^{\alpha_k}\right)^{\frac{1}{1-\alpha_n}}} \left(\frac{\alpha_n}{w_t}\right)^{\frac{\alpha_n}{1-\alpha_n}} - w_t \, (z_t k_t^{\alpha_k})^{\frac{1}{1-\alpha_n}} \left(\frac{\alpha_n}{w_t}\right)^{\frac{1}{1-\alpha_n}}$$

$$\Leftrightarrow \; \Pi_t(A_t, k_t, z_t; w_t) = (A_t z_t k_t^{\alpha_k})^{\frac{1}{1-\alpha_n}} \left(\frac{\alpha_n}{w_t}\right)^{\frac{\alpha_n}{1-\alpha_n}} (1 - \alpha_n)$$

5.2.2 Financing

The objective of managers is to maximize the sum of current and (present discounted) future net payments to shareholders from equation (4). Hence, the market value of the firm in period t is

$$V_t = \frac{1-\tau_d}{1-\tau_{cg}} d_t - s_t + P_t \tag{7}$$

The objective function of a firm

$$V_t(k_t, z_t) = \max_{\{k_{t+1}, i_t, d_t, s_t\}} \frac{1-\tau_d}{1-\tau_{cg}} d_t - s_t + \frac{1}{1 + \frac{(1-\tau_i)r}{1-\tau_{cg}}} \mathbb{E}_t \left[V_{t+1}(k_{t+1}, z_{t+1}) \middle| z_t \right] \tag{8}$$

Equation (8) shows that dividends, share repurchases and investment policy increase cum-dividend equity value, i.e. they generate a capital gain. Within the dynamic problem of a firm, the discount factor of the household has to be adjusted for capital gains taxes if the capital gain is expected to be capitalized into the market price of equity in the future. Since managers anticipate tax liability on capital gains in the future, they put a lower weight on future benefits, and thus the discount factor of the firm is reduced. When the capital gain is capitalized into the market price of equity in the current period t, the discount factor of the firm equals one. Moreover, at margin the value of dividends is $(1-\tau_d)/(1-\tau_{cg})$, while the value of share repurchases exactly equals one. This implies that share repurchases are already capitalized into the market price.

Flow of funds constraint is

$$d_t(k_t, z_t) + \phi_d(d_t - d^*)^2 + i_t + \frac{\psi}{2}\frac{i_t^2}{k_t} = (1-\tau_c)\Pi_t(A_t, k_t, z_t; w_t) + \tau_c \delta k_t + s_t(k_t, z_t) \tag{9}$$

Flow of funds constraint (9) indicates that if internal funds (after-tax operating profit $(1-\tau_c)\Pi_t(A_t, k_t, z_t; w_t)$ and depreciation allowance $\tau_c \delta k_t$) are not sufficient to cover investment needs, $i_t + \psi i_t^2/(2k_t)$, then a firm issues new equities $s_t \cdot \mathbb{1}_{s_t>0}$. Otherwise, the firm uses excess cash to distribute to shareholders as share repurchases $s_t \cdot \mathbb{1}_{s_t<0}$, and the rest of excess cash is available for dividends d_t. Note that a firm does not have an option to retain excess cash. Distributing dividends to shareholders triggers certain dividend adjustment costs $\phi_d(d_t - d^*)^2$, where d^* is the steady state level of dividends. There is an extensive literature that explains why firms prefer to have smooth dividends, starting from Lintner (1956). Following Jermann and Quadrini (2012), I introduce quadratic and symmetric adjustment costs of dividends as a proxy for smooth dividend payments.

Capital accumulation constraint

$$q_t: \quad k_{t+1}(k_t, z_t) = (1-\delta)k_t + i_t(k_t, z_t), \quad k_0 > 0 \textit{ given} \tag{10}$$

Capital accumulation constraint (10) indicates that any current investment in capital stock extends capital stock in the next period k_{t+1}. The depreciation rate is $\delta \in (0, 1)$. The Lagrange multiplier associated with the constraints (10) is denoted by q_t.

Financial constraints

$$\lambda_t^d: \quad d_t(k_t, z_t) \geq 0 \tag{11}$$

$$\lambda_t^s: \quad s_t(k_t, z_t) \geq -\eta k_t \tag{12}$$

Lagrange multipliers associated with the constraints (11) and (12) are λ_t^d and λ_t^s. Constraint (11) implies that a firm cannot reduce dividends without limits. Otherwise, costless external finance will make a financial problem of the firm negligible. Constraint on share repurchases is determined by (12). It has been argued that financially unconstrained firms are unable to perform equity repurchases efficiently due to the *legal constraint* imposed by the Internal Revenue Service (IRS) in the US (see Poterba and Summers, 1984). The legal constraint implies that periodic realizations of share repurchases become treated as dividends by the IRS, and thus capital gains lose their tax advantage over ordinary income. Therefore, a proper tax treatment of cash payouts to shareholders in the model economy requires some upper bound on share repurchases. For instance, Gourio and Miao (2011) assume that the upper limit on share repurchases is determined by a fixed number. Accordingly, the limit becomes independent from marginal source and use of funds of an individual firm, and insensitive to changes in government fiscal policy. However, there is no convincing reason to believe that the limit on share repurchases is constant over time and that the same limit applies to all firms. Moreover, government fiscal policy also has an effect on incentives for equity interventions, and thus it affects the endogenous constraints on share repurchases. Investigating only a direct effect of the fiscal policy on payout policy may lead to a misleading conclusion that dividends and share repurchases are almost perfect substitutes, which is observed in Figure 1, panel (b).

An additional problem that may restrict equity transactions is that important drivers of equity interventions, such as investment needs, cannot be observed by regulators within the IRS. Fortunately, changes in capital stock k_t are observable, and consequently they could serve as an indicator of changes in the investment needs of the firm. Hence, following Karabarbounis and Neiman (2012), this study imposes the upper bound on repurchases that depends on capital stock. In contrast to them, my model has to incorporate additional nominal frictions in the reallocation of capital among firms in order to steer cash distribution towards repurchases after the 2003 tax cuts.

Under SEC Rule 10b-18, larger firms could buy back their shares more than smaller firms. In short, when the constraint on share repurchases is endogenous, for any distribution of productivity equity repurchases become more skewed toward financially unconstrained firms than when the constraint is exogenous.

5.2.2.1 Optimal Financial Policy

Optimal financial policy of a firm is determined by:

$$s_t: \quad \left(\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_t^d\right) \cdot \frac{1}{1+2\phi_d(d_t - d^*)} + \lambda_t^s = 1 \tag{13}$$

Holding investment policy fixed, the interpretation of financial policy of a firm is as follows. If a firm issues a dollar of new equity, then it generates capital loss to existing shareholders. Hence, the RHS of (13) is the marginal costs of an additional unit of new equity issue to the shareholder at time t. At margin, if the firm distributes the raised dollar to the shareholder as dividends, then the shareholder receives $\$^{(1-\tau_d)}/_{(1-\tau_{cg})}$, corrected by dividend adjustment costs $\$(1+2\phi_d(d_t - d^*))$. In addition, issuing new equity and distributing dividends to the shareholder relax payout constraints by $\$\lambda_t^d$ and $\$\lambda_t^s$. The LHS of (13) is the marginal benefits to the shareholder at time t. At optimum, the equation (13) implies that the additional external finance is used to pay dividends until the point where the RHS equals the LHS. Alternatively, equation (13) shows that, in equilibrium, share repurchases have a marginal value equal to that of dividends, plus the shadow value of constraint on dividends, corrected by dividend adjustment costs, and plus the shadow value of constraint on share repurchases.

Holding investment policy (k_{t+1}) fixed, let us consider the influence of adjustment costs on dividends (ϕ_d) and tax changes (τ_d, τ_{cg}) on the optimal financial policy of firms. A higher ϕ_d reduces the marginal benefit of dividends to shareholders. Hence, dividend-paying firms do not have an incentive to pay large extra dividends, and similarly dividend-initiator firms are discouraged to start distributing dividends. Therefore, the role of ϕ_d in optimal financial policy is to stabilize the volatility of dividend payments. Next, before the tax reform, the tax wedge between dividends and capital gains is $\tau_d > \tau_{cg}$ or $^{(1-\tau_d)}/_{(1-\tau_{cg})} < 1$. Since the tax wedge reduces the value of dividends, and thus reduces the marginal benefit to the shareholder, one can say that the tax wedge makes new equity issue more costly than internal funds. Hence, the tax wedge acts as a financial friction in the allocation of capital across firms.

5.2.2.2 Optimal Investment Policy

Optimal investment policy of a firm is determined using the equations (14) and (15):

$$i_t: \; q_t = \left(\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_t^d\right) \cdot \frac{1}{1+2\phi_d(d_t - d^*)} \cdot \left(1 + \psi \frac{i_t}{k_t}\right) \tag{14}$$

$$k_{t+1}: \; q_t = \frac{1}{1+\frac{(1-\tau_i)r}{1-\tau_{cg}}} \mathbb{E}_t \left[\lambda_{t+1}^s \eta + q_{t+1}(1-\delta) + \left(\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_{t+1}^d\right) \cdot \left((1-\tau_c)\Pi_{k,t+1}(k,z;w) + \tau_c \delta + \frac{\psi}{2}\left(\frac{i_{t+1}}{k_{t+1}}\right)^2\right)\right] \tag{15}$$

$$\Leftrightarrow \; q_t = \frac{1}{1+\frac{(1-\tau_i)r}{1-\tau_{cg}}} \mathbb{E}_t \left[\frac{\partial V_{t+1}(k_{t+1}, z_{t+1})}{\partial k_{t+1}}\right]$$

Combination of (14) and (15) gives

$$\left(\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_t^d\right) \cdot \frac{1}{1+2\phi_d(d_t - d^*)} \cdot \left(1 + \psi \frac{i_t}{k_t}\right) = \frac{1}{1+\frac{(1-\tau_i)r}{1-\tau_{cg}}} \mathbb{E}_t \left[\frac{\partial V_{t+1}(k_{t+1}, z_{t+1})}{\partial k_{t+1}}\right] \tag{16}$$

The interpretation of investment policy of a firm is as follows. The LHS of (16) is the marginal costs of increasing the capital stock at time t. At margin, increasing investment in capital stock raises opportunity costs of investment (leaves less money for dividends) and raises the adjustment costs of investment. On the other hand, the RHS of (16) equals the discounted expected marginal Tobin's q, which is the marginal benefit of increasing the capital stock. The RHS of (16) consists of expected benefits from relaxing constraint on repurchases, reselling value of capital and after-tax cash flow in the next period. At optimum, equation (16) implies that firms invest in physical capital until the point where the RHS equals the LHS.

Current and next period marginal source of finance, tax changes $(\tau_d, \tau_{cg}, \tau_i)$, adjustment costs on dividends (ϕ_d), constraint on share repurchases (η), and adjustment costs on investment (ψ) generate static and dynamic effects on current investment decision.[21]

[21] Suppose that the next period marginal source of finance is expected to increase for a given capital stock. That is, if the firm expects to be hit by a higher productivity shock tomorrow $(\sigma_{z,t+1})$, then the marginal benefit of more investment in physical capital today is higher (dynamic effect). This stimulates the firm to increase current capital expenditure. However, higher investment incurs adjustment costs (static effect).

The quantitative results of this study show that current investment decision greatly depends on whether firms are currently issuing new equity, paying dividends or buying back their existing equities as well as their expected financial policy in the next period.

Equation (14) determines optimal investment responses of firms:

$$i_t = \left(q_t \cdot \left(\frac{\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_t^d}{1 + 2\phi_d(d_t - d^*)} \right)^{-1} - 1 \right) \cdot \frac{k_t}{\psi}$$

When the marginal source of finance is a new equity issue, then $s_t > 0$ and $d_t = 0$ for all time t. By complementary slackness conditions, $\lambda_t^s = 0$. Using equation (13), firms from regime 1 invest until $q_t = 1$. That is, at margin firms stop investing in capital when $q_t = 1$. An alternative interpretation is that at margin firms are indifferent between using an additional dollar of either external or internal funds to finance capital expenditure

$$i_t = (q_t - 1) \cdot \frac{k_t}{\psi}$$

When the marginal source of finance is internal funds, investment policy is an increasing function of capital stock as long as firms reach their desired level of capital. Firms start to reduce investment at the point where they are indifferent between using an additional dollar of internal funds for either paying dividends or capital expenditure

$$i_t = \left(q_t \cdot \left(\frac{\frac{1-\tau_d}{1-\tau_{cg}}}{1 + 2\phi_d(d_t - d^*)} \right)^{-1} - 1 \right) \cdot \frac{k_t}{\psi}$$

The above equation implies that the threshold level for investment of firms from the payout regime depends on taxes and adjustment costs on dividends.

5.2.3 Government Problem

The government collects revenue from taxing the household's incomes (labor income, interest income, dividends, capital gains) and from taxing firms' corporate income. Since the government rebates these tax revenues to the household in a lump-sum transfer, this study does not consider the redistributive effects of the tax reform, but rather focuses on the reallocation effects of the tax reform. The budget constraint of the government is

$$T_t = \tau_i w_t N_t + \tau_c \int (\Pi(A_t, k_t, z_t; w_t) - \delta k_t)\, \mu_t(dk, dz) + \tau_d \int d_t(k_t, z_t)\mu_t(dk, dz) \\ - \tau_{cg} \int s_t(k_t, z_t)\mu_t(dk, dz) \tag{17}$$

5.3 Stationary Distribution and Aggregation

Since there is no aggregate uncertainty, aggregate variables are constant in the long run, and thus a firm's choices are a function of individual state variables. The labor demand $n_t(k_t, z_t)$ is a static choice of a firm. The firm demands labor up to the point where the marginal product of labor is equal to (competitive) wage. The policy functions of the dynamic problem of firms (8) are

$$k_{t+1} = g(k_t, z_t; w_t),\ i_t = i(k_t, z_t; w_t),\ d_t = d(k_t, z_t; w_t),\ s_t = s(k_t, z_t; w_t)$$

The policy functions map the firms' state variables (k_t, z_t) into the firms' current choices (k_{t+1}, i_t, d_t, s_t). Denote $\mathbb{B}$ as the Borel σ algebra. For a set $B \in \mathbb{B}$, $\mu_t(B)$ is the cross-sectional distribution of firms over capital and productivity that lie in set B. The transition function $\Gamma((k_t, z_t), B)$ denotes the probability that a firm with a state (k_t, z_t) will have a state that lies in the set B in the next period. Let us denote the vector of state variables as $a = (k_t, z_t)$, which lies in $\mathbb{A} \times \mathbb{Z}$, where $\mathbb{Z}$ is the set of (discretized) productivity shocks. Therefore, the transition function $\Gamma : \mathbb{A} \times \mathbb{B} \to [0, 1]$ can be represented as

$$\Gamma(a, B_k \times B_z) = \begin{cases} \sum\limits_{z_{t+1} \in B_z} Q(z_t, z_{t+1}) & \text{if} \quad g(k_t, z_t; w_t) \in B_k \\ 0 & otherwise \end{cases}$$

Given the transition function, the law of motion for the firm distribution is given by

$$\mu_{t+1}(B) = \int_{\mathbb{A}} \Gamma(a, B)\mu_t(da) \tag{18}$$

Given the stationary distribution $\mu_{t+1} = \mu_t = \mu^*$, one can compute the aggregate variables:

- Aggregate labor demand:

$$N_t^d(\mu^*; w_t) = \int_{\mathbb{A}} n_t(k_t, z_t; w_t)\mu^*(dk, dz)$$

- Aggregate output:

$$Y_t(\mu^*; w_t) = \int_{\mathbb{A}} y_t(k_t, z_t; w_t)\mu^*(dk, dz)$$

- Aggregate investment:

$$I_t(\mu^*; w_t) = \int_{\mathbb{A}} i_t(k_t, z_t; w_t)\mu^*(dk, dz)$$

- Aggregate capital:

$$K_{t+1}(\mu^*; w_t) = \int_{\mathbb{A}} k_{t+1}(k_t, z_t; w_t)\mu^*(dk, dz)$$

- Aggregate operating profit:

$$\Pi_t(\mu^*; w_t) = \int_{\mathbb{A}} \Pi_t(k_t, z_t; w_t)\mu^*(dk, dz)$$

- Aggregate dividends:

$$D_t(\mu^*; w_t) = \int_{\mathbb{A}} d_t(k_t, z_t; w_t)\mu^*(dk, dz)$$

- Aggregate new equity issues:

$$S_t(\mu^*; w_t) = \int_{\mathbb{A}} s_t(k_t, z_t; w_t) \cdot \mathbb{1}_{s_t > 0}\ \mu^*(dk, dz)$$

- Aggregate share repurchases:

$$\tilde{S}_t(\mu^*; w_t) = \int_{\mathbb{A}} s_t(k_t, z_t; w_t) \cdot \mathbb{1}_{s_t < 0}\ \mu^*(dk, dz)$$

- Aggregate adjustment costs on investment:

$$ACI_t(\mu^*; w_t) = \int_{\mathbb{A}} \Big(\psi \frac{i_t(k_t, z_t; w_t)^2}{2k_t}\Big)\mu^*(dk, dz)$$

- Aggregate adjustment costs on dividends:

$$ACD_t(\mu^*; w_t) = \int_{\mathbb{A}} \phi_d \cdot (d_t(k_t, z_t; w_t) - d^*)^2 \mu^*(dk, dz)$$

5.4 Stationary Competitive Equilibrium

Given the government policy $\{\tau_c, \tau_d, \tau_{cg}, \tau_i, T\}$, a stationary competitive equilibrium is a sequence of allocations $\{C, N^s, B, \theta(k_t, z_t), g(k_t, z_t), d(k_t, z_t), s(k_t, z_t), i(k_t, z_t), n(k_t, z_t)\}$, prices $\{w, r, P(k_t, z_t)\}$, equity value $V(k_t, z_t) : \mathbb{A} \to \mathbb{R}$, and stationary distribution of firms $\mu^* : \mathbb{A} \to [0, 1]^{\mathbb{A}}$, such that:

- The allocations $\{C, N^s, B, \theta(k_t, z_t)\}$ solve the household's maximization problem (1).
- The allocations $\{g(k_t, z_t), d(k_t, z_t), s(k_t, z_t), i(k_t, z_t)\}$ solve the dynamic problem of firms (8), and $n(k_t, z_t)$ solves the static problem of firms (4).
- The government budget balances consistently with equation (17).
- The stationary distribution of firms, μ^*, satisfies (18).
- All markets simultaneously clear:
  - asset market: $\theta = 1$
  - bond market: $B = 0$
  - labor market: $N^s(\mu^*; w) = N^d(\mu^*; w)$
  - goods market: $Y(\mu^*; w) = C(\mu^*; w) + I(\mu^*; w) + ACI(\mu^*; w) + ACD(\mu^*; w)$

Equity prices $P(k_t, z_t)$, dividends and equity transactions are consistent with the non-arbitrage condition, equation (2). Factor prices (r, w) are determined by the Euler equation and the household's optimality condition with respect to labor supply, respectively:

$$r = \frac{1}{1-\tau_i}(\frac{1}{\beta} - 1), \quad w = -\frac{U_2(C, N^s)}{U_1(C, N^s)} \quad \Rightarrow \quad (1-\tau_i)w = h\frac{(N^s)^{\varphi}}{C^{-\sigma}}$$

Given equity price P_t and optimal equity decisions of firms s_t, the fraction of repurchased equity in equilibrium is $\gamma_t = -s_t/(P_t - s_t)$.

5.5 Finance Regimes and Capital Reallocation

Before providing the results of the model economy, I highlight the importance of investigating the finance regimes and mechanisms in the model economy.

5.5.1 Finance Regimes

Adjustment costs on dividends have two roles in the model economy: to stabilize volatility in dividends and to allow the determination of optimal financial policy after the tax cuts. To show the role of adjustment costs on dividends in defining finance regimes, I consider three cases.

Case 1. Miller and Modigliani (1961) theorem of financial policy irrelevance. Suppose that there are no financial frictions: $(1-\tau_d)/(1-\tau_{cg}) = 1$ and $\phi_d = 0$. Consequently, optimal financial policy of firms (13) implies that $\lambda_t^d = \lambda_t^s = 0$. In that case, financial policy becomes irrelevant to firm value and to investment decisions. That is, \$1 raised through new equity issuance or \$1 of internal funds has the same cost to the firm at margin. Consequently, a firm becomes indifferent between financing investment with internal or external funds. More importantly, payout policy remains indeterminate in equilibrium, i.e. dividends and repurchases have identical value.

Case 2. Introduce tax wedge between dividends and capital gains in the model economy. That is $\tau_d > \tau_{cg}$ with $\phi_d = 0$. Optimal financial policy of firms (13) indicates that one of the constraints on either dividends (11) or repurchases (12), or both constraints must be binding. This implies that firms do not simultaneously issue new equity and pay dividends at optimum.[22] Hence, a firm could be in one of the finance regimes (see below). Keeping in mind that the tax wedge becomes eliminated after the 2003 tax cuts, $(1-\tau_d)/(1-\tau_{cg}) = 1$, some other financial frictions must be incorporated in the model to activate financial policy and finance regimes. Otherwise, dividends and equity

[22]The economic intuition is the following. Any equity transaction (either new equity issue or share repurchase) changes firm value and capital gains. Since capital gains are taxed at a lower rate than dividends, a firm responds by increasing repurchases and decreasing dividends in order to maximize firm value of shareholders.

transactions (new equity issues and repurchases) become indeterminate after the 2003 tax reform.[23]

Case 3. Introduce the tax wedge between dividends and capital gains, and adjustment costs on dividends in the model economy. That is, $\tau_d > \tau_{cg}$, $\phi_d > 0$. These frictions feature the pre-tax reform period. The 2003 tax cuts eliminate the tax wedge $\tau_d = \tau_{cg}$. Still, finance regimes exist due to dividend adjustment costs, which open the scope for analysing a firm's responses even after the 2003 tax reform.[24] Importantly, the finance regimes change over time depending on idiosyncratic productivity and investment policy. That is, at any time t firms may appear in one of the four regimes depending on their marginal source of finance, i.e. idiosyncratic level of productivity and capital stock. These regimes include

- External growth regime: $s_t > 0$ and $d_t = 0$ (regime 1). Firms of this regime have a low capital stock but high marginal product of capital and productivity. Since these firms do not have sufficient internal funds to finance their high investment needs, they have to issue new equities, and thus do not distribute profits to shareholders.

- Share repurchase regime (regime 2): $s_t > -\eta k_t$ and $d_t = 0$. Firms grow sufficiently such that they start buying back their existing shares and set dividends to zero.

- Dividend-constrained regime (regime 3): $s_t = -\eta k_t$ and $d_t = 0$. Firms still do not pay dividends, but buy back their existing shares up to their upper limit. These firms do not need to issue new equity because the marginal return on investment may not be sufficient to cover lower firm value caused by share dilution.

- Payout regime (regime 4): $s_t = -\eta k_t$ and $d_t > 0$. Firms buy back their existing shares up to their upper boundary, and distribute the rest of excess cash to shareholders in a form of dividends.

Note that constraints on payout policy, equations (11) and (12), are also considered in defining the finance regimes of firms.[25] Similar to Gourio and Miao (2011), in finance

[23] The indeterminacy of financial policy of firms after 2003 is shown in Appendix A1.

[24] Quantitative results of my study show that in equilibrium some firms set dividends to the dividend target, which in turn makes the financial policy of such firms indeterminate after the tax reform. However, at aggregate, many firms with dividends have a certain level of deviations from the dividend target, leading to the determination of financial policy in equilibrium.

[25] Reasons for their consideration are provided in Section 4.2.2 and Appendix A1.

regimes 3 and 4, firms first tend to exploit all their opportunities for share repurchases, while only remaining earnings are distributed as dividends. The reasons are financial frictions, including higher taxes on dividends than taxes on capital gains prior to 2003, and extra costs on dividends. The finance regimes above are designed to acknowledge these payout preferences of firms. In contrast to Gourio and Miao (2011), where the upper limit on share repurchases is determined by a fixed number, the constraint on repurchases in my model economy depends on the size of capital. Additionally, this study introduces adjustment costs on dividends. Adjustment costs on dividends make the existing finance regimes keep the same structure after the tax cuts, and also discourage the shift of firms from regime 3 (2) to regime 4 (1) in the current period.

Note that the regime ($s_t > -\eta k_t, d_t > 0$) is not considered one of the regimes that could occur at optimum. Otherwise, a firm will tend to exploit profitable opportunity to reduce the tax burden by reducing dividends and increasing repurchases. The regime ($s_t = 0, d_t > 0$) cannot occur at optimum because I assume that the interests between managers and shareholders are aligned. In contrast to Gourio and Miao (2011), I do not consider the regime ($s_t = 0, d_t = 0$) because equity value has no kink point induced by equity transactions.

5.5.2 Capital Reallocation

The influence of financial frictions on capital investment depends on capital reallocation across the finance regimes. To explain their relationship, I resort to the user cost of capital framework. This framework provides equivalent results to those in equation (16). Following Gourio and Miao (2010), the user cost of capital, which is a price of capital stock, equals the after-tax marginal cash flow corrected for the adjustment cost of investment

$$uc_t = (1-\tau_c)\Pi_{k,t+1}(k,z) + \frac{\psi}{2}\left(\frac{i_{t+1}}{k_{t+1}}\right)^2 \tag{19}$$

Equation (15) implies

$$q_t = \frac{1}{1+\frac{(1-\tau_i)r}{1-\tau_{cg}}}\mathbb{E}_t\left[\lambda^s_{t+1}\eta + q_{t+1}(1-\delta) + \left(\frac{1-\tau_d}{1-\tau_{cg}} + \lambda^d_{t+1}\right)\cdot\left((1-\tau_c)\Pi_{k,t+1}(k,z;w) + \tau_c\delta + \frac{\psi}{2}\left(\frac{i_{t+1}}{k_{t+1}}\right)^2\right)\right]$$

Assuming a deterministic case of (15), and then plugging (19) in (15) yields

$$uc_t = \left[q_t\left(1+\frac{r(1-\tau_i)}{1-\tau_{cg}}\right)-\lambda^s_{t+1}\eta-q_{t+1}(1-\delta)-q_t(1-\delta)+q_t(1-\delta)\right]\cdot\left(\frac{1-\tau_d}{1-\tau_{cg}}+\lambda^d_{t+1}\right)^{-1}-\tau_c\delta$$

After rearranging the above expression, one can define the user cost of capital

$$uc_t = \left[q_t\left(\frac{r(1-\tau_i)}{1-\tau_{cg}}+\delta\right)-\lambda^s_{t+1}\eta-(q_{t+1}-q_t)\cdot(1-\delta)\right]\cdot\left(\frac{1-\tau_d}{1-\tau_{cg}}+\lambda^d_{t+1}\right)^{-1}-\tau_c\delta \quad (20)$$

Equation (14) implies

$$q_t = \left(\frac{1-\tau_d}{1-\tau_{cg}}+\lambda^d_t\right)\cdot\frac{1}{1+2\phi_d(d_t-d^*)}\cdot\left(1+\psi\frac{i_t}{k_t}\right)$$

Plugging equation (14) in (20) gives the expression for the user cost of capital:

$$uc_t = -\frac{\Psi_{i,t+1}(i,k)}{\Phi_{d,t+1}(d,d^*)}\cdot(1-\delta)-\tau_c\delta+\frac{\frac{1-\tau_d}{1-\tau_{cg}}+\lambda^d_t}{\frac{1-\tau_d}{1-\tau_{cg}}+\lambda^d_{t+1}}\cdot\frac{\Psi_{i,t}(i,k)}{\Phi_{d,t}(d,d^*)}\cdot\left(\frac{r(1-\tau_i)}{1-\tau_{cg}}+1\right)-\frac{\lambda^s_{t+1}\eta}{\frac{1-\tau_d}{1-\tau_{cg}}+\lambda^d_{t+1}} \quad (21)$$

where $\Psi_{i,t} = 1+\psi\frac{i_t}{k_t}$ and $\Phi_{d,t} = 1+2\phi_d(d_t-d^*)$. To specify the influence of the financial frictions on investment through capital reallocation decisions of transiting firms, let us consider as an illustrative example three possible cases a firm from the dividend-constrained regime faces:

Case 1. Switching from the dividend-constrained regime to the payout regime at $t+1$:

$$s_t = -\eta k_t,\ d_t = 0 \quad \text{while} \quad s_{t+1} = -\eta k_{t+1},\quad d_{t+1} > 0$$

$$uc^1_t = -\frac{\Psi_{i,t+1}(i,k)}{\Phi_{d,t+1}(d,d^*)}\cdot(1-\delta)-\tau_c\delta+\frac{(1-\lambda^s_t)}{\frac{1-\tau_d}{1-\tau_{cg}}}\cdot\Psi_{i,t}(i,k)\cdot\left(\frac{r(1-\tau_i)}{1-\tau_{cg}}+1\right)-\frac{\lambda^s_{t+1}\eta}{\frac{1-\tau_d}{1-\tau_{cg}}} \quad (22)$$

Case 2. Switching from the dividend-constrained to the external growth regime at $t+1$:

$$s_t = -\eta k_t,\ d_t = 0 \quad \text{while} \quad s_{t+1} > 0,\quad d_{t+1} = 0$$

$$uc^2_t = -\Psi_{i,t+1}(i,k)\cdot(1-\delta)-\tau_c\delta+(1-\lambda^s_t)\cdot\Psi_{i,t}(i,k)\cdot\left(\frac{r(1-\tau_i)}{1-\tau_{cg}}+1\right) \quad (23)$$

Case 3. Staying in the dividend-constrained regime at $t+1$:

$$s_t = -\eta k_t,\ d_t = 0 \ \text{ while } \ s_{t+1} > -\eta k_{t+1}, \quad d_{t+1} = 0$$

$$uc_t^3 = -\Psi_{i,t+1}(i,k)\cdot(1-\delta) - \tau_c\delta + (1-\lambda_t^s)\cdot\Psi_{i,t}(i,k)\cdot\Big(\frac{r(1-\tau_i)}{1-\tau_{cg}}+1\Big) \qquad (24)$$

The main message from the equations (22), (23), and (24) is that the financial frictions, including the tax wedge between dividends and capital gains $(1-\tau_d)/(1-\tau_{cg})$, adjustment costs on dividends (ϕ_d) and constraint on repurchases (η), have real effects on a firm from the dividend-constrained regime only if that firm switches to the payout regime in the next period. Moreover, such transition to the payout regime induces changes in the dynamics of dividends and repurchases over time. Therefore, the capital reallocation has an important role in explaining the investment and payout dynamics of firms.

For a dividend tax cut with an effect on the current capital investment of firms from the dividend-constrained regime with $d_t = 0$, these firms must switch to the payout distribution regime with $d_{t+1} > 0$, i.e. there should be reallocation of capital across firms. That is, the influence of changes in dividend tax on capital investment is realized through the reallocation channel. Changes in tax on capital gains affect the user cost of capital of a firm through after-tax return to equity, regardless of its transition to other regimes. Changes in capital gains tax are realized through the interest-rate channel. Since the 2003 tax reform consists of a drop in taxes on dividends and capital gains, then we should keep in mind both reallocation and interest-rate channels when considering the influence of tax changes on investment (and payout) dynamics. In Section 4.5.5.3, quantitative results of this study show that a capital gains tax cut has a stronger influence on investment than a dividend tax cut.

Equation (22) shows that $\eta > 0$ amplifies the positive effects of a capital gains tax on investment through the interest-rate channel, but it also amplifies the negative effects of a dividend tax on investment through the reallocation channel. Note that an increase in current capital investment also relaxes the constraint on share repurchases λ_{t+1}^s, which further reduces the user cost of capital and stimulates current investment. Adjustment costs on dividends $\phi_d > 0$ have a negative influence on capital expenditure if $d_t > d^*$. After the 2003 tax cuts, which increases the $(1 - \tau_d)/(1 - \tau_{cg})$ ratio, η (ϕ_d) exerts positive (no) effects on the capital investment of firms from the dividend-constrained regime only if that firm reallocates to the payout regime.

In contrast to the benchmark model of Gourio and Miao (2011, 2010), my model has two different implications. First, my model shows that the capital reallocation of a transiting firm is a necessary but not sufficient condition for the dividend tax cut increasing capital investment of the transiting firm. Hence, the utmost effects of the 2003 tax reform on investment and payout dynamics depend on the strength of the influence of financial frictions on reallocation decisions. Second, my model predicts that a dividend tax cut may have negative effects on investment in capital if return on investment is used for repurchases in the next period. The reason is the presence of a constraint on repurchases that is endogenous with capital stock. The intuition is the following. If a firm uses a dollar of internal funds for investment, then the marginal cost of investment rises because of a dividend tax cut. Nevertheless, the dividend tax cut does not affect the marginal benefit of investment if the return on investment is used for repurchases in the next period.

5.6 Calibration and Quantitative Results

5.6.1 Calibration

The model calibration aims to capture the key aspects of the payout and investment behaviour of firms: dividend smoothing and lagged investment effect observed in the data. The key moments that are closely related to these aspects are autocorrelation of dividend-capital ratio and autocorrelation of investment rate, respectively. The model also tends to match the changes in distribution of firms across finance regimes. Each time period is set to a year to better understand the extensive margin effects of the tax reform. The calibration period is 1988-2002, which is the period before the 2003 tax reform. I assume that the model economy reaches the initial steady state before 2003 in order to study the long-run effects of the 2003 tax cuts. Since this model economy does not have a closed-form solution for the stationary equilibrium, the numerical method is used to approximate stationary equilibrium.[26] The household and firms have myopic expectations, i.e. shocks are unexpected and permanent.

The model has 16 parameters:

$$\Lambda = \Big\{\beta, \delta, h, \psi, \alpha_k, \alpha_n, \sigma_z, \rho_z, \sigma, \varphi, \eta, \phi_d, \tau_d, \tau_{cg}, \tau_i, \tau_c\Big\}$$

Parameters are divided into two groups: internally and externally calibrated. The first group of parameters is determined in the stochastic environment, while the second group of parameters is set fixed in accordance with the estimates from the literature. Among internally calibrated parameters, there are parameters estimated by the Simulated Method of Moments (e.g. h, ψ, ϕ_d, η) and parameters that are calibrated directly from the data by solving non-stochastic steady state in which $z_t = 1$ for all t (e.g. β, δ, d^*). Table 3 shows obtained values for internally calibrated parameters, while Table 4 indicates values for externally calibrated parameters.

The SMM is used to estimate the set of key parameters of the model:

$$\omega = \{h, \psi, \phi_d, \eta\}$$

The goal is to determine the value of the set of parameters $\hat{\omega}$ such that the model moments $\hat{m}(\omega)$ matches the data moments m. If the model economy permitted an analytic solution, then we could directly compute model-generated moments from the system of equations. Since the model economy does not have a closed-form solution, the indirect inference is used for the estimation. The indirect inference proceeds in the following way: (1) for a set of (externally calibrated and guess for internally calibrated) parameters, solve the dynamic problem of firms by the Value Function Iteration on a grid, (2) compute policy functions and stationary distribution of firms, (3) calculate model moments; (4) given a guess for the values of vector θ, compute the difference between the model moments and data moments such that

$$g_i(\omega) = m_i - \hat{m}_i(\omega)$$

[26] Appendix A2 provides the procedure for solving the model numerically.

$$g(\omega) = (g_1(\omega), \ldots, g_n(\omega))$$

where $n = 4$ refers to the number of the data moments, (5) update the guess for θ using `fminsearch`, (6) continue until the difference between the model moments and data moments is minimized. The estimator of SMM:

$$\hat{\omega} = arg \min_{\omega} \; g(\omega)'\mathcal{W}g(\omega)$$

where $\mathcal{W}$ is the optimal weighting matrix. In the model, $\mathcal{W}$ is set to one. Estimated parameters are those that minimize the squared distance between simulated model moments and data moments (targets). Even though all the moments are jointly determined inside the model, some parameters are more suitable for matching certain moments.

Tax system. I assume constant and proportional rates in the model economy. Shareholder income tax rates, including tax rates on dividends, capital gains and personal income, depend on the income tax bracket the corresponding shareholder belongs to. Following Gourio and Miao (2011, 2010), I assume that the representative household (shareholder) has an average income in the US, which belongs to the lowest category of the top four income tax brackets. Therefore, I set the dividend tax $\tau_d = 0.25$, the capital gains tax $\tau_{cg} = 0.20$, and the personal income tax $\tau_i = 0.25$. Operating profit of a firm is taxed at $\tau_c = 0.34$.

Household preferences. The rate of time preferences β for firms is set to 0.966 such that average annualized real interest rate r equals 0.04, which corresponds to the after-tax risk free (T-bill) interest rate in the US over the sample period.[27] Choose the parameter h, which denotes the preferences for leisure, such that the aggregate labor supply equals 0.3 in the equilibrium. That is the average fraction of time devoted for work. Risk aversion parameter $\sigma = 1$ implies that the household has log utility of consumption. The inverse of Frisch labor elasticity is set to $\varphi = 1$, which is suggested by Chang et al. (2019) for the representative household model.

[27] In equilibrium, the discount factor of the household corresponds to $\beta = 1/(1 + (1 - \tau_i)r)$.

Production technology. Using Tauchen and Hussey (1991), the continuous productivity process from (3) is discretized. I borrow the (non-structural) estimated production parameters from Gourio and Miao (2011, 2010) such that the capital share in production function $\alpha_k = 0.311$, the labor share in production function $\alpha_n = 0.650$, persistence of the productivity shock $\rho_z = 0.767$ and standard deviation of the productivity shock $\sigma_z = 0.211$. The depreciation rate δ is determined by investment rate in steady state such that the model-generated aggregate investment rate matches the observed aggregate investment rate, which is 0.095 based on NIPA. Convex adjustment costs of capital is incorporated in the model to prevent firms from quick responses to productivity shocks. The parameter ψ is calibrated to match the cross-sectional volatility of the investment rate observed in the NIPA data, which is 0.156. Empirical motivation for capital adjustment costs comes from Cooper and Haltiwanger (2006).

Table 3: Internally calibrated parameters for the General Equilibrium model

Description	Parameter	Value	Target	Source
discount factor	β	0.971	r=0.04	typical in literature
depreciation rate	δ	0.095	I/K=0.095	NIPA
dividend target	d^*	0.0561	$mean(D/K)$=0.0561	Compustat
weight on leisure	h	7.0928	N^s=0.3	typical in literature
convex inv adj cost	ψ	0.9068	$sd(I/K)$=0.156	NIPA
dividend adj cost	ϕ_d	0.1799	$sd(D/K)$=0.0431	Compustat
repurchases constraint	η	0.0116	$mean(Sneg/K)$=0.0115	Compustat

Note: Sneg refers to repurchases. The Compustat data come from Gourio and Miao (2010).

In a steady-state equilibrium, the stochastic properties of productivity shocks (σ_z, ρ_z) do not matter, and dividends are equal to the long-term dividend target d^*. Although their corresponding parameters do not affect the steady state, they do affect the dynamics of the model. Note that in calibration $d^* = 0.0561$ is determined as total dividend payments normalized by capital stock for the 1988-2006 period. Normalization with respect to capital is done to abstract from differences in dividends that come from a firm size. I choose the single target for dividend payments that is common to all firms in order to allow the adjustment costs on dividends to play the role of stabilizing the volatility of dividend payments in the model economy.[28] The long-term dividend target is time-invariant, common across firms, exogenous and taken as given by all firms. The parameter on the constraint on repurchases $\eta = 0.0116$ is set to match average repurchases to capital ratio observed for the 1988-2002 period. The estimated value for η is similar to the estimated parameter by Karabarbounis and Neiman (2012) where $\eta = 0.0123$. The parameter on dividend adjustment costs $\phi_d = 0.1799$ is set to match standard deviation of dividends to capital ratio for the 1988-2002 period. Jermann and Quadrini (2012) estimated a similar value for $\phi_d = 0.1460$.

Table 4: Externally calibrated parameters for the General Equilibrium model

Description	Parameter	Value	Source
exponent on capital	α_k	0.311	GM(2010)
exponent on labor	α_n	0.650	GM(2010)
stand dev of shock	σ_z	0.211	GM(2010)
persistance of shock	ρ_z	0.767	GM(2010)
risk aversion	σ	1	typical in literature
inverse Frisch labor elasticity	φ	1	CKKR(2019)
tax on dividends	τ_d	0.25	GM(2010)
tax on capital gains	τ_{cg}	0.20	GM(2010)
tax on personal income	τ_i	0.25	GM(2010)
tax on operating profit	τ_c	0.34	GM(2010)

Note: GM(2010) refers to the benchmark paper written by Gourio and Miao (2010). CKKR(2019) indicates Chang et al. (2019).

[28] Suppose that a firm is hit by a positive productivity shock. In that case, the firm will tend to pay more dividends over time. However, the shock will also increase the dividend target, which decreases the cost of deviation and increases variations in dividends. Consequently, the role of the adjustment costs on dividends as a volatility stabilizer is mitigated with multiple targets.

5.6.2 Model Validation

The green elements in Table 5 show that the GE (general equilibrium) model economy well accounts for the targeted moments observed in the data: investment rate, volatility of investment rate, dividend-to-capital ratio, volatility of dividend-to-capital ratio, and repurchase-to-capital ratio. As for non-targeted moments, the model moments are close to the data moments. The exceptions are lower volatility of repurchases than volatility of dividends in the model, which may imply that there are shocks to earnings other than firm-level productivity shocks important for model fit. Eberly et al. (2012) claim that the best predictor of current investment rate is the last period investment rate. Accordingly, I expect a strong autocorrelation of investment rate in the data, which is confirmed in the model. There is a slightly larger deviation in autocorrelation of earnings-to-capital in the model than the one in the data. Strong dividend smoothing is reflected in high autocorrelation of dividends-to-capital. Model-generated autocorrelation of the new equity issues deviates from data-generated one, with 0.51 and 0.14, respectively. The introduction of fixed costs on new equity issues may reduce such autocorrelation.

Table 5: Model fit of the General Equilibrium at aggregate level

	Data			Model		
Ratios	Mean	SD	AC(1)	Mean	SD	AC(1)
I/K	0.09	0.16	0.60	0.09	0.14	0.63
E/K	0.36	0.15	0.80	0.17	0.19	0.66
D/K	0.05	0.04	0.40	0.04	0.06	0.69
Spos/K	0.03	0.10	0.14	0.02	0.06	0.51
Sneg/K	0.01	0.05	0.34	0.01	0.02	0.63
D/E	0.14	0.08	0.49	0.33	0.20	0.54
Sneg/E	0.09	0.07	0.65	0.04	0.18	0.58

Note: Targeted moments are colored green. Variable Spos, Sneg, E, D, I, K stand for aggregate equity issues, repurchases, earnings, dividends, investment, capital. The Compustat data are borrowed from Gourio and Miao (2010).

Table 6 shows changes in the number of firms in the data, my model economy and the model economy of the benchmark paper. Firms from regimes 2 and 3 in my model are grouped in one regime with transiting firms in order to be comparable with the data. In contrast to Gourio and Miao (2011), this study has a much better fit with the data before 2003. Moreover, my model predicts (long-run) changes in the distribution of firms across the finance regimes after 2003 consistent with the data, which has an important role in understanding the extensive margin effects of the tax reform. Comparing with the data, by introducing the payout flexibility through frictions on dividends and repurchases, my model generates a larger transition of firms from regime 2 to regime 1 and mitigates the transition of firms from regime 2 to regime 3.

Table 6: Model fit of General Equilibrium at cross-sectional level

	Compustat Data			General Equilibrium Model		
	regime 1	regime 2	regime 3	regime 1	regime 2	regime 3
This study	0.23(0.27)	0.30(0.20)	0.47(0.53)	0.21(0.32)	0.32(0.15)	0.47(0.53)
GM(2011)				0.25(0.31)	0.48(0.35)	0.27(0.34)

Note: Table shows the changes in the fraction of firms across the finance regimes. Numbers outside the brackets refer to the calibration 1988-2002 period. Numbers of the Compustat data inside the brackets indicate the 2003-2006 period. The Compustat data are borrowed from Gourio and Miao (2010). GM(2011) refers to implied changes in distribution of firms within the benchmark model of Gourio and Miao (2011). For easier comparison with the data, share-repurchases and dividend-constrained regimes are grouped in regime 2.

Although the model overpredicts the dividend smoothing at the aggregate level, it still well matches the changes in the distribution of firms across the finance regimes. Hence, the model-generated moments may serve as a starting point for policy analysis.

5.6.3 Quantitative Results

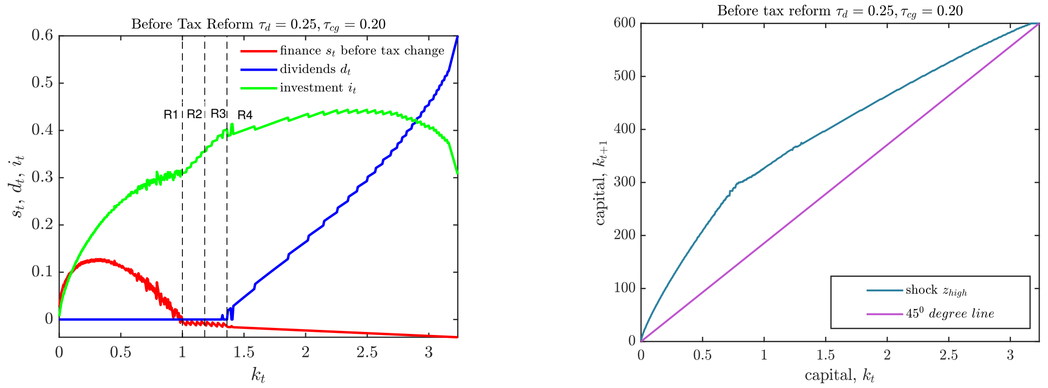
5.6.3.1 Responses of Firms for the pre-2003 Period

Figure 4 shows optimal financial and investment responses of firms obtained for the pre-2003 period in the General Equilibrium with the adjustment costs on dividends and constraint on repurchases. Panel (a) illustrates financial responses of firms across the finance regimes. It shows three optimal decision rules for a *mean* level of positive productivity and different levels of capital stock: equity finance, dividends, and investment.[29] Depending on the initial capital stock, firms are located in one of the four finance regimes. The regimes are separated by the vertical lines. Firms with a low level of capital need to borrow directly from their shareholders to finance their investment needs. Firms with a relatively high capital stock begin to buy back their existing shares due to tax and flexibility motives. Finally, firms from the payout regime start to pay dividends along with share repurchases. Once firms reach the targeted level of capital stock, capital investment remains relatively constant and finally exhibits a fall, while dividends start to rise even more over time. Panel (b) shows the dynamics of capital stock.

The inverted U-shape pattern of new equity issue as a function of physical capital could be explained by two opposing forces. On the one hand, larger external finance at time t increases capital expenditure, which generates expected operating profit at time $t + 1$. On the other hand, larger capital investment also increases capital adjustment costs[30], particularly at a low level of physical capital. The higher the capital stock, the lower the capital adjustment costs, which further causes the marginal benefit of external finance to become larger than the marginal costs of external finance. At some level of capital stock, expected operating profit of firms starts to decrease because of the DRTS technology. This technology induces a decreasing trend in external finance. The first force dominates at a low level of capital stock, while the second force dominates at a high level of capital.

[29] In the model economy, there are 10 points in the productivity grid. Figure 4 considers a mean level of positive productivity.

[30] Convex capital adjustment costs contain disruption costs during installation of new capital, costs related to learning production structure, etc.



(a) policy responses (b) capital dynamics

Figure 4: Optimal decisions of firms across regimes in the General Equilibrium, 1988-2002

5.6.3.2 Financial Responses of Firms for the post-2003 Period

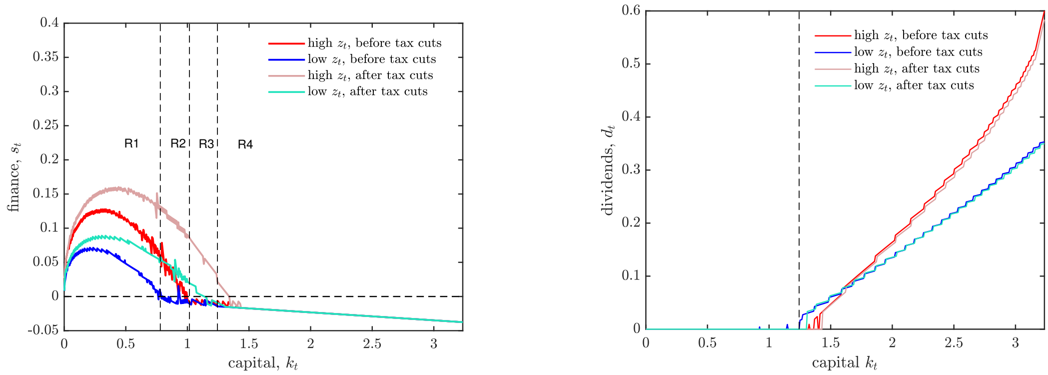
This subsection explains financial responses of firms to the idiosyncratic productivity shock and tax shock in the post-2003 period. Figure 5 shows heterogeneous responses of firms in equity transactions and dividends. The model economy has 10 grid points for productivity. High positive productivity refers to the 8th grid point, while low positive productivity indicates the 7th grid point. The finance regimes are separated taking into account low productivity before 2003.

For a given level of capital stock k_t and fixed government fiscal policy, panel (a) indicates heterogeneous equity responses that are generated as a result of different productivity levels (compare dark blue and dark red lines). Firms from regime 1, which are hit by higher positive productivity shock z_t, have larger investment needs, and thus are stimulated to issue more new equities $s_t > 0$. Firms from regime 2 increased new equity issues, implying that a positive productivity shock generates larger investment needs than it increases internal funds. Firms from regime 3 do not issue new equities because such transaction reduces the market value of shares that might not be sufficiently covered by return on investment due to the DRTS technology. Finally, higher positive productivity does not affect equity transactions of firms from regime 4. The intuition is the following; new equity issue of such firm induces additional dividends in the next period, which increases total dividend payments of the firm, and thus reduces its financial flexibility in the next period. Panel (b) indicates that for a given capital stock and fixed fiscal policy, a firm that is hit by a higher positive productivity shock responds by distributing dividends with a higher time lag because such firm intends to exploit larger investment opportunities (compare dark red and dark blue lines). Moreover, the slope of the dividend threshold becomes steeper with the higher positive productivity shock (compare dark red and dark blue lines). This implies that larger capital investment generates a larger return that could be used for distributing more dividends in the future.

From the previous sections, we know that the 2003 tax cuts stimulate payouts through higher after-tax return paid to the shareholder. Dividends become relatively more tax preferable than repurchases, but repurchases still keep the flexibility motive for returning capital to the shareholder. In addition, the tax reform makes external funds cheaper and increases the (after-tax) return on investment through the reduced user cost of capital, which in turn stimulates larger capital investment.

Holding capital stock and productivity fixed, the 2003 tax reform amplifies the equity responses of firms. That is, for example firms with high investment opportunities from regime 1 and regime 2 issue more new equities (compare dark red and light red lines). Hence, the tax reform has the intensive and extensive margin effects on equity decisions. Although panel (b) shows that the tax reform generates the slightly asymmetric dividend responses for the two selected different levels of productivity[31], the quantitative results from Table 7 predict a rise in aggregate dividends of around 11% after 2003.

[31] Depending on the level of productivity, there are opposing effects of the tax cuts on dividends. On the one hand, for a given capital stock and low productivity, the 2003 tax reform stimulates a firm to *increase* dividend payments (see dark blue and light blue lines). On the other hand, holding capital stock and high productivity fixed, a firm *decreases* dividend payments after the 2003 tax reform (see dark red and light red lines).



(a) finance (b) dividends

Figure 5: Optimal equity and dividend responses of firms in the General Equilibrium

5.6.3.3 Aggregate Payout Responses After 2003

Could the historical drop in taxes on dividends and capital gains generate large payouts to shareholders and large capital investment after 2003? Table 7 shows that the 2003 tax cuts ($\tau_d = 0.15, \tau_{cg} = 0.15$) in the General Equilibrium model (GE) trigger positive long-run aggregate dividends and investment of 10.78% and 3.27%, respectively. However, repurchases experienced a drop of 3.52% mainly because the tax reform induces a large extensive margin effect, i.e. a large reallocation of capital of transiting firms to the regime with new equity issues. That is, the payout flexibility of repurchases through two frictions, including adjustment costs on dividends and endogenous constraint on repurchases, were not sufficiently activated to generate positive responses in aggregate repurchase to the tax reform.

Sticky wages in the model ($\widetilde{GE}$) provide firms with excess cash such that transiting firms with relatively high investment opportunities decrease demand for external funds, which mitigates the extensive margin effects of the tax reform on reducing repurchases.[32] Moreover, transiting firms with low investment opportunities increase demand for repurchases, which amplifies the intensive margin effects of the tax reform on increasing

[32] See Appendix A.3 for more about the formulation of sticky wages in the current model. Transiting firms in the model economy are firms with positive repurchases, but without equity issues and dividends. Excess cash in the model implies that internal funds are larger than investment needs.

repurchases.[33] At the aggregate level, the model generates a rise in repurchases of 4.18% and dividends of 17.90%. These aggregate effects of the 2003 tax reform on dividends and repurchases are robust to different counterfactual experiments (see Appendix A5). Similar findings about the absence of substitution between dividends and repurchases after 2003 are documented in the empirical literature (see Floyd et al., 2015; Edgerton, 2013; and Chetty and Saez, 2005). The benchmark paper, denoted by GM(2011) in Table 7, confirms the importance of incorporating the payout flexibility of repurchases into the current model because, under the setting with sticky wages, the 2003 tax reform would not be able to generate positive responses in aggregate repurchases.

Table 7 contains different tax experiments that disentangle the effects of dividend tax cuts from capital gains tax cuts on payouts and capital investment. In addition, these tax experiments prove that my models ($GE, \widetilde{GE}$) do not force only one type of payouts, but instead firms take into consideration a certain type of a tax cut when making optimal payout decisions.

Table 7: Long-run aggregate effects of tax experiments

	% Change in aggregates (GE)			% Change in aggregates ($\widetilde{GE}$)		
	dividends	repurchases	investment	dividends	repurchases	investment
Empirics	20.00	7.14	10.20	20.00	7.14	10.20
GM(2011)	15.33	-13.61	4.03	31.55	-10.07	15.94
tax experiments						
(a) τ_d=0.20, τ_{cg}=0.20	10.90	-5.82	-0.20	13.51	-3.41	2.09
(b) τ_d=0.20, τ_{cg}=0.15	-0.07	2.74	3.39	4.46	7.72	8.00
(c) τ_d=0.15, τ_{cg}=0.15	10.78	-3.52	3.27	17.90	4.18	10.20

Note: Table shows percent changes in aggregate variables for the post-2003 period relative to the 1988-2002 calibration period. The taxes on dividends (τ_d) and capital gains (τ_{cg}) are set to 0.25 and 0.20 in the initial steady state. The 2003 tax reform: $\tau_d = 0.15, \tau_{cg} = 0.15$. GE indicates the General Equilibrium setting, and $\widetilde{GE}$ is the General Equilibrium with sticky wages ($\rho_w = 0.7848$). Estimated response in repurchases is $exp(0.069) \cdot 100\% - 100\% = 7.14\%$. GM(2011) refers to the benchmark model of Gourio and Miao (2011).

[33] Confirmation about the connection between sticky wages and extensive and intensive margin effects of the tax reform is represented in Table 8.

5.6.3.4 Distributional and Welfare Effects of the 2003 tax Reform

There is strong empirical support for heterogeneous responses of firms to the 2003 tax reform (see Campbell et al., 2013; Gourio and Miao, 2010; Chetty and Saez, 2006). One of the main arguments for the implementation of the tax cuts on dividends and capital gains was the lack of productive investment opportunities. Therefore, by stimulating cash payouts to shareholders through tax cuts, cash could circulate in capital markets to finance productive investment. This capital reallocation will be further reflected in a rise in welfare benefits. This study predicts a rise in Total Factor Productivity of 0.35pp (0.05pp) and consumption equivalent welfare of 0.97% (7.92%) in the General Equilibrium (General Equilibrium with sticky wages), respectively.

Table 8 shows changes in the distribution of firms across the finance regimes after the 2003 tax reform. Comparing with the GE-pre, the GE-post contains a drop in the transiting regime, which affects a rise in the number of firms within the external-growth and payout regimes. These capital reallocations exert large extensive effects of the tax reform on reducing repurchases and increasing dividends. As for the intensive margin effects, Figure 6 shows that some transiting firms reduce capital investment, which is in turn used for repurchases. Comparison between the last two columns of Table 8 shows that incorporating sticky wages in the General Equilibrium setting ($\widetilde{GE}$-post) mitigates the extensive margin effects of the 2003 tax cuts on reducing repurchases and amplifies the intensive margin effects of the tax cuts on increasing repurchases.

Figure 7 shows that high-productive firms increase capital investment, while low-productive firms decrease capital investment in the General Equilibrium setting. Since Table 7 displays that aggregate investment rises, the rise in investment of high-productive firms is higher than the drop in investment of low-productive firms. Higher aggregate capital leads to higher output and labor demand over time. Since the rise in aggregate output is driven by high-productive firms, aggregate output increases more than the rise in aggregate capital and employment, leading to a rise in Total Factor Productivity (TFP). The aggregate productivity gains, measured by TFP, become larger

Table 8: A fraction of firms across the finance regimes

	external-growth	transiting	payout
Data post	0.272	0.200	0.528
GE-pre	0.211	0.316	0.473
GE-post	0.315	0.154	0.531
$\widetilde{GE}$-post	0.308	0.156	0.536

Note: Data post stands for the fraction of firms across the finance regimes in the Compustat data for the 2003-2006 period. GE-pre refers to the General Equilibrium model for the pre-2003 period. GE-post is the General Equilibrium for the post-2003. $\widetilde{GE}$-post is the General Equilibrium with the sticky wages. A fraction of firms in one of the regimes is computed as the number of firms in that regime divided by the total number of firms across the all finance regimes. For easier comparison with the data, share-repurchases and dividend-constrained regimes are grouped in the transiting regime.

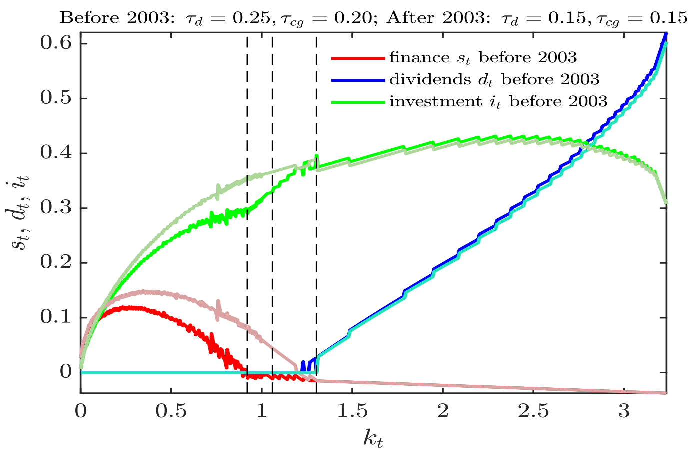


Figure 6: Optimal decisions of firms across different finance regimes, General Equilibrium

with the higher participation of the most productive firms in producing aggregate output. In contrast to Gourio and Miao (2011), my study generates larger total payouts (or a lower degree of substitution between aggregate payouts) and a slightly weaker growth in TFP in the General Equilibrium (see Table 9). The intuition behind the weaker growth of TFP is that although the payout flexibility helps to mitigate a rise in dividends and a drop in repurchases after the 2003 tax cuts, financial flexibility also mitigates a rise in new equity issues from the most productive firms.

The tax reform may have strong indirect effects on profits and returns on capital investment through wage changes. To quantify such effects, I consider the Partial Equilibrium setting (PE), which assumes that the wage rate is fixed at its level before the tax reform. Consequently, PE turns off the wage feedback effects on firms. In stark contrast to Gourio and Miao (2011), Table 9 reveals that the tax reform generates positive aggregate repurchases of 6.15% and TFP of 0.05pp. That is, additional labor market friction in my study reduces aggregate productivity gains, but still the other two financial frictions, including adjustment costs on dividends and endogenous constraint on repurchases, help to generate positive repurchases and maintain TFP positive after the 2003 tax cuts. A relaxed constraint on repurchases prevents reallocation inefficiency after the tax reform. Moreover, the model predicts that investment responses to reduction in shareholder taxes are larger when the constraint on repurchases is more relaxed.

Table 9: Aggregate productivity gains and aggregate payouts

Model	TFP(pp)		agg Dividends(%)		agg Repurchase(%)		total Payouts(pp)	
	GE	PE	GE	PE	GE	PE	GE	PE
GM(2011)	0.37	-0.05	15.42	31.52	-13.62	-10.22	1.80	21.30
This study	0.35	0.05	10.78	19.98	-3.52	6.15	7.26	26.13

Note: GM(2011) refers to Gourio and Miao (2011). Table shows percent changes in aggregate variables for the post-2003 period relative to the 1988-2002 calibration period. According to the San Francisco Federal Reserve's database, TFP recorded a rise of 0.85pp. Total Factor Productivity in the model is $TFP = Y/K^{\alpha_k}N^{\alpha_n}$. PE implies the Partial Equilibrium setting, GE is the General Equilibrium setting.

Figure 7 depicts changes in aggregate capital before and after 2003. A dividend tax cut (blue line) decreases capital among unproductive firms and increases capital among productive firms, i.e. the dividend tax cut drives the reallocation of capital from unproductive to productive firms. A capital gains tax cut (red line) increases capital among both unproductive and productive firms because of increased after-tax return. However, the effects of the tax cut on capital gains are not sufficiently strong to push up a capital accumulation among unproductive firms. Hence, quantitative results predict that, at an aggregate level, firms with negative and low positive productivity shocks are stimulated to decrease investment after the 2003 tax cuts. In the model, such generated excess cash flow could only be steered to increasing repurchases and dividends.

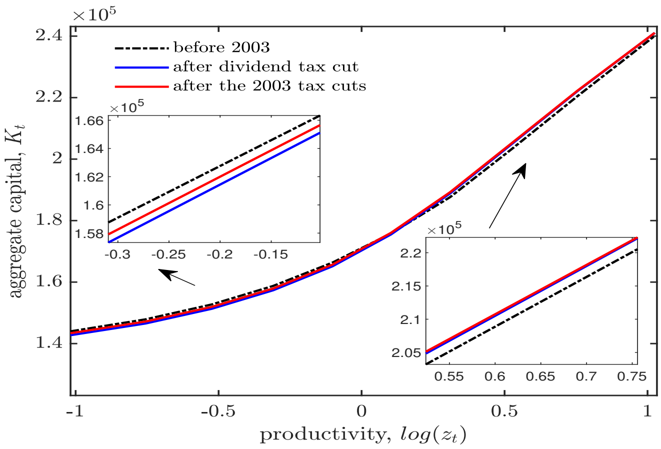


Figure 7: Capital reallocation across productivity bins in the General Equilibrium

The important channels through which the tax reform itself generates real effects on the economy are the reallocation and interest rate channels. The reallocation channel transfers capital among firms, while the interest-rate channel constitutes a large part of the user cost of capital. Figure 7 indicates that dividend taxes have much lower real effects than capital gains taxes.

Since the current model only considers payouts (dividends and repurchases) that are conducted in compliance with the long-term balance strategy of firms, the rise in payouts after the 2003 tax reform is followed by a rise in capital investment, job creation (employment), higher wages, and higher consumption (see Table 10). Welfare increases by 0.97% in the General Equilibrium, while it increases by 7.92% in the General Equilibrium with sticky wages.

Table 10: Aggregate real effects of tax changes in the General Equilibrium

Experiment	% Change in aggregates						
	investment	output	employment	wage	firm value	TFP	welfare
tax reform	3.26	1.54	0.28	1.25	10.31	0.35	0.97

Note: Holding leisure fixed at its initial level, changes in consumption is taken as a measure for welfare effects. Total Factor Productivity: $TFP = Y/K^{\alpha_k}N^{\alpha_n}$. The 2003 tax reform: $\tau_d = 0.15, \tau_{cg} = 0.15$. The calibration period is 1988-2002. Table shows percent changes in aggregate variables for the post-2003 period relative to the 1988-2002 calibration period.

6. Conclusion

In the last two decades, the US has intensively used corporate tax cuts to stimulate economic growth. This study specifically investigates the 2003 tax reform, which features a historical fall in taxes on dividends and capital gains. Although the empirical results from the literature show that both aggregate dividends and share repurchases saw a rise after the 2003 tax cuts, the quantitative frameworks in the literature indicate the presence of substitution between the two types of payouts to shareholders. This study uses the financial flexibility as an additional motive for share repurchases. The financial flexibility of repurchases is incorporated in the tax framework through two financial frictions, including dividend adjustment costs and endogenous constraint on repurchase. Consequently, firms have an opportunity to avoid a long-term commitment to large dividend payments by using repurchases because any deviation from such a commitment is penalized by the financial markets. Sticky wages provide firms with excess cash in the model, which opens the space for increasing aggregate dividends and repurchases by around 18% and 4%, respectively. This study also predicts a rise in Total Factor Productivity of 0.05pp and consumption equivalent welfare of 7.92% in the General Equilibrium setting with sticky wages.

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Appendix

A1. Indeterminacy of Financial Policy

To prove that financial policy of firms becomes irrelevant to firm value after 2003, I consider the following optimization problem of firms:

$$\max_{d_t, s_t, k_{t+1}} V_t = \frac{1-\tau_d}{1-\tau_{cg}} d_t - s_t + P_t \tag{A1.1}$$

$$s.t. \quad d_t + k_{t+1} - (1-\delta)k_t = (1-\tau_c)\Pi_t(A_t, k_t, z_t; w_t) + \tau_c \delta k_t + s_t \tag{A1.2}$$

By total differential:

$$dV_t = \frac{\partial V_t}{\partial d_t} dd_t + \frac{\partial V_t}{\partial s_t} ds_t + \frac{\partial V_t}{\partial k_{t+1}} dk_{t+1}$$

Note that $\tau_d > \tau_{cg}$, $\psi = \phi_d = 0$, investors are rational, capital markets are competitive and free of asymmetric information. Therefore, the dividend tax preference parameter is the only reason to deviate from perfect capital market.

Holding investment policy fixed, the effects of dividends on the firm value is:

$$\frac{dV_t}{dd_t} = \frac{\partial V_t}{\partial d_t} + \frac{\partial V_t}{\partial s_t}\frac{ds_t}{dd_t}$$

$$\frac{dV_t}{dd_t} = \frac{1-\tau_d}{1-\tau_{cg}} - 1 \tag{A1.3}$$

After the 2003 tax reform, when both taxes on dividends and capital gains were cut to the same 15%, i.e. $(1-\tau_d)/(1-\tau_{cg}) = 1$, one can show that dividend policy is indeterminate, i.e. firm value is independent from dividends:

$$\frac{dV_t}{dd_t} = 0$$

In a similar way, one can show the indeterminacy of share repurchases:

$$\frac{dV_t}{ds_t} = 1 - \frac{1-\tau_d}{1-\tau_{cg}} \tag{A1.4}$$

Therefore, after the 2003 tax cuts the above model specification generates results distinctive to the Miller and Modigliani world, where dividends and capital gains have identical value in equilibrium. In order to make financial policy determined after the

2003 tax reform, I incorporate adjustment costs on dividends in the model economy, $\phi_d(d_t - d^*)^2$. Consequently, equation (A1.3) becomes modified as:

$$\frac{dV_t}{dd_t} = \frac{1-\tau_d}{1-\tau_{cg}} - 1 - 2\phi_d(d_t - d^*) \tag{A1.5}$$

Even after imposing extra costs on dividends, equation (A1.5) may still induce $dV_t/dd_t = 0$ when $\tau_d = \tau_{cg}$ and $d_t = d^*$ after 2003. Numerical results suggest that if there is excess cash flow available for dividends, then there will be a deviation of dividend payments from data-determined dividend target d^*.

Adjustment costs on dividends play two roles in the model economy of this study, including stabilizing the volatility of dividends and determining the financial responses of firms to the tax reform at the aggregate level.

A2. Numerical Algorithm

Since there is no analytical solution to the dynamic problem of the model economy, I solve the model numerically. The procedure for solving the model economy consists of five steps:

1. *Given a guess of wage rate* w_0*, compute value function* $V(k_t, z_t)$ *and optimal decision rules* $(g(k_t, z_t), d(k_t, z_t), s(k_t, z_t), i(k_t, z_t), n(k_t, z_t))$ *for a firm by a value function iteration on a grid.* In the computation I assume that the constraint on share repurchases is always binding. That assumption implies that firms have to exploit all opportunities for repurchases due to tax and flexibility motives before starting to pay dividends. I set 600 grid points for capital stock and 10 grid points for productivity. The grid is finer for lower levels of capital stock. The lower bound for capital is $\underline{k} = 1e - 3$, while the upper bound for capital is set at the level to bind with small probability $\bar{k} = 3 \cdot k^*$. A targeted level of capital k^* is computed in the following manner. From (21), the firm's user cost of capital is:

$$uc_t = -\frac{\Psi_{i,t+1}(i,k)}{\Phi_{d,t+1}(d,d^*)} \cdot (1-\delta) - \tau_c \delta + \frac{\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_t^d}{\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_{t+1}^d} \cdot \frac{\Psi_{i,t}(i,k)}{\Phi_{d,t}(d,d^*)} \cdot \Big(\frac{r(1-\tau_i)}{1-\tau_{cg}} + 1\Big) - \frac{\lambda_{t+1}^s \eta}{\frac{1-\tau_d}{1-\tau_{cg}} + \lambda_{t+1}^d}$$

   where $\Psi_{i,t} = 1 + \psi \frac{i_t}{k_t}$ and $\Phi_{d,t} = 1 + 2\phi_d(d_t - d^*)$. In the absence of financial constraints, real and financial frictions and tax burdens, the firm always invests in physical capital to hit some targeted capital. This targeted capital is determined by production technology, interest rate, and depreciation of capital. Hence, we have $uc_t = r + \delta$. To determine the upper bound of capital stock, I set the marginal product of capital $F_{k,t} = uc_t$ such that in the equilibrium $\alpha_k (k^*)^{\alpha_k - 1} (n^*)^{\alpha_n} = r + \delta$. From the last expression, one can determine $k^* = (n^*)^{\frac{\alpha_n}{1-\alpha_k}} (\frac{\alpha_k}{r+\delta})^{\frac{1}{1-\alpha_k}}$. After setting grid points for capital and productivity, iterate on value function to solve the dynamic problem of firms (8).

2. *Compute the stationary distribution* $\mu^*(k_t, z_t; w_t)$. Iterate on the law of motion for the firm distribution (18).

3. *Given* μ^**, compute aggregate quantities* such as labor demand, output, investment, capital, profit, dividends, equity issues, share repurchases $(N^d, Y, I, K, \Pi, D, S, \tilde{S})$, respectively.

4. Once the aggregate labor demand is computed, check whether the labor market clears: $(1-\tau_i)w = h\frac{(N^s)^\varphi}{C^{-\sigma}}$, where C is computed from the resource constraint. If the labor market condition is not satisfied, then use the bisection method to update wage guess.

5. Repeat the above steps n times until the labor market clears. This delivers the market-clearing wage w_n^*.

A3. Wage Rigidity

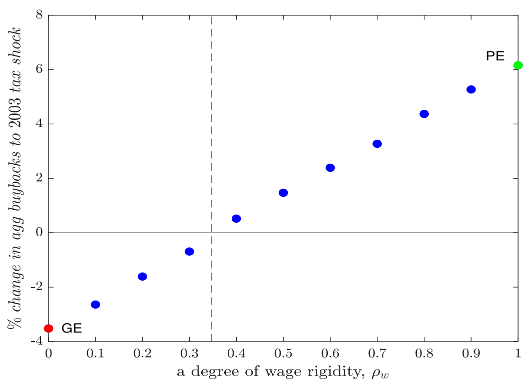
Following Blanchard and Galí (2007), I impose *ad hoc* wage rigidity:

$$\text{initial steady-state}: \; w_0 = w_n^{*,pre}$$

$$\text{final steady-state}: \; w_1 = (w_0)^{\rho_w} \cdot (w_n^{*,post})^{1-\rho_w}$$

where $\rho_w \in [0,1]$ measures persistence of wage rigidity. The parameter $\rho_w = 0$ stands for the General Equilibrium setting with fully-flexible wage that clears the labor market. I use the bisection method to clear excess (aggregate labor) demand in the labor market, i.e. after n steps one needs to determine wage that clears the labor market in the pre-tax period $w_n^{*,pre}$, and wage that clears the market in the post-tax period $w_n^{*,post}$. Figure A3 shows responses of aggregate repurchases to the 2003 tax reform for a different degree of wage rigidity. The green dot from Figure A3 implies that the wage is fixed at the level from the initial steady state. That is, labor demand determines aggregate employment in the model economy, while the labor market-clearing condition is ignored. Similar analysis is conducted by Di Nola et al. (2021) and Hong and Moon (2019) among many others. The values for the degree of wage rigidity range from 0.5 to 1 in the literature. Following Duval and Vogel (2012), I set $\rho_w = 0.7848$. The wage rigidity $\rho_w = 0.7848$ indicates that the wage feedback effects of the General Equilibrium do not play an important role in explaining the influence of the 2003 tax reform on aggregate repurchases.

Figure A3. Aggregate repurchases and wage rigidity



Note: Red dashed line determines the threshold for positive repurchases, $\rho_w = 0.3472$.

A4. Analytical Solution to Dynamic Problem of Firms

$$V_t(k,t) = \min_{\{\mu_t, q_t, \lambda_t^d, \lambda_t^s\}} \max_{\{k_{t+1}, i_t, d_t, s_t\}} \frac{1-\tau_d}{1-\tau_{cg}} d_t + \lambda_t^d d_t - s_t + \lambda_t^s(s_t + \eta k_t) - q_t(k_{t+1} - (1-\delta)k_t - i_t)$$

$$- \mu_t\Big(d_t + \phi_d(d_t - d^*)^2 + i_t + \frac{\psi}{2}\frac{i_t^2}{k_t} - (1-\tau_c)\Pi_t(A_t, k_t, z_t; w_t) - \tau_c \delta k_t - s_t\Big) + \beta \mathbb{E}_t\Big[V_{t+1}(k_{t+1}, z_{t+1})\Big| z_t\Big] \tag{A4.6}$$

$$d_t: \ \frac{1-\tau_d}{1-\tau_{cg}} + \lambda_t^d - \mu_t \cdot (1 + 2\phi_d(d_t - d^*)) = 0 \tag{A4.7}$$

$$s_t: \ -1 + \lambda_t^s + \mu_t = 0 \tag{A4.8}$$

$$k_{t+1}: \ -q_t + \beta \mathbb{E}_t\Big[\frac{\partial V_{t+1}(k_{t+1}, z_{t+1})}{\partial k_{t+1}}\Big| z_t\Big] = 0 \tag{A4.9}$$

$$i_t: \ q_t - \mu_t(1 + \psi \frac{i_t}{k_t}) = 0 \tag{A4.10}$$

$$EC[k_t]: \ \frac{\partial V_t(k_t, z_t)}{\partial k_t} = \lambda_t^s \eta + q_t(1-\delta) - \mu_t\left(\frac{\psi}{2}\Big(\frac{i_t}{k_t}\Big)^2 - (1-\tau_c)\frac{\partial \Pi_t(k_t, z_t)}{\partial k_t} - \tau_c \delta\right) \tag{A4.11}$$

$$KT_1: \ \lambda_t^d \geq 0, \ d_t \geq 0, \ \lambda_t^d \cdot d_t = 0 \tag{A4.12}$$

$$KT_2: \ \lambda_t^s \geq 0, \ s_t \geq -(\eta k_t), \ \lambda_t^s \cdot (s_t + \eta k_t) = 0 \tag{A4.13}$$

where the complementary slackness conditions from Kuhn-Tucker are given by KT_1 and KT_2. Shadow value of funds is denoted by μ_t. Note that since shadow value of funds determines financial policy of firms, it depends on the marginal source of finance (or the position of firms in finance regime). Equations (A4.7) and (A4.12) indicate that μ_t is bounded above by $\frac{1-\tau_d}{1-\tau_{cg}} \cdot (1 + 2\phi_d(d_t - d^*))^{-1} = 0$ (when

$d_t > 0$, $\lambda_t^d = 0$, and marginal source of finance is retained earnings), while equations (A4.8) and (A4.13) indicate that μ_t is bounded below by 1 (when $s_t > -(\eta k_t)$, $\lambda_t^s = 0$, and marginal source of finance is new equity issue). Therefore, tax wedge and adjustment costs on dividends together determine the lower bound of μ_t, while the upper bound of μ_t is exogenous. Considering that there is no kink in equity value, there is no inaction region with firms that do not either issue new equity (buy back their shares) or pay dividends. If there are no financial frictions in the model economy, $\tau_d = \tau_{cg} = 1$ and $\phi_d = 0$, then the wedge between the two bounds no longer exits, i.e. financial policy of heterogeneous firms becomes indeterminate. Therefore, $\mu_t \in \left[\frac{1-\tau_d}{1-\tau_{cg}} \cdot (1 + 2\phi_d(d_t - d^*))^{-1},\ 1\right]$.

A5. Robustness Analyses

In addition to the historical fall in taxes on dividends and capital gains, the post-2003 period was characterized by economic recovery, distrust among shareholders from the 2001-2002 dot-com crisis and regulatory changes in volume limit on repurchases by the US Securities and Exchange Commission (SEC). These robustness analyses aim to investigate the model reactions to the above potential sources of aggregate changes in the US, quantify and determine their importance.

The economic recovery from the 2001-2002 recession began in early 2003. Therefore, in addition to the tax cuts, this positive real shock may also account for a significant part of firms' behaviour. Hence, I conduct a counterfactual experiment to quantify a relative contribution of the rise in aggregate productivity to aggregate payouts to shareholders and aggregate capital investment. Following Baqaee and Farhi (2020), the rise in Total Factor Productivity is measured by using the San Francisco Federal Reserve's database[34]. Since aggregate productivity recorded an increase of 1.92% for the 2003-2006 period in the data, $A_t = 1$ for the initial steady state (1988-2002) is changed to $A_t = 1.0192$ in the final steady state (2003-2006). The economy is initially in steady state, and then it is hit by the permanent positive productivity shock in addition to the tax shock in the General Equilibrium. Table A5 shows that this positive real shock increases aggregate dividends, repurchases and capital investment by around 2.50%, 2.98%, 2.74%, respectively. Therefore, the tax shock remains the key driver of dividend payments and capital investment.

In order to quantify the contribution of changes in preferences of shareholders for dividends to changes in aggregate payouts, I perform counterfactual experiments where changes in the adjustment costs ϕ_d are added to the 2003 tax cuts. A drop in ϕ_d is expected for the post-2003 period because of the accounting scandals occurring in 2001-2002, which created distrust among shareholders, potentially

[34]https://www.frbsf.org/economic-research/indicators-data/total-factor-productivity-tfp/

Table A5. Aggregate responses after the 2003 tax cuts

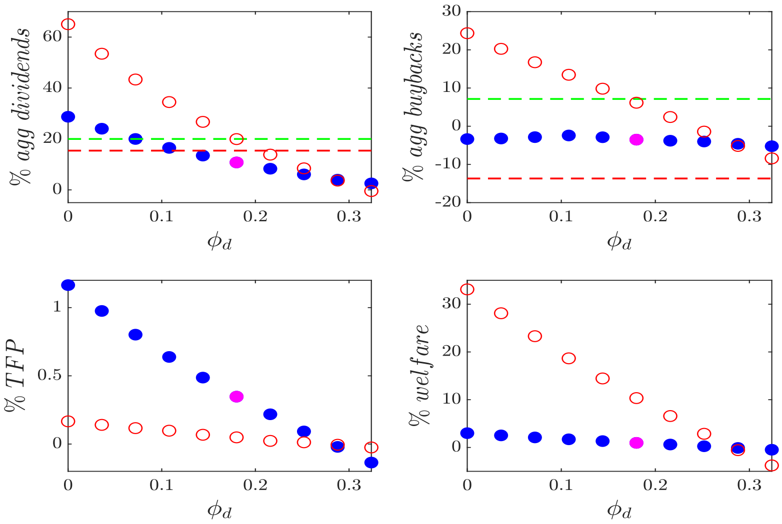
Aggregate	GE	PE	ER
Capital	3.26	11.99	6.00
Investment	3.26	11.99	6.00
Output	1.54	10.74	4.29
Employment	0.28	10.74	0.27
Consumption	0.97	10.33	3.73
Dividends	10.78	19.94	13.28
Repurchases	-3.52	6.16	-0.54
Wage	1.25	0	4.02
TFP	0.35	0.05	2.24

Note: Table shows percent changes in aggregate variables for the post-2003 period relative to the 1988-2002 calibration period. ER refers to economic recovery from the 2001-2002 crisis. GE stands for the General Equilibrium, PE refers to the Partial Equilibrium.

stimulating shareholders to request large dividends even in the absence of the tax reform. I also checked what would occur to aggregate payouts to shareholders if ϕ_d increased. Figure A5.1 shows that the changes in ϕ_d generate a slight complementarity between aggregate dividends and repurchases in the General Equilibrium setting (blue dots). Moreover, the reduction in ϕ_d increases benefits from a reallocation of resources across firms, including TFP and welfare. However, the drop in adjustment costs on dividends cannot contribute to positive aggregate repurchases observed by the empirical evidence from Section 4 (dotted green line) in the General Equilibrium setting. Aggregate payout responses become much more amplified in the Partial Equilibrium setting due to excess cash injected into firms with low investment needs (red dots). Fully rigid wages are considered for illustrative purposes.

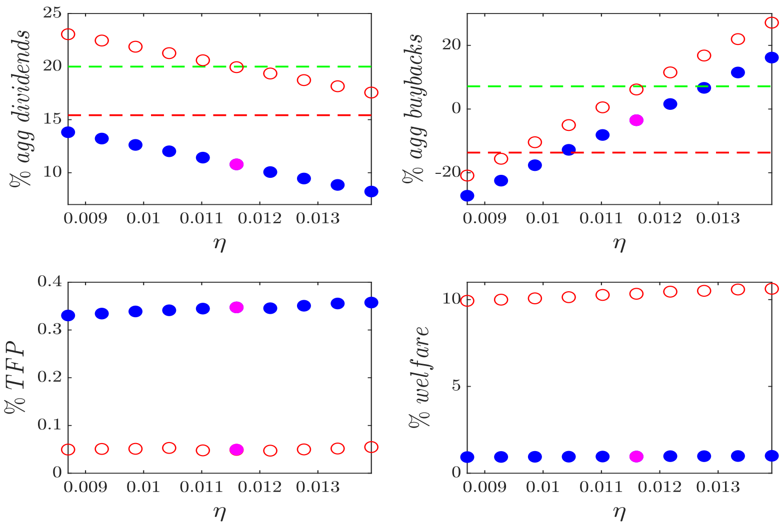
We could also expect a more relaxed constraint on repurchases because the SEC extended the limit for repurchases in 2003. Figure A5.2 shows that increasing η produces negative correlation between dividends and repurchases in the General and Partial equilibrium settings. TFP and welfare remain relatively constant.

Figure A5.1 Long-run aggregate effects of tax changes and dividend adjustment costs



Note: Purple dots refer to aggregate responses to the 2003 tax cuts for the estimated ϕ_d by the SMM. Blue dots indicate counterfactual experiments under which changes in ϕ_d are added to the tax cuts in the General Equilibrium setting, while the value of other parameters are kept fixed at their values in the initial steady state. Similar experiments are conducted in the Partial Equilibrium setting (red circles). For each value of ϕ_d, I solve the GE model and compute aggregates. Red dashed lines are model-generated aggregate responses by the benchmark paper Gourio and Miao (2011). Green dashed lines are estimated aggregate responses to the 2003 tax cuts by the literature. Holding leisure fixed at its initial level, changes in consumption are taken as a measure for welfare effects.

Figure A5.2 Long-run aggregate effects of tax changes and constraint on repurchases



Note: Purple dots refer to aggregate responses to the 2003 tax cuts for the estimated η by the SMM. Blue dots indicate counterfactual experiments under which changes in η are added to the tax cuts in the General Equilibrium setting, while the value of other parameters are kept fixed at their values in the initial steady state. Similar experiments are conducted in the Partial Equilibrium setting (red circles). For each value of η, I solve the *GE* model and compute aggregates. Red dashed lines are model-generated aggregate responses by Gourio and Miao (2011). Green dashed lines are estimated aggregate responses to the 2003 tax cuts by the literature. Holding leisure fixed at its initial level, changes in consumption are taken as a measure for welfare effects.

Abstrakt

Tato studie zkoumá hypotézu, že snížení zdanění dividend a kapitálových zisků v USA v roce 2003 vedlo ke zvýšení agregovaných dividend a agregovaného zpětného odkupu akcií. Zjišťuji, že daňová reforma v roce 2003 vedla ke zvýšení obou typů výplat v modelu obecné tržní rovnováhy se strnulými mzdami po zahrnutí dvou finančních frikcí, konkrétně nákladů na změny dividend a endogenní omezení na zpětný odkup akcií. Růst obou typů výplat lze odůvodnit dvěma faktory. Daňová reforma v roce 2003 snížila zdanění dividend více než zdanění kapitálových zisků. Druhým faktorem je vyšší motivace pro odkup akcií v důsledku vyšší flexibility ve srovnání s dividendami, jelikož výplata dividend v současném období vytváří závazek firem k výplatám budoucích dividend. Firmy s nízkým přebytkem hotovosti preferují zpětný odkup jako polštář k ochraně před dodatečnými penalizacemi spojenými s vyšší volatilitou dividend, protože jakýkoliv odklon od dividendového závazku je pro firmy nákladný. Strnulé mzdy v modelu obecné tržní rovnováhy poskytují firmám přebytek hotovosti.

Klíčová slova: flexibilita výplat, kapitálová realokace, daňová reforma, heterogenní firmy.

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