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

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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 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 (2011) 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 with the introduction of heterogeneity and financing frictions, 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 these 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, potentially, 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 of 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 are 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 that 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 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, the reform implicitly transfers wealth from high marginal utility workers to lower marginal utility stockholders, i.e. there is a negative redistribution effect. Using a utilitarian social welfare function we find the reform reduces social welfare by 1.24% in consumption equivalent terms. This can be decomposed in a positive aggregate component of 1.12% and a larger, negative distributional component of −2.3%. The latter arises because low wealth and low labor earnings households stand to lose from the reform while stockholders gain. Since the former are a majority in the economy and they have relatively high marginal utility, this negative redistribution reduces average welfare.

Regarding the second question, the optimal allocation of capital income taxes presents some interesting trade-offs. 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 trade-offs in the choice of how to tax capital income and these trade-offs 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 interpreted 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 $w_t$ but each household is subject to an idiosyncratic shock $\epsilon_{it}$ to their productivity, so that labor income of household $i$ is $w_t \epsilon_{it}$. The productivity shock is i.i.d. across households and follows a Markov process with transition matrix $\Omega_{\epsilon}(e' \epsilon)$ and $N_e$ 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. 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 and the traded asset is risk free. 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

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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 buy shares in each individual firm, with the restriction that they have to hold the same share of all firms.
be expressed as:

\[ c_{it} + P_t \theta_{it} = (1 - \tau_{it}) w_t c_{it} + ((1 - \tau_d) D_t + P_0^t) \theta_{it-1} - \tau_g (P_t^0 - P_{t-1}) \theta_{it-1} \quad (2) \]

Share ownership, entitles the household to a share 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 period \(t - 1\). The increase in the value of this existing equity \((P_{0t} - P_{t-1}) \theta_{it-1}\) represents accrued capital gains, which are taxed at the rate \(\tau_g.\) Since we allow the mutual fund to raise new equity, the market value of equity at time \(t\) (after new equity is issued) is \(P_t = P_t^0 + S_t\). Thus, \(P_t\) also represents the competitive market price at which shares are bought.4

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 \(\{P_t, P_t^0, w_t, D_t, \tau_d, \tau_t, \tau_g\}_{t=0}^{\infty}\). The optimal choice of shares by an unconstrained household equates the (risk-free) after tax return \(r_t\) of the asset to that household’s intertemporal marginal rate of substitution

\[
1 + r_t = \frac{P_{t+1}^0 + (1 - \tau_d) D_{t+1} - \tau_g (P_{t+1}^0 - P_t)}{P_t} = \frac{u'(c_{it})}{\beta E_t u'(c_{it+1})} \]

### 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

\[
y = zf(k, l) = z k^{\alpha_k} l^{\alpha_l} \quad (4)\]

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:

\[
\pi^j_t \left(k^j_t, z^j_t; w_t\right) = \max_{l^j_t} \left\{ z^j_t f(k^j_t, l^j_t) - w_t l^j_t \right\} \quad (5)\]

\[3\] 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) or Zhang (2001).

\[4\] This distinction between \(P_t\) and \(P_t^0\) 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.
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 $x^i_t$ and dividend payout $d^i_t$. External funds are obtained by issuing new equity. The total value of new equity issued in period $t$ is denoted by $s^i_t$. 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, $\psi \frac{x^i_t}{2}$. 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

$$d^i_t + x^i_t = (1 - \tau_c) \pi^i_t \left( k^i_t, s^i_t; w_t \right) + \tau_c \delta k^i_t - \frac{\psi \left( x^i_t \right)^2}{2k^i_t} + s^i_t \quad (6)$$

Investment $x^i_t$ adds to the firm’s capital stock according to:

$$k^i_{t+1} = x^i_t + (1 - \delta) k^i_t \quad (7)$$

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

$$d^i_t \geq 0 \quad (8)$$

and no repurchases are allowed

$$s^i_t \geq 0 \quad (9)$$

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

$$E_t \sum_{m=0}^{\infty} \left( \prod_{i=0}^{m-1} \frac{1}{1 + \frac{\tau_d}{1 - \tau_g} \rho_{i+m}} \right) \left[ \frac{1 - \tau_d}{1 - \tau_g} \rho^j_{i+m} - s^j_{i+m} \right] \quad (10)$$

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.\footnote{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).} 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 $\tau_c$, $\tau_L$, $\tau_d$ and $\tau_g$ respectively. We assume that the government maintains a balanced budget. The government budget constraint is given by

$$G = \tau_d D_t + \tau_L L_t + \tau_g (P^0_t - P_{t-1}) + \tau_c (\Pi_t - \delta K_t)$$  \hspace{1cm} (11)$$

where $D_t$, $K_t$, $L_t$ and $\Pi_t$ denote aggregate dividends, capital, labor and profits.

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.\(^6\) 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:

$$v_h (\theta, \epsilon) = \max_{(\theta', \epsilon')} u(c) + \beta \sum_{e'} \Pi_e (\epsilon', \epsilon) v_h (\theta', \epsilon') \hspace{0.5cm} \text{s.t.}$$

$$c + P \theta' = (1 - \tau_t) w + ((1 - \tau_d) D + P^0) - \tau_g (P^0 - P) \theta$$

$$\theta' \geq 0$$  \hspace{1cm} (12)$$

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:

$$c = c(\theta, \epsilon), \quad \theta' = g_h (\theta, \epsilon)$$  \hspace{1cm} (13)$$

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

$$\pi (k, z) = \max_l \{ zf(k, l) - wl \}$$  \hspace{1cm} (14)$$

and its dynamic problem is as follows:

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

$$d + x + \frac{\psi(x)^2}{2k} = (1 - \tau_c) \pi (k, z) + \tau_c \delta k + s, \quad d \geq 0, \; s \geq 0$$  \hspace{1cm} (15)$$

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:

$$x = x(k, z), \; k' = g(k, z), \; s = s(k, z), \; d = d(k, z), \; y = y(k, z)$$  \hspace{1cm} (16)$$

\(^6\)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

$$\mu_h = \Gamma_h (\mu_h) \quad \text{(17)}$$
$$\mu_f = \Gamma_f (\mu_f) \quad \text{(18)}$$

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

$$C = \int c(\theta, \epsilon) \, d\mu_h (\theta, \epsilon) \quad \text{(19)}$$
$$L^s = \int c d\mu_h (\theta, \epsilon)$$
$$\Theta = \int g_h (\theta, \epsilon) \, d\mu_h (\theta, \epsilon)$$

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

$$L = \int l(k, z) \, d\mu_f (k, z), \quad X = \int x(k, z) \, d\mu_f (k, z), \quad K' = \int g(k, z) \, d\mu_f (k, z) \quad \text{(20)}$$
$$Y = \int y(k, z) \, d\mu_f (k, z), \quad \Pi = \int \pi^s (k, z) \, d\mu_f (k, z)$$
$$D = \int d(k, z) \, d\mu_f (k, z), \quad S = \int s(k, z) \, d\mu_f (k, z)$$

**Definition:** Given the transition matrices $\Omega_h$ and $\Omega_z$, a stationary recursive competitive equilibrium relative to a government policy $(\tau_d, \tau_g, \tau_c, G)$, 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 $v(k, z)$ 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), (20) and $P^0 = P - S$.

- **Government Budget Balance:** Government spending equals government revenue:

$$G = \tau_l w L_d + \tau_d D + \tau_g (P^0 - P) + \tau_c (\Pi - \delta K)$$

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Market Clearing: Prices are such that all markets clear:

\[ \Theta = 1 \]
\[ L = L^s \]
\[ C + X + G + \Psi = Y \]

where \( \Psi \equiv \int \frac{\psi(x(k,z))^2}{2k} \, d\mu_f(k, z) \) represents 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, \( u(c) = \frac{c^{1-\varpi}}{1-\varpi} \), with a risk aversion of \( \varpi = 2 \). 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 COMPUSTAT 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 \( z_t \) 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 \( \Omega_z(\varepsilon'|z) \) 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 (2012). The productivity values $\epsilon$, transition matrix $\Omega$, $(\epsilon' | \epsilon)$ 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. $^7$ This is achieved by choosing productivity values that assign productive individuals 46 times the productivity of unproductive individuals and a transition matrix implying a non-trivial probability of transition from high productivity to medium and, eventually, low productivity.

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. $^8$ 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.

### 3.2 Tax Reform

Given our calibrated benchmark economy, we consider a revenue neutral tax reform that reduces dividend and capital gains taxes and makes up for lost revenue through adjustments in labor income taxes. Government spending is kept fixed at the same level $G$ as in the benchmark economy. The labor tax rate is adjusted both in the long run as well as during the transition in order to maintain a balanced budget. We briefly describe the properties of the benchmark economy and then consider the effect of the reform on the aggregate economy in the long run, the resulting transitional dynamics as well as the welfare implications at the aggregate and the household level.

#### 3.2.1 Benchmark Economy

The benchmark economy features substantial heterogeneity on both the firm side and the household side.

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$^7$For details on this see also Diaz, Pijoan-Mas, Rios-Rull (2003) and Castaneda, Diaz-Gimenez and Rios-Rull (2003).

$^8$The data we use can be downloaded from [http://www.nber.org/taxsim](http://www.nber.org/taxsim).
Firms are differentiated according to their current level of capital and their level of productivity. Depending on the combination of these two state variables, a firm will be in one of three financing regimes: equity issuance (EI), liquidity constrained (LC) or dividend distribution (DD). Intuitively, firms with low capital but high productivity find it optimal to invest aggressively. They exhaust internal funds for investment so they pay no dividends and the returns to investment are high enough to justify seeking costly external financing. As a result, they fall under the EI regime. At the opposite extreme, firms with a large capital stock but low productivity find it optimal to invest little or even disinvest. As a result, they payout their cash flow to shareholders and fall under the DD regime. At intermediate levels of productivity and capital stock, there are some firms that find it optimal to invest and grow but whose returns to investment do not justify the tax costs of raising new equity. These firms fall under the LC regime. The LC regime exists only because $\tau^d > \tau^g$ which creates a wedge between the return on investment funded with internal funds and the return on investment funded using equity issuance. LC firms use their internal funds to invest, so they don’t pay dividends but they do not issue equity either.

Table 4 provides the characteristics of the distribution of firms across the three regimes in our benchmark economy. Given that this sector is calibrated as in Gourio and Miao (2010) it is not surprising that these characteristics closely resemble their economy. As expected, equity issuing firms are relatively small, have relatively high earnings to capital and investment to capital ratios and high Tobin’s Q. Most of the capital in the economy is held by large firms in the DD regime, but the majority of the investment is undertaken by smaller, productive firms in the EI and LC regimes. These are the firms that are especially sensitive to changes in dividend taxes, as we explain in the following section. Although Gourio and Miao (2010) report a majority of investment undertaken by dividend distributing firms in COMPUSTAT data, it is important to note that this can be sensitive to the way firms in the data are allocated to different regimes. Contrary to the model, many firms issue equity and distribute dividends simultaneously, a behavior that cannot be rationalized within this model. Gourio and Miao count such firms in the DD regime, but presumably these firms are also sensitive to changes in dividend taxes since they are issuing equity. In terms of numbers, the model predicts approximately 50%, 28% and 22% of firms in the DD, LC and EI regimes respectively. Using Gourio and Miao’s way of allocating firms across regimes yields shares of firms in the data that are very close to the model.

Turning to the household sector, heterogeneity in labor income is exogenously determined by the calibration of the productivity process. The process yields a stationary distribution with 50% of households at the low productivity, 46% with medium productivity and only 6% with high productivity (see Table 3). The implied Gini coefficient of labor earnings is equal to 0.60, which is very close to the value of 0.636 reported in Diaz-Gimenez, Glover and Rios-Rull (2011) based on the 2007 Survey of Consumer Finances. They also report a Gini coefficient of wealth equal to 0.82, wealth held by the bottom two quintiles of less than 1% and wealth held by the top quintile equal to 83.4%. In the model, the wealth distribution is endogenous but the productivity process has
been carefully chosen to deliver a reasonable wealth Gini. Thus, the Gini is close to the data and equal to 0.84. Table 5 provides additional information on the quintiles of the wealth distribution. Consistent with the data, the bottom two quintiles hold no wealth and there is substantial concentration of wealth at the top. From a quantitative perspective, the concentration at the top quintile is more pronounced than the data (95%).

3.2.2 Long Run Effects

Starting at the steady state of the benchmark economy described in the preceding section, the government unexpectedly and permanently reduces both dividend and capital gains taxes to 0.19. We focus first on the new steady state to which the economy converges in the long run and leave the discussion of the transition to the following section.

Given the assumption of a balanced budget and fixed government spending $G$, the labor income tax rate has to increase to make up for lost revenue. In the long run, the new labor income tax rate is 0.298, representing a moderate increase from the value of 0.280 in the benchmark. The third column of Table 6 presents the percent change in the main aggregate variables from the old to the new steady state. Share values increase by 3.85% but the aggregate capital stock falls by 2.9%. Interestingly, output increases, albeit by a small amount of approximately 0.3%. This also implies a small increase in aggregate consumption. Finally, both (before-tax) wages and interest rates are higher. The responses of aggregate capital and output arise as a combination of several opposing forces. To understand those, it is helpful to consider simplified versions of the model with no firm heterogeneity and no heterogeneity in turn. The long run effects of the reform in these simplified economies are shown in columns 1 and 2 of Table 6.9

Consider the case with no firm heterogeneity, i.e. no firm productivity shocks and a representative firm. This firm is mature in the sense that it is paying dividends and does not need to issue equity. A reduction in dividend taxes is fully capitalized in share values and does not directly affect the after tax return of stocks. However, shareholders find their existing stockholdings are now worth more and this affects their saving behavior because of incomplete markets. Specifically, these agents, who save for precautionary reasons, experience an increase in wealth above their desired level and this pushes the return upwards. In turn, the firm responds by lowering capital to raise the marginal product of capital. That is, aggregate capital falls because of a shift in aggregate savings. We refer to this as the wealth effect. The capital gains tax decrease directly affects the firm’s cost of capital and would, other things equal, lead to an increase in investment and capital. However, the wealth effect from the dividend tax cut dominates and the economy converges to a steady state with lower capital, output and consumption and higher share values as reflected in column 1 of Table 6. As expected, before-tax wages and interest rates move in opposite

---

9In these experiments, the parameters of the benchmark economy are recalibrated to match the same targets. This boils down to changing the discount factor $\beta$. 

13
directions, with the former falling and the latter increasing as a result of lower capital.

Suppose now that we maintain firm heterogeneity, but we shut down labor productivity shocks and assume a representative household. It is still true that a dividend tax cut raises share values, but with complete markets the representative household has a perfectly elastic long run demand for savings. That is, the long run interest rate remains unchanged and simply equals the time preference rate, but the representative household does not change its demand for stocks. In this scenario, it is rather capital demand on the firm side that responds, as has been explained in Gourio and Miao (2010). Recall that a firm can be in one of three regimes, equity issuance (EI), liquidity constrained (LC) and dividend distribution (DD). A reduction in the gap between dividend and capital gains tax rates reduces financing frictions. For an equity issuing firm, this implies an increase in equity issuance and investment. In addition, some previous liquidity constrained firms now find it profitable to raise external finance and also increase their investment. As a result, the aggregate capital stock increases. With higher capital held by these smaller, more productive firms, labor demand also increases. This pushes the wage upwards which induces lower capital demand by the larger, less productive firms in the DD regime. This general equilibrium effect mitigates the increase in capital. Importantly, these changes also imply reallocation effects. With more capital in the hands of the more productive firms, aggregate productivity increases. Thus, aggregate output increases for two reasons: higher aggregate capital and more efficiently distributed capital. In addition, since the reform also lowers capital gains taxes, this increases capital and output even further. These effects are reflected in Column 2 of Table 6. Notice in particular that capital increases by 4.1% and output increases by more than $\alpha_k$ times this increase, because of the reallocation effect.

The results for the full economy can now be understood as a combination of the effects on the household side and the firm side. The reallocation effects on the firm side can be seen in Table 7, which shows the distribution of firms across regimes after the reform. The reform equalizes dividend and capital gains taxes and therefore eliminates the financing friction arising from the tax code. As a result, there are no firms that are liquidity constrained. Firms either have enough internal funds to invest their desired amount and pay the remainder as dividends or they need to raise additional funds through new equity and do not pay dividends.10 Compared to the benchmark economy, the new steady state features more EI firms (21.8% to 38.6%) and the average EI firm holds more capital so that the share of capital held by EI firms increases from 10.4% to 22.7%. The share of capital held by DD firms also increases from 69.2% to 77.3%, but this is only due to the increase in the share of DD firms (50% to 61.4%). The average DD firm holds less capital than before. At the aggregate

---

10Note that, in this case, the well-known Modigliani Miller theorem holds, which means dividends and equity issuance are indeterminate. In other words, only the total payout (dividends net of issuance) can be determined. We classify firms with positive total payout in the DD regime and those with negative total payout in the EI regime. A dividend tax rate infinitesimally above the capital gains tax can justify this classification.
level, the wealth effect dominates so capital stock is lower, but the fall is smaller in the presence of financing frictions. Despite the lower capital, aggregate output is higher. This is due to the reallocation effect: even though aggregate capital is lower, it is distributed more efficiently across firms and results in higher overall production. The stock return is higher, but wages are also higher due to the increase in labor demand coming from productive firms. That is, the reallocation effect creates another interesting phenomenon: (before-tax) wages and interest rates move in the same direction. Finally, consistent with the data, stock prices, dividend payout and equity issuance are all higher in the new steady state.

To gauge whether these changes are welfare enhancing or not, the short run effects on these aggregates need to be taken into account. In addition, changes in the aggregates can hide substantial heterogeneity in the experience of individual households in the sense that the reform can be welfare improving for some but welfare reducing for others. Short run effects and distributional effects are the subject of the following section.

3.2.3 Transitional Dynamics and Welfare Effects

The transitional paths for the main aggregate variables as a percentage of their initial value are depicted in figures 1 and 2. For each variable, the transitional paths for three economies are presented. These are the economies with only household heterogeneity, only firm heterogeneity and, lastly, the full economy with both types of heterogeneity. In what follows, we focus on the full economy (dashed lines) and refer to the other economies only insofar as they can help with intuition.

Assuming for the sake of argument that wages are fixed, the immediate effect from the elimination of the wedge between $\tau_d$ and $\tau_g$ is to increase incentives of firms to issue equity and invest. Firms in the EI regime increase their equity issuance and investment. Firms in the LC regime, who previously did not find it profitable to issue equity for investment, now do so. Thus, with fixed wages, the distribution of firms across regimes in the first period would simply move to one where all LC firms switch to the EI regime. If, in addition, there were no adjustment costs, the distribution of firms would simply jump to the new steady state in the following period as some of those firms reach their optimal capital level and switch to the DD regime. The presence of adjustment costs, however, means that the distribution of firms will only converge to the new steady state gradually. These changes in firm distribution are complicated by the general equilibrium response of wages. The increase in capital and labor demand resulting from new investment pushes the wage rate upwards. This has the effect of reducing the optimal capital level for firms and implies that some firms directly switch to the DD regime. In addition, firms already in the DD regime downsize in response to the wage increase, which further increases aggregate dividend payout. The result of those movements is an increase in both dividends and equity issuance. In addition, with permanently lower dividend taxes, after tax dividends rise and this results in an immediate increase in share values.
In the absence of household heterogeneity, the initial response of capital is negative. This is driven by the downsizing of firms in the DD regime, which happens faster than the growth of EI firms because depreciation allows capital to drop without any adjustment costs. However, this is quickly reversed as the EI firms keep growing and adding more capital to the economy. With household heterogeneity, the supply of capital also responds due to the wealth effect. With higher stock values, stockholders require a higher return which, other things equal, would lead to a drop in capital across all regimes. Thus, aggregate capital falls sharply initially because of the combined effects on the household and firm sides. Subsequently, the effects on capital from the firm and household sides are opposite, but the wealth effect dominates so capital keeps falling.

The productivity gains arising from the reallocation of capital and labor follow the change in the distribution of firms. Thus, productivity gains increase gradually due to adjustment costs, but the transition to the new distribution is relatively fast: within 5-6 years of the reform, TFP measured as $\frac{Y}{K^\tau L^\tau}$ has increased by slightly more than 1% which is also the long run increase. This change in productivity explains the hump shape response of output and wages. Both output and wages rise as TFP rises, but as the distribution of firms converges to its new shape and TFP stops growing, output and wages start falling together with capital.

The capital gains arising from the initial increase in share values generate tax revenues in the form of capital gains taxes, which explains the initial drop in the labor tax rate that balances the budget. Subsequently, stock prices adjust downwards, so this tax revenue disappears and the labor tax rate needs to rise above the pre-reform levels. In terms of household income, there is an initial increase in capital gains, a large increase in after tax dividends (both due to higher dividend payout and lower taxes) and even an increase in after tax wages because of lower labor taxes. From the second period onwards, capital gains disappear so labor taxes increase and the after tax wage falls. However, this fall is mitigated by increasing before-tax wages whereas after tax dividend income remains high. As a result, household after-tax income spikes initially and then gradually falls, but it always remains above the pre-reform levels. These dynamics are reflected in aggregate consumption.

To summarize, the dynamic response of aggregate variables exhibits three phases: an initial response influenced by the initial response of the labor tax and the immediate downsizing of DD firms, followed by a relatively short period where the influence of an increasing TFP can be seen, followed by a longer period where the usual transition dynamics of capital are driving the responses.

The fact that aggregate consumption is higher both in the short run and in the long run, implies that the reform would be welfare improving from a representative agent perspective. However, these gains mask substantial heterogeneity across households in terms of welfare. Table 8 presents welfare measures (equivalent variation in consumption) based on a utilitarian social welfare function. These are decomposed into aggregate and distributional components
using the method of Domeij and Heathcote (2004). According to our social welfare function, the reform leads to a reduction in welfare equivalent to a fall in consumption of 1.24% across all households and all dates. This reduction is due to the negative redistribution implicit in the reform. If the changes in aggregate consumption were equally distributed across all households, social welfare would increase by 1.12% (aggregate component). Thus, the fall in social welfare is attributed to the distributional component being negative and equal to −2.3%. In the absence of household heterogeneity (column 2), the distributional effects are absent and the reform would yield a welfare gain of 1.08%. Compared to our benchmark economy, the economy with only firm heterogeneity has significantly higher consumption in the long run, but lower consumption in the short run. The overall effect on welfare is of a similar order of magnitude as the aggregate component in our benchmark economy.

The presence of household heterogeneity drives the result of negative overall welfare effects from the reform. These arise due to negative redistribution, which can be further understood by looking at figure 3. This figure shows the individual welfare gains for different combinations of productivity (labor income) and asset levels. The figure reflects that welfare gains are increasing in the amount of asset wealth held by an individual. Most individuals holding stocks gain from this reform and only some individuals holding no stocks (and some holding very few stocks) lose. This is not surprising, since the reform reduces the taxation of asset wealth and increases the taxation of labor earnings. We also observe that, for a large amount of asset wealth, welfare gains are higher for low productivity individuals. This is because, among agents with the same asset level, agents with lower productivity rely less on labor income compared to asset income. Therefore, the increase in labor income taxes and the decrease in after-tax wage hurts them the least. However, given little or no wealth, welfare gains are lower (or rather, welfare losses are larger) for low productivity households. This is because those households enjoy very low levels of consumption anyway and their marginal utility is very high. In addition, given the persistence of the labor productivity process, they are unlikely to benefit from low asset taxation in the future either. In sum, the reform benefits wealthy households and high labor income households and hurts those with low wealth and labor income. Since the latter are a majority in the economy and they have the highest marginal utility, they dominate the effects on the social welfare function which explains the negative overall welfare effect.

3.3 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 het-
erogeneity 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 \( k' = g(s_f) \), equity issuance \( s = s(s_f) \) and dividends \( d = d(s_f) \). Using these policies, we can also compute output \( \phi = (s_f) \) and the ex dividend market values for each firm \( v = v(s_f) \) and \( p = p(s_f) \):

\[
v(s_f) = \max_{(k', s, d, \lambda)} \frac{1 - \tau_d}{1 - \tau_g} d - s + \frac{1}{1 + r^0} \sum_{z'} \Pi_z (z' | z) v(s_f) \]

\[
p(s_f) = v(s_f) - d(s_f) \]

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 \( w \).
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 heir 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 $v_h^0 = v_h(s_h)$, 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

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

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 consumptions $S_h = \int \theta(s_h) d\mu_h(s_h)$ and

$$C = \int c(s_h) d\mu_h(s_h).$$

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 1: Parameter Values

<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>
</tr>
<tr>
<td>Capital Adjustment Cost</td>
<td>( \psi )</td>
</tr>
<tr>
<td>Depreciation Rate</td>
<td>( \delta )</td>
</tr>
<tr>
<td>Intertemporal Discount Factor</td>
<td>( \beta )</td>
</tr>
<tr>
<td>Risk Aversion Parameter</td>
<td>( \sigma )</td>
</tr>
</tbody>
</table>

\( \tau_d = 0.310 \)

\( \tau_g = 0.240 \)

\( \tau_c = 0.340 \)

\( \tau_i = 0.280 \)

\( \alpha_k = 0.311 \)

\( \alpha_l = 0.650 \)

\( \psi = 1.030 \)

\( \delta = 0.095 \)

\( \beta = 0.900 \)

\( \sigma = 2.000 \)
Table 2: Firm Level Productivity Process

\[
\mathbf{z} = \begin{bmatrix}
0.36 & 0.47 & 0.59 & 0.73 & 0.90 & 1.11 & 1.36 & 1.69 & 2.13 & 2.79 \\
\end{bmatrix}
\]

\[
\mathbf{\Omega}_z^* = \begin{bmatrix}
0.00 & 0.02 & 0.08 & 0.16 & 0.24 & 0.24 & 0.16 & 0.08 & 0.02 & 0.00 \\
0.308 & 0.463 & 0.195 & 0.031 & 0.003 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.062 & 0.327 & 0.404 & 0.175 & 0.030 & 0.002 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.007 & 0.114 & 0.354 & 0.360 & 0.141 & 0.022 & 0.002 & 0.000 & 0.000 & 0.000 \\
0.001 & 0.022 & 0.166 & 0.374 & 0.316 & 0.106 & 0.014 & 0.001 & 0.000 & 0.000 \\
0.000 & 0.003 & 0.045 & 0.218 & 0.385 & 0.269 & 0.073 & 0.007 & 0.000 & 0.000 \\
0.000 & 0.000 & 0.007 & 0.073 & 0.269 & 0.385 & 0.218 & 0.045 & 0.003 & 0.000 \\
0.000 & 0.000 & 0.001 & 0.014 & 0.106 & 0.316 & 0.374 & 0.166 & 0.022 & 0.001 \\
0.000 & 0.000 & 0.000 & 0.002 & 0.022 & 0.141 & 0.360 & 0.354 & 0.114 & 0.007 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.002 & 0.030 & 0.175 & 0.404 & 0.327 & 0.062 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.003 & 0.031 & 0.195 & 0.463 & 0.308 \\
\end{bmatrix}
\]

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1.00</td>
<td>5.29</td>
<td>46.55</td>
</tr>
<tr>
<td>0.498</td>
<td>0.443</td>
<td>0.059</td>
</tr>
<tr>
<td>0.992</td>
<td>0.008</td>
<td>0.000</td>
</tr>
<tr>
<td>0.009</td>
<td>0.980</td>
<td>0.011</td>
</tr>
<tr>
<td>0.000</td>
<td>0.083</td>
<td>0.917</td>
</tr>
</tbody>
</table>

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

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

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

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

(Benchmark Calibration) - (τ_d=0.31 , τ_g=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>
</tr>
<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>

### Table 5: Wealth Distribution

<table>
<thead>
<tr>
<th></th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
</tr>
</thead>
<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 Effects of Tax Reforms: Long Run *

<table>
<thead>
<tr>
<th></th>
<th>Household Heterogeneity</th>
<th>Firm Heterogeneity</th>
<th>Household and Firm Heterogeneity</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>Consumption</td>
<td>-1.22%</td>
<td>1.80%</td>
<td>0.38%</td>
</tr>
<tr>
<td>Share Values</td>
<td>3.28%</td>
<td>13.64%</td>
<td>3.85%</td>
</tr>
<tr>
<td>Dividends</td>
<td>2.50%</td>
<td>16.86%</td>
<td>16.62%</td>
</tr>
<tr>
<td>Equity Issuance</td>
<td>N/A</td>
<td>151.17%</td>
<td>130.39%</td>
</tr>
<tr>
<td>Wage (before tax)</td>
<td>-1.59%</td>
<td>2.17%</td>
<td>0.29%</td>
</tr>
<tr>
<td>Wage (after tax)</td>
<td>-4.58%</td>
<td>0.00%</td>
<td>-2.21%</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>16.47%</td>
<td>0.00%</td>
<td>12.94%</td>
</tr>
<tr>
<td>Welfare: CE Total</td>
<td>-3.36%</td>
<td>1.80%</td>
<td>-1.27%</td>
</tr>
<tr>
<td>Welfare: CE Aggregate</td>
<td>-1.22%</td>
<td>0.38%</td>
<td></td>
</tr>
<tr>
<td>Welfare: CE Distribution</td>
<td>-2.15%</td>
<td></td>
<td>-1.63%</td>
</tr>
</tbody>
</table>

* All results are measured in percentage change from initial steady state before the reform
Table 7: Distribution of Firms Across Finance Regimes (Model)

\[(\text{After Tax Reform}) \cdot (\gamma_d=0.19, \gamma_g=0.19)\]

<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>0.386</td>
<td>NaN</td>
<td>0.614</td>
</tr>
<tr>
<td>Share of Capital</td>
<td>0.227</td>
<td>NaN</td>
<td>0.773</td>
</tr>
<tr>
<td>Share of Investment</td>
<td>0.779</td>
<td>NaN</td>
<td>0.221</td>
</tr>
<tr>
<td>Earnings-Capital Ratio</td>
<td>0.384</td>
<td>NaN</td>
<td>0.186</td>
</tr>
<tr>
<td>Investment-Capital Ratio</td>
<td>0.327</td>
<td>NaN</td>
<td>0.027</td>
</tr>
<tr>
<td>Tobin's Q</td>
<td>2.434</td>
<td>NaN</td>
<td>1.464</td>
</tr>
</tbody>
</table>
Table 8: Welfare Gains : Transition

<table>
<thead>
<tr>
<th></th>
<th>Household Heterogeneity</th>
<th>Firm Heterogeneity</th>
<th>Household and Firm Heterogeneity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare: CE Total</td>
<td>-2.21%</td>
<td>1.08%</td>
<td>-1.24%</td>
</tr>
<tr>
<td>Welfare: CE Aggregate</td>
<td>1.53%</td>
<td></td>
<td>1.12%</td>
</tr>
<tr>
<td>Welfare: CE Distribution</td>
<td>-3.68%</td>
<td></td>
<td>-2.33%</td>
</tr>
</tbody>
</table>
Figure 1: Macro Aggregates over the Transition

* value relative to the pre-reform level
Figure 2: Macro and Financial Aggregates over the Transition

* value relative to the pre-reform level
Figure 3: Individual Welfare Gains (Consumption Equivalent)
(Firm and Household Heterogeneity)