Stony Brook University

Anticipation Effects of Capital Gains and Dividend Tax Changes under a Realization-Based or an Accrual-Based Tax System

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Abstract of the Dissertation

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The Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) and the Jobs and Growth Tax Relief Reconciliation Act of 2003 (JGTRRA), introduced a reduction in capital gains and dividend tax rates, generating interest in understanding the macroeconomic effects of capital gains and dividend taxation. My dissertation focuses on the impact of the capital gains and dividend tax changes in a realization-based capital gains tax system, motivated by the fact that capital gains taxes are paid upon realization in the United States. I find that modelling the capital gains tax system as realization-based is crucial for the following reasons: The realization-based capital gains model generates more accurate quantitative results than the accrual-based capital gains model in the sense that the results of the former model are closer to the data for the periods where my models were able to capture the trend of the variables. In the U.S. data for the years 2010-2013, we observe that the dividend-output ratio increases by 68% before the reforms expire and then declines by 23.5% upon impact, whereas our realization-based capital gains model estimates that the dividend-output ratio declines by 63.3% upon impact after nine quarters of increase by about 56%, moving very closely with the data. On the other hand, the accrual-based model estimates a decline of 67.6% in the dividend-output ratio after a sharp increase of 250% for nine quarters. Although we could not capture the trend of the dividend tax revenue at impact, the performance of the realization-based model was better than the accrual-based model before the tax rates go up. Moreover, the capital gains tax revenue estimate of the realization-based model moves closer to the data than the estimate of the accrual-based model until the expiration of the tax reforms. It is also crucial to incorporate the anticipation effects. As expected, similar to the data, when the tax changes are expected, both of our models predict that agents start adjusting their decisions before the tax changes happen, whereas in the unexpected case agents do not react until after the tax rates actually go up.

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Chapter 1

Introduction

The U.S. economy has been experiencing important tax reforms since the 1940s. The two most recent tax reforms are The Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001, which was introduced by the Bush Administration, and The Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) of 2003, together known as the "Bush tax cuts". Among the changes brought by the Bush tax cuts, the changes in capital gains and dividend tax rates are of main interest to our study. The EGTRRA generally lowered the individual income tax rates, qualified dividend and long-term capital gains tax rates, and with the JGTRRA the long-term capital gains tax rate was reduced from 20% to 15%, and the qualified dividend tax rate was reduced from 39.6% to 15% for individuals in the highest income tax bracket. The JGTRRA was initially set to expire in 2008, then extended through 2010, and then extended through 2012 once again by the Obama Administration. In 2013, the tax reforms expired as announced and the tax rates went back up to their pre-reform levels. (see Fig. 1.1)

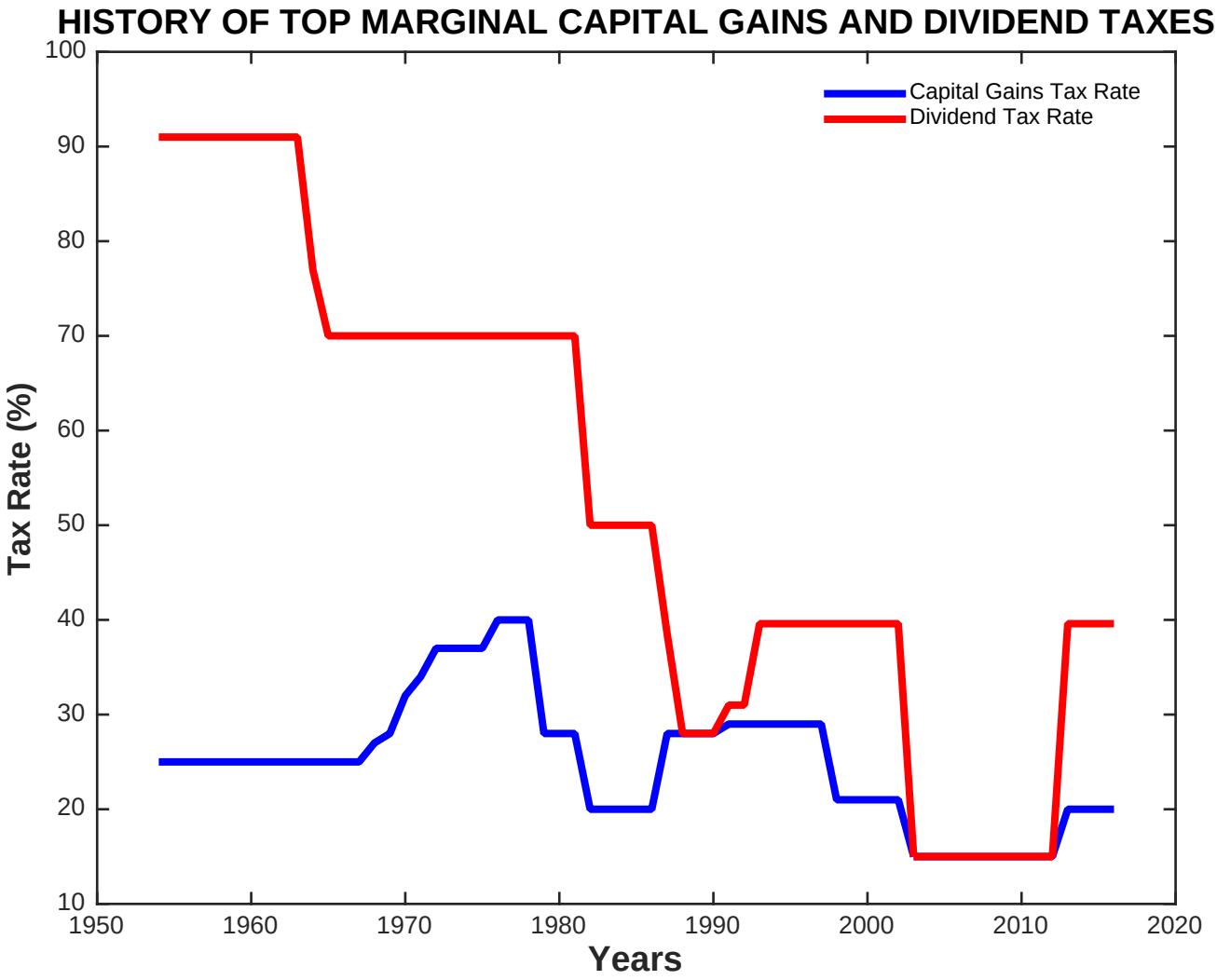

Figure 1.1: The Top Marginal Capital Gains and Dividend Tax Rates, 1954-2015

There is a large theoretical and empirical literature on the macroeconomic effects of the Bush tax cuts. This dissertation contributes to the existing literature in three important ways. First, unlike the majority of the related studies, we develop a realization-based capital gains taxation model. Second, we consider the anticipation effects of changes in capital gains and dividend tax rates and distinguish between the effects of anticipated and unanticipated tax policy changes. Third, we focus particularly on the effects of the expirations of the JGTRRA by assuming that households and firms perceive these expirations as permanent.

Existing analyses use an accrual-based capital gains tax system to evaluate the effects of the capital gains and dividend tax reforms largely because of computational reasons. I model the decision to realize or not and evaluate these tax reforms in the light of the more realistic assumption using a realization-based capital gains tax system which is the tax system in effect in the U.S. and majority of the countries in the world. I find that modelling the capital gains tax system as realization-based is crucial for the following reasons: Although the evolution of the macroeconomic variables is qualitatively similar in the two models, the realization-based capital gains model generates much more accurate quantitative results than the accrual-based capital gains model in the sense that the results of the former model are much closer to the data for the periods where my models were able to capture the trend of the variables. In the U.S. data for the years 2010-2013, we observe that the dividend-output ratio increases by 68% before the reforms expire and then declines by 23.5% upon impact, ie when the Bush tax cuts expire, whereas our realization-based capital gains model estimates that the dividend-output ratio declines by 63.3% upon impact after nine quarters of increase by about 56%, moving very closely with the data. On the other hand, the accrual-based model estimates a decline of 67.6% in the dividend-output ratio after a sharp increase of 250% for nine quarters. Due to the fact that the dividend tax revenue data was not available, we constructed a series for dividend tax revenue using the dividend data and the top marginal statutory dividend tax rates. Although we could not capture the trend of the dividend tax revenue at impact, the performance of the realization-based model was better than the accrual-based model before the tax rates go up. Moreover, the capital gains tax revenue estimate of the realization-based model moves much closer to the data than the estimate of the accrual-based model until the expiration of the tax reforms. The reason behind the superiority of the realization-based capital gains model over the accrual-based capital gains model stems from the following: The realization-based capital gains model provides the stockholders with an additional means of smoothing their consumption, that is, it allows the stockholders smooth their consumption by choosing how much capital gains to realize today and how much capital gains to leave as

unrealized for tomorrow. The accrual-based capital gains model, however, does not provide the stockholders with such a decision mechanism because in the accrual-based capital gains model capital gains taxes are paid on the total value of capital gains regardless of whether a stock is sold or not. These different decision mechanisms of the stockholders in the two models are also reflected in the firm decisions, and ultimately the equilibrium stock price. Since the firms take into account the fact that stockholders have the ability to adjust their unrealized-to-realized capital gains ratio and this ratio affects the discount factor of the firm, making it larger, firms do not need to adjust their capital level in the realization-based capital gains model as aggressively as in the accrual-based capital gains model. Because the firms do not need to compensate the stockholders for the stock price fluctuations due to tax rate changes in the realization-based capital gains model as much as in the accrual-based capital gains model and they value future in the realization-based capital gains model more than they do in the accrual-based capital gains model, they behave less aggressively. In order to make their stocks more attractive to the stockholders and help mitigate the stock price fluctuations, the expectations of increased dividend tax rate drive firms to distribute much more dividends prior to the policy and the expectations of increased capital gains tax rate induce firms to increase their capital accumulation more intensely in the accrual-based capital gains model than in the realization-based capital gains model. It is also crucial to incorporate and analyze the anticipation effects, because the expiration of the tax reforms were pre-announced, creating anticipation towards higher tax rates among economic agents. Therefore, one would expect that the results of the experiment where both capital gains and dividend tax rate go up expectedly would perform better when compared with the data than the results of the experiment where the tax rates go up unexpectedly. As expected, similar to the data, when the tax changes are expected, both of our models predict that agents start adjusting their decisions before the tax changes happen, whereas in the case where the tax changes were unanticipated, agents do not react until after the tax rates actually go up.

A limitation of the existing theoretical literature on the first and most important dimen-

sion of our contribution, realization-based capital gains tax system, is that it deals mostly with the taxation of capital gains on an accrual basis. Researchers have studied how changes in capital gains and dividend taxes affect investment decisions, dividend distributions and equity prices assuming that capital gains are taxed on an accrual basis (see, Gourio and Miao (2008), Gourio and Miao (2011), Anagnostopoulos, Carceles-Poveda and Lin (2010), Atesagaoglu (2011)). For example, Gourio and Miao (2011) provide an analysis of unexpected permanent dividend and capital gains tax cuts where capital gains are taxed regardless of whether an asset is sold or not. Therefore, their analysis does not explore the anticipation effects in a realization-based capital gains tax system. They also do not consider expected and simultaneous permanent changes in dividend and capital gains taxes. Our paper fills this gap by developing a realization-based capital gains taxation model and presenting an analysis of the effects of expected permanent increases in both capital gains and dividend tax rates. It is important and necessary to analyze the anticipation effects in a realization-based capital gains taxation system because unlike an accrual-based model, a realization-based model allows us to point out how investors take advantage of tax arbitrage by tax deferrals. Furthermore, taxing capital gains upon realization has been the common practice adopted by most of the countries, including the U.S. It is also necessary to consider expected increases in both capital gains and dividend taxes simultaneously, because both tax rates went back up to their pre-reform levels with the expiration of the JGTRRA.

The existing literature on the second aspect of our contribution, an economy with expectations, lacks an analysis which incorporates expectations for tax changes into such an economy (see, Gavin, Kydland and Pakko (2007), Auerbach (1992), Auerbach (1998), Auerbach, Burman and Siegel (1998)). For example, Gavin, Kydland and Pakko (2007) study the interaction of inflation with the tax code using a realization-based capital gains taxation model. They do not consider the interaction between the anticipation of investors and firms and their timing decision of capital gains realizations, firms' dividend distributions, government revenue and stock prices. Building on this existing literature, we develop a model

that differs from the existing literature by incorporating expectations into our economy. It is crucial to take into account the anticipation effects because investors started forming expectations towards higher tax rates with the announcement in 2010 expecting that the tax reforms introduced by the JGTRRA will expire at the end of 2012. Therefore, it is important to distinguish between the effects of expected and unexpected tax changes on the behavior of the economy.

As we mentioned earlier, the third dimension we depart from many other related studies is that we investigate the effects of the expiration of the JGTRRA. We conduct our analysis from the point of view of 2010 when the Obama Administration announced that the tax reforms will expire in around two years. After this announcement, households started forming anticipation towards higher tax rates after the U.S. presidential elections in 2012. Due to the uncertainty regarding whether the capital gains and dividend taxes will increase or not, firms' and households' expectations play an important role in their level of capital accumulation, dividend distribution, production, investment, consumption, capital gains realizations, tax revenues and also on equity values, wages, and interest rates.

There is an extensive empirical literature on the effects of capital gains and dividend tax rate changes and Bush tax cuts EGTRRA and JGTRRA. These empirical studies provide projections of the evolution for dividend distributions, capital gains realizations, government revenue and stock prices for different tax reform scenarios. One would expect symmetry between reactions to an expected tax cut and expected tax raise. However, a common feature of these studies is that they assume that the tax cuts are perceived as temporary, whereas we test the effects of permanent tax raises. For example, House and Shapiro (2004), Mertens and Ravn (2010) and Korinek and Stiglitz (2009) focus on the comparison between the effects of unanticipated temporary and anticipated temporary tax cuts. Consistent with our findings, they show that anticipated tax changes create opportunities for intertemporal tax arbitrage and unanticipated changes in taxes affect behavior when the tax changes are implemented, while anticipated changes in taxes may affect the economy ahead of their

introductions.

The elasticity of taxable income with respect to marginal tax rates has been one of the most popular research topics in many empirical studies (see Saez, Slemrod and Giertz (2012), Auten, Carroll and Gee (2008), Saez, Slemrod and Giertz (2009) and Hungerford (2010)). For example, Saez, Slemrod and Giertz (2012) show how capital gains realizations increase until the capital gains tax rate goes up and then fall with higher tax rates and our predictions are consistent with theirs. Among the papers that study the relationship between corporate dividend payout policy and tax rates (see Chetty and Saez (2006), Auerbach and Hassett (2005), Poterba and Summers (1984), Chetty and Saez (2004), Poterba (2004), Julio and Ikenberry (2005) and Blouin, Raedy and Shackelford (2004)), Chetty and Saez (2006) suggest that the tax reform plays a significant role in the increase in dividend payouts. Parallel to our findings, they conclude that firms shift the timing of their dividend payments and there is a surge of dividends immediately before the dividend tax rates were expected to increase. Another interesting stream of the empirical literature is related to the reaction of stock prices to changes in tax rates (see Auerbach and Hassett (2006), Amromin, Harrison and Sharpe (2008) and Ayers, Cloyd and Robinson (2002)). For instance, Auerbach and Hassett (2006) report that the 2003 dividend tax reductions significantly affected equity markets and reject the view that taxes are irrelevant like we do. Lastly, the papers that present an analysis of the connection between tax revenue and tax rates (see Auerbach (2012), Crandall-Hollick (2012) and Auerbach and Gale (2009)) argue that the tax cuts cause significant loss in government revenue. These findings, which are consistent with ours, seem to match the actual reactions of the firms in the U.S. in terms of their dividend distributions, household decisions in terms of their capital gains realizations and the final impact on stock prices.

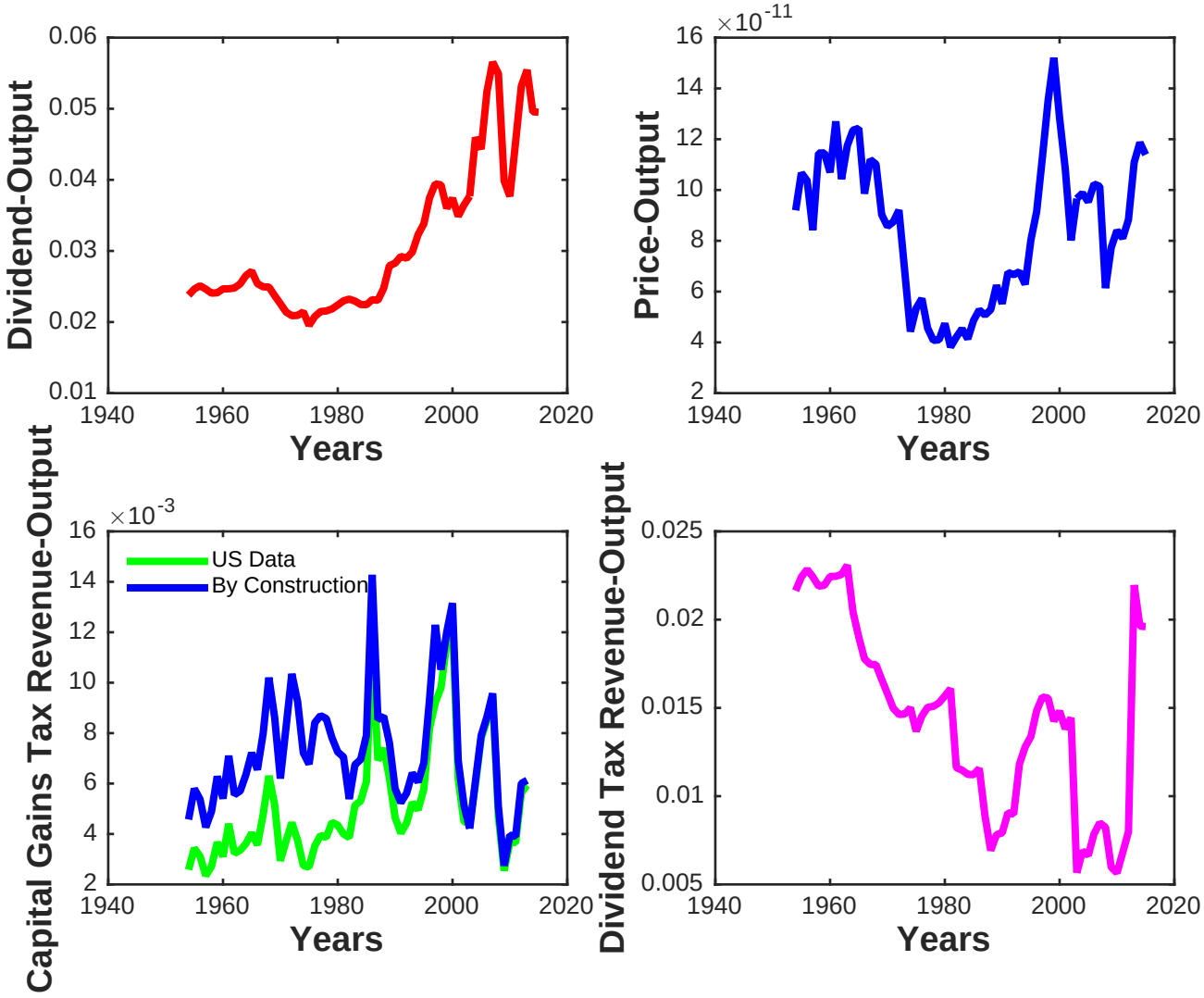

Figure 1.2: The Ratio of Dividend Distributions, Stock Prices, Capital Gains Tax Revenue and Dividend Tax Revenue to Real GDP, 1954-2014

The rest of this dissertation is organized as follows: In order to analyze the effects of different expectations for the expiration of tax reforms, in Chapter 2 we build a general equilibrium realization-based capital gains tax model with three types of agents in the economy: the households, the firms, and the government. We assume that there is a continuum unit mass of homogeneous households and homogeneous firms. Households value their period consumption, but not leisure and are subject to two types of taxes, namely dividend tax

and capital gains tax paid on a realization basis, that is after the sale of stocks. They can choose how much capital gains to realize and how much capital gains to leave unrealized. However, there is a cost of both realizing capital gains and not realizing capital gains. The cost of realizing capital gains is the burden of the capital gains tax and there is a portfolio management cost associated with the capital gains that are left unrealized. The rest of the household activities is as follows: Households own the firms, so they own the shares from which they receive dividend payments. They can trade these shares and one-period bonds among themselves, and are subject to dividend taxes on the dividends they receive. In addition to the income from dividends, bonds and share sales, they also receive an untaxed labor income and a lump-sum tax transfer from the government. The firms maximize their equity value and pay corporate income taxes. The role of the government is to collect taxes and redistribute its tax revenue back to the households in a lump-sum manner. Lastly, there is no uncertainty in our model.

Using the model described briefly above, we make two main experiments. The first experiment assumes that in 2010 all households anticipate that the tax reforms will permanently expire after the elections and they will be subject to higher tax rates from 2013 on. Since the tax reforms affected both capital gains and dividend taxes simultaneously, we focus on a simultaneous increase in both capital gains and dividend tax rates. We also test what would happen if only capital gains taxes go up and if only dividend taxes go up. The second experiment is the other extreme in the sense that no individual expects the tax reforms to expire, so this is a case where the expiration of the tax reforms is completely unexpected.

After analyzing the effects of expectations in a realization-based capital gains tax model, we extend our discussion in Chapter 3 by studying an accrual-based capital gains tax model and comparing it with the implications of the realization-based capital gains tax model. We study and compare both models because, as discussed in the Future Work section of this dissertation, both systems have their own advantages and disadvantages, which is one of the reasons why the way capital gains are taxed has been a highly debated issue.

Chapter 2

Effects of Expectations in a Realization-Based Capital Gains Tax System

The announcement that the Bush tax cuts will expire at the end of 2012 was announced in the third quarter of 2010, creating an expectation towards higher capital gains and dividend taxes in around 14 quarters, during the first quarter of 2013. Our main experiment is the experiment where both the capital gains tax and the dividend tax go up simultaneously and expectedly in quarter 10. The U.S. data we aim to compare with our model results are the dividend-to-output ratio, stock price-to-output ratio and capital gains tax revenue-to-output ratio (see Fig. 1.2). Due to the fact that the dividend tax revenue data was not available, we construct a series of dividend tax revenue by multiplying the dividend data by the top marginal statutory dividend tax rates in order to get a rough estimate of the dividend tax revenue and compare with our model results. Although we have the data for capital gains tax revenue, we construct a series of capital gains tax revenue as well using the same method we use for the dividend tax revenue. For data purposes, dividends are defined as the distributed portion of the net corporate dividend payments which are corporate profits after tax with Inventory Valuation and Capital Consumption Adjustments and reported in the Bureau of Economic Analysis tables. Stock prices are defined as the StandardPoor's Price Index. Dividend tax revenue data is constructed by multiplying the top marginal statutory dividend tax rates reported in Figure 1.1 by the corresponding dividend distribution data provided

by the Bureau of Economic Analysis. Capital Gains Tax Revenue data is published by the US Department of the Treasury. (see Appendix E for more details)

Our model results capture the increasing trend in the dividend-to-output ratio until quarter 10 qualitatively. The quantitative comparison performs quite well too: In our model, the dividend-to-output ratio goes up by 56% and in the data it goes up by 68% until quarter 10. In quarter 10, the ratio falls by 63.3% in our model and about 23.5% in the data. After quarter 10, there is an increase both in the results and the data for one period. The price-to-output ratio goes up by 8.48% in the data whereas in the model it falls by 16.4%. The Capital Gains Tax Revenue-to-output ratio from the data and our model coincide until quarter 5. However they deviate from each other after that. The ratio goes up by 11.4% at impact, whereas in the model results it goes down by 193%. The dividend tax revenue-to-output ratio is matched qualitatively and quantitatively until quarter 10 but then the data and results deviate from each other.

2.1 The Realization-Based Model

We consider an economy with an infinite horizon. There is a continuum unit mass of infinitely lived homogeneous households, homogeneous firms and a government. The time is discrete and indexed by t=0,1,2,...We assume that there is no population growth and the economy grows at the technology growth rate γ.

2.1.1 Households

The households in our model have preferences of the following form:

$$\sum_{t=0}^{\infty} \beta^t U(C_t) \tag{2.1}$$

where $\beta \in (0,1)$ is the discount factor and C_t is consumption per capita. We assume that U(.) $\Re+\rightarrow\Re$ is strictly increasing, strictly concave, and continuously differentiable and the

Inada conditions hold, i.e $\lim_{C\to 0} U'(C) = \infty$ and $\lim_{C\to\infty} U'(C) = 0$.

The importance of this model lies in its household budget constraint which reflects the assumption that the capital gains are taxed only upon realization and households can choose how much capital gains to realize and how much capital gains to leave unrealized. However, there is a cost of both realizing capital gains and not realizing capital gains. The cost of realizing capital gains is the burden of the capital gains tax and there is a portfolio management cost associated with the capital gains that are left unrealized. The rest of the household activities is as follows: Households own the firms, so they own the shares from which they receive dividend payments. They can trade these shares and one-period bonds among themselves, and are subject to dividend taxes on the dividends they receive. In addition to income from dividends, bonds and share sales, they also receive an untaxed labor income and a lump-sum tax transfer from the government.

We can write the household budget constraint and the unrealized capital gains accumulation equation as:

$$C_t + P_t S_{t+1} + B_{t+1} = [(1-\tau_t^d)D_t + P_t]S_t - \tau_t^g G_t - M\gamma^2 \frac{U_{t+1}^2}{G_t} + W_t L_t + (1+R_t)B_t + T_t \quad (2.2)$$

$$G_t + U_{t+1} = U_t + (P_t - P_{t-1})S_t, \quad (2.3)$$

where P_t is the ex-dividend equity price, S_t is the number of shares held at the beginning of period t (we assume that there is only one perfectly divisible share at any t), B_{t+1} is the one-period bond purchased by households at period t, τ_t^d is the proportional tax on dividend income, D_t is the dividend payment per share, τ_t^g is the proportional tax on realized capital gains, M is the portfolio management cost parameter, G_t is the value of realized gains, U_{t+1} is the value of unrealized gains, W_t is the wage rate per unit of labor supplied, L_t is the labor supplied, R_t is the one-period bond interest rate and T_t is the lump-sum government transfer.

Lemma: There exists a balanced growth path such that:

$$c_t + p_t s_{t+1} + \gamma b_{t+1} = [(1 - \tau_t^d)d_t + p_t]s_t - \tau_t^g g_t - M\gamma^2 \frac{u_{t+1}^2}{g_t} + w_t l_t + (1 + r_t)b_t + t_t \quad (2.4)$$

$$g_t + \gamma u_{t+1} = u_t + (p_t - \frac{p_{t-1}}{\gamma})s_t \quad (2.5)$$

,where households maximize the discounted sum of their period utility and choose consumption c_t, number of shares s_{t+1}, number of bonds b_{t+1}, realized gains g_t, unrealized gains u_{t+1} and labor l_t.

2.1.2 Firms

The firm's objective is to maximize its equity value by choosing its capital level, dividend distributions and investment using the capital it owns and labor it hires to produce goods according to the production technology:

$$Y_t = F(K_t, X_t L_t) \quad (2.6)$$

where $F(.)$ is a constant returns to scale production function, K_t is the firm's capital stock, L_t is the firm's labor and X_t is the technology growth.

We assume that there is no new equity or debt issuance. The firm uses its income from production for its corporate income tax, dividend and wage payments and for investment. Hence, we can write the firm's dividend distribution constraint as:

$$D_t = F(K_t, X_t L_t) - I_t - W_t L_t - T_t^c \quad (2.7)$$

where I_t is investment and is given by $I_t = K_{t+1} - (1 - \delta)K_t$, δ is the depreciation

rate and T_t^c is the corporate income tax payment which is given by:

$$T_t^c = \tau^c[F(K_t, X_t L_t) - W_t L_t - \delta K_t] \tag{2.8}$$

Therefore, dividend payments can be written as:

$$D_t \;\; = \;\; (1-\tau^c)[F(K_t, X_t L_t) - W_t L_t - \delta K_t] + K_t - K_{t+1} \tag{2.9}$$

2.1.3 The Government

The government determines the tax rates, and redistributes the tax revenue back to the households in a lumpsum manner. The government budget constraint is given by:

$$T_t = \tau_t^d D_t + \tau^c[K_t^\alpha L_t^{1-\alpha} - W_t L_t - \delta K_t] + \tau_t^g G_t \tag{2.10}$$

Lemma: There exists a balanced growth path such that:

$$t_t = \tau_t^d d_t + \tau^c[k_t^\alpha l_t^{1-\alpha} - w_t l_t - \delta k_t] + \tau_t^g g_t \tag{2.11}$$

2.1.4 Competitive Equilibrium

Given government policy $\{\tau_t^d,\, \tau_t^g,\, \tau_t^c\}$, a competitive equilibrium is a sequence of allocations $\{c_t,\, l_t^d,\, l_t^s,\, \mathrm{s}_{t+1},\, b_{t+1},\, g_t,\, u_{t+1},\, k_{t+1},\, i_t,\, d_t,\, t_t\}$, prices $\{w_t,\, r_t,\, p_t\}$ and value of the firm $\{v_t\}$ such that:

1) Given $\{w_t,\, r_t,\, p_t\}$, the allocations $\{c_t,\, l_t^s,\, s_{t+1},\, b_{t+1},\, g_t,\, u_{t+1},\}$ solve the household's maximization problem;

2) Given $\{w_t,\, r_t,\, p_t\}$, the allocations $\{\, l_t^d,\, d_t,\, k_{t+1},\, i_t\}$ solve the firm's maximization problem;

3) $\{w_t,\, r_t,\, p_t\}$ are such that all markets clear:

$$Stock\;\; market: \qquad\qquad s_t = 1 \qquad\qquad \forall t$$

$$\textit{Labor market}: \qquad l_t = 1 \qquad \forall t$$

$$\textit{Bond market}: \qquad b_t = 0 \qquad \forall t$$

$$\textit{Goods market}: \quad c_t + M\gamma^2 \frac{u_{t+1}^2}{g_t} + \gamma k_{t+1} - (1-\delta)k_t = f(k_t, l_t) \qquad \forall t$$

4) The government budget constraint is satisfied:

$$t_t = \tau_t^d d_t + \tau^c [k_t^\alpha l_t^{1-\alpha} - w_t l_t - \delta k_t] + \tau_t^g g_t$$

2.2 Quantitative Analysis

2.2.1 Calibration

We simulate our model economy to evaluate how macroaggregates change both in the short-run and the long-run for six different cases presented below. Household preferences are represented by a logarithmic utility function: $U(c) = log(c)$ and the firm's production technology is represented by a Cobb-Douglas production function: $f(k,l) = k^\alpha l^{1-\alpha}$. Before simulating the model, we calibrate it to fit the quarterly U.S. data for the years 1954-2015 following the calibration method of Cooley and Prescott (1995) and our steady-state equations. Using the NIPA tables provided by the Bureau of Economic Analysis, we find that the average capital share of income, α, which is calculated as the ratio of the sum of the income from private capital, consumer durables and government capital to the sum of Gross National Product, income from consumer durables and government capital, is approximately 0.361. We also calculate the average annual real GDP growth rate as 3.16%, which corresponds to the quarterly real GDP growth rate of 0.79%. Our technology growth parameter, γ, matches this growth rate and is equal to 1.0079. The household's discount parameter, β, matches the average quarterly real interest rate which is defined as the lending interest rate adjusted for inflation as measured by the GDP deflator, and is calculated as 0.98% using

the annual data provided by the World Bank and β is equal to 0.998. The capital depreciation parameter, δ, matches the average quarterly investment-to-capital ratio as 0.021 and is equal to 0.0131. Investment is defined as the sum of gross private domestic investment, change in private inventories, net government investment, consumption of durable goods and net exports of goods and services. Capital stock is calculated by adding fixed assets (both private residential and non-residential and government residential and non-residential fixed assets) to consumer durable goods. The realization-based model has an additional portfolio management cost parameter M. Using the Federal Reserve Board's Flow of Funds Accounts for the accrued capital gains defined as the Households and Non-profit organizations Corporate Equities, and using the realized capital gains data provided by the US Department of the Treasury, we calibrate M to equal 5.5109e-05 to match the quarterly realized-to-accrued capital gains ratio of 0.0626.

Our calibration targets of GDP growth rate, real interest rate, capital share of income, realized-to-accrued capital gains ratio and investment-to-capital ratio are quite stable over the time period 1954-2015 as can be seen from the annual data presented in Figure 2.1. Therefore, targeting these variables for different periods of time would result in parameter values very close to our values, not affecting the robustness of our results significantly. The calibration results using the quarterly data are summarized Table 2.1 below:

Table 2.1: Calibration Results

Parameter Name	Value	Moment
α	0.361	Capital Share of Income=0.361
β	0.998	Real Interest Rate=0.0098
δ	0.0131	Investment-to-Capital Ratio=0.021
γ	1.0079	Real GDP Growth Rate=0.0079
M	5.5109e-05	Realized-to-Accrued Capital Gains Ratio=0.0626

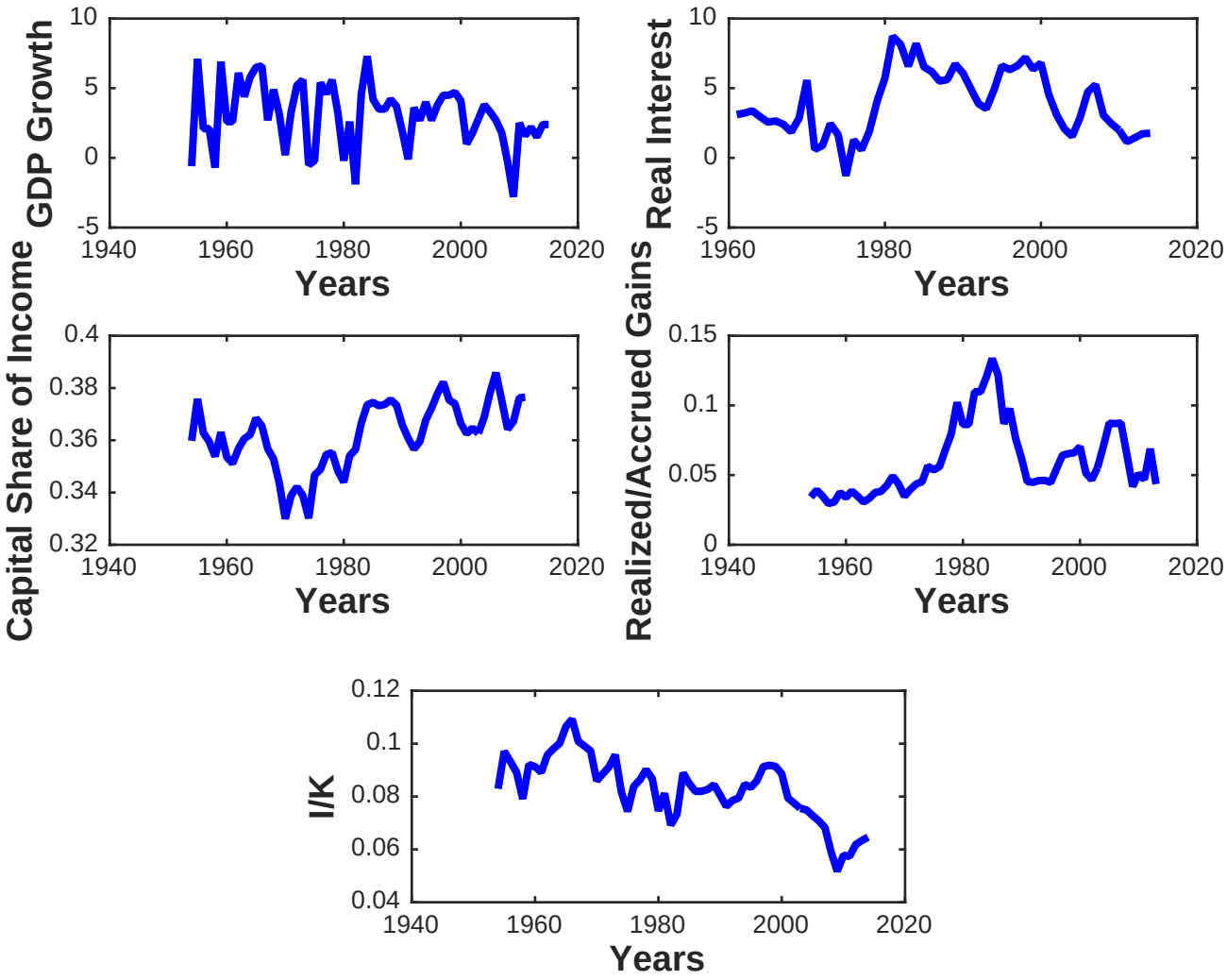

Figure 2.1: Evolution of the calibration targets, US Annual Data 1954-2015

The marginal statutory tax rates are found by calculating the capital gains, dividend and corporate tax payments using the SOI data for the years 1997-2012. Because there is not sufficient data for the higher tax rates after the expiration of the tax reforms, we calculate the tax rates for the after-expiration periods by taking an average of the tax rates for the years 1997-2002 where the tax rates were at high levels just as the rates after the expiration of the reforms. For the benchmark economy, we calculate the tax rates by taking an average of the rates in years 2003-2012 when the tax rates were low. The capital gains tax rate is

14.8% for the benchmark economy and then permanently goes up to 19.6% in quarter 10. Likewise, the dividend tax rate is 14.3% for the benchmark economy and then permanently goes up to 31.2% in quarter 10. The corporate income tax rate is 34.6% and is fixed for our model.

2.2.2 Results

Due to the fact that the expiration of the tax reforms affected both capital gains tax rates and dividend tax rates simultaneously and it was pre-announced, the main experiment of this paper is the expected increase in both capital gains and dividend tax rates in quarter 10. However, in order to be able to explain the main idea behind the effect of the dividend and capital gains taxes individually, the results of the expected increase only in dividend tax and only in capital gains tax are presented first. Then the main experiment is presented. Lastly, the results of an unexpected increase in dividend tax only, capital gains tax only and both dividend and capital gains taxes simultaneously are presented respectively. Using the parameters and tax rates set at levels explained above, we simulate our model starting from the initial steady state given by the benchmark values and analyze the transitional dynamics resulting from the permanent changes in the tax rates in quarter 10. This section presents the long-run and transition results of the six experiments mentioned above and provides explanations for the intuition behind these results.

LONG-RUN RESULTS

Increase in Dividend Tax:

As can be seen in the steady state equations in Appendix C, the long-run level of the interest rate, capital, investment, unrealized-to-realized capital gains ratio, dividend and firm's discount rate are all independent of the dividend tax rate. Therefore, the initial steady state value of these variables are the same as the final steady state values. Prices fall in the long-run with the introduction of higher dividend tax rates because higher dividend tax rates lower the after tax value of each dollar of investment of a household in a stock,

making the stock less attractive. Due to the fall in prices, the value of realized gains and unrealized gains fall as the prices determine the level of the total accrued gains available to realize and leave unrealized. Portfolio magement cost falls as well since unrealized gains fall although the unrealized-to-realized capital gains ratio is constant. Consumption increases because although there is no change in output and investment, the portfolio management cost is now lower. Government transfers increase in the long-run because the increase in dividend tax revenue dominates the fall in capital gains tax revenue. (see Appendix F-Table 6.1 for steady state values)

Increase in Capital Gains Tax: The interest rate is independent of the capital gains tax rate, so it is constant in the long-run. The capital level is inversely related to the capital gains tax rate, so it falls in the long-run because higher capital gains tax rates reduce the incentive for capital accumulation for value creation, as higher capital would result in higher stock prices but much higher capital gains tax payments. Lower capital in the long-run results in lower investment and higher dividend payments. Prices are the discounted sum of dividends, and in the long-run there are higher dividend payments with higher value assigned to each dividend payment in the future because of higher capital gains taxes. Therefore, prices go up in the long-run. The firm's discount rate increases in the long-run because as capital gains taxes go up, firms value today much more than tomorrow where capital accumulation is more costly. With higher capital gains tax rates, households tend to lower their level of realized gains in the long-run as it becomes more costly to realize, and they tend to increase the level of unrealized gains. Therefore, the unrealized-to-realized capital gains ratio increases in the long-run, increasing the portfolio management cost. Consumption falls because the combined effect of the fall in output and increase in portfolio management cost dominates the fall in investment. Government revenue increases with higher dividend tax revenue due to higher dividends and higher capital gains tax revenue due to higher capital gains rate in the long-run. (see Appendix F-Table 6.2 for steady state values)

Increase in Dividend and Capital Gains Taxes: When both taxes go up simultaneously, the effect of the capital gains tax dominates that of the dividend tax except for stock prices. The reason why prices fall is because the increase in dividend tax together with lower capital dominate the benefit of higher capital gains tax in the long-run. (see Appendix F-Table 6.3 for steady state values)

TRANSITION RESULTS

2.2.2.1 Expected Increase in Dividend Tax Rate

Until the tax rate increases: With the announcement that the dividend tax rate will go up from 14.3% to 31.2% in quarter 10, the stocks become less attractive to the households and cause the demand for the stocks, hence the stock prices, to start falling. To overcome this effect, as soon as the announcement happens, firms increase their dividend distributions sharply and then continue increasing dividend distributions until the increase occurs in quarter 10 in order to make their equities more attractive and help mitigate the decline in stock prices by taking advantage of low dividend taxes. Since dividends are increased, investment level, and hence aggregate capital, the trend of which is followed by wage and output, fall until quarter 10. The return on stock is the marginal product of capital, therefore it moves in the opposite direction with capital. Also, the firm's discount rate follows the stock return and the unrealized-to-realized capital gains ratio is inversely related to the stock return.

With the higher tax rate: When the dividend tax rate goes up in quarter 10, dividends fall by 84% so that paying much higher dividend taxes is partially avoided. Prices fall by 18.3% with the sale of stocks which are not as attractive as before. The return on stock falls sharply by 509.8% because both the dividend yield and the capital gains yield fall. With the fall in return on stock, the discount rate falls by 500.8% and the unrealized-to-realized capital gains ratio goes up by 77.78%. Government transfers decrease by 40% due to lower dividend tax revenue and capital gains tax revenue. The dividend-to-output ratio falls by

70.6%, price-to-output ratio falls by 18.26%, Capital Gains Tax Revenue-to-output ratio falls by 225% and the dividend tax revenue-to-output ratio falls by 43.75% at impact. All variables start converging to their final steady state levels after the change.

2.2.2.2 Expected Increase in Capital Gains Tax Rate

Until the tax rate increases: In this case capital gains tax rate increases from 14.8% to 19.6% expectedly in quarter 10. In order to take advantage of the low capital gains taxes, firms start investing in value creating activities to make their equities more attractive and move away from distributing dividends until quarter 10 through the capitalization of dividend savings, i.e. they lower the dividends and increase aggregate capital which is reflected in the equity values. Since dividends go down, investment goes up. Wage and output follow aggregate capital. The return on stock is the marginal product of capital, therefore it moves in the opposite direction with capital. Also, the firm's discount rate follows the stock return and the unrealized-to-realized capital gains ratio is inversely related to the stock return.

With the higher tax rate: Then, with the new higher capital gains tax rates in quarter 10, dividend distributions go up by 52.2%, stock prices go up by 3.89%. The return on stock increases by 113.9% due to the increase in both dividend yield and capital gains yield, the discount rate increaes by 291% and the unrealized-to-realized capital gains ratio falls by 27.8% as realizations go up more to avoid higher capital gains taxes. Government transfers increase by 30% with higher dividend tax revenue due to higher dividends and higher capital gains tax revenue due to higher realizations and higher capital gains taxes. The dividend-to-output ratio increases by 56.4%, price-to-output ratio increases by 5.44%, Capital Gains Tax Revenue-to-output ratio rises by 176.4% and the dividend tax revenue-to-output ratio increases by 56.4% at impact. All variables start converging to their final steady state levels after the change.

2.2.2.3 Expected Increase in Both Capital Gains and Dividend Tax Rates

There are two opposing forces in this experiment. The two forces, the increase in the dividend tax rate and the increase in capital gains tax rate cause all of the variables move in opposite directions in the two experiments above. However, the increase in dividend tax rate dominates that of the capital gains tax rate with weakened effect compared to when only dividend taxes go up:

Until the tax rate increases: With the announcement that the dividend tax rate will go up from 14.3% to 31.2% in quarter 10, the stocks become less attractive to the households and cause the demand for the stocks, hence the stock prices, to start falling. To overcome this effect, as soon as the announcement happens, firms increase their dividend distributions sharply and then continue increasing dividend distributions until the increase occurs in quarter 10 in order to make their equities more attractive and help mitigate the decline in stock prices by taking advantage of low dividend taxes. Since dividends are increased, investment level, and hence aggregate capital, the trend of which is followed by wage and output, fall until quarter 10. The return on stock is the marginal product of capital, therefore it moves in the opposite direction with capital. Also, the firm's discount rate follows the stock return and the unrealized-to-realized capital gains ratio is inversely related to the stock return.

With the higher tax rate: When the dividend tax rate goes up in quarter 10, dividends fall by 66.7% so that paying much higher dividend taxes is partially avoided. Prices fall by 12.6% with the sale of stocks which are not as attractive as before. The return on stock falls sharply by 478% because both the dividend yield and the capital gains yield fall. With the fall in return on stock, the discount rate falls by 397% and the unrealized-to-realized capital gains ratio goes up by 46.8%. Government transfers decrease by 36% due to lower dividend tax revenue and capital gains tax revenue. The dividend-to-output ratio falls by 63.3%, price-to-output ratio falls by 16.4%, Capital Gains Tax Revenue-to-output ratio falls by 193% and the dividend tax revenue-to-output ratio falls by 41.6% at impact.

2.2.2.4 Unexpected Increase in the Tax Rates

Since the tax change is unexpected, there is no change in the variables until the expiration of the reform is observed in quarter 10 because agents do not react until after the dividend tax rate actually goes up. They react qualitatively similar to the case when the tax change was expected but quantitatively, the adjustments are smaller when the tax rate increases unexpectedly.

2.3 Comparison to Data

The announcement that the Bush tax cuts will expire at the end of 2012 was announced in the third quarter of 2010, creating an expectation towards higher capital gains and dividend taxes in around 14 quarters, during the first quarter of 2013. In this section, we compare the U.S. data with our model results for the corresponding quarters starting from 2010-Q3 (this is when the announcement happens) until the end of 2013 (the last year we have data for realized capital gains and capital gains tax revenue). Our model results are for the experiment where both the capital gains tax and the dividend tax go up simultaneously and expectedly in quarter 10. The U.S. data we aim to compare with our model results are the dividend-to-output ratio, stock price-to-output ratio and capital gains tax revenue-to-output ratio (see Fig. 1.2). Due to the fact that the dividend tax revenue data was not available, we construct a series of dividend tax revenue by multiplying the dividend data by the top marginal statutory dividend tax rates in order to get a rough estimate of the dividend tax revenue and compare with our model results. Although we have the data for capital gains tax revenue, we construct a series of capital gains tax revenue as well using the same method we use for the dividend tax revenue. For data purposes, dividends are defined as the distributed portion of the net corporate dividend payments which are corporate profits after tax with Inventory Valuation and Capital Consumption Adjustments and reported in the Bureau of Economic Analysis tables. Stock prices are defined as the StandardPoor's Price Index.

Dividend tax revenue data is constructed by multiplying the top marginal statutory dividend tax rates reported in Figure 1.1 by the corresponding dividend distribution data provided by the Bureau of Economic Analysis. Capital Gains Tax Revenue data is published by the US Department of the Treasury. (see Appendix E for more details)

Our model results capture the increasing trend in the dividend-to-output ratio until quarter 10 qualitatively. The quantitative comparison performs quite well too: In our model, the dividend-to-output ratio goes up by 56% and in the data it goes up by 68% until quarter 10. In quarter 10, the ratio falls by 63.3% in our model and about 23.5% in the data. After quarter 10, there is an increase both in the results and the data for one period. The price-to-output ratio goes up by 8.48% in the data whereas in the model it falls by 16.4%. The Capital Gains Tax Revenue-to-output ratio from the data and our model coincide until quarter 5. However they deviate from each other after that. The ratio goes up by 11.4% at impact, whereas in the model results it goes down by 193%. The dividend tax revenue-to-output ratio is matched qualitatively and quantitatively until quarter 10 but then the data and results deviate from each other.

Chapter 3

Comparison of the Results of the Realization-Based and Accrual-Based Models

In the U.S. data for the years 2010-2013, we observe that the dividend-output ratio increases by 68% before the reforms expire and then declines by 23.5% upon impact, ie when the Bush tax cuts expire, whereas our realization-based capital gains model estimates that the dividend-output ratio declines by 63.3% upon impact after nine quarters of increase by about 56%, moving very closely with the data. On the other hand, the accrual-based model estimates a decline of 67.6% in the dividend-output ratio after a sharp increase of 250% for nine quarters. Due to the fact that the dividend tax revenue data was not available, we constructed a series for dividend tax revenue using the dividend data and the top marginal statutory dividend tax rates. Although we could not capture the trend of the dividend tax revenue at impact, the performance of the realization-based model was better than the accrual-based model before the tax rates go up. Moreover, the capital gains tax revenue estimate of the realization-based model moves much closer to the data than the estimate of the accrual-based model until the expiration of the tax reforms. The reason behind the superiority of the realization-based capital gains model over the accrual-based capital gains model stems from the following: The realization-based capital gains model provides the stockholders with an additional means of smoothing their consumption, that is, it allows the stockholders smooth their consumption by choosing how much capital gains to realize today

and how much capital gains to leave as unrealized for tomorrow. The accrual-based capital gains model, however, does not provide the stockholders with such a decision mechanism because in the accrual-based capital gains model capital gains taxes are paid on the total value of capital gains regardless of whether a stock is sold or not. These different decision mechanisms of the stockholders in the two models are also reflected in the firm decisions, and ultimately the equilibrium stock price. Since the firms take into account the fact that stockholders have the ability to adjust their unrealized-to-realized capital gains ratio and this ratio affects the discount factor of the firm, making it larger, firms do not need to adjust their capital level in the realization-based capital gains model as aggressively as in the accrual-based capital gains model. Because the firms do not need to compensate the stockholders for the stock price fluctuations due to tax rate changes in the realization-based capital gains model as much as in the accrual-based capital gains model and they value future in the realization-based capital gains model more than they do in the accrual-based capital gains model, they behave less aggressively. In order to make their stocks more attractive to the stockholders and help mitigate the stock price fluctuations, the expectations of increased dividend tax rate drive firms to distribute much more dividends prior to the policy and the expectations of increased capital gains tax rate induce firms to increase their capital accumulation more intensely in the accrual-based capital gains model than in the realiation-based capital gains model.

3.1 The Accrual-Based Model

We consider an economy with an infinite horizon. There is a continuum unit mass of inifitely lived homogeneous households, homogeneous firms and a government. The time is discrete and indexed by t=0,1,2,...

3.1.1 Households

The households in our model have preferences of the following form:

$$\max \sum_{t=0}^{\infty} \beta^t U(C_t) \tag{3.1}$$

where $\beta \in (0,1)$ is the discount factor and C_t is consumption per capita. We assume that U(.) $\Re+\rightarrow\Re$ is strictly increasing, strictly concave, and continuously differentiable and the Inada conditions hold, i.e $\lim_{C\rightarrow 0} U'(C) = \infty$ and $\lim_{C\rightarrow\infty} U'(C) = 0$.

Households own the firms, so they own the shares from which they receive dividend payments. They can trade these shares and one-period bonds among themselves, and are subject to dividend taxes on the dividends they receive, and to capital gains taxes on their capital gains resulting from the appreciation of shares. If they have capital losses they are refunded by the amount they would pay if they accrued capital gains. In addition to income from dividends, bonds and share sales, they also receive an untaxed labor income and a lump-sum tax transfer from the government.

We can write the household budget constraint as:

$$C_t + P_t S_{t+1} + B_{t+1} = [(1-\tau_t^d)D_t + P_t - \tau_t^g(P_t - P_{t-1})]S_t + W_t L_t + (1+R_t)B_t + T_t, \tag{3.2}$$

where P_t is the ex-dividend equity price, S_t is the number of shares held at the beginning of period t (we assume that there is only one perfectly divisible share at any t), B_{t+1} is the one-period bond purchased by households at period t, τ_t^d is the proportional tax on dividend income, D_t is the dividend payment per share, τ_t^g is the proportional tax on accrued capital gains, W_t is the wage rate per unit of labor supplied, L_t is the labor supplied, R_t is the one-period bond interest rate and T_t is the lump-sum government transfer.

3.1.2 Firms

The firm uses the capital it owns and labor it hires to produce goods according to the production technology:

$$Y_t = F(K_t, X_t L_t) \tag{3.3}$$

where $F(.)$ is a constant returns to scale production function, K_t is the firm's capital stock, L_t is the firm's labor and X_t is the technology growth.

We assume that there is no new equity or debt issuance. The firm uses its income from production for its corporate income tax, dividend and wage payments and for investment. Hence, we can write the firm's dividend distribution constraint as:

$$D_t = F(K_t, X_t L_t) - I_t - W_t L_t - T_t^c \tag{3.4}$$

where I_t is investment and given by $I_t = K_{t+1} - (1-\delta)K_t$, δ is the depreciation rate and T_t^c is the corporate income tax payment which is given by:

$$T_t^c = \tau^c[F(K_t, X_t L_t) - W_t L_t - \delta K_t] \tag{3.5}$$

Therefore, dividend payments can be written as:

$$D_t \;=\; (1-\tau^c)[F(K_t, X_t L_t) - W_t L_t - \delta K_t] + K_t - K_{t+1} \tag{3.6}$$

3.1.3 The Government

The government determines the tax rates, and redistributes the tax revenue back to the households in a lumpsum manner. The government budget constraint is given by:

$$T_t = \tau_t^d D_t + \tau^c[K_t^\alpha L_t^{1-\alpha} - W_t L_t - \delta K_t] + \tau_t^g (P_t - P_{t-1}) S_t \tag{3.7}$$

3.1.4 Competitive Equilibrium

A competitive equilibrium with taxes is a set of allocations $\{c_t,\ l_t^d,\ l_t^s,\ s_{t+1},\ b_{t+1},\ k_{t+1},\ i_t,\ d_t,\ t_t\}$, prices $\{w_t,\ r_t,\ p_t,\ v_t\}$ and tax rates $\{\tau_t^d,\ \tau_t^g,\ \tau_t^c\}$ such that:

1) Given $\{w_t,\ r_t,\ p_t,\ v_t\}$, the allocations $\{c_t,\ l_t^s,\ s_{t+1},\ b_{t+1}\}$ solve the household's maximization problem;

2) Given $\{w_t,\ r_t,\ p_t,\ v_t\}$, the allocations $\{\ l_t^d,\ d_t,\ k_{t+1},\ i_t\}$ solve the firm's maximization problem;

3) $\{w_t,\ r_t,\ p_t,\ v_t\}$ are such that all markets clear:

$$\begin{aligned}
&\textit{Stock market}: && s_t = 1 && \forall t \\
&\textit{Labor market}: && l_t = 1 && \forall t \\
&\textit{Bond market}: && b_t = 0 && \forall t \\
&\textit{Goods market}: && c_t + \gamma k_{t+1} - (1-\delta)k_t = f(k_t, l_t) && \forall t
\end{aligned}$$

4) The government budget constraint is satisfied:

$$t_t = \tau_t^d d_t + \tau^c[k_t^\alpha l_t^{1-\alpha} - w_t l_t - \delta k_t] + \tau_t^g(p_t - \frac{p_{t-1}}{\gamma})s_t \tag{3.2}$$

3.2 Quantitative Analysis

3.2.1 Comparison of the Results of the Realization-Based and Accrual-Based Models

There are common features of the qualitative results of the Realization-Based model and the Accrual-Based model. However, the quantitative results of the two models differ significantly from each other.

The long-run trends of the majority of the variables in the accrual-based model are the same as those in the realization-based model. However, the long-run values as well as the initial steady state values of the variables in the accrual-based model differ from those in the realization-based model because the realization-based capital gains model provides the stockholders with an additional means of smoothing their consumption, that is, it allows the stockholders smooth their consumption by choosing how much capital gains to realize today and how much capital gains to leave as unrealized for tomorrow. The accrual-based capital gains model, however, does not provide the stockholders with such a decision mechanism because in the accrual-based capital gains model capital gains taxes are paid on the total value of capital gains regardless of whether a stock is sold or not. These different decision mechanisms of the stockholders in the two models are also reflected in the firm decisions, and ultimately the equilibrium stock price. Since the firms take into account the fact that stockholders have the ability to adjust their unrealized-to-realized capital gains ratio and this ratio affects the discount factor of the firm, making it larger, firms do not need to adjust their capital level in the realization-based capital gains model as aggressively as in the accrual-based capital gains model. As a result, the long-run values of capital and hence investment are lower and the long-run values of the discount factor, dividends and prices are higher in the accrual-based model than in the realization-based model for all experiments.

The difference between the transition results of the two models stems from the same idea. The higher discount factor of the firms in the accrual-based model lead them to react much more aggresively than in the realization-based model and this is reflected in all variables. For example, because the firms do not need to compensate the stockholders for the stock price fluctuations due to tax rate changes in the realization-based capital gains model as much as in the accrual-based capital gains model and they value future in the realization-based capital gains model more than they do in the accrual-based capital gains model, they behave less aggressively. In order to make their stocks more attractive to the stockholders and help mitigate the stock price fluctuations, the expectations of increased dividend tax rate drive

firms to distribute much more dividends prior to the policy and the expectations of increased capital gains tax rate induce firms to increase their capital accumulation more intensely in the accrual-based capital gains model than in the realization-based capital gains model.

Because the intuition behind the short-run and the long-run trends of the variables in the Realization-Based model and the Accrual-Based model is very similar, the following section focuses primarily on the quantitative differences between the results of the two models.

LONG-RUN RESULTS

Initial Steady State Values

The initial steady state level of capital is higher in the Realization-Based model than in the Accrual-Based model because of the additional cost term that appears in the steady state equation for capital (see Appendix C). Therefore, output and investment levels are higher whereas dividend level is lower in the Realization-based model. The firm's discount rate and stock price are both lower in the Realization-Based model due to the cost term that appears in the denominator of the equations for these variables. Government transfer is lower in the Realization-Based model because the combined effect of lower dividend and capital gains tax revenue (than the revenues in the Accrual-based model) dominates the higher corporate income tax revenue (than the revenue in the Accrual-Based model) resulting from higher capital level. Lastly, consumption is higher in the Realization-Based model due to the fact that the higher level of output dominates the sum of the higher level of investment and portfolio management costs.

Final Steady State Values

Increase in Dividend Tax:

The major difference between the long-run results of the two models when the dividend tax goes up is the consumption level. In the Accrual-Based model, consumption depends only on the capital level, whereas in the Realization-Based model the consumption level is affected also by the portfolio management costs determined by the level of realized and unrealized capital gains. Since the portfolio management costs are lower in the long-run, the

consumption level is higher in the long-run in the Realization-Based model, whereas it is constant in the Accrual-Based model. In both models, the level of the capital, investment, dividend, interest rate, output and firm's discount rate are independent of the dividend tax rate. Therefore, they remain constant. Both the fall in stock prices and the increase in government revenue are higher in the Accrual-Based model. (see Appendix F-Table 6.4 for steady state values)

Increase in Capital Gains Tax:

The long-run level of capital, investment, output and consumption is lower in both models, whereas the long-run level of dividends, firm's discount rate, stock price and government revenue are higher in both models. Although qualitatively similar, as explained before, since the capital level falls more in the Accrual-Based model, investment, output and consumption fall more and dividends, firm's discount rate, stock price and government revenue increase more in the Accrual-Based model than in the Realization-Based model. (see Appendix F-Table 6.5 for steady state values)

Increase in Dividend and Capital Gains Taxes:

The effect of the increase in capital gains tax dominates the effect of the dividend tax for both models, so just like in the experiment where only capital gains tax rate goes up the long-run level of capital, investment, output and consumption fall more in the Accrual-Based model and the level of dividends, firm's discount rate, stock price and government revenue increase more in the Accrual-Based model than in the Realization-Based model.

TRANSITION RESULTS

As we mentioned earlier, the transition trends of the variables look qualitatively similar in the Realization-Based model and the Accrual-Based model. However, there is a significant difference between the quantitative changes, especially at impact when the tax rates go up. In particular, the reactions of the variables in the Accrual-Based model are much sharper than those in the Realization-Based model as explained before. Therefore, we focus only on the quantitative differences of the results of the two models below.

3.2.1.1 Expected Increase in Dividend Tax Rate

With the higher tax rate:

When the dividend tax rate goes up in quarter 10, dividends fall by 84% in the Realization-Based model and by 92.2% in the Accrual-Based model so that paying much higher dividend taxes is partially avoided. Prices fall by 18.3% in the Realization-Based model and by 21.7% in the Accrual-Based model with the sale of stocks which are not as attractive as before. The return on stock falls sharply by 509.8% in the Realization-Based model and by 1490% in the Accrual-Based model because both the dividend yield and the capital gains yield fall. With the fall in return on stock, the discount rate falls by 500.8% in the Realization-Based model and by 1490% in the Accrual-Based model. Government transfers decrease by 40% in the Realization-Based model and by 398.9% in the Accrual-Based model due to lower dividend tax revenue and capital gains tax revenue. The dividend-to-output ratio falls by 70.6% in the Realization-Based model and by 85.7% in the Accrual-Based model, price-to-output ratio falls by 18.26% in the Realization-Based model and by 19.14% in the Accrual-Based model, Capital Gains Tax Revenue-to-output ratio falls by 225% in the Realization-Based model and by 2390% in the Accrual-Based model and the dividend tax revenue-to-output ratio falls by 43.75% in the Realization-Based model and by 48.1% in the Accrual-Based model at impact. All variables start converging to their final steady state levels after the change.

3.2.1.2 Expected Increase in Capital Gains Tax Rate

With the higher tax rate:

With the new higher capital gains tax rates in quarter 10, dividend distributions go up by 52.2% in the Realization-Based model and by 133.3% in the Accrual-Based model, stock prices go up by 3.89% in the Realization-Based model and by 5.94% in the Accrual-Based model . The return on stock increases by 113.9% in the Realization-Based model and by 498.2% in the Accrual-Based model due to the increase in both dividend yield and capital

gains yield, the discount rate increaes by 291% in the Realization-Based model and by 503.4% in the Accrual-Based model. Government transfers increase by 30% in the Realization-Based model and by 160% in the Accrual-Based model with higher dividend tax revenue due to higher dividends and higher capital gains tax revenue due to higher realizations and higher capital gains taxes. The dividend-to-output ratio increases by 56.4% in the Realization-Based model and by 142.1% in the Accrual-Based model , price-to-output ratio increases by 5.44% in the Realization-Based model and by 5.68% in the Accrual-Based model, Capital Gains Tax Revenue-to-output ratio rises by 176.4% in the Realization-Based model and by 100.2% in the Accrual-Based model and the dividend tax revenue-to-output ratio increases by 56.4% in the Realization-Based model and by 142.1% in the Accrual-Based model at impact. All variables start converging to their final steady state levels after the change.

3.2.1.3 Expected Increase in Both Capital Gains and Dividend Tax Rates

There are two opposing forces in this experiment. The two forces, the increase in the dividend tax rate and the increase in capital gains tax rate cause all of the variables move in opposite directions in the two experiments above. However, the increase in dividend tax rate dominates that of the capital gains tax rate for both models:

With the higher tax rate:

When the dividend tax rate goes up in quarter 10, dividends fall by 66.7% in the Realization-Based model and by 69.7% in the Accrual-Based model so that paying much higher dividend taxes is partially avoided. Prices fall by 12.6% in the Realization-Based model and by 14.2% in the Accrual-Based model with the sale of stocks which are not as attractive as before. The return on stock falls sharply by 478% in the Realization-Based model and by 1306% in the Accrual-Based model because both the dividend yield and the capital gains yield fall. With the fall in return on stock, the discount rate falls by 397% in the Realization-Based model and by 1229% in the Accrual-Based model. Government transfers decrease by 36% in the Realization-Based model and by 389.4% in the Accrual-Based model

due to lower dividend tax revenue and capital gains tax revenue. The dividend-to-output ratio falls by 63.3% in the Realization-Based model and by 67.6% in the Accrual-Based model, price-to-output ratio falls by 16.4% in the Realization-Based model and by 17.8% in the Accrual-Based model, Capital Gains Tax Revenue-to-output ratio falls by 193% in the Realization-Based model and by 2249% in the Accrual-Based model and the dividend tax revenue-to-output ratio falls by 41.6% in the Realization-Based model and by 32.4% in the Accrual-Based model at impact. All variables start converging to their final steady state levels after the change.

3.2.1.4 Unexpected Increase in the Tax Rates

In both models since the tax change is unexpected, there is no change in the variables until the expiration of the reform is observed in quarter 10 because agents do not react until after the dividend tax rate actually goes up. They react qualitatively similar to the case when the tax change was expected but quantitatively, the adjustments are smaller when the tax rate increases unexpectedly and the adjustments are even smaller in the Realization-Based model than in the Accrual-Based model.

3.3 Conclusions

Existing analyses use an accrual-based capital gains tax system to evaluate the effects of the capital gains and dividend tax reforms largely because of computational reasons. I model the decision to realize or not and evaluate these tax reforms in the light of the more realistic assumption using a realization-based capital gains tax system which is the tax system in effect in the U.S. and majority of the countries in the world. I find that modelling the capital gains tax system as realization-based is crucial for the following reasons: Although the evolution of the macroeconomic variables is qualitatively similar in the two models, the realization-based capital gains model generates much more accurate quantitative results

than the accrual-based capital gains model in the sense that the results of the former model are much closer to the data. In the U.S. data for the years 2010-2013, we observe that the dividend-output ratio increases by 68% before the reforms expire and then declines by 23.5% upon impact, ie when the Bush tax cuts expire, whereas our realization-based capital gains model estimates that the dividend-output ratio declines by 63.3% upon impact after nine quarters of increase by about 56%, moving very closely with the data. On the other hand, the accrual-based model estimates a decline of 67.6% in the dividend-output ratio after a sharp increase of 250% for nine quarters. Due to the fact that the dividend tax revenue data was not available, we constructed a series for dividend tax revenue using the dividend data and the top marginal statutory dividend tax rates. Although we could not capture the trend of the dividend tax revenue at impact, the performance of the realization-based model was better than the accrual-based model before the tax rates go up. Moreover, the capital gains tax revenue estimate of the realization-based model moves much closer to the data than the estimate of the accrual-based model until the expiration of the tax reforms. The reason behind the superiority of the realization-based capital gains model over the accrual-based capital gains model stems from the following: The realization-based capital gains model provides the stockholders with an additional means of smoothing their consumption, that is, it allows the stockholders smooth their consumption by choosing how much capital gains to realize today and how much capital gains to leave as unrealized for tomorrow. The accrual-based capital gains model, however, does not provide the stockholders with such a decision mechanism because in the accrual-based capital gains model capital gains taxes are paid on the total value of capital gains regardless of whether a stock is sold or not. These different decision mechanisms of the stockholders in the two models are also reflected in the firm decisions, and ultimately the equilibrium stock price. Since the firms take into account the fact that stockholders have the ability to adjust their unrealized-to-realized capital gains ratio and this ratio affects the discount factor of the firm, making it larger, firms do not need to adjust their capital level in the realization-based capital gains model as aggressively as

in the accrual-based capital gains model. Because the firms do not need to compensate the stockholders for the stock price fluctuations due to tax rate changes in the realization-based capital gains model as much as in the accrual-based capital gains model and they value future in the realization-based capital gains model more than they do in the accrual-based capital gains model, they behave less aggressively. In order to make their stocks more attractive to the stockholders and help mitigate the stock price fluctuations, the expectations of increased dividend tax rate drive firms to distribute much more dividends prior to the policy and the expectations of increased capital gains tax rate induce firms to increase their capital accumulation more intensely in the accrual-based capital gains model than in the realiation-based capital gains model. It is also crucial to incorporate and analyze the anticipation effects, because the expiration of the tax reforms were pre-announced, creating anticipation towards higher tax rates among economic agents. Therefore, one would expect that the results of the experiment where both capital gains and dividend tax rate go up expectedly would perform better when compared with the data than the results of the experiment where the tax rates go up unexpectedly. As expected, similar to the data, when the tax changes are expected, both of our models predict that agents start adjusting their decisions before the tax changes happen, whereas in the case where the tax changes were unanticipated, agents do not react until after the tax rates actually go up.

3.4 Future Work

Extending our study towards searching for the optimal capital gains taxation system is worthwhile because the two major ways of taxing capital gains, namely a realization-based capital gains tax system where capital gains taxes are paid on the capital gain in an asset's value only when the asset is sold, and an accrual-based capital gains tax system where the increase in the value of an asset is taxed periodically regardless of whether the asset is sold or held, have been a highly debated issue because there are many distortions caused by a

realization-based capital gains tax system although it is the system adopted by the majority of the countries. As summarized below, there are actually pros and cons of both taxing capital gains on a realization basis and taxing them on an accrual basis.

The major benefits of a realization-based capital gains tax can be summarized as follows: Firstly, as The Policy Advice Division of the Inland Revenue Department and the New Zealand Treasury (2009), like many other studies, explain, it is more convenient for taxpayers to be exposed to a realization-based system because they are able to fund their tax liability through the sale of their assets. Secondly, the sale price of assets is known at the time of sale, so it is easy to determine the capital gain or loss, which means little administrative costs for investors. In addition to its advantages, a realization-based system has disadvantages as well. The most important problem associated with a realization-based system, on which the opponents of this system base their arguments, is the effect referred to as the "lock-in" effect in the literature. Auerbach (1992), Auerbach (1988) and Auerbach, Burman and Siegel (1998) argue that, as long as the investors are subject to a tax only upon the disposal of their assets, they will continue delaying the sale of appreciating assets and sell the depreciating ones immediately. Therefore, they always tend to keep the "good" assets and this is what is called the "lock-in" effect and this effect is higher with a higher tax rate and higher gains. Moreover, as Shakow (1986) argues, when capital gains are taxed on a realization basis and taxpayers are locked-in to appreciating assets, this reduces the level of liquidity in the market. This tax deferral and tax arbitrage opportunity create distortions in the optimal investment decisions. One common solution to this problem has been the limitation of allowable capital loss deductions. As Burman and Randolph (1994) mentions, capital losses can be offset against capital gains only and this rule is called "ring-fencing". In the U.S. only $3,000 of the total losses can be used the offset the gains. According to

An accrual-based capital gains taxation is beneficial firstly because it does not provide incentives to delay the sale of appreciating assets. Therefore, the investors are freed in their investment decisions in the sense that they do not need to take into account the tax arbitrage

factor in order to decide for the timing of asset sales and this eliminates the lock-in effect. Moreover, there is a greater potential of revenue collection for the government. Then why is an accrual-based capital gains tax system not adopted by most of the countries?[1]One answer is that, as Merrett (1969) explains, an accrual-based capital gains tax system also brings with it some practical difficulties and these practical difficulties are reflected in the difficulty of analyzing this system theoretically. The biggest problem is the periodical valuation of assets, some of which are really hard to value. Determining the market value of commonly traded assets like shares and land is not an issue, but it may be very difficult and costly to value assets like intellectual properties such as patent rights. A second problem in an accrual-based system is the difficulty with fulfilling tax liabilities when assets appreciate but not sold and this is referred to as the "liquidity problem" by Auerbach (1992). Another obstacle is the determination of accrual-based effective capital gains tax rates based on the realization-based statutory capital gains tax rates. Another possible answer to the question why a realization-based system is more popular may be that the lock-in effect is not seen as distortionary as the theory suggests. There are indeed studies which show that the timing of the realizations are not very sensitive to the capital gains tax changes. Burman and White (2003) claim that the lock-in effect is not very important, because if it was, then there would be notable changes in asset realizations when the tax rates change. Furthermore, Auerbach (1989) notes that the U.S. time-series studies do not exhibit sensitive capital gains realizations to tax rates. The findings by Burman and Randolph (1994) also support the idea that the capital gains tax changes have a negligible effect on realizations if these changes are permanent, whereas this effect may be large when the changes are temporary.

Because neither a realization-based taxation nor an accrual-based taxation of capital gains is perfect, a hybrid method, which carries the features of the other two methods, is suggested by many studies including The Policy Advice Division of the Inland Revenue Department and the New Zealand Treasury (2009). They suggest an approach in which

[1]See Alworth, Arachi and Hamaui (2002) for exceptions like Italy who introduced an accrual-based taxation in 1998 but switched to realization-based system soon after.

the assets, valuation of which is easy, are taxed on an accrual basis, whereas the assets with difficult valuation are taxed on a realization basis. This approach, like others, has imperfections. Since publicly listed, frequently traded assets like common stocks are easy to value, they should be taxed on an accrual basis according to the hybrid system. The rest of the assets should be taxed on a realization basis. This means that companies will tend not to list some shares so that these assets fall into the category of assets taxed on realization basis and they can take advantage of tax deferral opportunity.

In addition to the literature mentioned above, there is a large literature on the comparison and improvement of these different types of tax practice as well. Winston (2001) presents both an accrual-based and a realization-based capital gains tax model distinguishing between franked and unfranked dividends. Auerbach (1992) argues that the solution of the liquidity problem suggested by Vickrey (1939) does not work. Vickrey (1939) formulates a "cumulative averaging" rule, according to which gains are taxed on an accrual basis but the tax payments can be deferred with interest until realization. However, this method requires information on both the amount of the gain and on how this gain accumulated over time. Auerbach (1992) also argues that the taxation of capital gains as they accrue increases the intertemporal distortion of savings caused by the mere existence of the capital gains tax because it eliminates the lock-in effect and tax deferral advantage. Instead of overcoming the lock-in effect through an accrual-based capital gains tax, Auerbach (1991) develops a new model which eliminates the tax arbitrage, tax deferral and lock-in problems. This model is actually a realization-based model but charges interest on gains accrued from the date an asset is purchased until it is sold. The advantage of this model is that it does not require substantial information regarding gains unlike the model suggested by Vickrey (1939). Menoncin and Panteghini (2009) criticize Auerbach (1991) claiming that the retrospective capital gains tax model presented is equivalent to an accrual-based model only on an ex-ante basis, not on ex-post basis which still requires information on gains. Alworth, Arachi and Hamaui (2002) also supports the ex-ante equivalence of accrual and realization based taxes.

OECD Tax Policy Studies (2006) explains the different approaches to eliminate the lock-in effect such as setting different capital gains tax rates based on the holding period, charging interest on deferred taxes and retrospective taxation.

Due to the complexity of the trade-offs between the advantages and disadvantages involved with a realization-based capital gains tax system and an accrual-based tax system, determining the optimal government policy requires an extensive analysis and is left for future work.

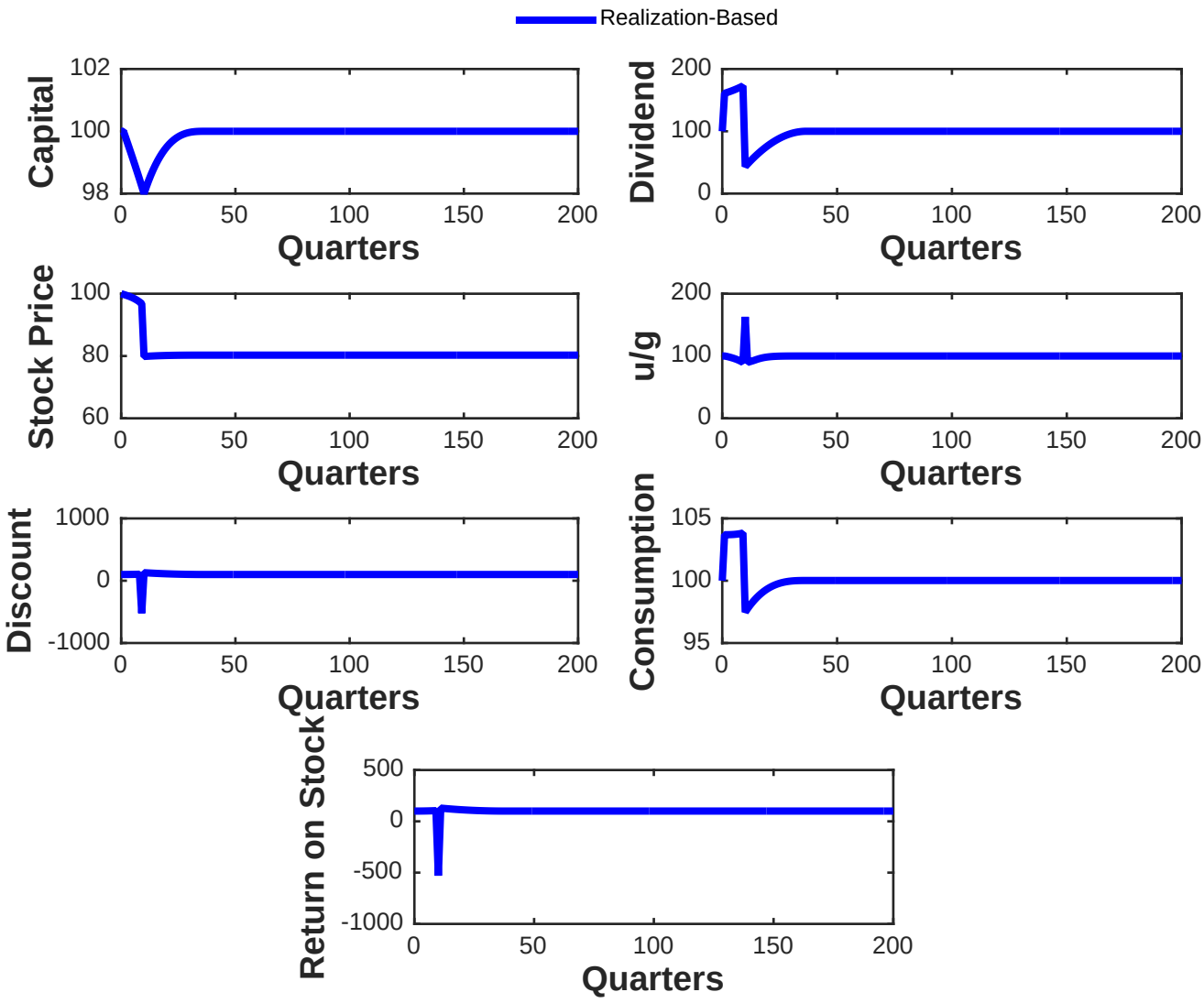

Figure 3.1: Transitional dynamics resulting from an expected increase in dividend tax rate from 14.3% to 31.2% in quarter 10

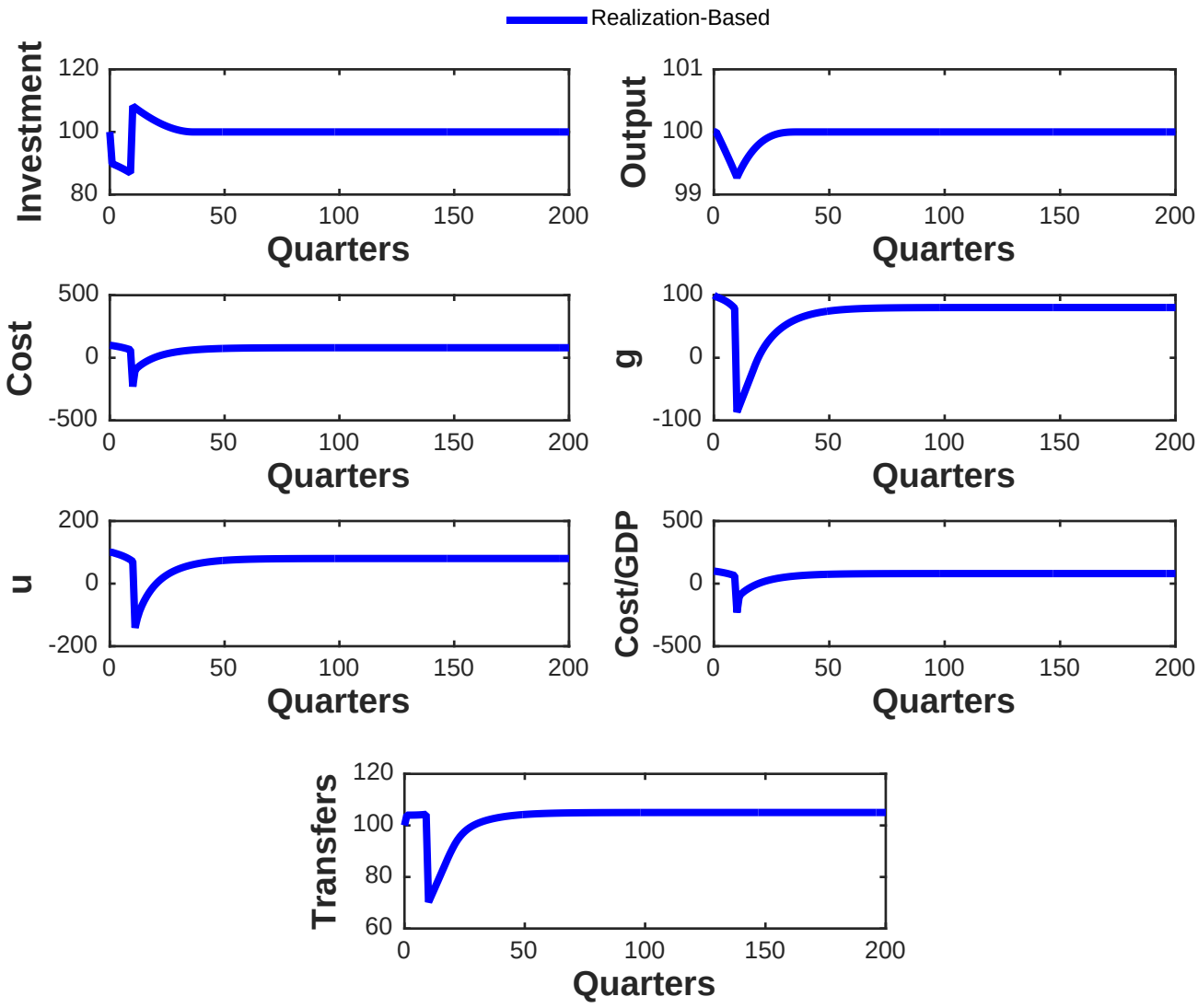

Figure 3.2: Transitional dynamics resulting from an expected increase in dividend tax rate from 14.3% to 31.2% in quarter 10

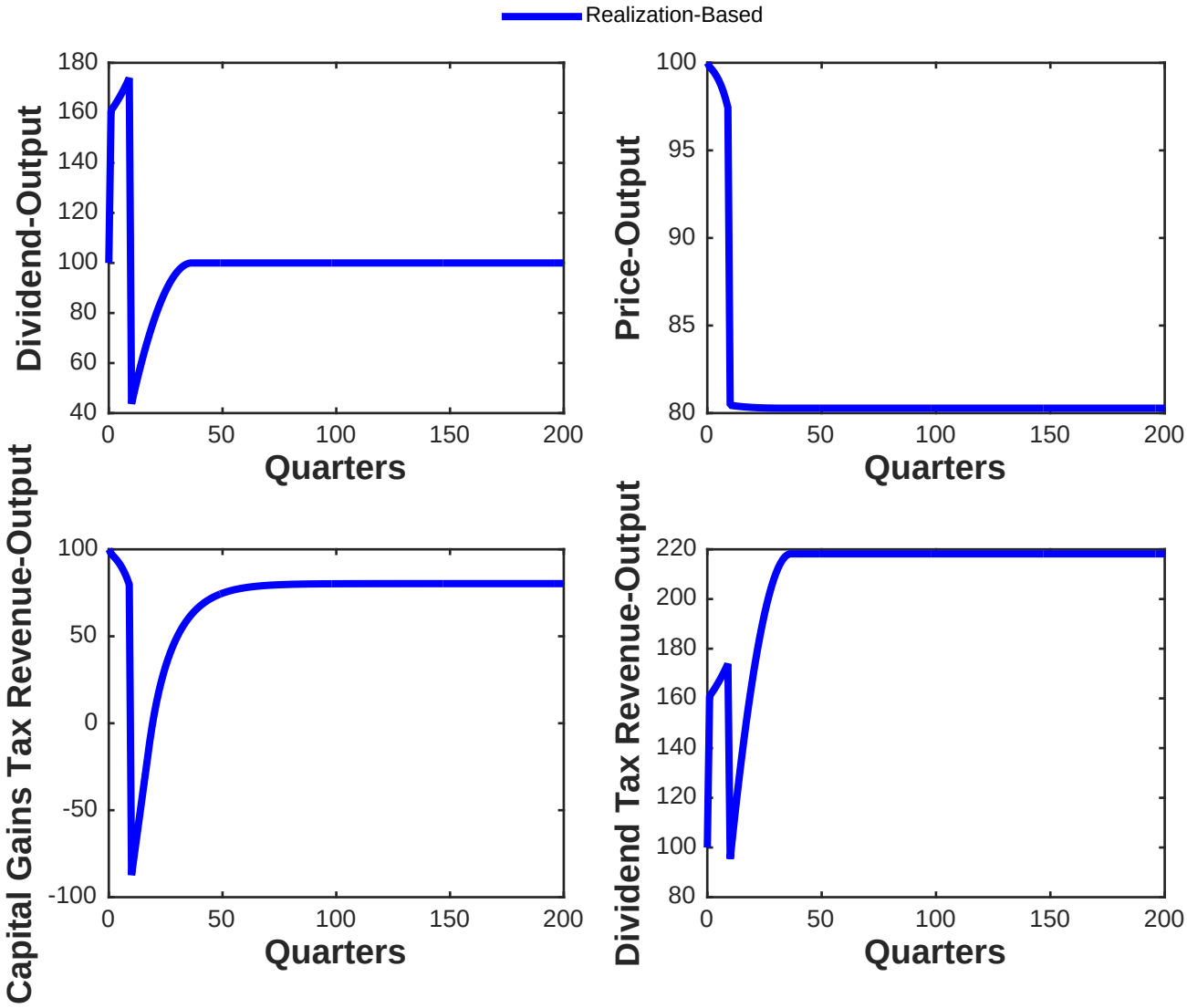

Figure 3.3: Transitional dynamics resulting from an expected increase in dividend tax rate from 14.3% to 31.2% in quarter 10

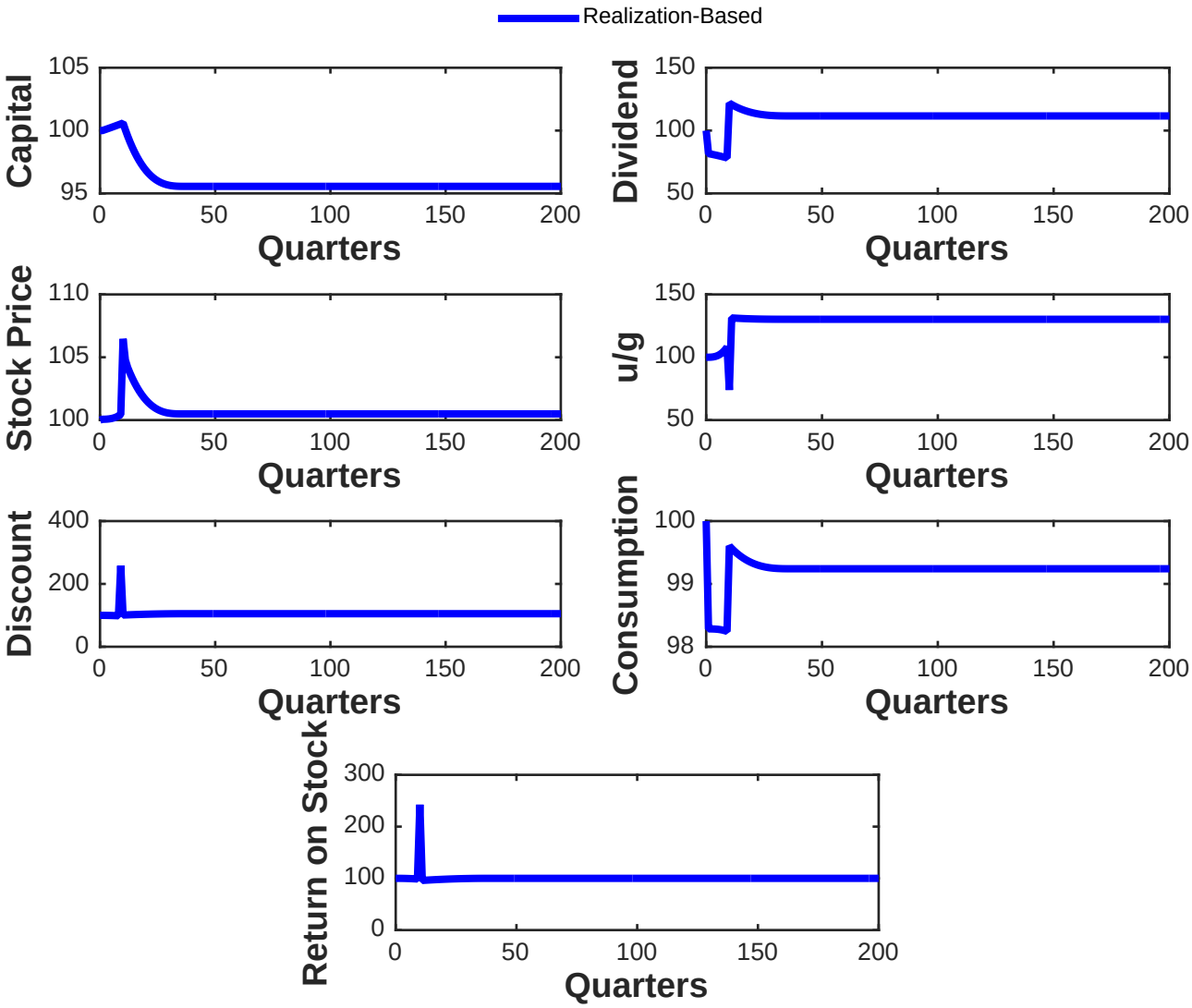

Figure 3.4: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% in quarter 10

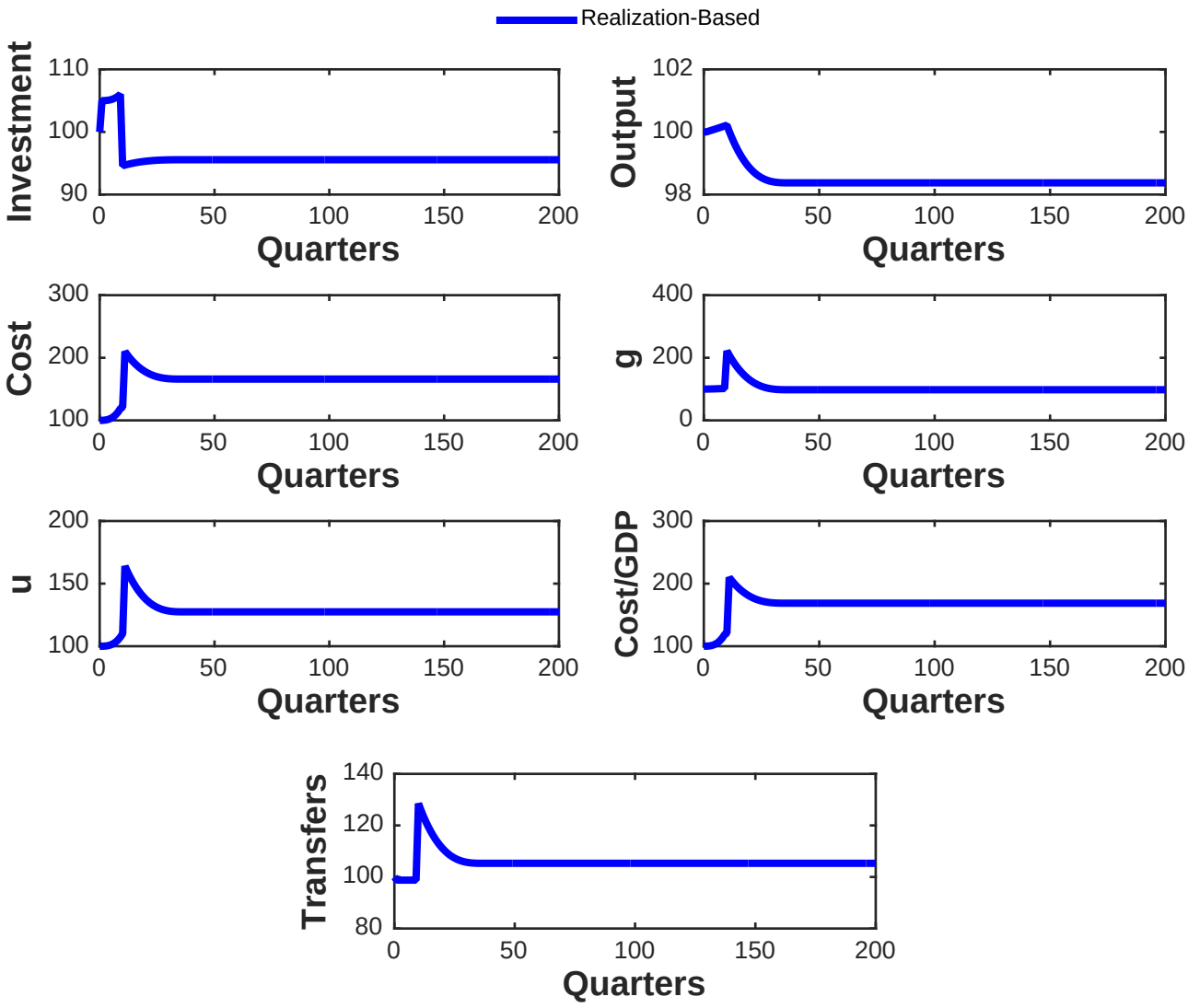

Figure 3.5: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% in quarter 10

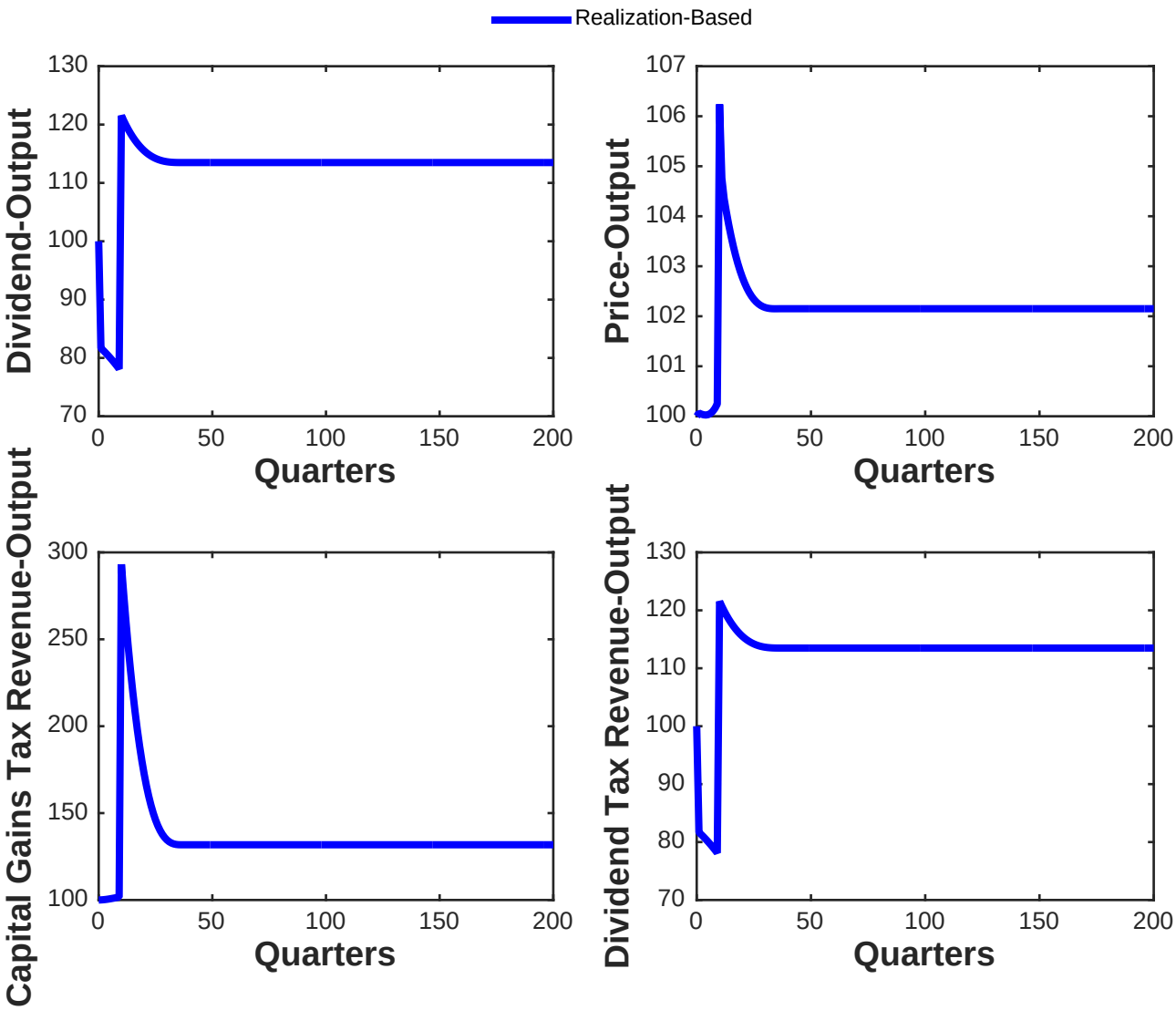

Figure 3.6: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% in quarter 10

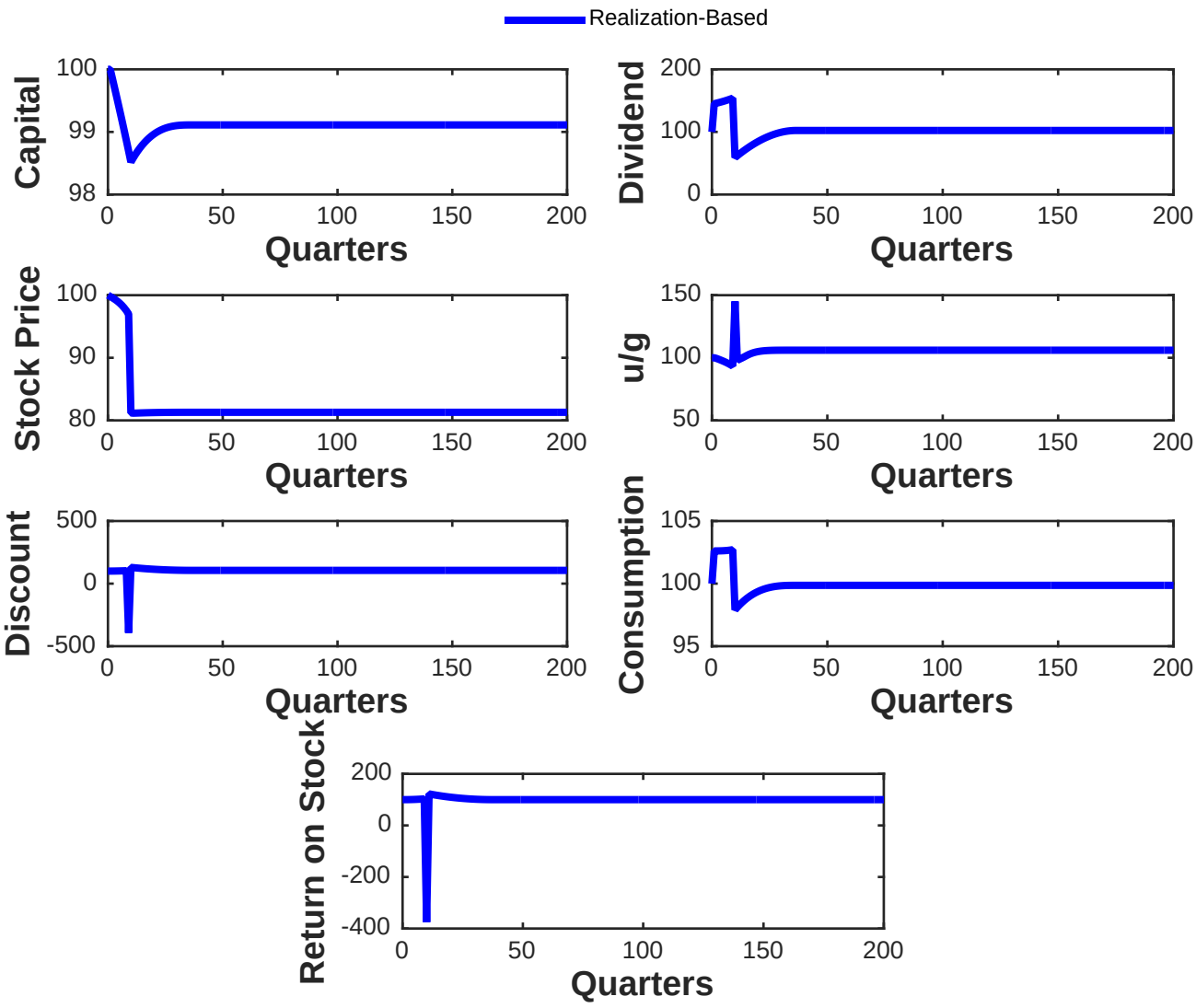

Figure 3.7: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

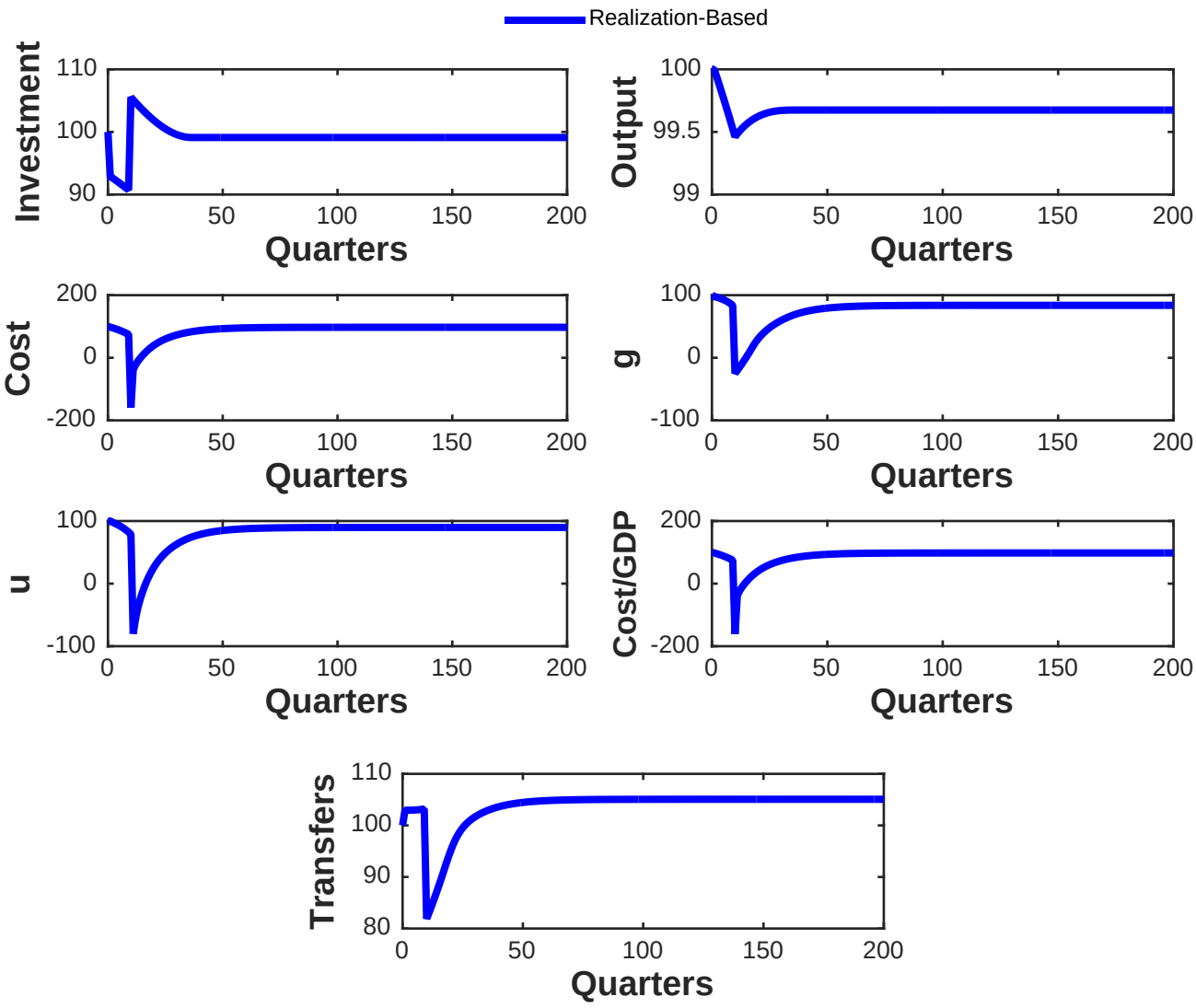

Figure 3.8: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

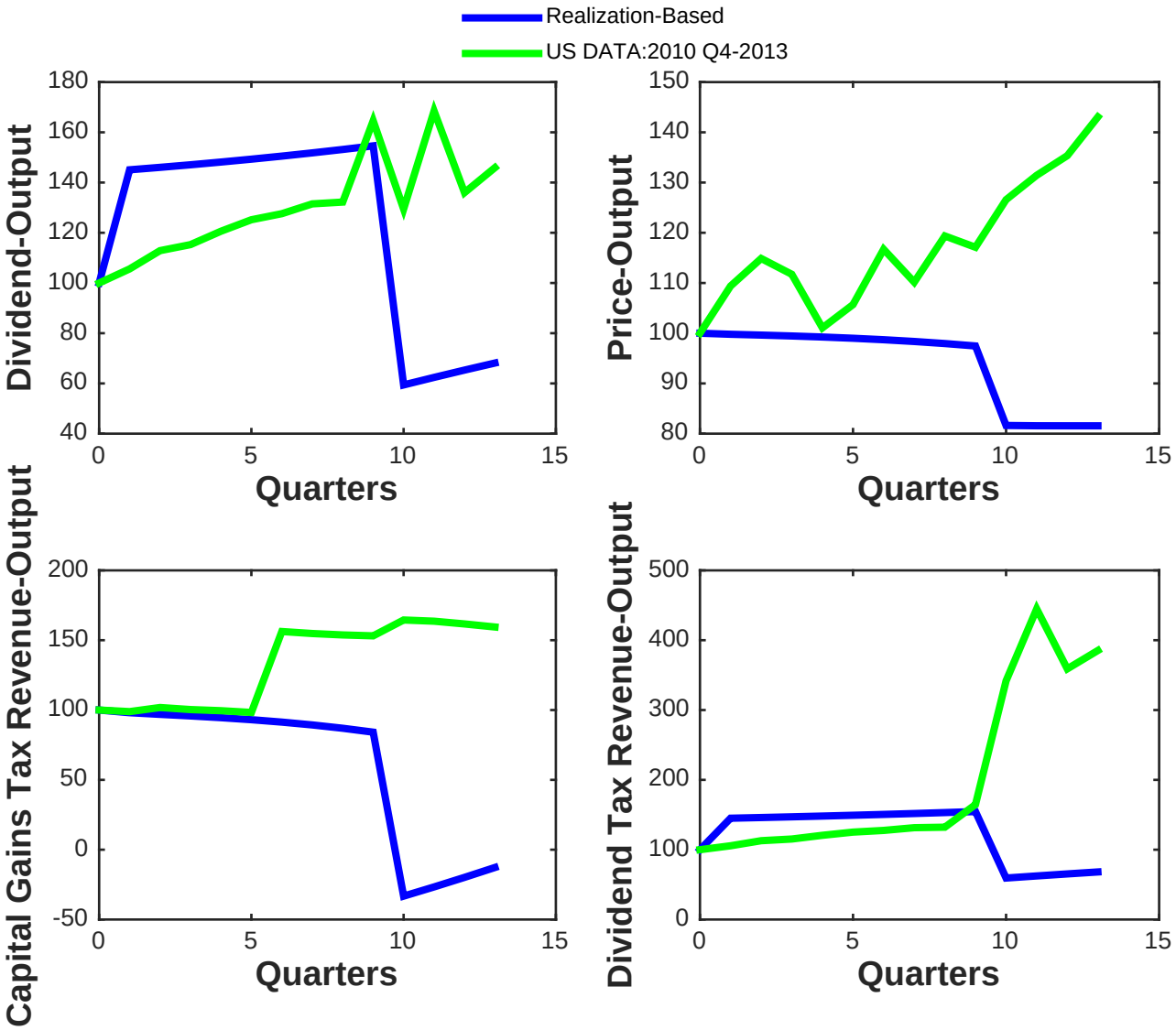

Figure 3.9: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

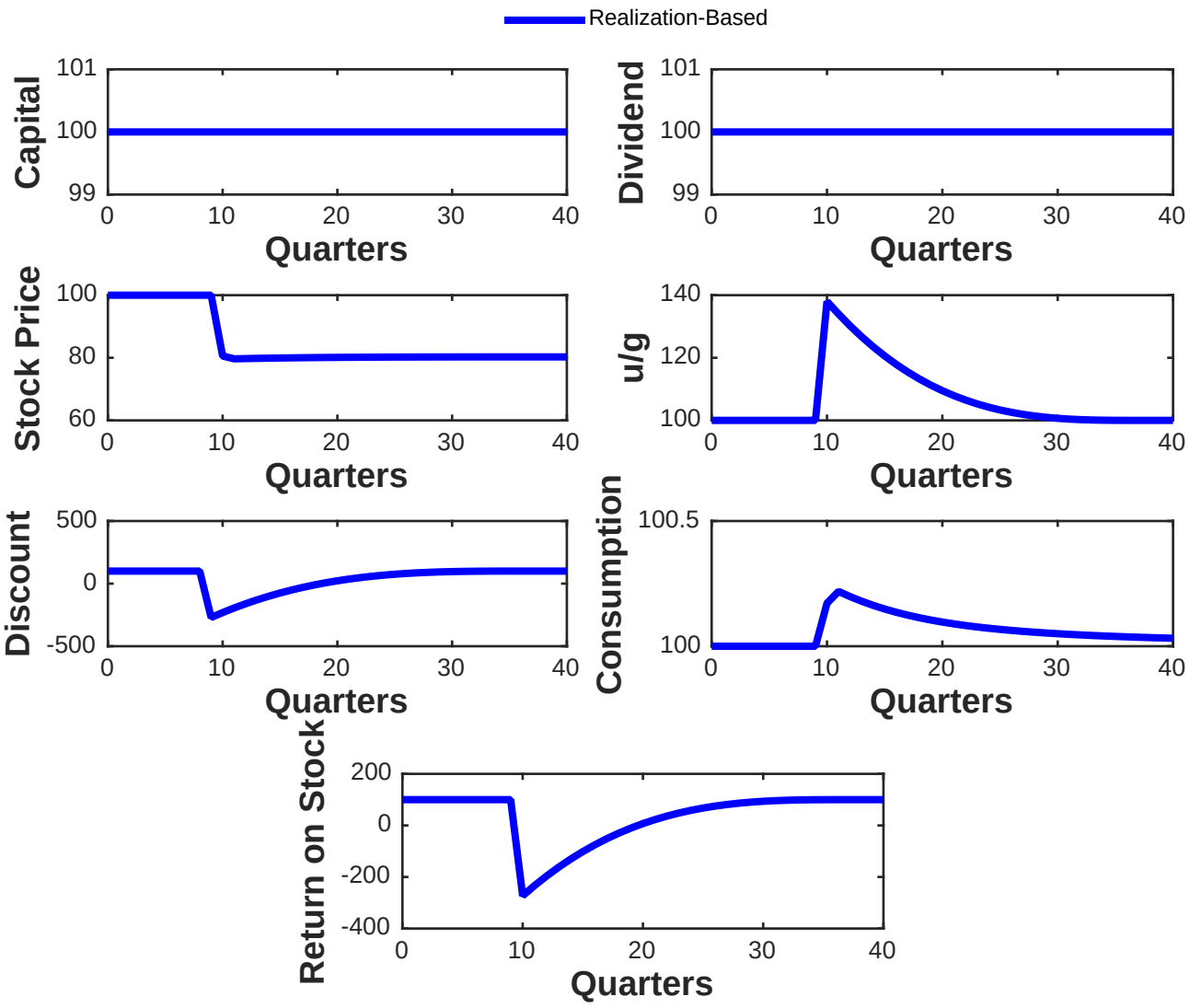

Figure 3.10: Transitional dynamics resulting from an unexpected increase in dividend tax rate from 14.3% to 31.2%

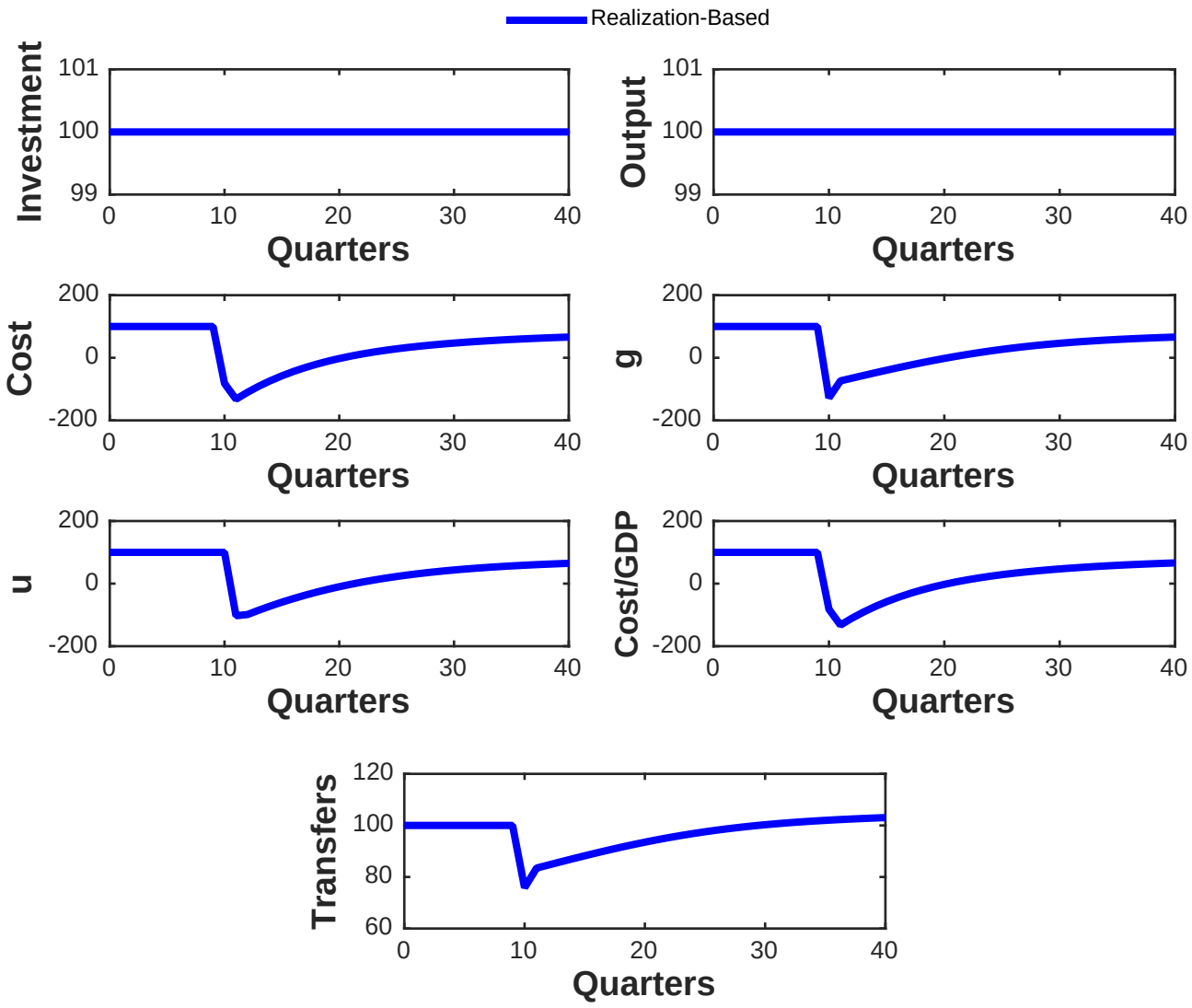

Figure 3.11: Transitional dynamics resulting from an unexpected increase in dividend tax rate from 14.3% to 31.2%

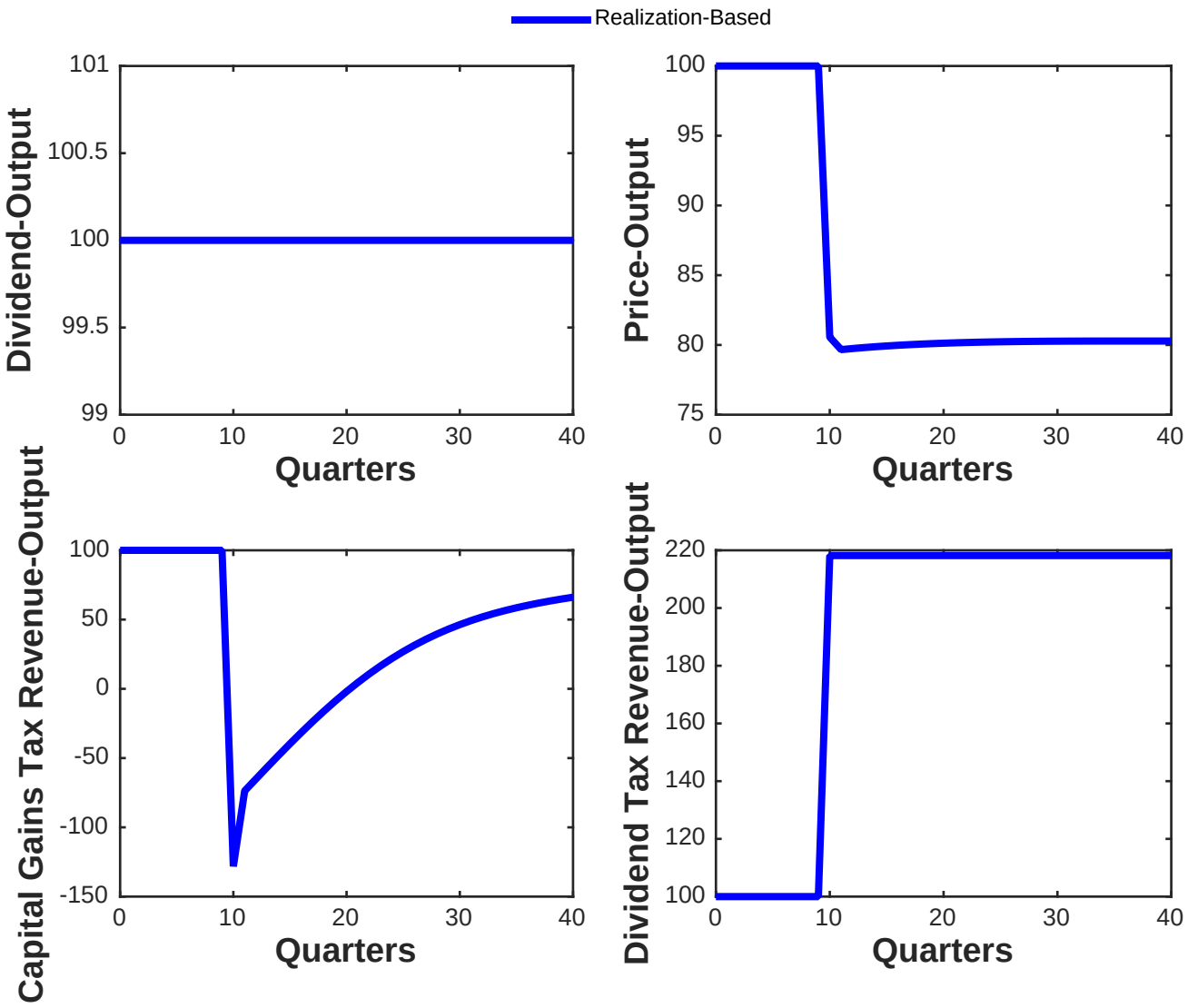

Figure 3.12: Transitional dynamics resulting from an unexpected increase in dividend tax rate from 14.3% to 31.2%

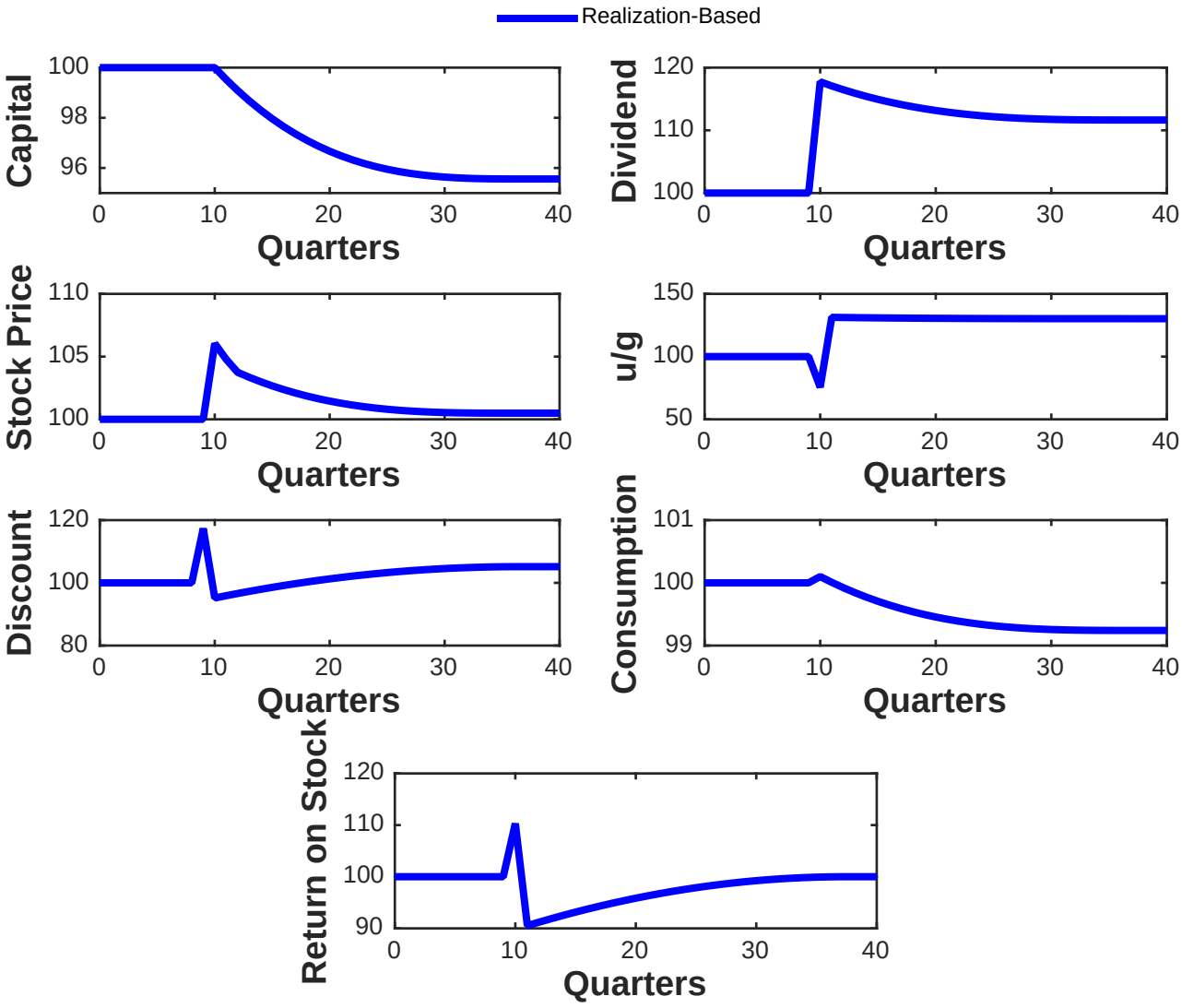

Figure 3.13: Transitional dynamics resulting from an unexpected increase in capital gains tax rates from 14.8% to 19.6% in quarter 10

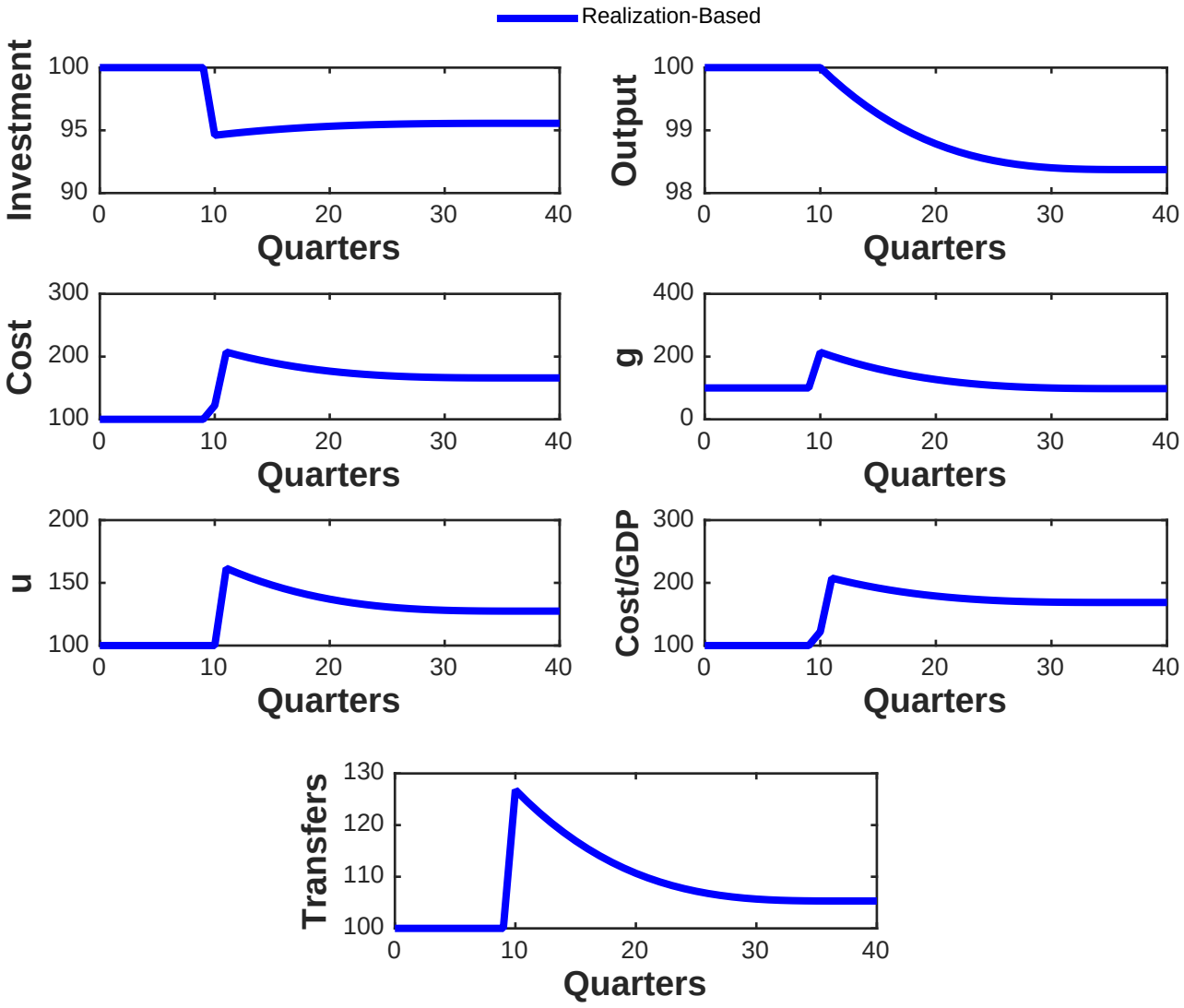

Figure 3.14: Transitional dynamics resulting from an unexpected increase in capital gains tax rates from 14.8% to 19.6% in quarter 10

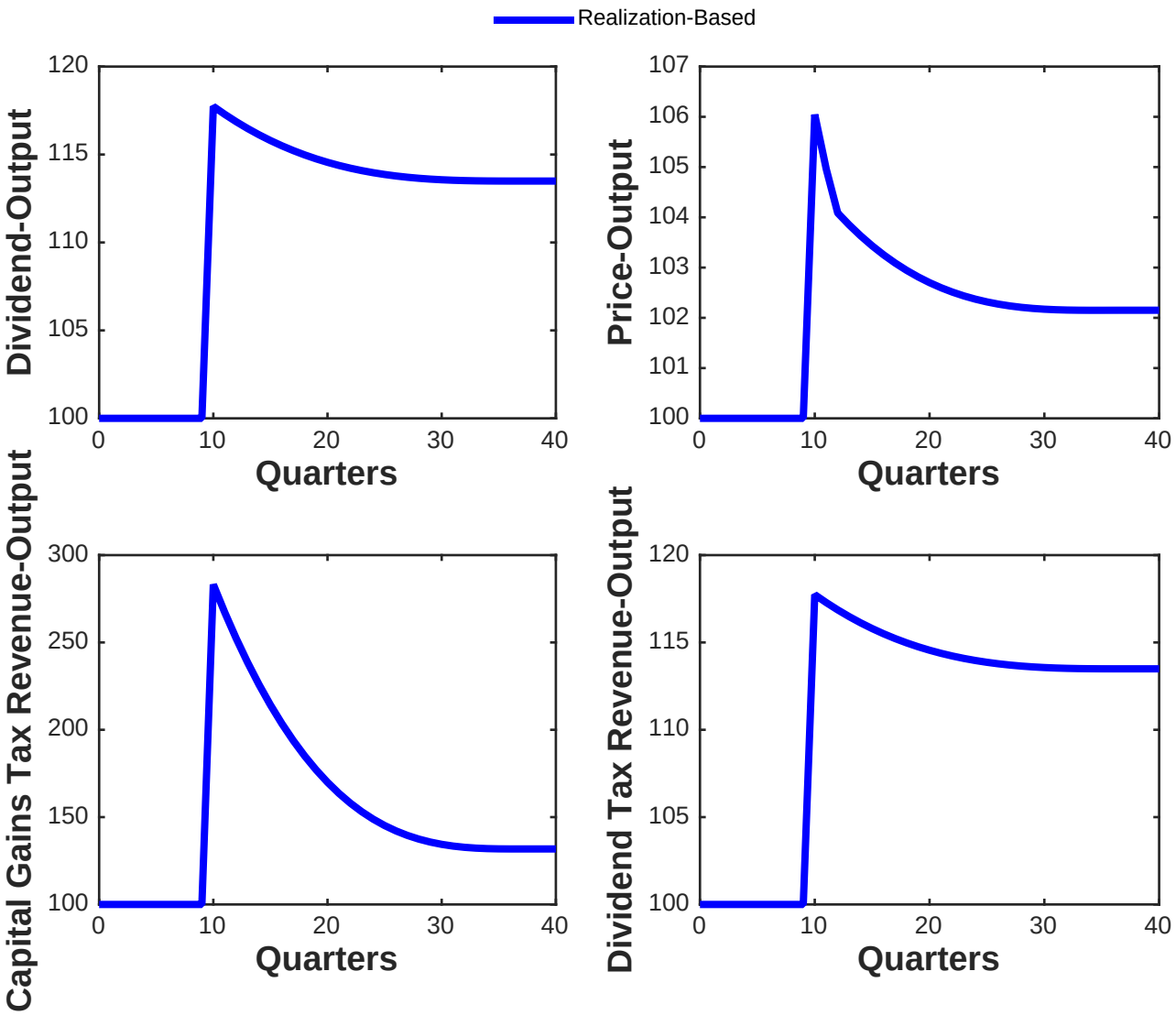

Figure 3.15: Transitional dynamics resulting from an unexpected increase in capital gains tax rates from 14.8% to 19.6% in quarter 10

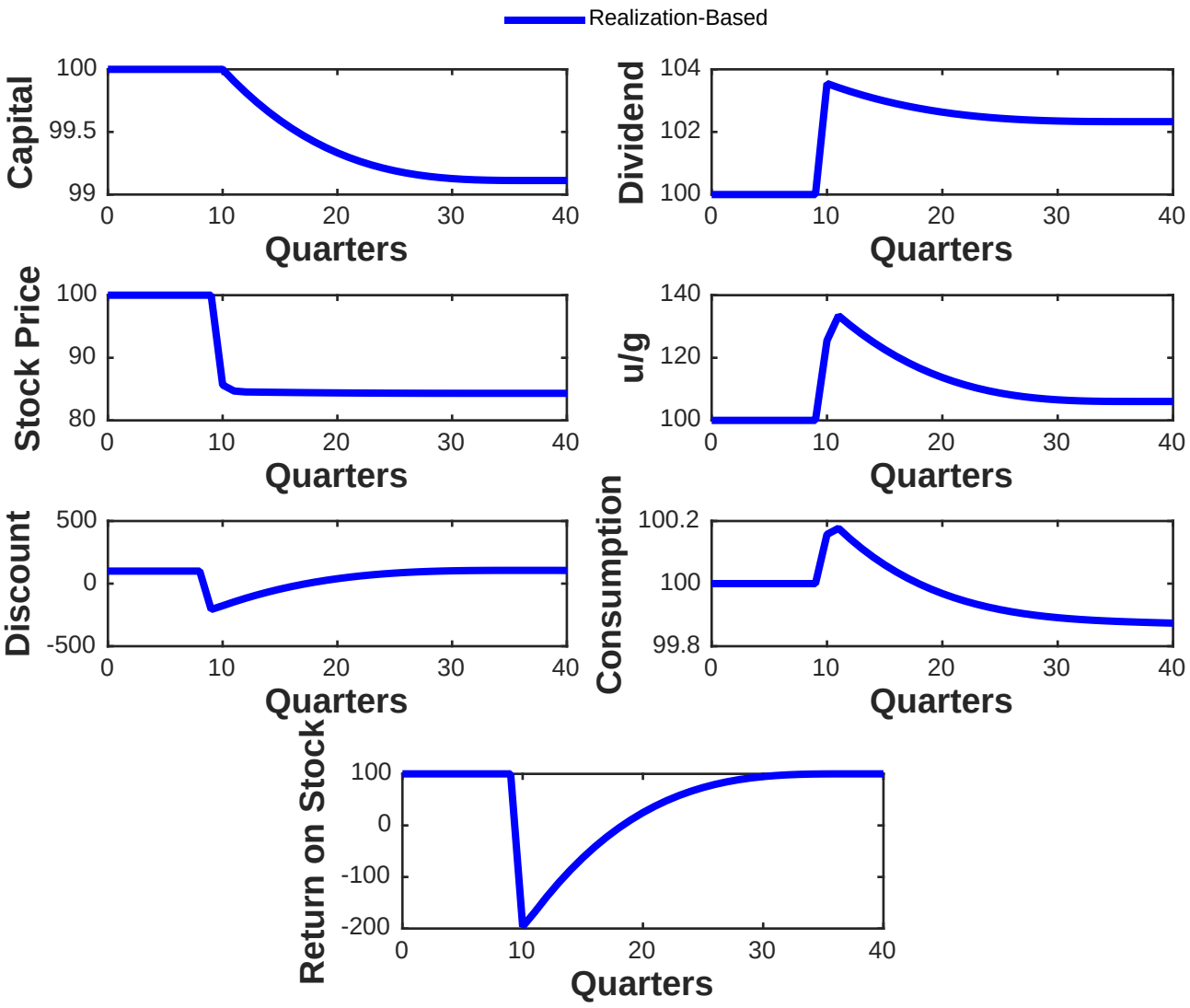

Figure 3.16: Transitional dynamics resulting from an unexpected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

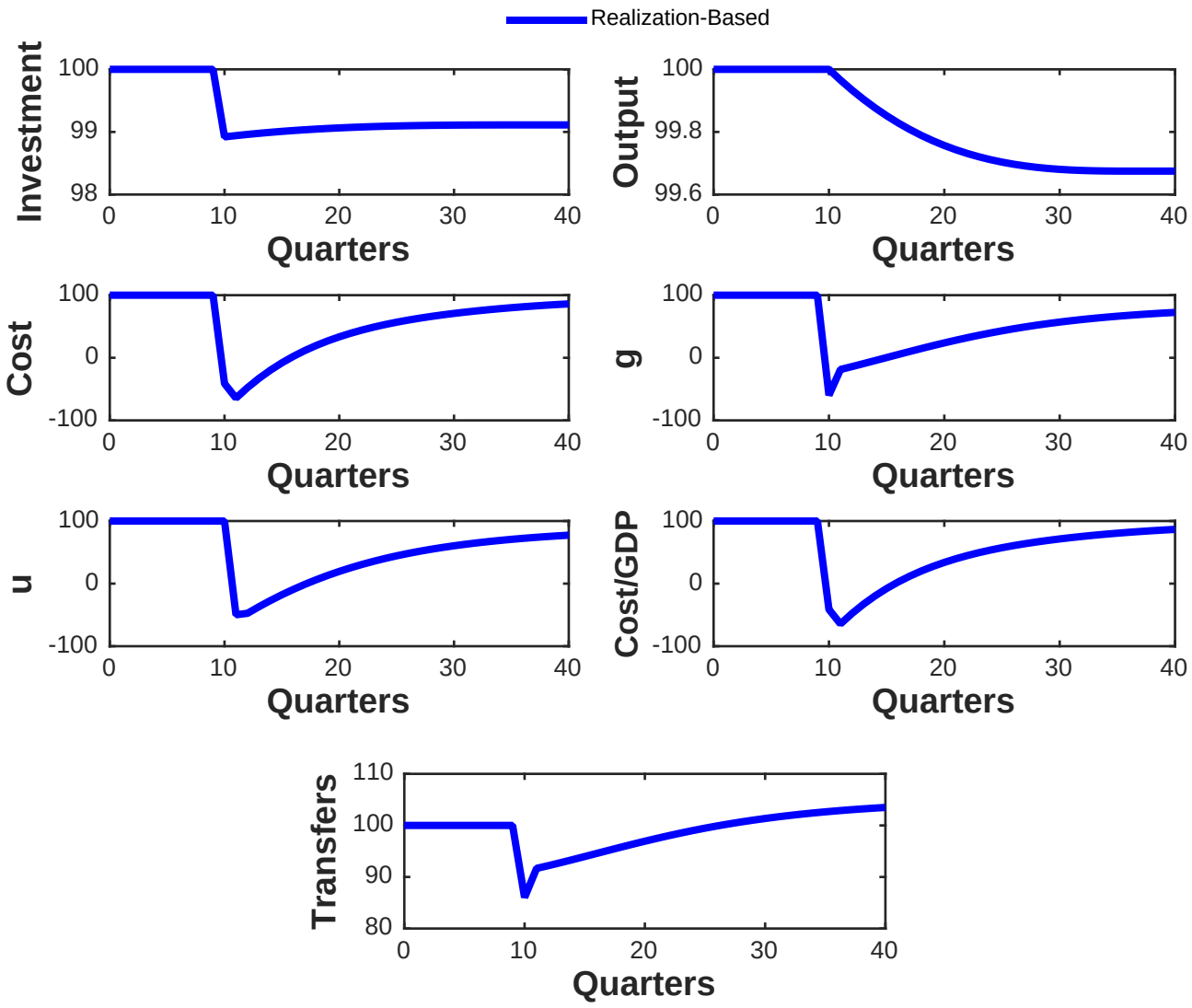

Figure 3.17: Transitional dynamics resulting from an unexpected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

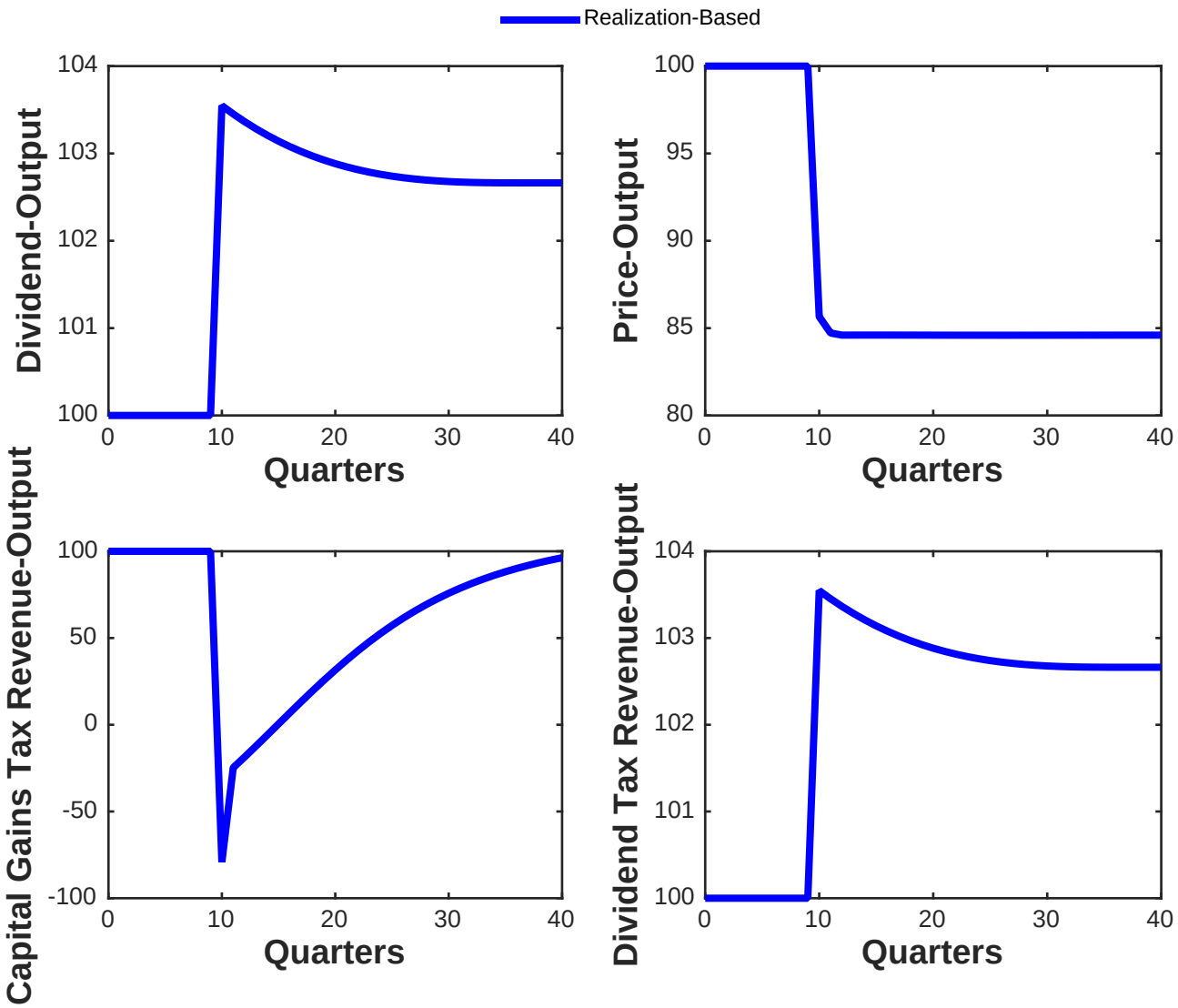

Figure 3.18: Transitional dynamics resulting from an unexpected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

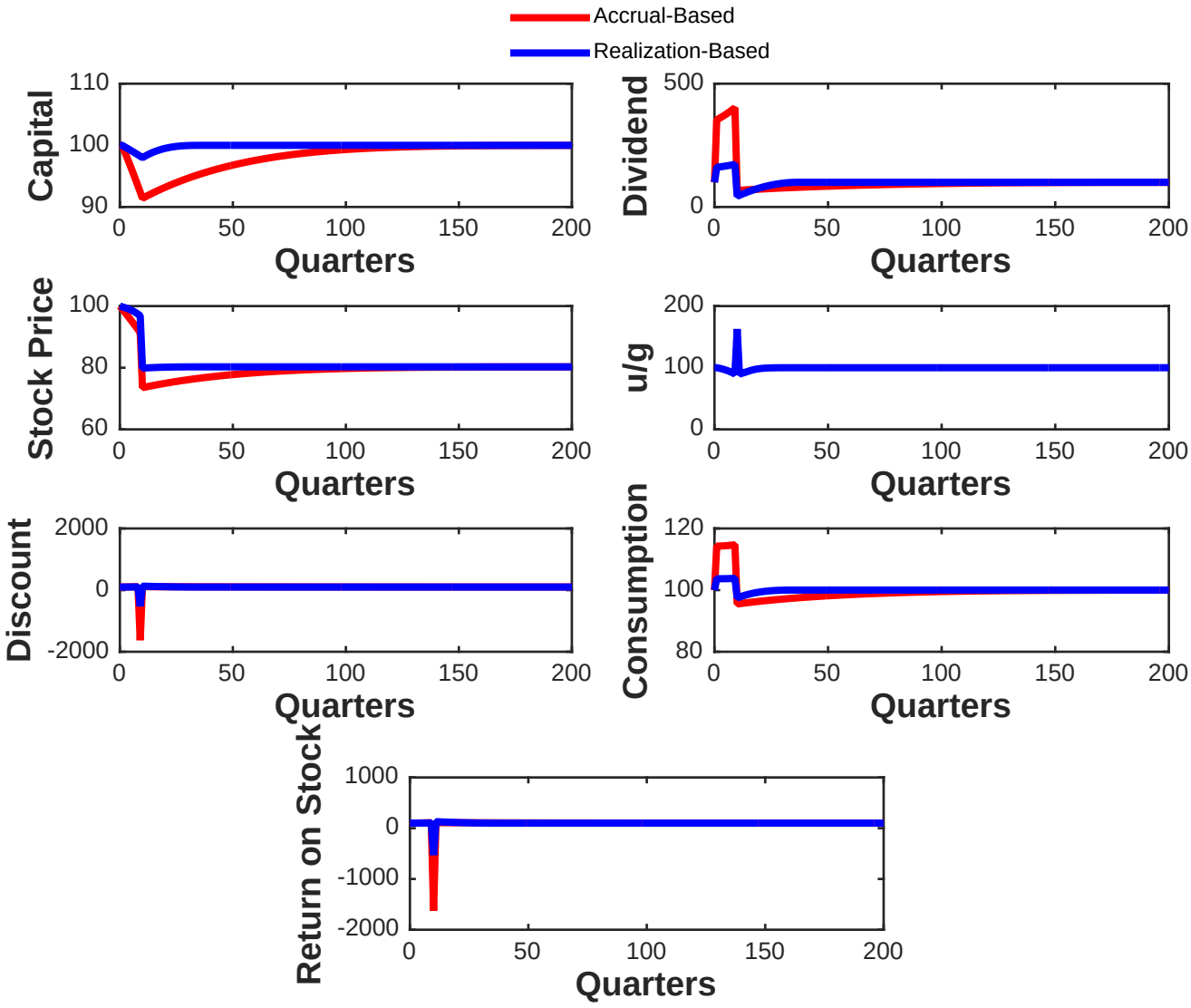

Figure 3.19: Transitional dynamics resulting from an expected increase in dividend tax rate from 14.3% to 31.2% in quarter 10

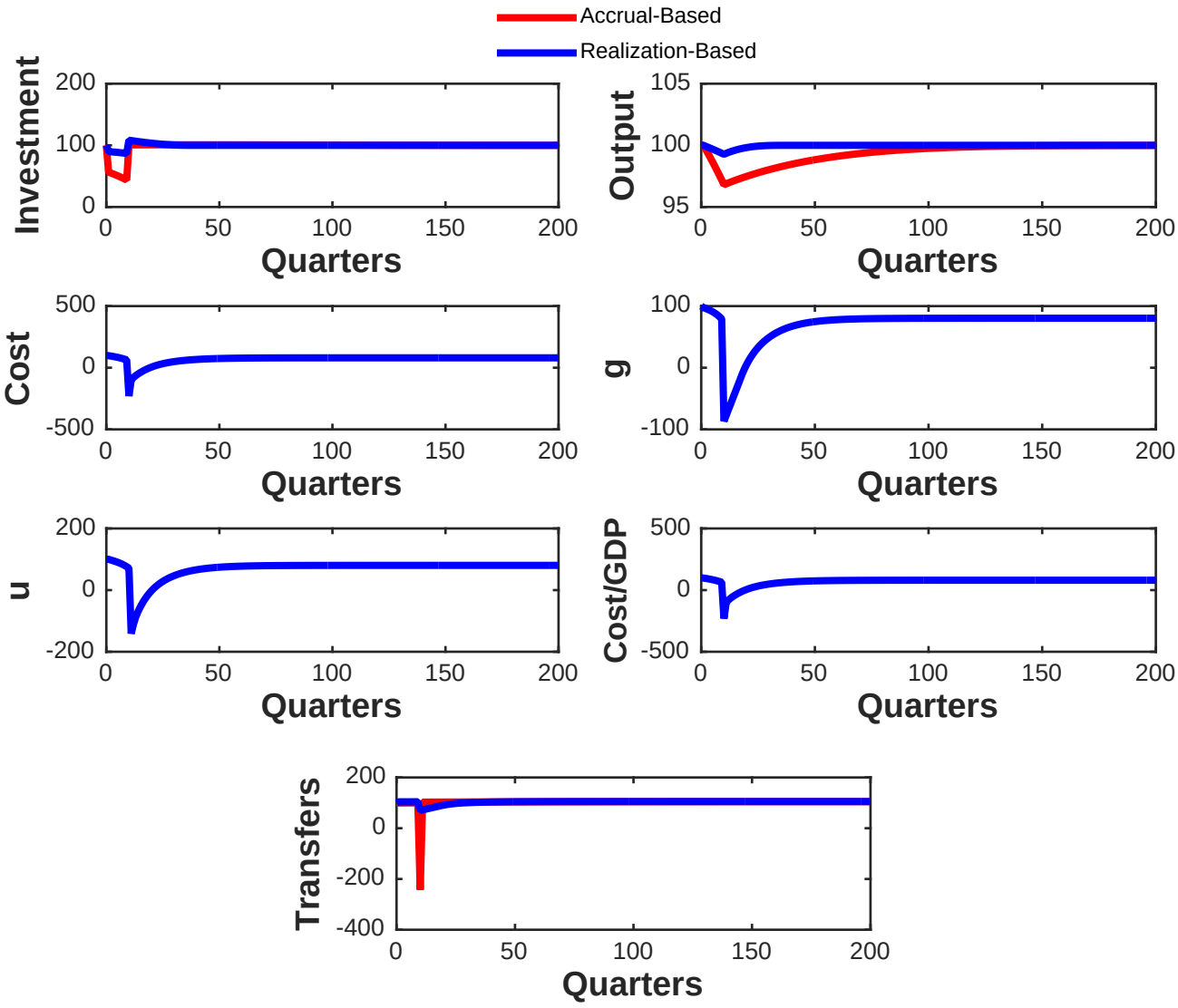

Figure 3.20: Transitional dynamics resulting from an expected increase in dividend tax rate from 14.3% to 31.2% in quarter 10

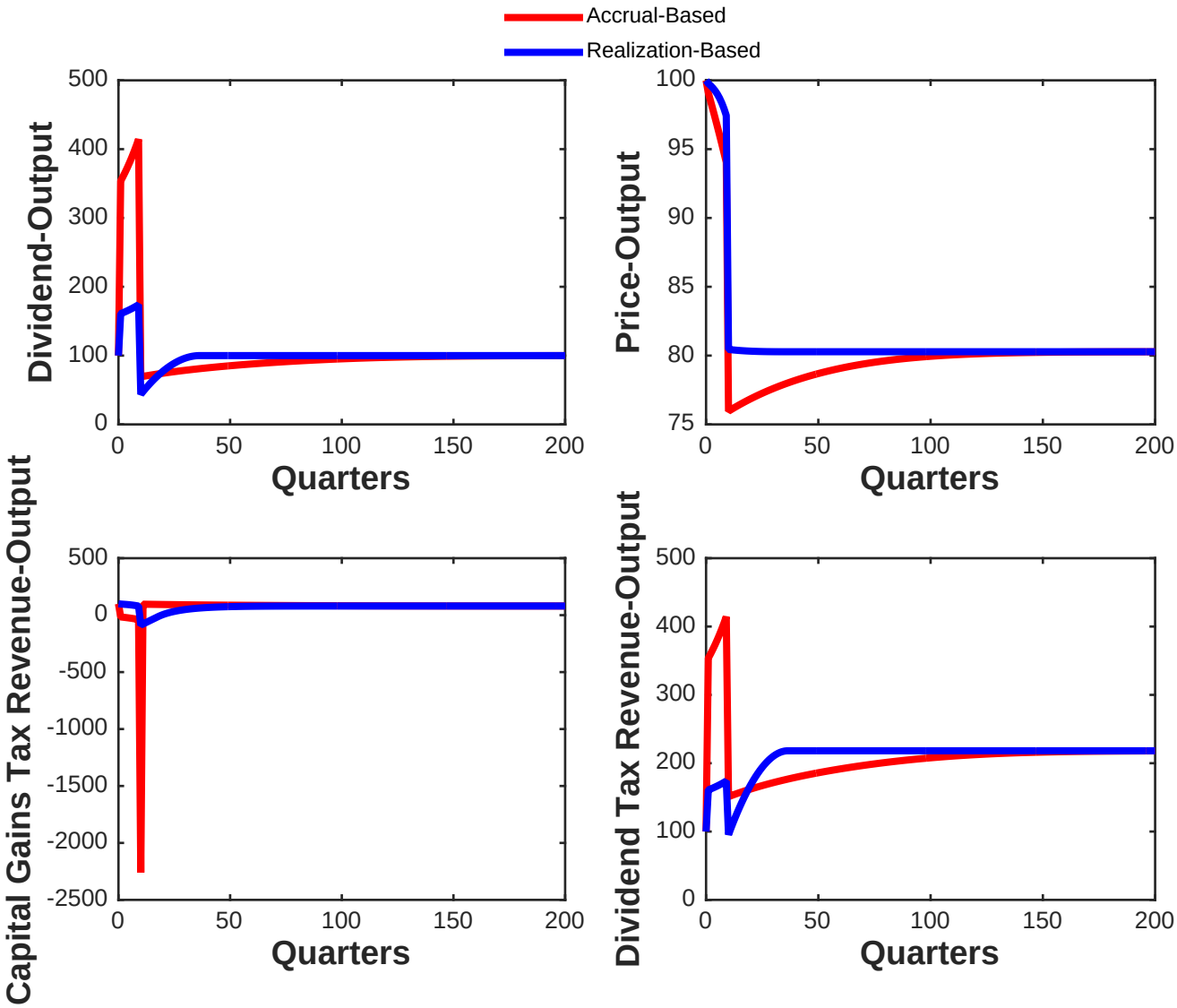

Figure 3.21: Transitional dynamics resulting from an expected increase in dividend tax rate from 14.3% to 31.2% in quarter 10

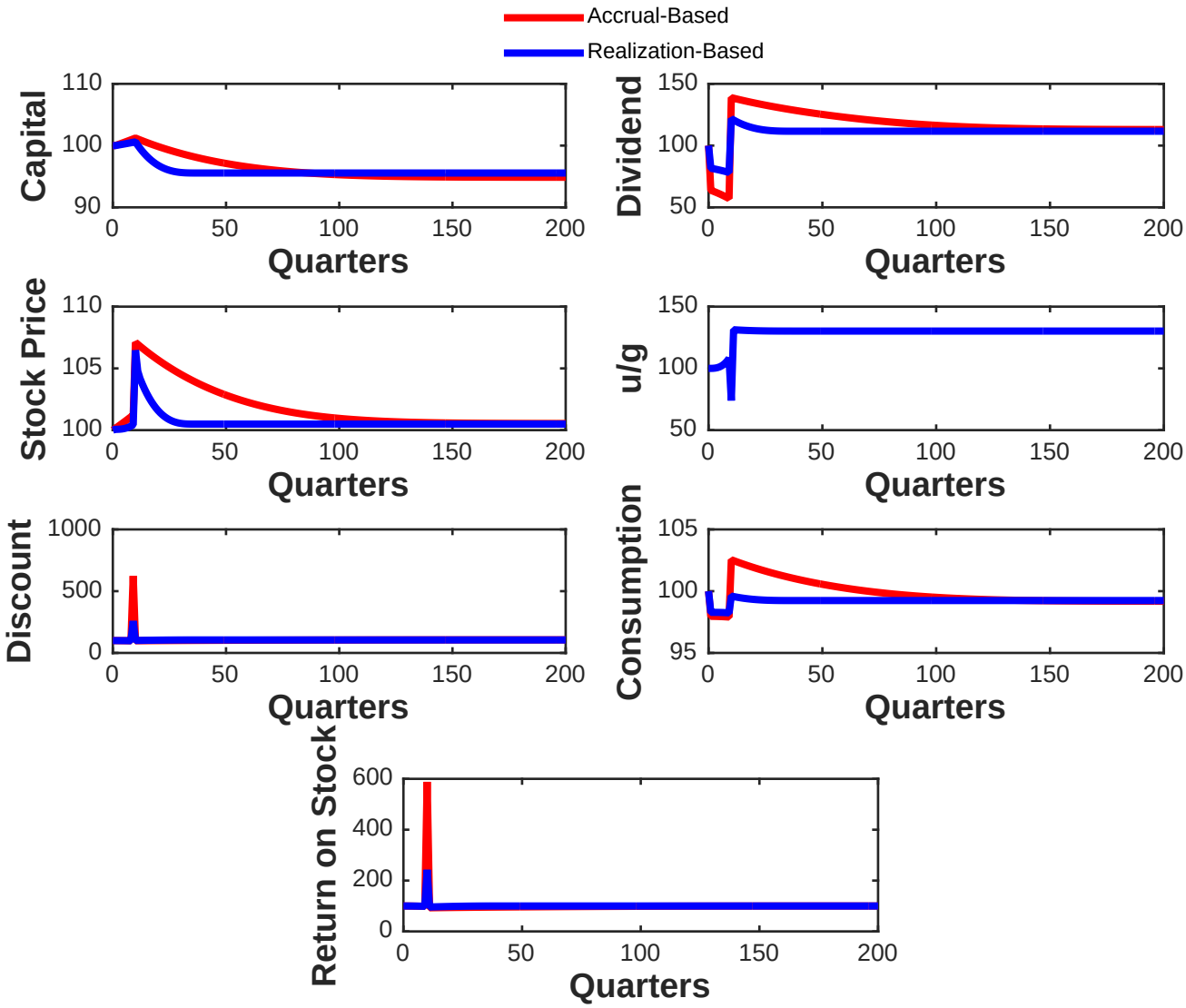

Figure 3.22: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% in quarter 10

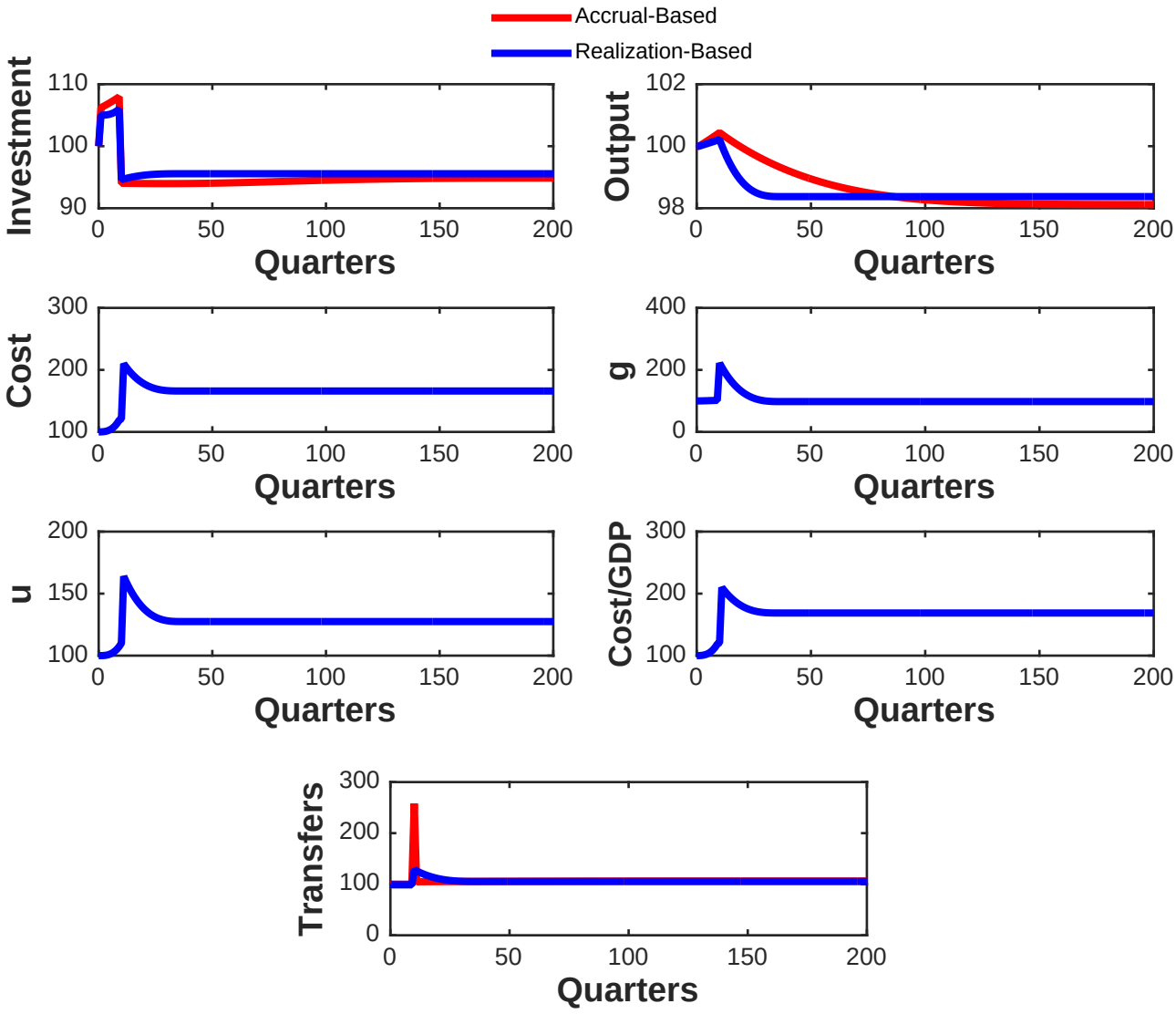

Figure 3.23: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% in quarter 10

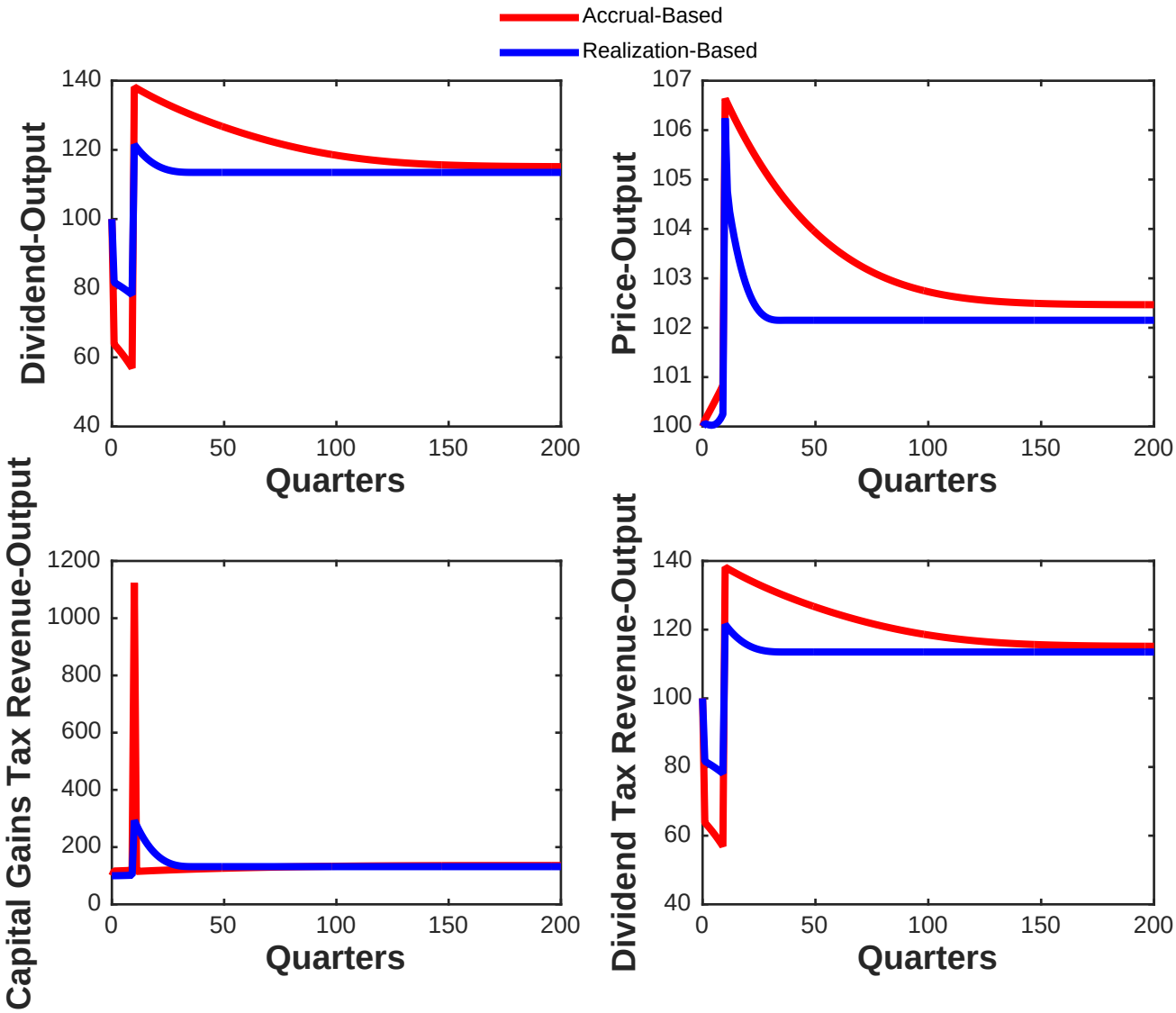

Figure 3.24: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% in quarter 10

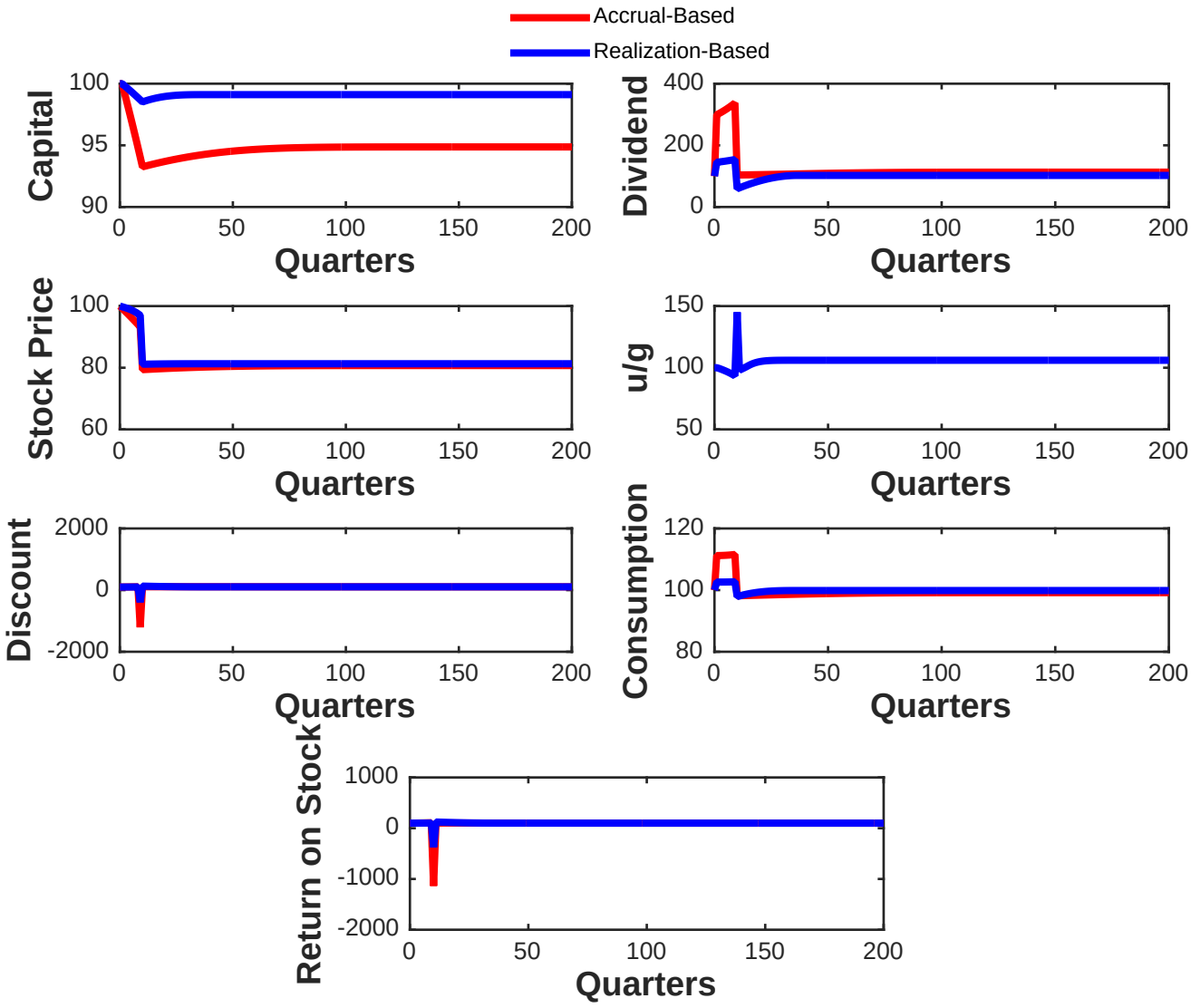

Figure 3.25: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

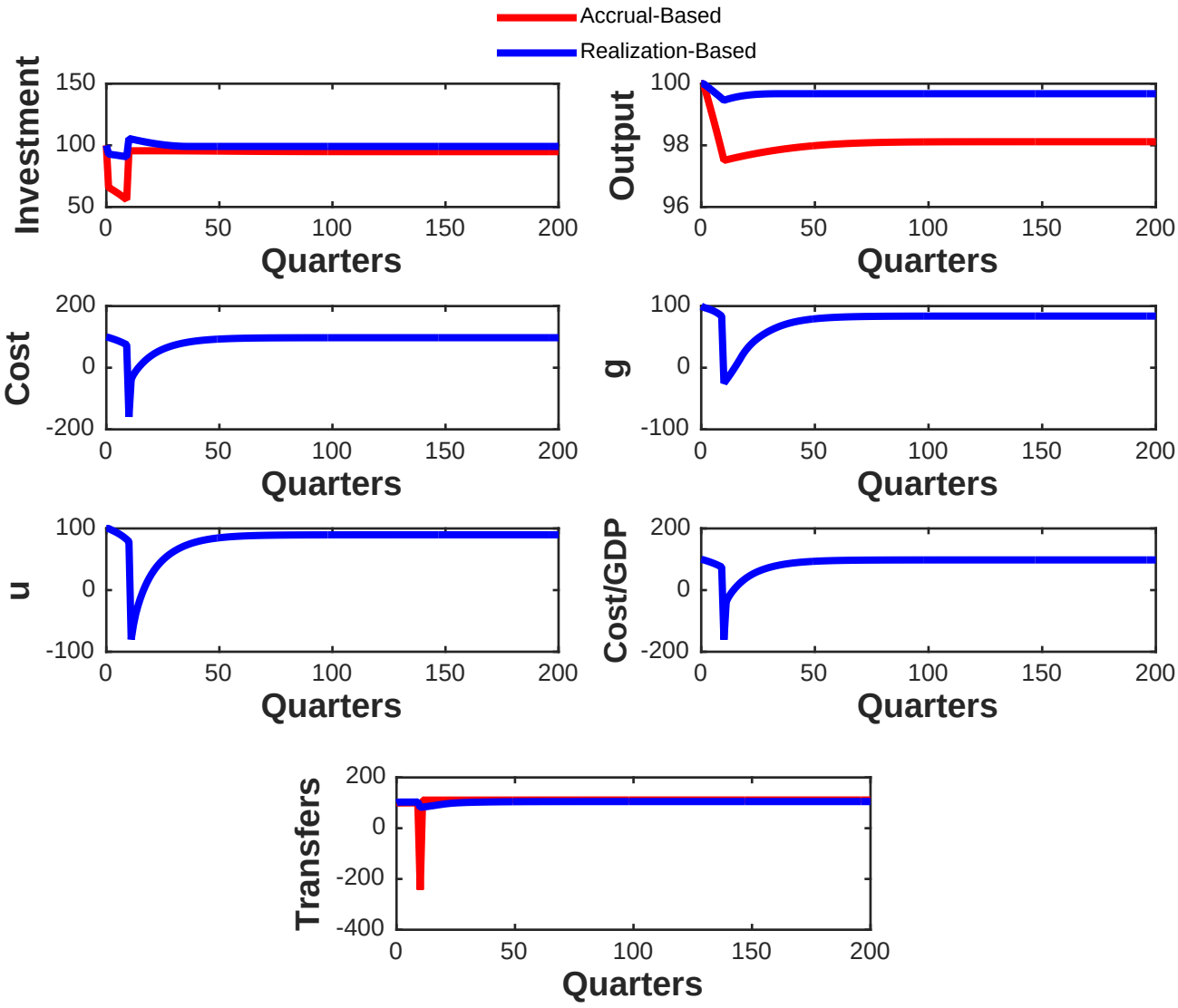

Figure 3.26: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

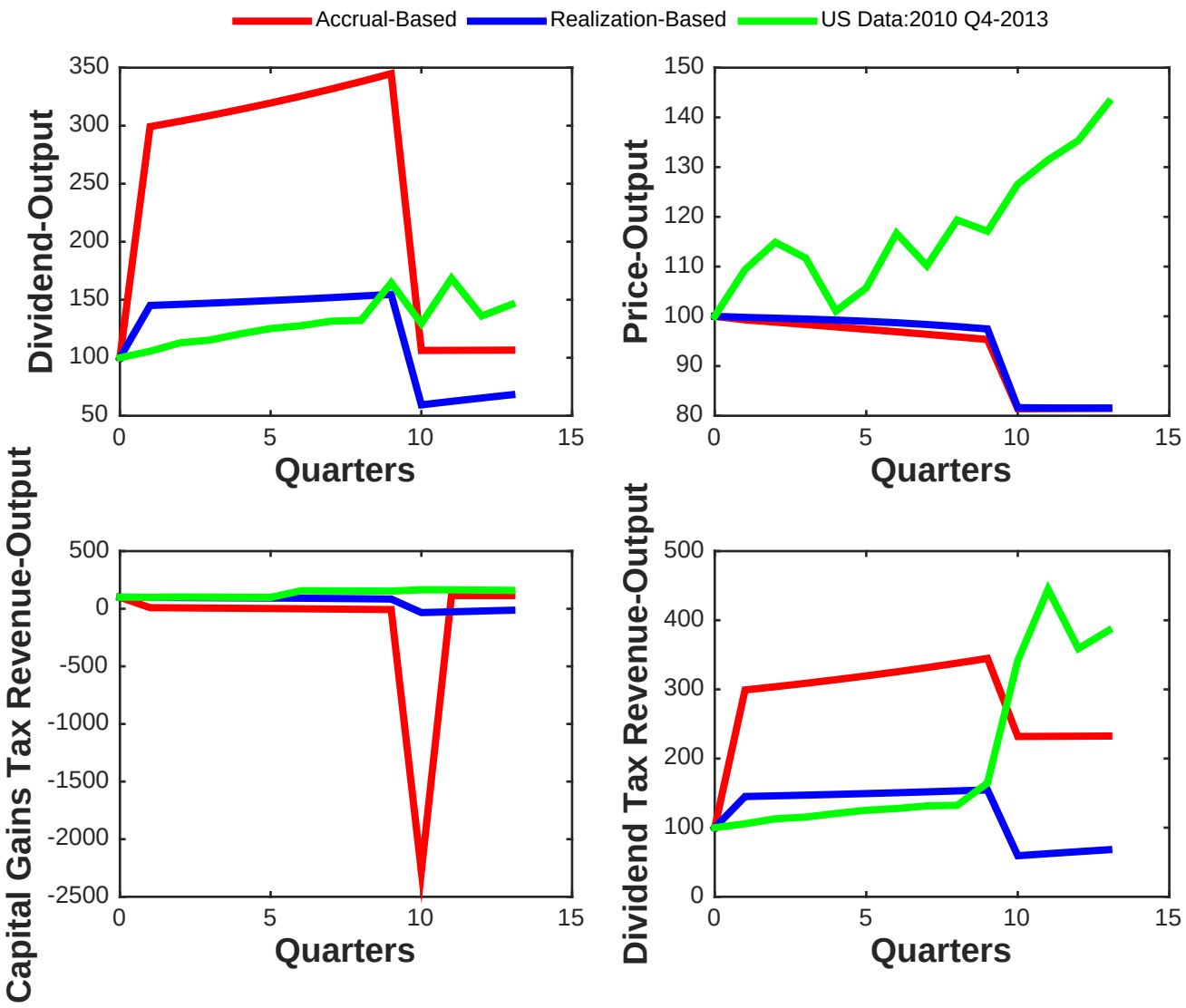

Figure 3.27: Transitional dynamics resulting from an expected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

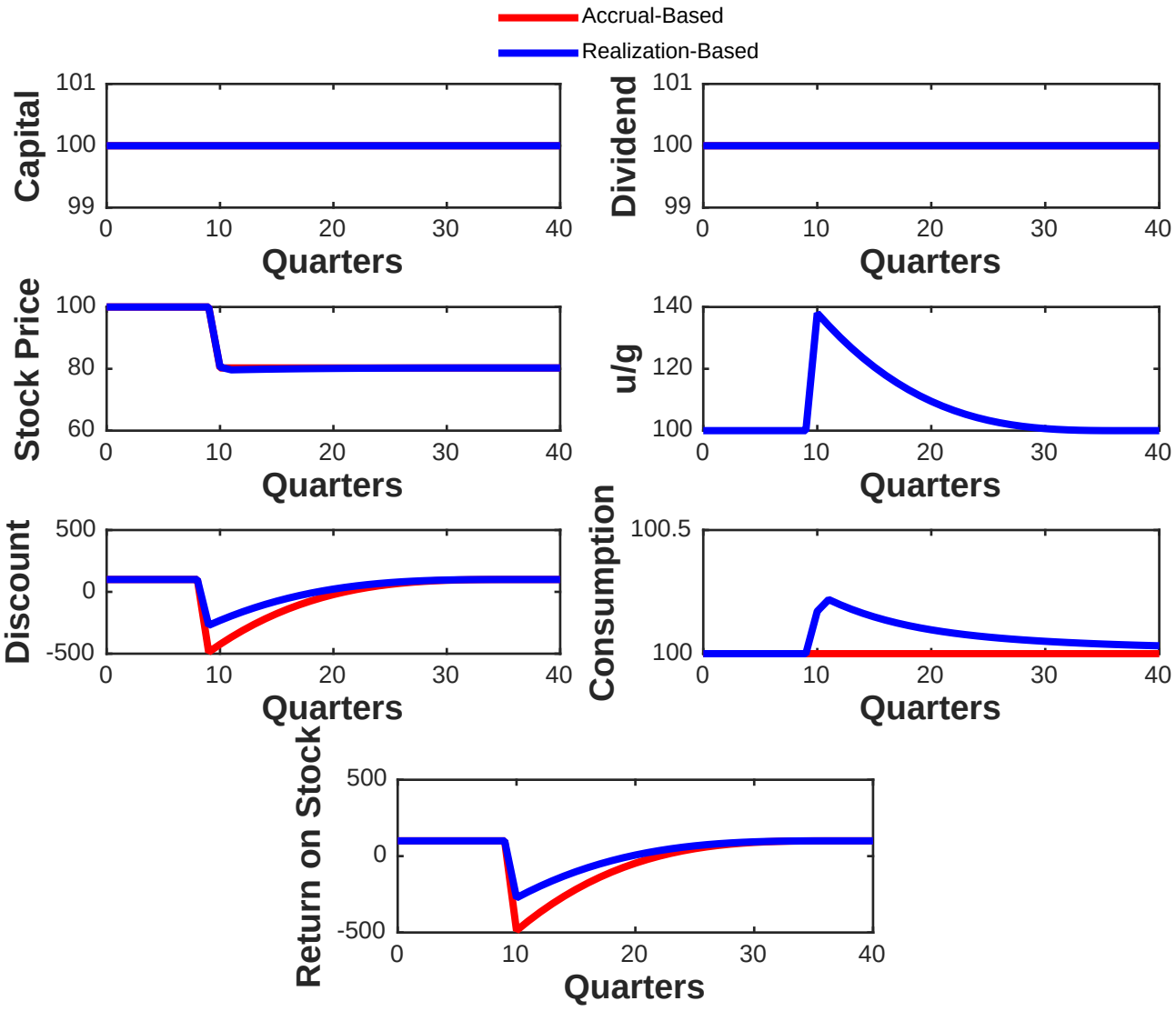

Figure 3.28: Transitional dynamics resulting from an unexpected increase in dividend tax rate from 14.3% to 31.2%

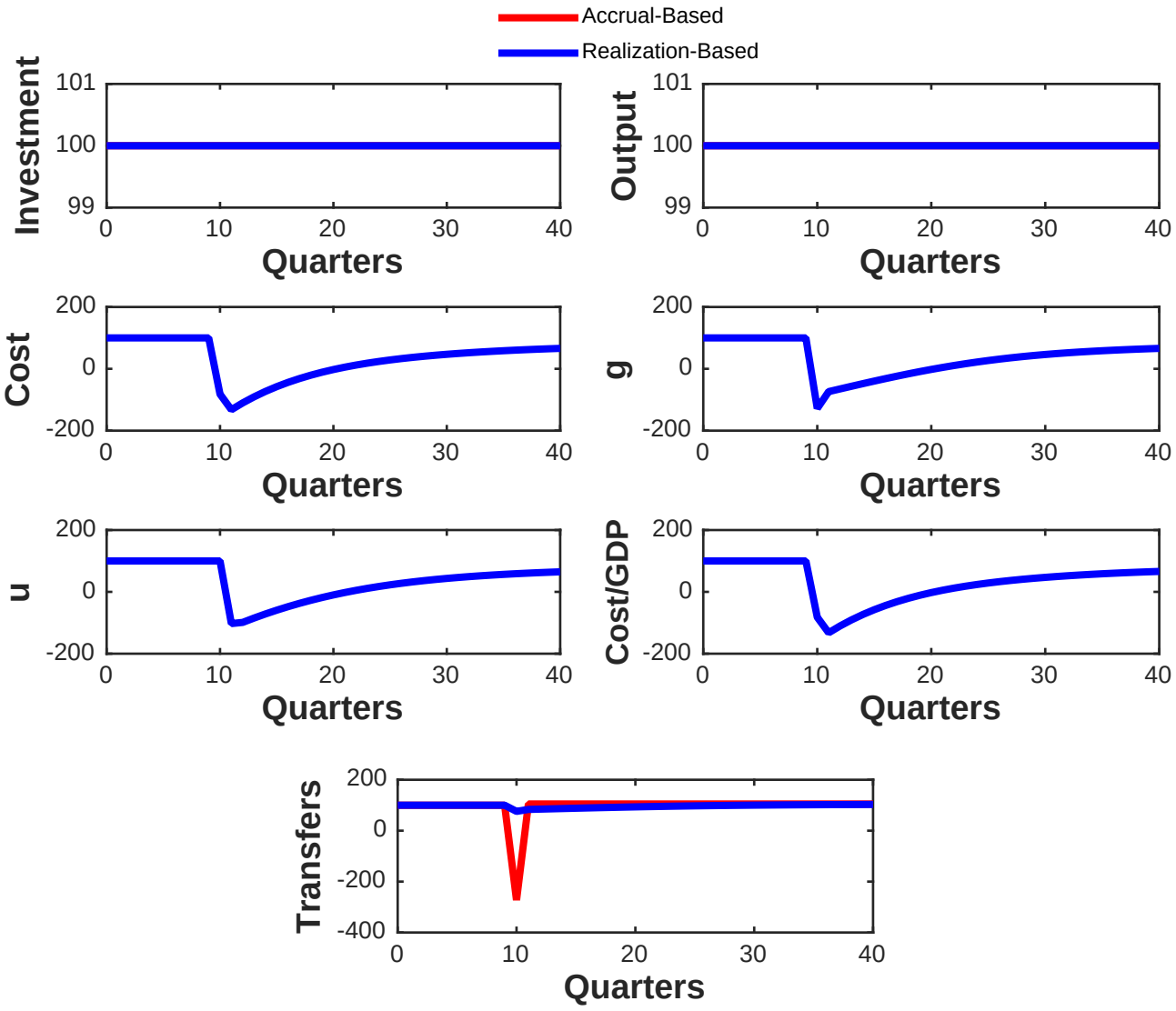

Figure 3.29: Transitional dynamics resulting from an unexpected increase in dividend tax rate from 14.3% to 31.2%

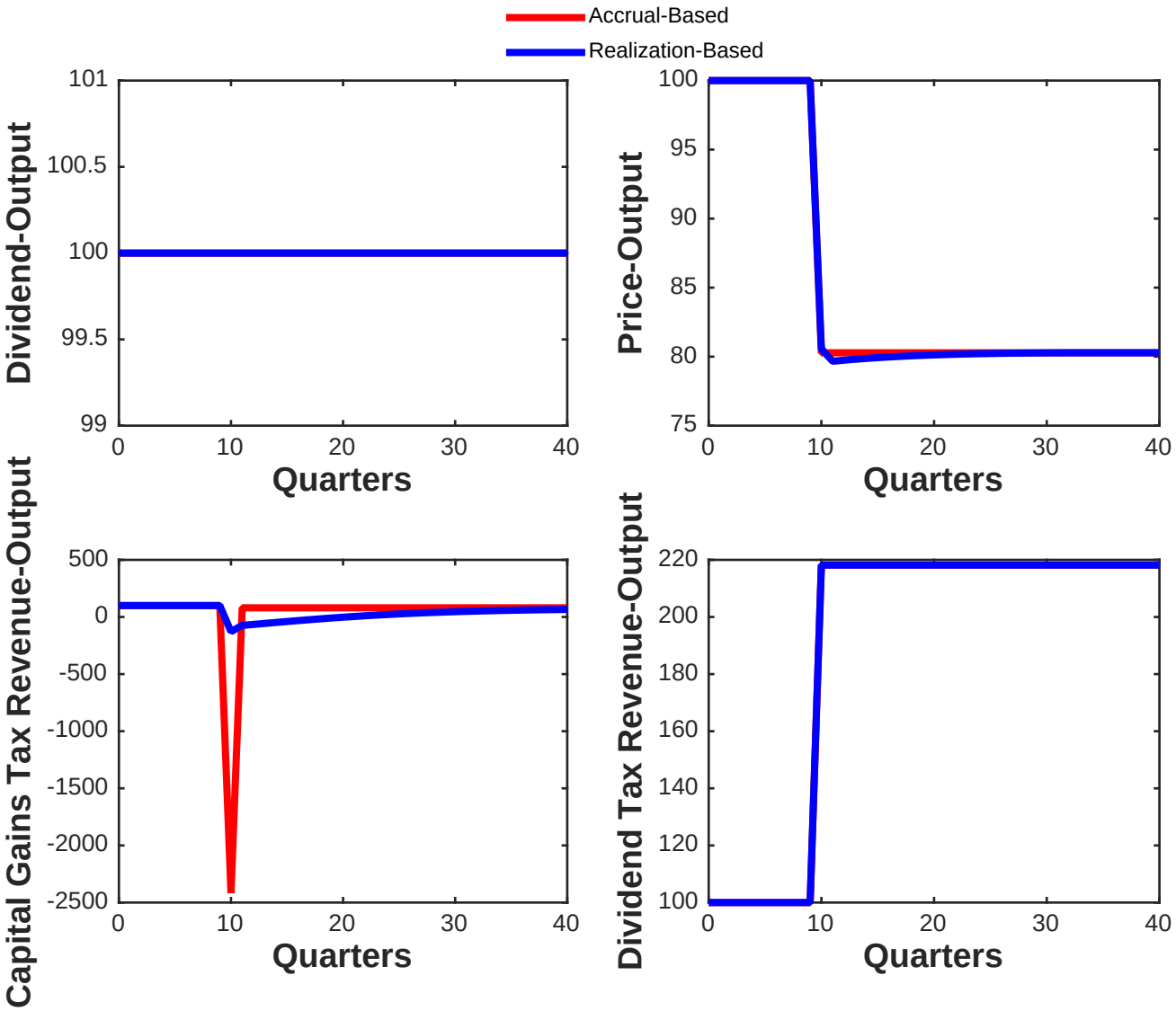

Figure 3.30: Transitional dynamics resulting from an unexpected increase in dividend tax rate from 14.3% to 31.2%

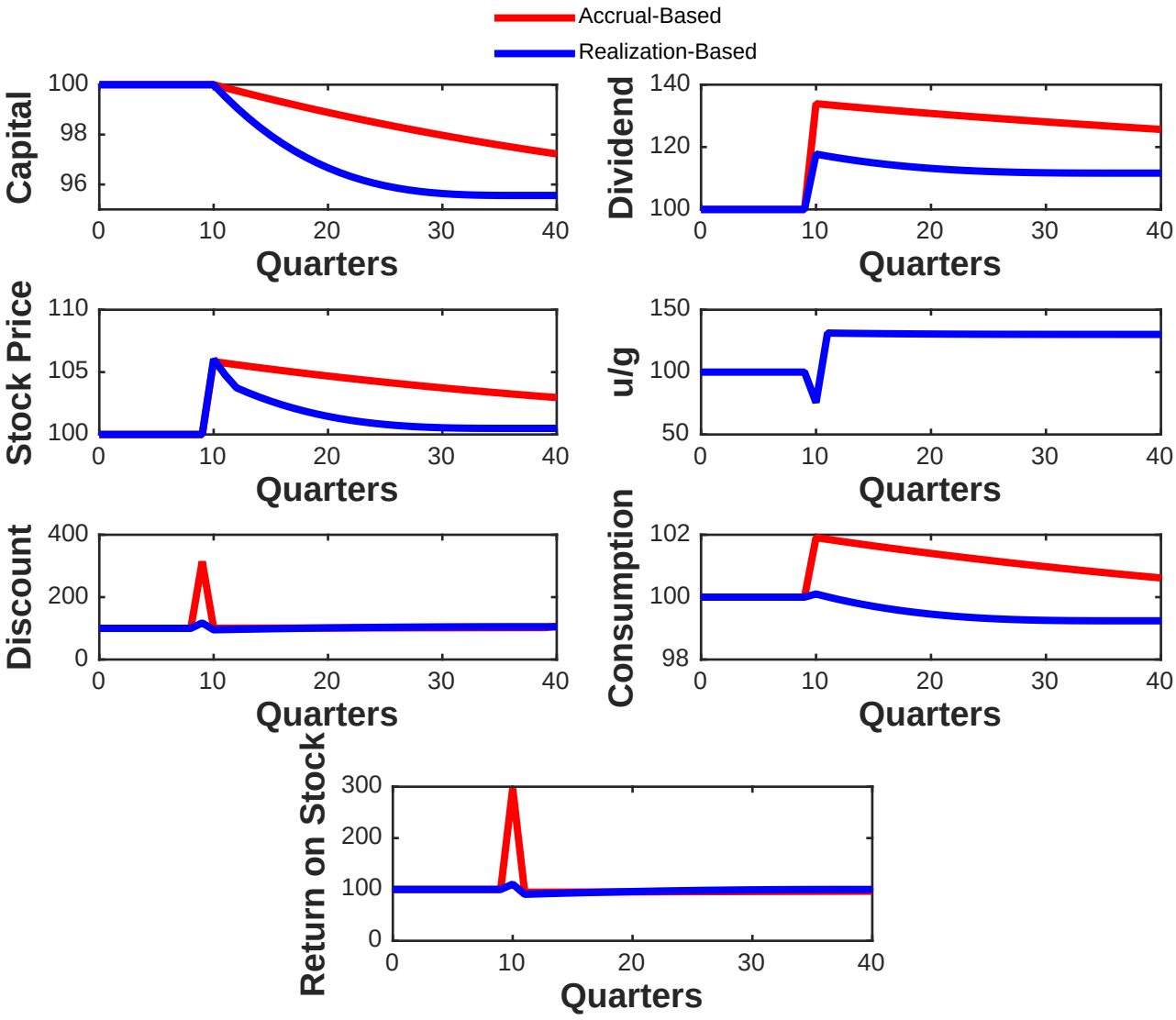

Figure 3.31: Transitional dynamics resulting from an unexpected increase in capital gains tax rates from 14.8% to 19.6% in quarter 10

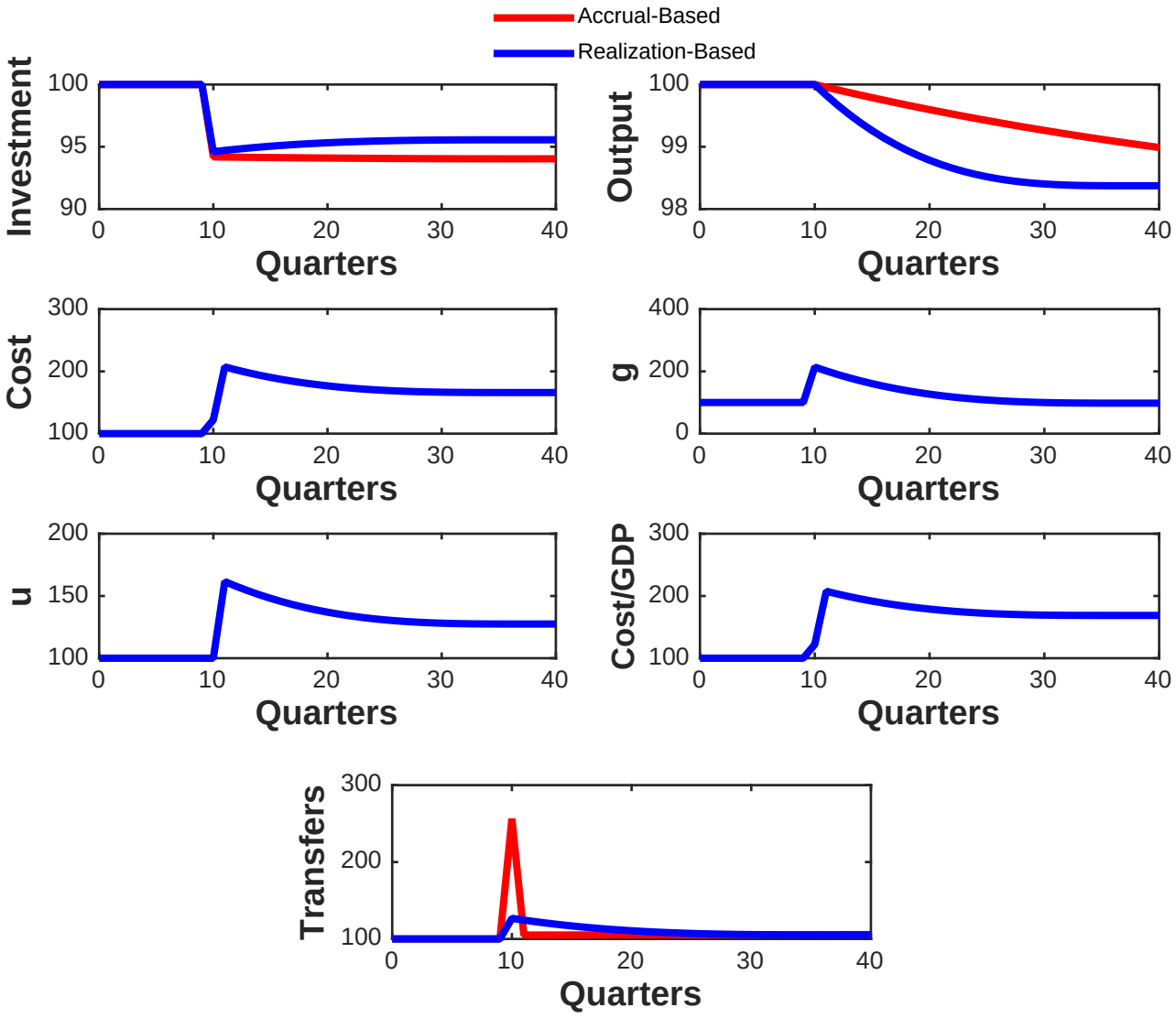

Figure 3.32: Transitional dynamics resulting from an unexpected increase in capital gains tax rates from 14.8% to 19.6% in quarter 10

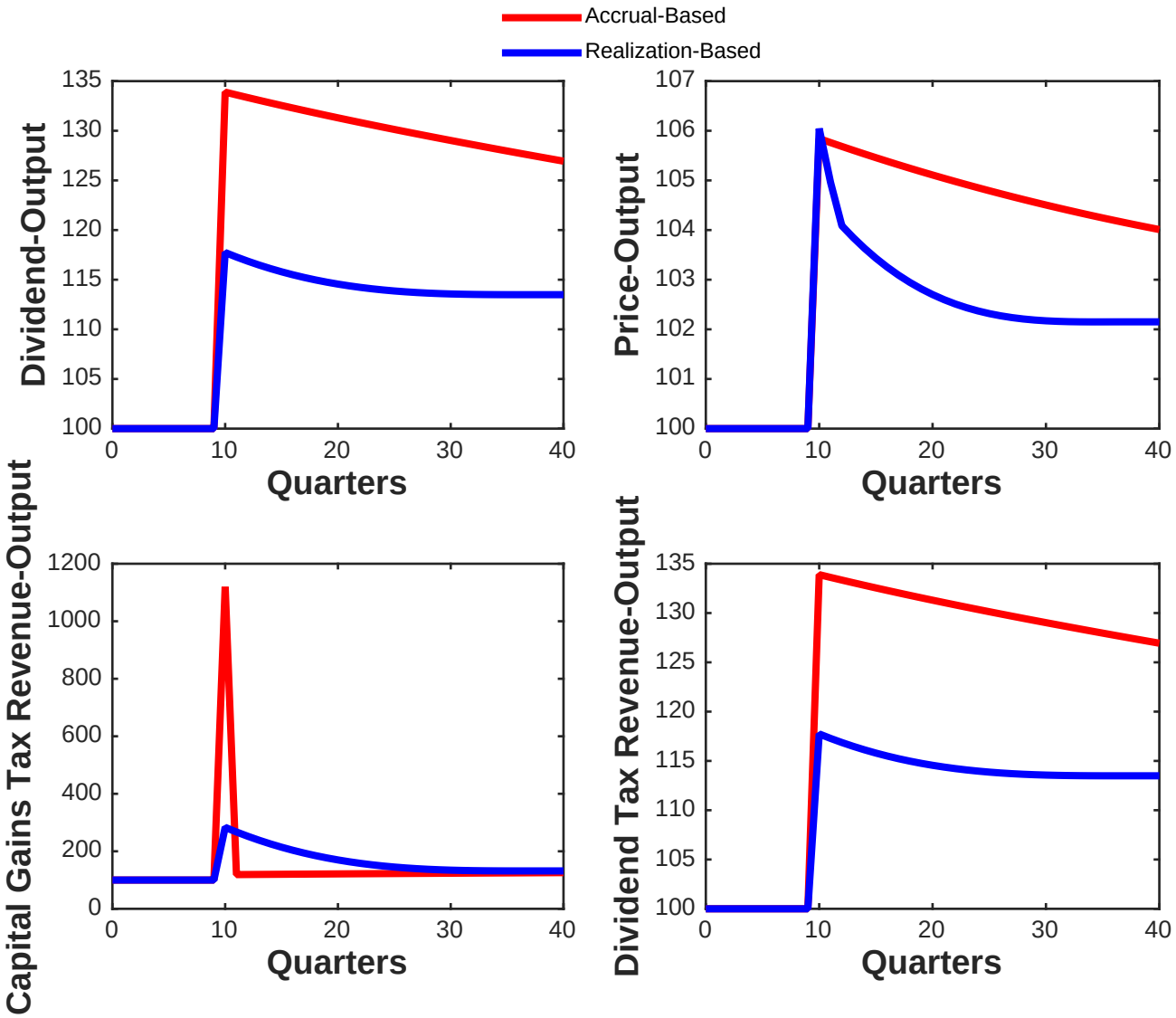

Figure 3.33: Transitional dynamics resulting from an unexpected increase in capital gains tax rates from 14.8% to 19.6% in quarter 10

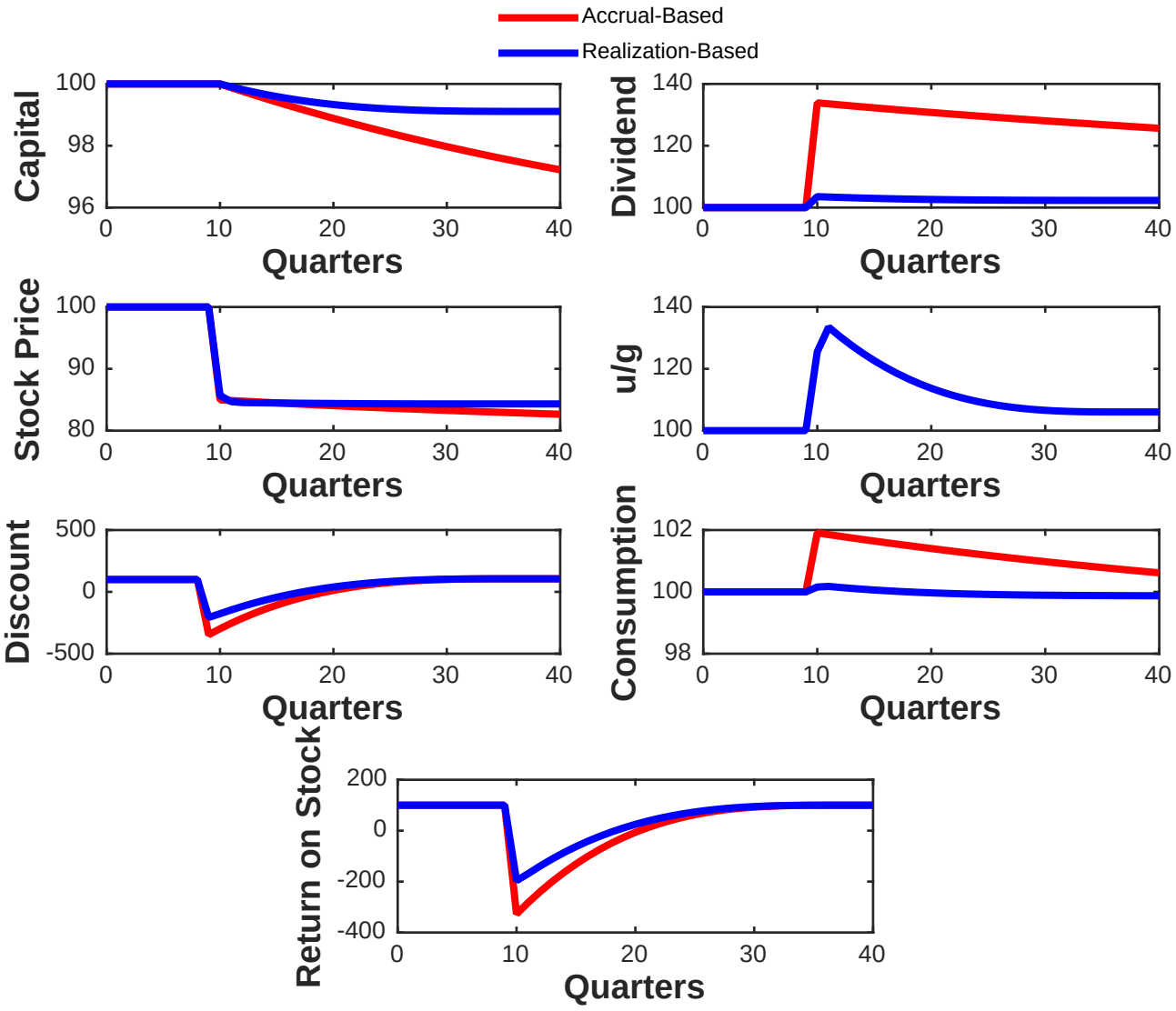

Figure 3.34: Transitional dynamics resulting from an unexpected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

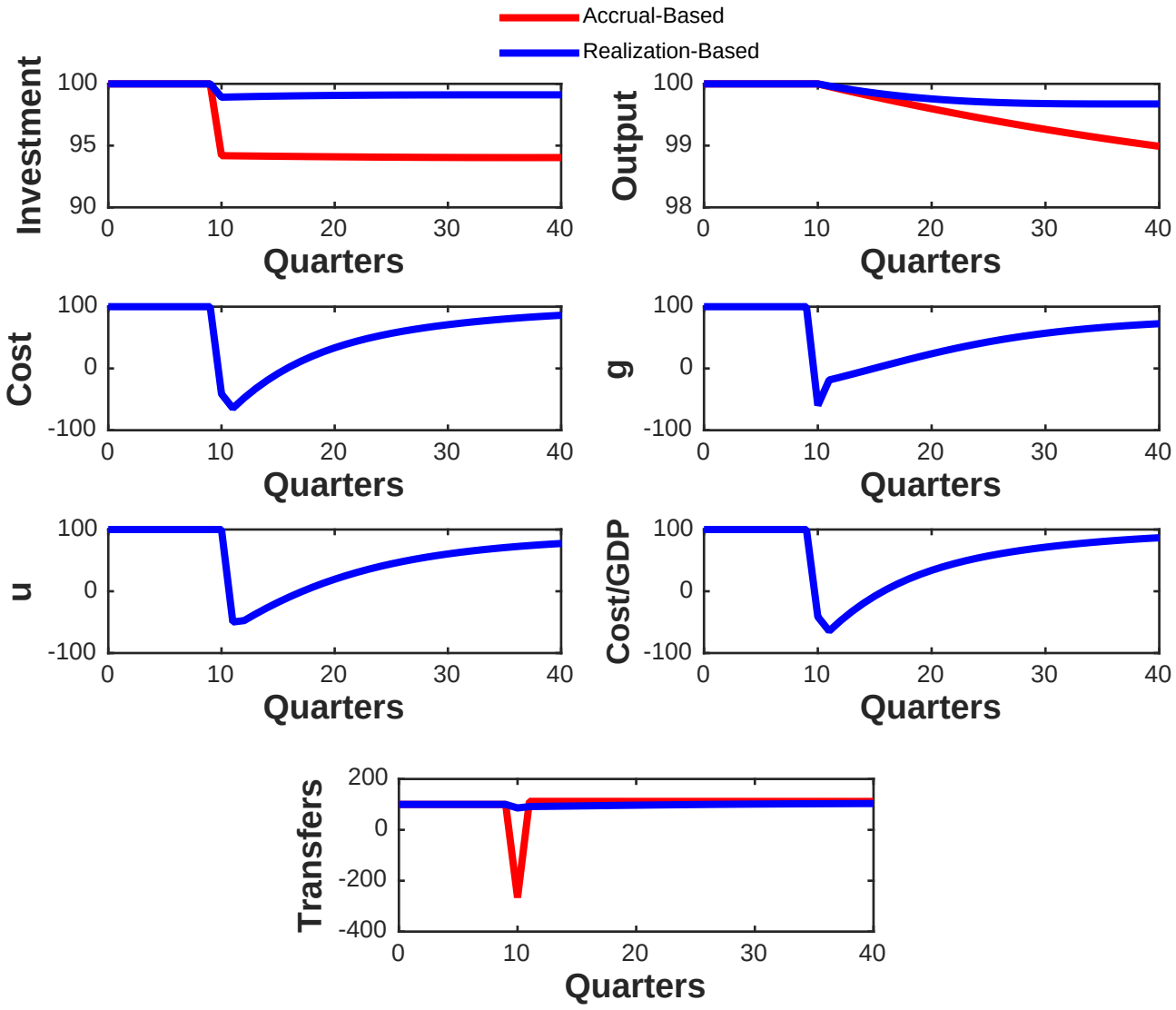

Figure 3.35: Transitional dynamics resulting from an unexpected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

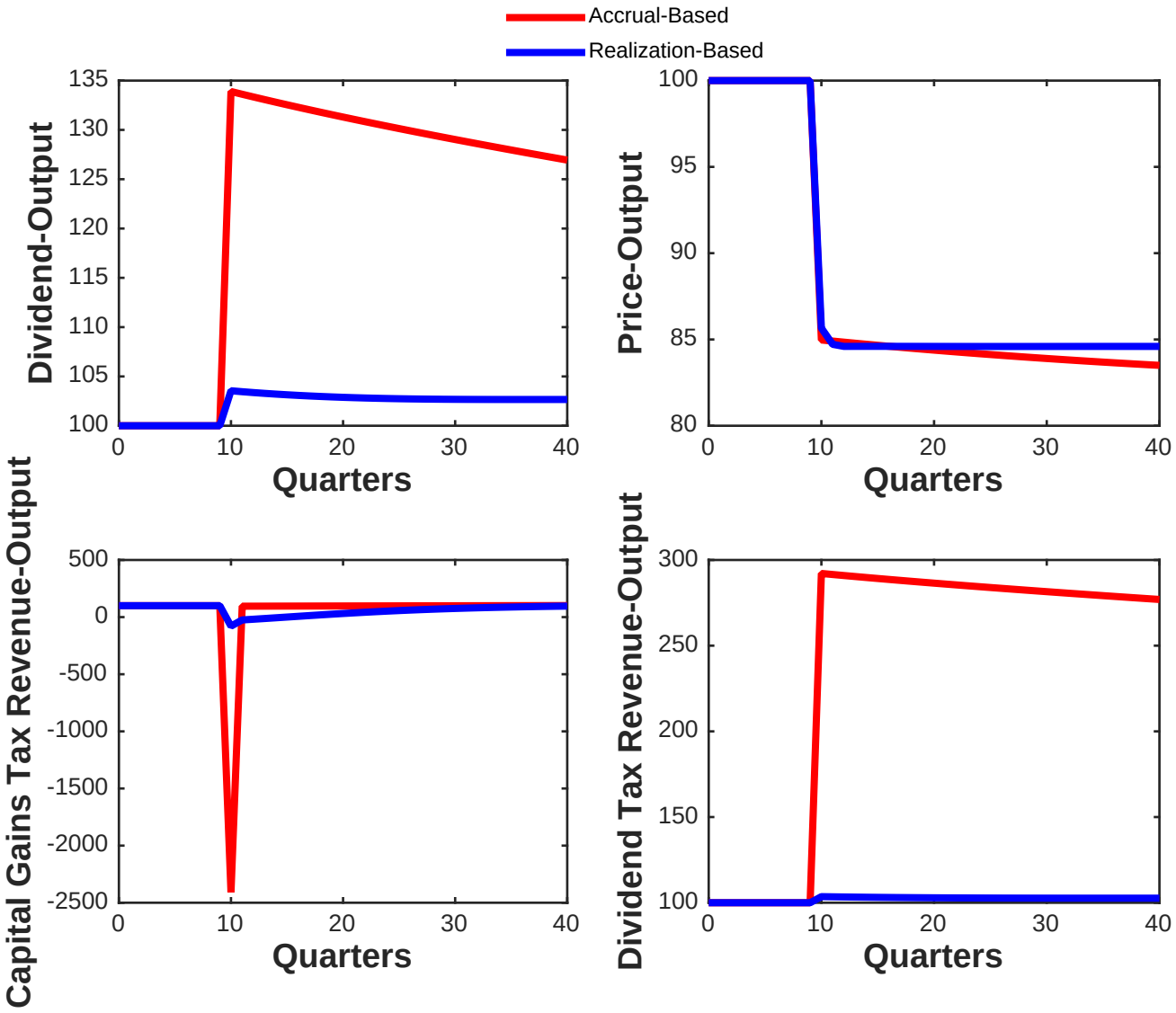

Figure 3.36: Transitional dynamics resulting from an unexpected increase in capital gains tax rate from 14.8% to 19.6% and dividend tax rate from 14.3% to 31.2% in quarter 10

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Appendix A

First Order Conditions

$$\max \sum_{t=0}^{\infty} \beta^t \log(c_t) \tag{A.1}$$

subject to:

$$c_t + p_t s_{t+1} + \gamma b_{t+1} = [(1 - \tau_t^d) d_t + p_t] s_t - \tau_t^g g_t - M\gamma^2 \frac{u_{t+1}^2}{g_t} + w_t l_t^s + (1 + r_t) b_t + tr_t \tag{A.2}$$

$$g_t + \gamma u_{t+1} = u_t + \left(p_t - \frac{p_{t-1}}{\gamma} \right) s_t \tag{A.3}$$

Multipliers: λ_t, ψ_t

State Variables: s_t, b_t, u_t

Control Variables: c_t, s_{t+1}, l_t^s, b_{t+1}, g_t, u_{t+1}

Consumption choice:

$$\frac{1}{c_t} = \lambda_t \tag{A.4}$$

Stock choice:

$$\beta\lambda_{t+1}\left[(1-\tau^d_{t+1})d_{t+1} + p_{t+1}\right] + \beta\psi_{t+1}\left(p_{t+1} - \frac{p_t}{\gamma}\right) = \lambda_t p_t \tag{A.5}$$

Bond choice:

$$\beta\lambda_{t+1}(1+r_{t+1}) = \gamma\lambda_t \tag{A.6}$$

Realized Capital Gains choice:

$$\lambda_t M\gamma^2\frac{u^2_{t+1}}{g^2_t} = \lambda_t\tau^g_t + \psi_t \tag{A.7}$$

Unrealized Capital Gains choice:

$$\beta\psi_{t+1} = \lambda_t 2M\gamma^2\frac{u_{t+1}}{g_t} + \gamma\psi_t \tag{A.8}$$

The first order conditions of the households' problem lead to the following:

Bond choice:

$$1 + r_{t+1} \;=\; \gamma\frac{U'(c_t)}{\beta U'(c_{t+1})} \tag{A.9}$$

Stock choice:

$$p_t \;=\; \frac{\gamma}{1+r_{t+1}}[(1-\tau^d_{t+1})d_{t+1}+p_{t+1}+(M\gamma^2\frac{u^2_{t+2}}{g^2_{t+1}}-\tau^g_{t+1})(p_{t+1}-\frac{p_t}{\gamma})] \tag{A.10}$$

Combining the two conditions above, we get:

$$1+r_{t+1} \;=\; \gamma\frac{[(1-\tau^d_{t+1})d_{t+1}+p_{t+1}+(M\gamma^2\frac{u^2_{t+2}}{g^2_{t+1}}-\tau^g_{t+1})(p_{t+1}-\frac{p_t}{\gamma})]}{p_t}=\gamma\frac{U'(c_t)}{\beta U'(c_{t+1})} \tag{A.11}$$

Manipulating (A.11), we get (A.12) and (A.13):

$$p_t=\frac{\gamma}{1+\frac{r_{t+1}}{1-\tau^g_{t+1}+M\gamma^2\frac{u^2_{t+2}}{g^2_{t+1}}}}\left[\frac{1-\tau^d_{t+1}}{1-\tau^g_{t+1}+M\gamma^2\frac{u^2_{t+2}}{g^2_{t+1}}}d_{t+1}+p_{t+1}\right] \tag{A.12}$$

$$r_t=\gamma\frac{(1-\tau^d_t)d_t+(1-\tau^g_t+M\gamma^2\frac{u^2_{t+1}}{g^2_t})(p_t-\frac{p_{t-1}}{\gamma})}{p_{t-1}} \tag{A.13}$$

Then, following the method shown in Anagnostopoulos, Carceles-Poveda and Lin (2010), we can derive the price-dividend mapping based on the no-bubble condition as follows:

$$p_t \;=\; \sum_{j=1}^{\infty}\left(\prod_{i=0}^{j-1}\frac{\gamma}{1+\frac{r_{t+1+i}}{(1-\tau^g_{t+1+i}+M\gamma^2\frac{u^2_{t+2+i}}{g^2_{t+1+i}})}}\right)\frac{(1-\tau^d_{t+j})}{(1-\tau^g_{t+j}+M\gamma^2\frac{u^2_{t+1+j}}{g^2_{t+j}})}d_{t+j} \tag{A.14}$$

The last condition we have is:

$$r_{t+1} \;=\; \frac{\left(M\gamma^2\frac{u^2_{t+2}}{g^2_{t+1}}-\tau^g_{t+1}\right)}{2M\gamma\frac{u_{t+1}}{g_t}+M\gamma^2\frac{u^2_{t+1}}{g^2_t}-\tau^g_t}-1 \tag{A.15}$$

$$v_t = max \frac{1-\tau_t^d}{\left(1-\tau_t^g + M\gamma^2 \frac{u_{t+1}^2}{g_t^2}\right)} d_t + \frac{\gamma}{1+\frac{r_{t+1}}{1-\tau_{t+1}^g + M\gamma^2 \frac{u_{t+2}^2}{g_{t+1}^2}}} v_{t+1} \quad \text{(A.16)}$$

s.t.

$$d_t = (1-\tau^c)[k_t^\alpha l_t^{d1-\alpha} - w_t l_t^d - \delta k_t] + k_t - \gamma k_{t+1} \quad \text{(A.16)}$$

State Variables: k_t

Control Variables: k_{t+1}, l_t^d, d_t

Capital choice:

$$\frac{1-\tau_t^d}{1-\tau_t^g + M\gamma^2 \frac{u_{t+1}^2}{g_t^2}} = \frac{1}{1+\frac{r_{t+1}}{1-\tau_{t+1}^g + M\gamma^2 \frac{u_{t+2}^2}{g_{t+1}^2}}} v'_{t+1} \quad \text{(A.17)}$$

Labor choice:

$$w_t = (1-\alpha)k_t^\alpha \quad \text{(A.18)}$$

The first order conditions of the firms' problem lead to the following:

Capital choice:

$$r_{t+1} = \frac{(1-\tau_t^g + M\gamma^2 \frac{u_{t+1}^2}{g_t^2})(1-\tau_{t+1}^d)}{(1-\tau_t^d)}[(1-\tau^c)(\alpha k_{t+1}^{\alpha-1} - \delta) + 1] + \tau_{t+1}^g - 1 - M\gamma^2 \frac{u_{t+2}^2}{g_{t+1}^2} \quad \text{(A.19)}$$

Labor choice:

$$w_t = (1-\alpha)k_t^\alpha \quad \text{(A.20)}$$

Appendix B

Derivation of Price-Capital Mapping

From equation (2.4) we get:

$$P_t = \frac{1}{1 + r_{t+1} - \tau^g_{t+1}} \left[(1 - \tau^d_{t+1})d_{t+1} + (1 - \tau^g_{t+1})P_{t+1}\right] \tag{B.1}$$

Expanding (2.15)

$$P_t = \frac{(1 - \tau^d_{t+1})}{(1 + r_{t+1} - \tau^g_{t+1})} d_{t+1} + \frac{(1 - \tau^g_{t+1})}{(1 + r_{t+1} - \tau^g_{t+1})} \frac{1}{(1 + r_{t+2} - \tau^g_{t+2})} (1 - \tau^d_{t+2}) d_{t+2} + \tag{B.1}$$

$$\frac{(1 - \tau^g_{t+1})}{(1 + r_{t+1} - \tau^g_{t+1})} \frac{(1 - \tau^g_{t+2})}{(1 + r_{t+2} - \tau^g_{t+2})} P_{t+2} \ldots$$

The last term with "P_t" becomes zero as $t \to \infty$ with the no-bubble condition and the price-dividend mapping can be derived as:

$$P_t = \sum_{j=1}^{\infty} \left(\prod_{i=0}^{j-1} \frac{1}{1 + \frac{r_{t+1+i}}{(1 - \tau^g_{t+1+i})}} \right) \frac{(1 - \tau^d_{t+j})}{(1 - \tau^g_{t+j})} d_{t+j} \tag{B.1}$$

Now, in order to obtain the price-capital mapping, we first derive the capital-dividend

mapping and then compare it with the price-dividend mapping. To do that, we multiply both sides of the condition for optimal investment by k_{t+1}:

$$k_{t+1} = \frac{1}{1 + \frac{r_{t+1+i}}{(1-\tau^g_{t+1+i})}}[(1-\tau^c)(k_{t+1}f_k(k_{t+1}, l_{t+1}) - \delta k_{t+1}) + k_{t+1}] \tag{B.2}$$

Since we have CRS, we can rewrite above the condition as:

$$k_{t+1} = \frac{1}{1 + \frac{r_{t+1+i}}{(1-\tau^g_{t+1+i})}}[(1-\tau^c)(f(k_{t+1}, l_{t+1}) - w_{t+1}l_{t+1} - \delta k_{t+1}) + k_{t+1}] \tag{B.3}$$

And using the firm's dividend constraint (2.11) we can reexpress this condition as follows:

$$k_{t+1} = \frac{1}{1 + \frac{r_{t+1+i}}{(1-\tau^g_{t+1+i})}}[d_{t+1} + k_{t+2}] \tag{B.4}$$

Iterating forwards and using the transversality condition, we obtain the following capital-dividend mapping:

$$k_{t+1} = \sum_{j=1}^{\infty} \left(\prod_{i=0}^{j-1} \frac{1}{1 + \frac{r_{t+1+i}}{(1-\tau^g_{t+1+i})}} \right) d_{t+j} \tag{B.5}$$

Assuming that the tax rates are constant and comparing (3.1) with (3.5) imply the following price-capital mapping:

$$P_t = \frac{(1-\tau^d)}{(1-\tau^g)} k_{t+1} \tag{B.6}$$

If we don't make the constant tax rates assumption, the derivation of the price-capital mapping suggested by Anagnostopoulos, Carceles-Poveda and Lin (2010) gets complicated. Hence, we try to obtain this mapping using a "guessing" method rather than an explicit analytical solution. We guess that $P_t = \frac{(1-\tau^d_t)}{(1-\tau^g_t)} k_{t+1}$ and plug this into the bond interest rate obtained from the household's problem (2.5) and check if the resulting equation is equal to the equation for the return on stock derived from the firm's problem (2.14). Our initial guess was indeed the correct one and we conclude that $P_t = \frac{(1-\tau^d_t)}{(1-\tau^g_t)} k_{t+1}$ regardless of whether the tax rates are constant or not.

Appendix C

Steady State and Transition Equations

For the Accrual-Based Model:

- Steady State Equations:

$$
\begin{aligned}
k &= \left(\frac{1-\beta}{\alpha\beta(1-\tau^g)(1-\tau^c)} + \frac{\delta}{\alpha}\right)^{\frac{1}{\alpha-1}} \\
c &= k^\alpha - \delta k \\
i &= \delta k \\
y &= k^\alpha \\
w &= (1-\alpha)k^\alpha \\
r &= (1-\tau^g)(1-\tau^c)(\alpha k^{\alpha-1} - \delta) = \frac{(1-\beta)}{\beta} \\
P &= \frac{1-\tau^d}{1-\tau^g}k \\
V &= \frac{1-\tau^d}{1-\tau^g}d + P \\
d &= (1-\tau^c)(\alpha k^\alpha - \delta k) \\
T &= \tau^d(1-\tau^c)(\alpha k^\alpha - \delta k) + \tau^c(\alpha k^\alpha - \delta k)
\end{aligned}
$$

- Transition Equations:

$$
\begin{aligned}
y_t &= k_t^{\alpha} \\
i_t &= k_{t+1} - (1-\delta)k_t \\
c_t &= y_t - i_t \\
w_t &= (1-\alpha)k_t^{\alpha} \\
r_t &= \frac{(1-\tau_{t-1}^{g})(1-\tau_t^{d})}{(1-\tau_{t-1}^{d})}[(1-\tau^{c})(\alpha k_t^{\alpha-1} - \delta) + 1] + \tau_t^{g} - 1 \\
P_t &= \frac{1-\tau_t^{d}}{1-\tau_t^{g}} k_{t+1} \\
V_t &= \frac{1-\tau_t^{d}}{1-\tau_t^{g}} d_t + P_t \\
d_t &= (1-\tau^{c})(k_t^{\alpha} - w_t - \delta k_t) + k_t - k_{t+1} \\
T_t &= \tau_t^{d} d_t + \tau^{c}(k_t^{\alpha} - w_t - \delta k_t) + \tau_t^{g}(P_t - P_{t-1})
\end{aligned}
$$

Appendix D

Solution Methodology

For the Accrual-Based Model:

- Define a new variable "asset holdings" denoted as a_{t+1}=$P_t s_{t+1}$ and rewrite the household B.C. as:

$$c_t + a_{t+1} = (1 + r_t)a_t + w_t + T_t \tag{D.1}$$

- Equate the "r_t" resulting from the HH Foc's and the "r_t" resulting from the Firm Foc's to obtain the following P-K mapping:

$$a_{t+1} = P_t = \frac{1 - \tau_t^d}{1 - \tau_t^g} k_{t+1} \tag{D.2}$$

- Solve the steady states using the calibrated parameters and steady state equations.

- Transition path:

  - For the cases where the tax changes are expected:

    1. Fix the aggregate capital K_1 at K_{ss1} and K_{200} at K_{ss2}. Then guess a path for K_t for $t = 2...199$.

    2. Calculate r_t, w_t, P_t, d_t, and T_t based on K_t.

3. Solve for policy functions, and transition path for consumption, investment, output, and assets.

4. Check whether the K_t we guessed clears the market, i.e. if:

$$A_{t+1} = \frac{1-\tau_t^d}{1-\tau_t^g} K_{t+1} \tag{D.3}$$

5. Repeat this process by updating K_t until the guess for K_t clears the market.

– For the cases where the tax changes are completely unexpected:

1. Fix the aggregate capital K_t for $t = 1..30$ at K_{ss1} and K_{200} at K_{ss2}. Then guess a path for K_t for $t = 31...199$.

2. Follow steps 2 to 5 above.

Appendix E

U.S. Data

Dividends:

Definition: The distributed portion of the Net Corporate Dividend Payments defined as the corporate profits after tax with inventory valuation and capital consumption adjustments

Source: Bureau of Economic Analysis-GDP Personal Income Table 1.12/Line 16

website: http://bea.gov

Stock Price:

Definition: Stock Price Index

Source: Standard and Poor's 500

websites:

politicalcalculations.blogspot.com/search?q=quarterly+data+for+s%26p+500#.V4PXz84-DEY

https://docs.google.com/spreadsheets/d/1wsvNIOW19AKC495MEEHJamTIuUNTTz2TNOm8ituVaUQ/edit#gid=0

Realized Capital Gains:

Definition: Realized capital gains including short and long-term total net positive gains

Source: US Department of the Treasury, Office of Tax Analysis

website: https://www.treasury.gov/resource-center/tax-policy/Pages/Tax-Analysis-and-Research.aspx

Accrued Capital Gains:

Definition: Households and Nonprofit Organizations' Corporate Equities

Source: Board of Governors of the Federal Reserve System (US)

Table Title: Households and Nonprofit Organizations' Corporate Equities: Asset

Series ID: HNOCEA

Release: Z.1 Financial Accounts (Flow of Funds) of the United States

Source Series ID: LM153064105Q

website: https://fred.stlouisfed.org/series/HNOCEA/downloaddata

Capital Gains Tax Revenue:

Definition: Capital Gains Tax Revenue

Source: US Department of the Treasury, Office of Tax Analysis

website: https://www.treasury.gov/resource-center/tax-policy/Pages/Tax-Analysis-and-Research.aspx

Real GDP Growth Rate:

Definition: Percentage Change in Real GDP

Source: Bureau of Economic Analysis-GDP Personal Income Table 1.1.1

website: http://bea.gov

Investment:

Definition: Sum of gross domestic private investment, change in private inventories, net government investment, consumption of consumer durable goods and net exports of goods and services

Source: Bureau of Economic Analysis-GDP Personal Income Tables 1.1.5 (Gross domestic private investment, Change in private inventories, Net exports of goods and services)-1.5.5 (Consumption of consumer durable goods)-5.1 (Net government investment)

website: http://bea.gov

Capital:

Definition: Sum of fixed assets and consumer durable goods, where fixed assets include private residential and nonresidential fixed assets as well as government residential and non-residential fixed assets

Source: Bureau of Economic Analysis-Fixed Assets Table 1.1

website: http://bea.gov

Real Interest Rate:

Definition: The lending interest rate adjusted for inflation as measured by the GDP deflator

Source: International Monetary Fund, International Financial Statistics and data files using World Bank data on the GDP deflator (World Development Indicators)

website: data.worldbank.org/indicator/FR.INR.RINR?locations=US

Appendix F

Steady State Values

REALIZATION-BASED MODEL

Table 6.1: Steady State Values-Increase in Dividend Tax

Variable	Inital SS Value	Final SS Value
Consumption	3.032	3.0326
Cost	0.0029	0.0023
Dividend	0.1667	0.1667
Discount	0.0114	0.0114
Realized gains	0.3428	0.2752
Investment	1.0031	1.0031
Capital	47.7667	47.7667
Unreal-to-real	12.2014	12.2014
Price	47.9575	47.9575
Stock return	0.0098	0.0098
Transfers	0.3624	0.3806
Unrealized gains	4.1832	3.3583
Output	4.038	4.038

Table 6.2: Steady State Values-Increase in Capital Gains Tax

Variable	Inital SS Value	Final SS Value
Consumption	3.032	3.009
Cost	0.0029	0.0047
Dividend	0.1667	0.1862
Discount	0.0114	0.012
Realized gains	0.3428	0.3356
Investment	1.0031	0.9586
Capital	47.7667	45.6462
Unreal-to-real	12.2014	15.8883
Price	47.9575	48.1925
Stock return	0.0098	0.0098
Transfers	0.3624	0.3817
Unrealized gains	4.1832	5.3323
Output	4.038	3.9723

Table 6.3: Steady State Values-Increase in Capital Gains and Dividend Tax

Variable	Inital SS Value	Final SS Value
Consumption	3.032	3.01
Cost	0.0029	0.0038
Dividend	0.1667	0.1862
Discount	0.0114	0.012
Realized gains	0.3428	0.2694
Investment	1.0031	0.9586
Capital	47.7667	45.6462
Unreal-to-real	12.2014	15.8883
Price	47.9575	38.689
Stock return	0.0098	0.0098
Transfers	0.3624	0.4002
Unrealized gains	4.1832	4.2808
Output	4.038	3.9723

Table 6.4: Steady State Values-Increase in Dividend Tax

Variable	Inital SS Value	Final SS Value
Consumption	3.0309	3.0309
Dividend	0.1706	0.1706
Discount	0.0115	0.0115
Investment	0.9944	0.9944
Capital	47.3523	47.3523
Price	48.0065	38.5396
Stock return	0.0098	0.0098
Transfers	0.3682	0.3861
Output	4.0253	4.0253

Table 6.5: Steady State Values-Increase in Capital Gains Tax

Variable	Inital SS Value	Final SS Value
Consumption	3.0309	3.0061
Dividend	0.1706	0.1927
Discount	0.0115	0.0122
Investment	0.9944	0.9434
Capital	47.3523	44.9237
Price	48.0065	48.2634
Stock return	0.0098	0.0098
Transfers	0.3682	0.3914
Output	4.0253	3.9495

Table 6.6: Steady State Values-Increase in Capital Gains and Dividend Tax

Variable	Inital SS Value	Final SS Value
Consumption	3.0309	3.0061
Dividend	0.1706	0.1927
Discount	0.0115	0.0122
Investment	0.9944	0.9434
Capital	47.3523	44.9237
Price	48.0065	38.7459
Stock return	0.0098	0.0098
Transfers	0.3682	0.4093
Output	4.0253	3.9495