Capital Income Taxation with Household and Firm Heterogeneity

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Abstract
The US tax code stipulates taxation of capital income at the firm level (corporate profits) and at the household level (dividends and capital gains). Even though all of those are capital income taxes, they have different effects both on incentives for household savings and firm investment and in terms of distribution. We argue that these effects can work both from the aggregate savings (household) side and from the aggregate investment (firms) side and provide a model that incorporates both aspects. The model features heterogeneous households and heterogeneous firms and is used to: 1. Evaluate the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) of 2003, which reduced and equalized tax rates on dividends and capital gains and 2. Analyze the optimal mix between the different types of capital income taxes. We find that the JGTRRA reduces investment and capital mainly due to a wealth effect. In particular, the dividend tax cut raises stock prices and, as a result, aggregate wealth held by stockholders. In order to be willing to hold additional wealth, stockholders require a higher return which pushes capital demand and investment down. Interestingly, capital is more efficiently allocated and, as a result, GDP actually rises slightly. On the second question, we search for a tax scheme that provides incentives for investment without the usual negative redistribution side effects.

Heterogeneous Firms, Heterogeneous Households, Incomplete Markets, Capital Income Taxes

1 Introduction
Before 2003, the US tax code treated income from dividends differently than income from capital gains. Dividend income was lumped together with other

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personal income, whereas capital gains were taxed at a separate, generally lower, rate. The Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) of 2003 changed this in two ways. First, the tax rate on long term capital gains was reduced. Second, dividend income was separated from the rest of income and put together with capital gains income for tax purposes. Thus, the dividend tax rate was reduced and equalized to the capital gains tax rate. Although the initial reform was voted as temporary, these changes were extended repeatedly in subsequent years until recently. In 2012, the removal of dividends from the personal income tax code and lumping together with capital gains was made permanent, but the (now common) tax rate of dividends and capital gains was brought back to the pre-2003 levels. It is conceivable that further changes to this aspect of the tax code lie ahead of us. This paper has two goals. First, to investigate the effects of such reforms on capital formation, investment and welfare. Second, to shed light on the overall question of capital income taxation and, in particular, the optimal mix between taxes on dividends, capital gains and corporate profits.

Taxes on dividends and capital gains distort both the savings behavior of households as well as the investment behavior of firms. We argue that in order to understand the overall effects of these taxes on capital formation and welfare, careful modelling of both sides of the market is required. A brief review of existing literature will illustrate this idea. In a standard growth model, asset returns are not affected by a permanent decrease in dividend taxes because this is fully capitalized in the value of stock prices. As a result, a dividend tax cut has no effect on real allocations except raising the value of the stock market (see McGrattan and Prescott (2005) or Santoro and Wei (2009) amongst many others). When the household side is nuanced with the introduction of wealth heterogeneity and incomplete markets, as in Anagnostopoulos et al (2012), this result breaks down. In that scenario, stockholders find that the value of their savings increases above the desired amount and require higher returns. With a decreasing marginal product of capital, this leads to a fall in the capital stock. When the firm side is nuanced, as in Gourio and Miao (2010), dividend tax cuts again have effects on capital formation, but this time the effect is positive. Heterogeneous firms using external finance in order to grow, find their financing frictions relaxed by a decrease in dividend taxes and can grow faster thus raising investment and the capital stock. Given the potentially different effect of dividend taxes in different environments, it remains unclear whether the aforementioned reforms promote or hinder investment and growth. We propose to resolve the issue by incorporating all the relevant margins in a calibrated model.

Our model features heterogeneous households facing uninsurable idiosyncratic labor income risk and heterogeneous firms whose investment and financing decisions are subject to the distortions introduced by the tax code. In order to make the model tractable, we assume that households invest in shares of a mutual fund that is composed of all firms. Household income includes labor income as well as capital income, the latter comprising dividend and capital gains income. All three types of income are taxed by the government at, po-
tentially, different rates. Firms use capital and labor to produce goods using a decreasing returns to scale technology which is subject to idiosyncratic productivity shocks. As a result, firms are heterogeneous in terms of their productivity shock and their level of capital. Each firm decides on how much to invest, whether (and how much) to pay in dividends, as well as whether to finance investment using equity issuance or retained earnings. Corporate profits are taxed by the government at a flat rate. In any period, a firm can be in one of three financing regimes: the equity issuance, the dividend distribution or the liquidity constrained regime. Firms in the first regime use equity issuance to finance investment and do not pay any dividends, whereas firms in the second regime use retained earnings to finance investment and pay the residual out as dividends. Liquidity constrained firms do not issue equity or pay dividends and their investment is limited to the amount of retained earnings. Different firms respond differently to changes in capital income taxes depending on the regime they find themselves in. Similarly, due to the fact that households are in different points in the wealth distribution, they are affected differently by taxation and this has important distributional effects that are also reflected in aggregate savings.

To our knowledge, there is a theoretical contribution in specifying a model combining substantial heterogeneity on both the household and the firm side. Relative to existing literature, our model combines the household heterogeneity aspects in Anagnostopoulos et al (2012) to the firm heterogeneity aspects in Gourio and Miao (2010). Tractability of our model relies crucially on assuming that households do not trade shares in each individual firm, but rather trade only shares in a mutual fund which serves as an aggregator, as in Favilukis, Ludvigson and van Nieuwerburgh (2013) who study the macroeconomic effects of the housing market. In their model, households buy stocks in a mutual fund that combines two productive sectors, a consumption good producing sector and a housing sector.

We calibrate our model to US data. Our calibration is standard and follows closely the existing literature, a feature which allows for comparison across papers. We use our calibrated model to answer two questions. 1. What are the quantitative effects of the JGTRRA along various dimensions including aggregate, distributional and welfare effects? 2. What would be the optimal allocation the capital income tax burden between corporate income, dividend income and capital gains income?

To answer the first question, we conduct the following experiment. Starting at the benchmark calibrated economy, we assume that dividend and capital gains taxes a unexpectedly and permanently lowered to the levels stipulated by the JGTRRA. We compute the new long run steady state implied by the new tax scheme as well as the transitional dynamics the precede it. We find that the reform leads to a gradual decrease in the capital stock to a new, lower level. The main reason for this is the wealth effect of the decrease in dividend taxes on aggregate savings. Specifically, the stock price increase that results from the reform, increases the wealth held by stockholders, prompting them to require a higher return and resulting in disinvestment on the firm side. Aggregate GDP
however increases. The reason is that capital is more efficiently allocated across firms, since productive firms find it easier to raise external funds as a result of the tax reform and less productive firms downsize. Consistent with the data, the model also predicts an increase in stock prices, dividend payments and equity issuance. Importantly, these imply higher aggregate consumption both in the short run and in the long run. That is, from an aggregate perspective, the reform would be welfare enhancing. However, to the extent that wealth is transferred from high marginal utility workers to lower marginal utility stockholders, a utilitarian social welfare function could actually reveal negative overall welfare effects. This remains to be determined.

Regarding the second question, the optimal allocation of capital income taxes presents some interesting tradeoffs. It is well known (see for example Domeij and Heathcote (2004)) that reducing taxes on the return to investment and savings is optimal from an efficiency perspective, but can be sub-optimal when distributional considerations are taken into account. On the other hand, increasing dividend taxes does not directly impact on the after tax return to savings and, in fact, under incomplete markets could increase saving through a general equilibrium effect. In addition, an increase in dividend taxes could have positive redistribution effects in the sense of transferring wealth from wealthy stockholders to less wealthy workers. It would appear that a reform that eliminates corporate income taxes and replaces the tax revenue through dividend taxes could increase efficiency without introducing negative redistribution. Note, however, that increasing dividend taxes while keeping capital gains taxes fixed, can introduce significant distortions in terms of financing investment through equity issuance. This could be avoided by raising capital gains simultaneously to maintain no wedge between dividend and capital gains taxation. Unfortunately, capital gains taxes do directly impact on the return to savings and could, therefore, undo the positive effects of lower corporate income taxes. In sum, there are interesting tradeoffs in the choice of how to tax capital income and these tradeoffs can be evaluated quantitatively in the context of our model.

The rest of the paper is organized as follows. Section 2 presents the model, Section 3 defines the stationary recursive competitive equilibrium, Section 4 discusses the calibration and the quantitative results from the tax reform experiment. Section 5 summarizes and concludes. The Appendix describes the computational solution method.

2 The Model

We consider an infinite horizon economy with endogenous production, where time is discrete and indexed by $t = 0, 1, 2, \ldots$. We allow for both household and firm heterogeneity, but no aggregate uncertainty. Firms are ex ante identical, but ex post heterogeneous due to idiosyncratic productivity risk. Similarly, households are ex ante identical but ex post heterogeneous due to uninsurable idiosyncratic labor income risk. They trade only a single asset, which is in-
terpreted as a mutual fund composed of all the firms in the economy\(^1\). The sole role of the mutual fund is to intermediate between firms and households\(^2\). A government maintains a balanced budget by taxing firm profits as well as household labor, dividend and capital gains income.

### 2.1 Households

There is a continuum (measure 1) of households indexed by \(i\) with identical utility functions given by

\[
E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}),
\]

where \(\beta \in (0, 1)\) is the subjective discount factor and \(E_0\) denotes the expectation conditional on information at date \(t = 0\). The period utility function \(u(\cdot) : \mathbb{R}_+ \to \mathbb{R}\) is assumed to be strictly increasing, strictly concave and continuously differentiable, with \(\lim_{c_i \to 0} u'(c_i) = \infty\) and \(\lim_{c_i \to -\infty} u'(c_i) = 0\).

In the absence of leisure in the utility, households supply a fixed amount of labor (normalized to one) and receive labor income that is, from their point of view, exogenous. The economy-wide wage rate is denoted by \(\omega_t\) but each household is subject to an idiosyncratic shock \(\xi_{it}\) to their productivity, so that labor income of household \(i\) is \(w_t \xi_{it}\). The productivity shock is i.i.d. across households and follows a Markov process with transition matrix \(\Omega(\xi'|\xi)\) and \(N_\xi\) possible values.

Households can only partially insure against uncertainty by trading shares \(\theta_{it}\) of a mutual fund, which comprises all the firms in the economy\(^3\). Holding shares provides income to the household in the form of dividends as well as capital gains resulting from changes in the market value of these shares. Since there is no aggregate uncertainty, dividends and share prices are certain, the traded asset is risk free and markets are incomplete.

The government levies proportional taxes on labor income, dividend income and capital gains income at rates of \(\tau_{lt}, \tau_d\) and \(\tau_g\) respectively. Households can use their after-tax income from all sources to purchase consumption goods or to purchase shares in the mutual fund. The households’ budget constraint can be expressed as:

\[
c_{lt} + P_t \theta_{lt} = (1 - \tau_{lt})w_t \xi_{lt} + \left( (1 - \tau_d)D_t + P_t^{0} \right) \theta_{lt-1} - \tau_g \left( P_t^{0} - P_{t-1} \right) \theta_{lt-1}
\]

Share ownership, entitles the household to a share \(\theta_{lt-1}\) of the total (after tax) dividend payout \((1 - \tau_d)D_t\). The shareholder can also sell his share of the fund at a price \(P_t^{0}\), which represents the time \(t\) value of equity outstanding in

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\(^1\)This assumption is made for tractability and it is used by Favilukis et al (2013) in a model with two sectors that produce housing and consumption goods.

\(^2\)Alternatively, one can view this model as one in which households can invest directly in the firms with the restriction that they have to invest the same amount in each firm.

\(^3\)The assumption that households only trade mutual fund shares is taken from Favilukis et al (2013). Allowing households to trade shares in each individual firm would make the model intractable.
period $t - 1$. The increase in the value of this existing equity $(P_{0t} - P_{t-1}) \theta_{t-1}$ represents accrued capital gains, which are taxed at the rate $\tau_g$. Since we allow the mutual fund to raise new equity $S_t$, the market value of equity at time $t$ (after new equity is issued) is $P_t = P^0_t + S_t$. Of course, $P_t$ also represents the competitive market price at which shares are bought.

Short-selling of the mutual fund shares is not allowed, i.e. households cannot borrow

$$\theta_{it} \geq 0$$

In each period $t$, households choose how much to consume and how many shares to buy in the mutual fund given prices, dividends and tax rates $\{P_t, P^0_t, w_t, D_t, \tau_d, \tau_t, \tau_g\}$. The optimal choice of shares by an unconstrained household equates the (risk-free) after tax return of the asset to that household’s intertemporal marginal rate of substitution

$$1 + r_t = \frac{P^0_{t+1} + (1 - \tau_d)D_{t+1} - \tau_g\left(P^0_{t+1} - P_t\right)}{P_t} = \frac{u'(c_{it})}{\beta E_t u'(c_{it+1})}$$

2.2 Firms

We borrow the production sector from Gourio and Miao (2010). Firms use capital $k$ and labor $l$ to produce consumption goods $y$ using a Cobb-Douglas production function with decreasing returns to scale

$$y = zf(k, l) = zk^{\alpha_k}l^{\alpha_l}$$

where $0 < \alpha_k, \alpha_l < 1$ and $\alpha_k + \alpha_l < 1$. Production is subject to an idiosyncratic productivity shock $z$ which is i.i.d. across firms and follows a Markov process with transition matrix $\Omega_z(z'|z)$ and $N_z$ possible values. We now consider the problem of a particular firm $j$.

Each period $t$, given the available capital and the current productivity realization, firm $j$ chooses labor demand optimally. The choice of labor demand is a static problem and it defines the operating profit of the firm as follows:

$$\pi^*_{it} \left(k^j_{it}, z^j_{it}; w_t\right) = \max_{l^j_t} \left\{z^j_t f(k^j_{it}, l^j_t) - w_t l^j_t\right\}$$

where $w_t$ is the aggregate wage rate.

Given the determination of operating profits, we can now turn to the dynamic aspect of the firm’s decision making problem, which includes the investment, financing and payout decisions. The firm has two sources of funds, internal and external, which it can allocate to investment $x^j_t$ and dividend payout $d^j_t$. External funds are obtained by issuing new equity. The total value of

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4 Note that we have simplified by assuming capital gains taxes are paid on an accrual basis and that capital losses are subsidized at the same rate. For a way to model capital gains taxes on a realization basis see Kydland, Gavin and Pakko (2007).

5 This distinction between $P_t$ and $P^0_t$ is introduced, as in Gourio and Miao (2010), because we allow for equity issuance. In an environment without equity issuance, the two values would collapse to $P_t$ and the budget constraint would take the more familiar form.
new equity issued in period $t$ is denoted by $s^j_t$. Internal funds consist of after-tax operating profits minus capital adjustment costs. In particular, we assume that investment is subject to quadratic capital adjustment costs, $\psi \frac{x_t^2}{2k^j}$. Operating profits are taxed at a flat corporate income tax rate $\tau_c$, with depreciation spending excluded from taxation. Thus, the firm’s financing constraint is given by

$$d_t^j + x_t^j = (1 - \tau_c) \pi_t^j \left( k_t^j, z_t^j, w_t \right) + \tau_c \delta k_t^j - \frac{\psi \left( x_t^j \right)^2}{2k^j} + s_t^j \quad (6)$$

Investment $x_t^j$ adds to the firm’s capital stock according to:

$$k_{t+1}^j = x_t^j + (1 - \delta) k_t^j \quad (7)$$

where $\delta \in [0, 1]$ is the capital depreciation rate. Finally, we impose that dividend payments cannot be negative

$$d_t^j \geq 0 \quad (8)$$

and that no repurchases are allowed

$$s_t^j \geq 0 \quad (9)$$

We assume that firm $j$ maximizes the following objective as in Gourio and Miao (2010)

$$E_t \sum_{j=0}^{\infty} \left( \prod_{i=0}^{j-1} \frac{1}{1 + \frac{\tau_t}{\tau_{t+i}}} \right) \left[ \frac{1 - \tau_d}{1 - \gamma} d_{t+j}^j - s_{t+j}^j \right] \quad (10)$$

This represents the expected present discounted value of cash flows, where the discounting is in terms of the risk free rate. Recall that households buy shares of a mutual fund that is composed of all firms, but do not invest directly in each individual firm. In this sense, the firms are only indirectly owned by the shareholders through the mutual fund and it is not entirely clear who should decide on the firm’s objective. Moreover, even if firms were traded and owned directly, the combination of shareholder heterogeneity, market incompleteness and decreasing returns to scale technologies would imply lack of unanimity regarding the objective of the firm. In the absence of a commonly agreed upon objective, we have to take a stand and we assume that the firm maximizes (10) subject to (6)-(9).

### 2.3 Government

In each period $t$, the government consumes an exogenous, constant amount $G$ and taxes corporate profits, labor, dividend and capital gains income at rates

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6 See Coen-Pirani and Carceles-Poveda (2009) for a discussion of shareholder unanimity in the presence of constant returns to scale. A discussion of alternative assumptions about the discount factor can also be found in Ludvigson et al (2013).
\[ G = \tau_d D_t + \tau_L w_t L_t + \tau_g (P_t^0 - P_{t-1}) + \tau_c (\Pi_t - \delta K_t) \] (11)

where \( D_t, K_t, L_t \) and \( \Pi_t \) denote the aggregate value of the corresponding variable.

### 2.4 Stationary Recursive Competitive Equilibrium

In this section, we provide the recursive formulation of the household and firm problems and define a stationary recursive competitive equilibrium.\(^7\) Given the absence of aggregate uncertainty, in the long run all aggregates are constant and household and firm problems can be expressed in terms of individual state variables only.

The household’s state vector is fully characterized by the pair \((\theta, \epsilon)\) and its problem can be written recursively as follows:

\[
v_h(\theta, \epsilon) = \max_{(\theta', \epsilon')} \{ u(c) + \beta \sum \Pi_t(\epsilon', \epsilon) v_h(\theta', \epsilon') \text{ s.t.} \}
\]

\[
c + P^0' = (1 - \tau_l) w_e + ((1 - \tau_d) D + P^0) \theta - \tau_g (P^0 - P) \theta
\]

\[ \theta' \geq 0 \]

The solution to the household’s problem consists of a value function \(v_h\) as well as policy rules for shares and consumption which we denote by:

\[
c = c(\theta, \epsilon), \quad \theta' = g_h(\theta, \epsilon)
\]

Similarly, the state vector for a given firm is given by the pair \((k, z)\), its static labor demand decision is described by a decision rule \(l = l(k, z)\) obtained from

\[
\pi(k, z) = \max_l \{zf(k, l) - w(l)\}
\]

and its dynamic problem is as follows:

\[
v_f(k, z) = \max_{(k', s, d, x)} \frac{1 - \tau_d}{1 - \tau_g} d - s + \frac{1}{1 - \tau_g} \sum \Pi_z(z'|z) v_f(k', z')
\]

\[
d + x + \frac{\psi(x)^2}{2k} = (1 - \tau_c) \pi^*(k, z) + \tau_c \delta k + s, \quad d \geq 0, \quad s \geq 0
\]

The solution to the firm’s problem consists of a value function \(v_f\) as well as policy rules for investment, capital, equity issuance, dividends and output:

\[
x = x(k, z), \quad k' = g(k, z), \quad s = s(k, z), \quad d = d(k, z), \quad y = y(k, z)
\]

\(^7\)The corresponding definitions for the non-stationary transitions are omitted but are available upon request.
Let $\mu_h$ be the cross sectional distribution of households over the state $(\theta, \epsilon)$ and $\mu_f$ the cross sectional distribution of firms over the state $(k, z)$. These distributions follow the laws of motion
\begin{align}
\mu_h' &= \Gamma_h (\mu_h) \\
\mu_f' &= \Gamma_f (\mu_f)
\end{align}
(17) (18)

These stationary distributions can be used to calculate aggregate consumption demand $C$, aggregate effective labor supply $L^s$ and aggregate demand for share holdings $\Theta$ from the household side
\begin{align}
C &= \int c(\theta, \epsilon) \, d\mu_h(\theta, \epsilon) \\
L^s &= \int \epsilon \, d\mu_h(\theta, \epsilon) \\
\Theta &= \int g_h(\theta, \epsilon) \, d\mu_h(\theta, \epsilon)
\end{align}
(19)

as well as aggregate labor demand $L$, investment $X$, capital stock $K'$, output $Y$, operating profits $\Pi$, dividends $D$ and equity issuance $S$ from the firm side
\begin{align}
L &= \int l(k, z) \, d\mu_f(k, z) \\
x &= \int x(k, z) \, d\mu_f(k, z) \\
K' &= \int g(k, z) \, d\mu_f(k, z) \\
Y &= \int y(k, z) \, d\mu_f(k, z) \\
\Pi &= \int \pi^s (k, z) \, d\mu_f(k, z) \\
D &= \int d(k, z) \, d\mu_f(k, z) \\
S &= \int s(k, z) \, d\mu_f(k, z)
\end{align}
(20)

**Definition:** Given the transition matrices $\Omega_x$ and $\Omega_z$, a *stationary recursive competitive equilibrium* relative to a government policy $(\tau_l, \tau_d, \tau_g, G)$, consists of stationary distributions $\mu_h$ and $\mu_f$, laws of motion $\Gamma_h$ and $\Gamma_f$, prices $w$ and $P$, decision rules for firms and households, $l = l(k, z)$, $x = x(k, z)$, $k' = g(k, z)$, $s = s(k, z)$, $d = d(k, z)$, $y = y(k, z)$, $c = c(\theta, \epsilon)$, $\theta' = g_h(\theta, \epsilon)$, as well as associated value functions $v_h(\theta, \epsilon)$ and $v(\theta, k, z)$ such that:

- **Optimal Household Choice:** Given prices and aggregates, the individual policy functions $c$ and $\theta'$ and the value function $v_h$ solve the problem of the household in (12)
- **Optimal Firm Choice:** Given the wage rate, $l$ solves the static problem in (14) and $k', s, d$ solve the dynamic problem in (15)
- The aggregates satisfy equations (19) and (20) and $P^0 = P - S$.
- **Government Budget Balance:** Government spending equals government revenue:
\[ G = \tau_l w L_d + \tau_d D + \tau_g (P^0 - P) + \tau_c (\Pi - \delta K) \]
Market Clearing: Prices are such that all markets clear:

\[ \Theta = 1 \]

\[ L = L^s \]

\[ C + X + G + \Psi = Y \]

where \( \Psi \equiv \int \frac{\psi(x(k,z))^2}{2k} d\mu_f(k,z) \) are the aggregate adjustment costs.

Consistency: \( \Gamma_h \) and \( \Gamma_f \) are consistent with the households’ and firms’ optimal decisions respectively.

3 Quantitative Results

We use a calibrated version of our model to study the effects of the 2003 capital tax reforms. First, we discuss the calibration for the benchmark economy which follows closely the ones in Gourio and Miao (2010) and Anagnostopoulos et al (2012) to allow for comparison with the cases of no firm and no household heterogeneity respectively. Subsequently, we study both the long run and the transitional effects of the JGTRRA reform.

3.1 Calibration

Table 1 reports the parameters used for our benchmark economy. The time period is assumed to be one year. Preferences are of the CRRA class, \( u(c) = \frac{c^{1-\mu}-1}{1-\mu} \), with a risk aversion of \( \mu = 2 \). The discount factor is set to \( \beta = 0.9 \) to obtain an after tax risk free rate of 4.1%. The implied aggregate capital to output ratio is 1.57, which is roughly in line with the average capital output ratio in the US corporate sector.

Technology parameters are taken from Gourio and Miao (2010). They estimate the degree of decreasing returns to scale using COMPSTAT Industrial Annual Data for the years 1988-2002. The production function parameters \( \alpha_k \) and \( \alpha_l \) are obtained by choosing \( \alpha_l = 0.650 \) to match the average labor income share in US data and \( \alpha_k = 0.311 \) to capture the estimated degree of decreasing returns to scale. The process for firm level productivity shocks is estimated by fitting an AR(1) process to the residuals of their estimated regression

\[ \ln z_t = \rho \ln z_{t-1} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma^2) \]

The estimated values for \( \rho \) and \( \sigma \) are 0.767 and 0.211 respectively. This process is approximated using a 10-state Markov chain obtained by applying the method of Tauchen and Hussey (1991). Table 2 presents the resulting productivity values \( z \), transition matrix \( \Omega_z(z'|z) \) and associated stationary distribution \( \Omega_z^* \).

The adjustment cost parameter \( \psi \) is chosen to match a cross-sectional volatility of the investment rate of 0.156, which is the value reported by Gourio and Miao (2010). The calibrated value of \( \psi \) is equal to 1.030. The depreciation rate
\( \delta \) is set to 0.095 to match the aggregate investment-capital ratio of 0.095 in the National Income and Product Accounts (NIPA).

The idiosyncratic labor productivity process for the households is taken from Davila, Hong, Krusell and Rios-Rull (2007). The productivity values \( \varepsilon \), transition matrix \( \Omega \), \( (\varepsilon'|\varepsilon) \) and associated stationary distribution \( \Omega^* \) are given in Table 3. The process is constructed so as to generate inequality measures for earnings and (endogenously) wealth that are close to US data using a parsimonious Markov chain model with only three states.\(^8\) This is achieved by choosing a transition matrix exhibiting very strong persistence and productivity values that assign productive individuals 46 times the productivity of unproductive individuals.

Feenberg and Coutts (1993) report Federal plus State marginal tax rates for wages, qualified dividends and long term capital gains. In 2002, the year before the reform, these were \( \tau_l = 0.28 \), \( \tau_d = 0.31 \) and \( \tau_g = 0.24 \) respectively.\(^9\) We set the corporate tax rate to \( \tau_c = 0.34 \) as in Gourio and Miao (2010). This is standard in the literature, it is very close to the statutory rate at the top bracket (0.35) as well as to the average effective tax rate for the period 1982-2002 implied by NIPA corporate sector data (0.37). We use those tax rates in our benchmark economy and obtain endogenously the level of government spending \( G \) implied by budget balance. Regarding tax rates after the reform, Feenberg and Coutts report marginal tax rates of 18.42 and 19.64 for dividends and capital gains respectively for 2003. Since the intention of the reform was to equalize the two tax rates, and since the case of equal tax rates is a natural theoretical benchmark, we assume \( \tau_d = \tau_g = 0.19 \) after the reform. The level of government spending \( G \) is kept fixed and the budget is balanced by adjusting the labor income tax rate.

### 3.2 Tax Reform Experiments

We first describe our benchmark economy and then analyze both the long run implications and the transitional dynamics of a revenue neutral tax reform that reduced dividend and capital gains taxes at the expense of higher labor income taxes. We require the government to maintain a balanced budget for the same level of government spending as in the benchmark economy. This implies that labor taxes have to be adjusted upwards unless the reform is self-financing.

### 3.3 Benchmark Economy

We first consider the pre-reform economy with household and firm heterogeneity. As discussed earlier, firms find themselves in different financing regimes and this means that they will respond differently to dividend tax changes. Table 4 below reports the distribution of firms across the different financing regimes in the model.

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\(^{8}\) For details on this see also Díaz, Pijoan-Mas, Ríos-Rull (2003) and Castaneda, Diaz-Gimenez and Rios-Rull (2003).

\(^{9}\) The data we use can be downloaded from http://www.nber.org/taxsim.
As reflected by the table, the smallest share of firms (around 21%) is in the equity issuance regime. These are relatively small firms that account for only around 10% of the aggregate capital but they undertake a lot of the investment (around 38%). In other words, firms in the equity issuance regime are small and productive in terms of investment. The table also reflects that the biggest firms are in the dividend distribution regime but they account for a much smaller share of aggregate investment (around 20%). Finally, around one third of all firms are liquidity constrained before the reform and they do not issue equity or pay any dividends. As in Gourio and Miao (2010), we note that the model does not match the shares of capital and investment in the data. However, it matches the distribution of firms across financing regimes and the share of equity issuance.

Note that households are also distributed across different wealth and income groups and they will also respond differently to the tax cuts. Note that the Gini coefficient for earnings implied by our idiosyncratic shock process is equal to 0.58, which is very close to the Gini of 0.6 in the US data. Table 5 below contains information about the wealth distribution in our benchmark model.

As we see in the table, a lot of the wealth is concentrated in the highest quintile, consistent with what we see in the data. We also see a considerable amount of households at the borrowing constraint.

Some of the aggregate statistics of the benchmark economy are depicted in Table 6 below. The table reflects the Investment to capital ratio, the cross sectional standard deviation of the investment rate, the decomposition of output and the tax revenue shares of different taxes. The first two moments are targeted by our calibration and they replicate the same moments in the Compustat database. As for the output decomposition, we see a slightly higher government to output ratio than in the literature due to the fact that output in our model only includes the corporate sector. We also see that labor income taxes represent most of the government revenues (around 64%), followed by corporate income taxes (24%) and dividend taxes (13%).

### 3.4 Tax Reforms

We now consider the effects of decreasing the dividends and capital gains taxes to 0.19. Some of the aggregate results are depicted in the third column of Table 7. To get a better intuition for these results, we have also computed the same reforms for the cases with no household heterogeneity and no firm heterogeneity. These are depicted in the first and second columns of the table.

Looking at the reform with both household and firm heterogeneity, the table reflects that reducing the dividends and capital gains taxes leads to an long run increase in the interest rate as well as a long run reduction in the aggregate capital stock of around 3%. Surprisingly, the decrease in aggregate capital is accompanied by a modest increase in both output and consumption of around 0.3 and 0.4 percent respectively. The reform also generates a stock market boom or an increase in the stock price of the mutual fund.

Note that aggregate capital is affected by several opposite forces. First, the
reform eliminates the differential tax treatment of dividends and capital gains, and thus the frictions that make external finance more costly than internal funds\textsuperscript{10}. This will tend to push up aggregate capital, investment and output. After the tax cuts, some of the previously liquidity constrained firms will start issuing equity and move to the equity issuance regime. As discussed earlier, these firms are more productive and they will both invest more and demand more labor, raising the aggregate wage rate. In turn, this will imply that some of the firms in the liquidity constrained and dividend distribution regimes have to downsize and start distributing dividends. The new distribution of firms across regimes obtained after the reform is reflected in Table 8.

As reflected by the table, around 10\% of the previously liquidity constrained firms start issuing equity and about 7\% start distributing dividends. As a result, the model generates a positive reallocation of capital from less productive to more productive firms that tends to increase capital formation. In addition to this reallocation effect, the decrease in the capital gains tax reduces the user cost of capital for all firms, and this also increases their incentives to invest. This mechanism alone would lead to an increase in the aggregate capital stock of around 4\%, as reflected in the second column of the table.

Second, the decrease in dividend taxes will raise the market value of capital and thus the value of the assets held by individuals. With incomplete markets, this wealth effect leads to an increase in the rate of return (so that households are willing to hold the additional wealth) and to a decrease in the aggregate capital stock. In addition, there is a secondary channel through which the capital stock is reduced. The reform leads to a change in the composition of income, with labor income, which is risky, becoming a smaller fraction of the total. This reduces the amount of risk faced by households and, consequently, reducing precautionary savings. This mechanism would lead to a decrease in the aggregate capital, as reflected by the first column of the table.

Overall, the negative wealth effect dominates the positive reallocation and user cost of capital effects and the reform leads to a lower aggregate capital stock in the long run. Due to the more efficient reallocation of capital, however, both long run output and aggregate consumption increase modestly after the reform. In the next section, we study the transitional dynamics to the new stationary equilibrium.

### 3.5 Transitional Dynamics

The transitional paths for the main aggregate variables as a percentage of their initial value is depicted in the figures below. As before, the figures also depict the results for the cases with no household heterogeneity and with no firm heterogeneity.

\textsuperscript{10}Note that this implies that the well known Modigliani Miller theorem holds and the dividends and equity issuance are indeterminate. In other words, only the total payout (dividends net of issuance) can be determined. In spite of this, we can still classify firms in the three regimes depending on whether the total payout is positive, negative or zero.
In the benchmark economy with both household and firm heterogeneity, we see an increase in the interest rate, which stays higher in the long run, as well as a smooth decrease in capital towards its lower long run value. As explained earlier, whereas the tax cuts lead to an increase in the aggregate capital due to the presence of firm heterogeneity, the opposite happens in the presence of household heterogeneity, but the latter effect dominates throughout the transition. Note that capital in the benchmark economy falls faster initially than under household heterogeneity alone due to the initial downsizing of firms that we have discussed above. Interestingly, aggregate output is higher than the initial steady state throughout the whole transition due to the positive investment reallocation. Note that this effect is particularly strong initially, since some of the new equity issuance firms that are trying to grow faster have a relatively high marginal productivity. As for the interest rate, we see an initial increase due to the sudden reduction in the capital gains tax. Whereas the interest rate would converge to the pre-reform level in the absence of household heterogeneity, it remains higher when households are heterogeneous to induce them to hold the additional wealth created by the higher shadow price of capital after the tax reforms.

Looking at the financial variables, we see a sharp increase in dividends and equity issuance after the reform, followed by their convergence to a higher long run value. Note that dividends increase due to two different effects that work in the same direction. Due to the presence of firm heterogeneity, some of the previously liquidity constraint firms start paying dividends, while the firms that were in the dividend distribution regime increase their dividend payments when they downsize after the reform. At the same time, in the presence of household heterogeneity, the wealth effect creates incentives to disinvest and the decline in investment lead to higher dividend payments. As for the aggregate equity issuance, we see an initial upward increase due to the reduction in financial frictions that persists throughout the transition due to the fact that capital adjustment costs do not let firms grow immediately to their optimal level. We also see that the stock market value increases sharply after the reform due to the increase in the present value of the total payout (dividends net of issuance), followed by a smooth decline to a higher long term value.

Following dividends, we also see that aggregate consumption initially spikes up and it stays above the pre-reform level throughout the whole transition. Apart from higher dividend payments, the initial increase in the stock market value implies that households also have higher capital gains in the short run that remain above the pre-reform level throughout. Note that this indicates that there will be positive aggregate welfare effects that will have to be contrasted with the negative redistributional effects of the tax cuts.

In sum, the reform leads to an increase in dividends and equity issuance as well as a stock market boom. In addition, we see a decrease in the aggregate capital but a rise in output and investment due to a more efficient capital allocation, both of which change relatively little in the long run with respect to their pre-reform levels.
3.6 Optimal Capital Income Taxes

To be completed.

4 Conclusion

This paper studies the effects of a reduction in dividend and capital gains taxes in the presence of both household and firm heterogeneity. Whereas firm heterogeneity generates a positive reallocation if investment after the dividend tax cuts, the wealth effect that is present when households are heterogeneous works in the opposite direction by decreasing the aggregate capital. We find that the latter effect dominates and this implies that a dividend tax cut can have the exact opposite effect from the one intended, i.e. it can reduce investment instead of increasing it, although not by much. In spite of a lower capital stock, however, the model generates a slight increase in the aggregate output due to a reallocation of investment to the more productive firms.
Computing the Stationary Competitive Equilibrium

To solve the problems of individual firms and households we use a value function iteration algorithm. We first describe how to solve the problem of firms given prices.

The state vector for firms is composed of their individual capital $k$ and their idiosyncratic shock $z$. We denote this vector by $s_f = (k, z)$. To solve the problem, we first guess a vector of prices, composed of the wage rate and the interest rate $(w, r)$. We then follow the steps below.

Step 1.1. For a given initial wage and interest rate $(w^0, r^0)$ and initial value function $v^0(s_f)$, compute the optimal decision rules for the firms. These are policies for labor demand $\lambda = \lambda(s_f)$, investment $x = x(s_f)$, capital $k^g = g(s_f)$, equity issuance $s = s(s_f)$ and dividends $d = d(s_f)$. Using these policies, we can also compute output $y = y(s_f)$ and the cum dividend and ex dividend market values for each firm $v = v(s_f)$ and $p = p(s_f)$:

$$v(s_f) = \max_{(k', s, d, \lambda)} \left( \frac{1 - \tau_g}{1 - \tau_d} d - s + \frac{1}{1 + \frac{r_g}{1 - r_d}} \sum_{z'} \Pi_z (z'|z) v(s_f) \right)$$

$$p(s_f) = v(s_f) - d(s_f)$$

Step 1.2. After obtaining the firm decision rules from step 1, we solve for the stationary distribution of firms $\mu_f = \mu_f(k, z)$.

Step 1.3. After obtaining the stationary distribution of firms, we obtain the aggregates for the firms, namely, the aggregate labor demand $L_d = \int l_d(s_f) d\mu_f(s_f)$, investment $X = \int x(s_f) d\mu_f(s_f)$, capital $K = \int k(s_f) d\mu_f(s_f)$, output $Y = \int y(s_f) d\mu_f(s_f)$, equity issuance $S = \int s(s_f) d\mu_f(s_f)$, dividends $D = \int d(s_f) d\mu_f(s_f)$ and aggregate values for all firms $V = \int v(s_f) d\mu_f(s_f)$, $P = \int [v(s_f) - d(s_f)] d\mu_f(s_f)$ and $P_0 = \int [v(s_f) - d(s_f) - s(s_f)] d\mu_f(s_f)$.

Step 1.4. Check that the aggregate wage rate $w^0$ clears the labor markets, namely, that

$$L_d = \int l_d(s_f) d\mu(s_f) = L$$

where $L$ is the exogenous labor supply from the households. If labor markets do not clear, update the wage rate.

Step 1.5: Repeat Steps 1.2-1.4 until convergence. This will deliver a new wage $w$. 

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After the problem of individual firms is solved, we proceed to solving the problem of the households given the new wage rate $w$ the interest rate guess $r^0$ and the aggregate prices and dividends from the firms’ problem $P, P_0$ and $D$. The state vector for the households is given by their individual shares in the mutual fund $\theta$ and their idiosyncratic shock $\epsilon$. We denote this vector by $s_h = (\theta, \epsilon)$. To solve the problem for the households, we follow the steps below.

Step 2.1. For a given vector $(r^0, w, P, P_0, D)$ and an initial guess for the households’ value function $v^0_h = v_h(s_h)$, compute the optimal decision rules for the households. These are policies for asset holdings $\theta' = \theta(s_h)$ and consumption choices $c = c(s_h)$. Using these policies, we can compute the optimal value function

$$v_h(s_h) = \max_{\theta'} u (D (1 - \tau_d) + P_0 \theta - \tau_g (P_0 - P) \theta + w \epsilon - P \theta') + \beta \sum_{\epsilon'} \Pi_{\epsilon} (\epsilon' | \epsilon) v(s_h').$$

Step 2.2. After obtaining the firm decision rules from step 1, we solve for the stationary distribution of households $\mu_h$.

Step 2.3. After obtaining the stationary distribution of households, we obtain the aggregate asset demand and consumption

$$S_h = \int \theta(s_h) \, d\mu_h(s_h) \quad \text{and} \quad C = \int c(s_h) \, d\mu_h(s_h).$$

Step 2.4. Check that the interest rate $r^0$ clears the asset market, namely, that

$$S_h = 1$$

If asset markets do not clear, update the interest rate.

Step 2.5: Repeat Steps 2.2-2.4 until convergence. This will deliver a new interest rate $r$.

After doing this, update the new price vector $(w^0, r^0) = (w, r)$ and solve the problem of the firms and households described above until the prices converge, namely until $(w^0, r^0) \approx (w, r)$.
References


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax Rate on Dividends</td>
<td>$\tau_d$</td>
</tr>
<tr>
<td>Tax Rate on Capital Gains</td>
<td>$\tau_g$</td>
</tr>
<tr>
<td>Tax Rate on Corporate Income</td>
<td>$\tau_c$</td>
</tr>
<tr>
<td>Tax Rate on Personal Income</td>
<td>$\tau_i$</td>
</tr>
<tr>
<td>Share of Capital in Production</td>
<td>$\alpha_k$</td>
</tr>
<tr>
<td>Share of Labor in Production</td>
<td>$\alpha_l$</td>
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<tr>
<td>Capital Adjustment Cost</td>
<td>$\psi$</td>
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<tr>
<td>Depreciation Rate</td>
<td>$\delta$</td>
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<tr>
<td>Intertemporal Discount Factor</td>
<td>$\beta$</td>
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<tr>
<td>Risk Aversion Parameter</td>
<td>$\sigma$</td>
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</table>
Table 2: Firm Level Productivity Process

\[ \begin{align*}
Z &= \begin{bmatrix}
0.36 & 0.47 & 0.59 & 0.73 & 0.90 & 1.11 & 1.36 & 1.69 & 2.13 & 2.79
\end{bmatrix} \\
\Omega_z^* &= \begin{bmatrix}
0.36 & 0.47 & 0.59 & 0.73 & 0.90 & 1.11 & 1.36 & 1.69 & 2.13 & 2.79 \\
0.062 & 0.327 & 0.404 & 0.175 & 0.030 & 0.002 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.007 & 0.114 & 0.354 & 0.360 & 0.141 & 0.022 & 0.002 & 0.000 & 0.000 & 0.000 \\
0.001 & 0.022 & 0.166 & 0.374 & 0.316 & 0.106 & 0.014 & 0.001 & 0.000 & 0.000 \\
\end{bmatrix} \\
\Omega_z(z'/z) &= \begin{bmatrix}
0.000 & 0.003 & 0.045 & 0.218 & 0.385 & 0.269 & 0.073 & 0.007 & 0.000 & 0.000 \\
0.000 & 0.000 & 0.007 & 0.073 & 0.269 & 0.385 & 0.218 & 0.045 & 0.003 & 0.000 \\
0.000 & 0.000 & 0.001 & 0.014 & 0.106 & 0.316 & 0.374 & 0.166 & 0.022 & 0.001 \\
0.000 & 0.000 & 0.000 & 0.002 & 0.022 & 0.141 & 0.360 & 0.354 & 0.114 & 0.007 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.002 & 0.030 & 0.175 & 0.404 & 0.327 & 0.062 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.003 & 0.031 & 0.195 & 0.463 & 0.308 \\
\end{bmatrix}
\end{align*} \]

* Notation: \( z \) denotes the values of the firm level productivity shock, \( \Omega_z^* \) is the stationary distribution of the firm level productivity shock process, and \( \Omega_z(z'/z) \) is the Markov transition matrix.
Table 3: Earnings Process *

\[ \mathbf{c} = \begin{bmatrix} 1.00 & 5.29 & 46.55 \end{bmatrix} \]

\[ \Omega_{e}^{*} = \begin{bmatrix} 0.498 & 0.443 & 0.059 \end{bmatrix} \]

\[ \Omega_{e}(e'/e) = \begin{bmatrix} 0.992 & 0.008 & 0.000 \\ 0.009 & 0.980 & 0.011 \\ 0.000 & 0.083 & 0.917 \end{bmatrix} \]

* Notation: \( e \) denotes the values of the labor productivity shock, \( \Omega_{e}^{*} \) is the stationary distribution of the labor productivity shock process, and \( \Omega_{e}(e'/e) \) is the Markov transition matrix.
Table 4: Distribution of Firms Across Finance Regimes (Model)

(Benchmark Calibration) - (τd=0.31, τg =0.24)

<table>
<thead>
<tr>
<th></th>
<th>Equity Issuance Regime</th>
<th>Liquidity Constrained Regime</th>
<th>Dividend Distribution Regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of Firms</td>
<td>0.218</td>
<td>0.281</td>
<td>0.500</td>
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<tr>
<td>Share of Capital</td>
<td>0.104</td>
<td>0.204</td>
<td>0.692</td>
</tr>
<tr>
<td>Share of Investment</td>
<td>0.376</td>
<td>0.420</td>
<td>0.204</td>
</tr>
<tr>
<td>Earnings-Capital Ratio</td>
<td>0.432</td>
<td>0.287</td>
<td>0.173</td>
</tr>
<tr>
<td>Investment-Capital Ratio</td>
<td>0.344</td>
<td>0.196</td>
<td>0.028</td>
</tr>
<tr>
<td>Tobin's Q</td>
<td>2.625</td>
<td>1.893</td>
<td>1.317</td>
</tr>
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Table 5: Wealth Distribution

<table>
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<tr>
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<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
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<tbody>
<tr>
<td>Wealth</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.5%</td>
<td>3.7%</td>
<td>94.8%</td>
</tr>
</tbody>
</table>
Table 6: Aggregate and Cross Sectional Statistics

(Benchmark Calibration)

<table>
<thead>
<tr>
<th>Model</th>
</tr>
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<tbody>
<tr>
<td>I/K</td>
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<tr>
<td>Std. Dev. of Investment Rate</td>
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Decomposition of Output

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>I / Y</td>
<td>0.149</td>
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<tr>
<td>C / Y</td>
<td>0.539</td>
</tr>
<tr>
<td>AC / Y</td>
<td>0.028</td>
</tr>
<tr>
<td>G / Y</td>
<td>0.284</td>
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Tax Revenue Shares

<table>
<thead>
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<tbody>
<tr>
<td>Labor Income</td>
<td>0.64</td>
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<tr>
<td>Capital Income</td>
<td>0.24</td>
</tr>
<tr>
<td>Dividends</td>
<td>0.13</td>
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<tr>
<td>Capital Gains</td>
<td>-0.01</td>
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Table 7: Aggregate Effects of Tax Reforms *

<table>
<thead>
<tr>
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<th>Household Heterogeneity</th>
<th>Firm Heterogeneity</th>
<th>Household and Firm Heterogeneity</th>
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<tbody>
<tr>
<td>Capital</td>
<td>-5.04%</td>
<td>4.10%</td>
<td>-2.91%</td>
</tr>
<tr>
<td>Output</td>
<td>-1.59%</td>
<td>2.17%</td>
<td>0.29%</td>
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<tr>
<td>Consumption</td>
<td>-1.22%</td>
<td>1.80%</td>
<td>0.38%</td>
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<tr>
<td>Share Values</td>
<td>3.28%</td>
<td>13.64%</td>
<td>3.85%</td>
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<tr>
<td>Wage</td>
<td>-1.59%</td>
<td>2.17%</td>
<td>0.29%</td>
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<tr>
<td>Interest Rate</td>
<td>16.47%</td>
<td>0.00%</td>
<td>12.94%</td>
</tr>
</tbody>
</table>

* All results are measured in percentage change from initial steady state before the reform.
Figure 1: Capital Stock
(value relative to the pre-reform level)

Figure 2: Output
(value relative to the pre-reform level)
Figure 3: Consumption
(value relative to the pre-reform level)

Figure 4: Investment
(value relative to the pre-reform level)
Figure 5: Adjustment Cost
(value relative to the pre-reform level)

Figure 6: Interest Rate (after tax)
Figure 9: Equity Issuance
(value relative to the pre-reform level)

Table 2: Corporate Debt and Equity Markets - Period Averages ($\tau_c$-constant)

<table>
<thead>
<tr>
<th>Period</th>
<th>Data Model</th>
<th>Debt / GDP</th>
<th>Tobin's q (V/k)</th>
</tr>
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<tr>
<td>1964-1983</td>
<td></td>
<td>0.607</td>
<td>0.665</td>
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<tr>
<td>1984-2004</td>
<td></td>
<td>0.575</td>
<td>0.748</td>
</tr>
</tbody>
</table>

1964-1983 1984-2004
Data Model Data Model
Debt / GDP 0.607 0.575 0.805 0.725
Tobin's q  (V/k) 0.665 0.748 0.929 0.932
Table 2: Corporate Debt and Equity Markets - Period Averages ($\tau_c$-constant)