

Dividends and Capital Gains Taxation under Incomplete Markets

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ABSTRACT. The capital income tax cuts that were part of the Jobs and Growth Tax Relief Reconciliation Act of 2003 are expiring this year and the administration has to decide whether to extend them or not. This paper assesses the effects of these tax cuts in a calibrated dynamic general equilibrium framework with uninsurable labor income risk. In particular, it looks at the effects of dividend (and capital gains) taxes on investment and welfare in a framework where firms are the owners of capital and make investment decisions to maximize their market value. While the effects of capital gains taxes are qualitatively similar to those found when households own the capital, we find that the effects of dividend taxes are different. A dividend tax cut leads to a reduction in investment, since it reduces the uncertain part of income (labor) relative to the safe part. As a result, the precautionary savings motive is weaker and firms, acting in the interest of households, invest less in capital. In the long run, dividend tax cuts are welfare reducing, not only because of the traditional reasons of redistribution from the poor to rich, but also because of a fall in aggregate production and consumption. Taking into account transition effects mitigates the losses. Using our benchmark calibration, a reduction of dividend and capital gains taxes from 35% and 20% to 15% leads to a reduction of more than 5% in aggregate welfare in consumption equivalent terms.

Keywords: Incomplete Markets, Tax Reform, Dividend Taxes, Capital Gains Taxes.

JEL Classification: E23, E44, D52

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1. INTRODUCTION

In 2001, the Bush Administration introduced the Economic Growth Tax Relief Reconciliation Act (EGTRRA) which, amongst other reforms, lowered dividend and capital gains taxes. In 2003, the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) accelerated the EGTRRA provisions and introduced further reductions in dividend and capital gains taxes. These two acts are expected to sunset this year and the current administration has to decide whether to extend them or not. This paper attempts to shed light into the quantitative effects of these capital income tax changes by calibrating a dynamic stochastic general equilibrium model to US data.

Discussions on tax policy, especially capital income tax policy, have always been politically divisive. One of the reasons is that economic theory provides arguments for both sides of the discussion. On the one hand, reductions in capital taxes are viewed as positive because of the resulting increase in incentives for investment and hence growth. On the other hand, reductions in capital taxes are viewed as negative because of the resulting increase in budget deficits as well as in inequality. As to the particular reform we study, there has been a lot of debate on whether it only favors the rich, since they are the ones that hold most of the stocks. Hence, the question can only be settled in a quantitative analysis of the size of the costs and benefits associated with these reforms.

To that end, we build a general equilibrium economy in which households face uninsurable idiosyncratic labor income risk. In addition to labor income, households earn income from owning shares in firms. Both labor income and capital income are taxed by the government. Importantly, capital income is taxed both at the dividend level and at the capital gains level, possibly at different rates. Firms in our model undertake investment with a view to maximizing shareholder value. We use the results in Carceles-Poveda and Coen-Pirani (2009) to ensure shareholder unanimity with respect to this objective despite the presence of shareholder heterogeneity and market incompleteness. Two assumptions are crucial for this: constant returns to scale production and no short selling constraints. We calibrate the model to US data and compute steady states as well as transitions.

Our results regarding steady states are as follows. First, a reduction in dividend tax rates has a negative effect on aggregate welfare, which is measured using a utilitarian welfare function. Following Domeij and Heathcote (2004), we decompose the welfare effects into "aggregate" and "distributional" components. The former refers to the effect arising from a change in aggregate consumption, for a given distribution of consumption across households, while the latter captures the effect of changes in the distribution of consumption and is computed as a residual. We find that the distributional component of the reform turns out to be negative, which is in line with previous research on capital income taxation (see e.g. Aiyagari (1995), Domeij and Heathcote (2004) and Abraham and Carceles-Poveda (2009)). The reason is straightforward. A reduction in dividend taxes benefits the wealthier parts of

the distribution and hurts the less wealthy¹. Since the marginal utility of the latter agents is higher, and there are more of them, aggregate welfare inevitably falls. Interestingly, we find that the aggregate component is also negative. This result, which is in contrast to the findings in the literature on capital income taxation mentioned above, arises from the fact that we model dividend taxes explicitly rather than bunching all capital income taxes together. In particular, modelling firms as dynamic optimizers that undertake the investment decision is crucial. The intuition for this result is as follows. A reduction in dividend taxes, increases the fraction of total household income that arises from capital income versus labor income. Assuming, as we do, that labor income is riskier, this implies a reduction in overall income risk. As a result, the precautionary savings motive is less strong and households prefer the level of capital held by firms to be reduced. That is, investment and therefore production and (per capita) consumption are reduced.

Second, a reduction in capital gains tax rates has a small but positive welfare effect. To understand this result it is important to note that capital gains are zero at steady state. Capital gains taxes only affect steady states through the intertemporal marginal rate of substitution of households and, hence, through the discount factor used by the firm when deciding on the investment level. This has an unambiguous positive effect on investment, aggregate consumption, and aggregate welfare. Moreover, because the government makes no revenues from capital gains taxation at steady state, the decrease in capital gains tax does not have a direct effect on the government's budget. The indirect effect on the budget (through the increase in investment and wages) is actually positive, so the capital gains tax reduction actually improves the government budget and allows for lower labor income taxes. As result, the distributional component of welfare is also positive. Overall, we conclude that reducing capital gains taxes are welfare improving in the long run.

As our previous discussion has hinted, when we combine the dividend and capital gains tax cuts, the dividend tax cut effects dominate and the overall effect is a reduction in aggregate social welfare.

Looking at steady states allows us to clarify the intuition for our results and understand the qualitative mechanisms taking place in our model. However in order to obtain a quantitative assessment of the effects of the tax reform it is imperative that we consider transitional effects. In fact, it is well known that results about the long run are often mitigated, and sometimes even reversed, when the short run effects are taken into account. In our case, it is clear that this could be so. After all, a reduction in the capital stock arising from the dividend tax cut will reduce aggregate consumption in the long run but increase aggregate consumption in the short run. We therefore conduct our experiment including the transition period. The experiment is as follows. The economy begins at a steady state with dividend taxes that are equal to 35% (the top income bracket before the reform) and capital gains

¹We are assuming here that the dividend tax reduction is financed by a labor income tax increase.

taxes that are equal to 20% (the top bracket before the reform). Subsequently, these rates are reduced to 15% and 15% respectively and the economy is simulated until convergence to the new steady state. We assume these changes are unexpected and perceived as permanent

The transitional path is as expected. Aggregate capital falls monotonically to the new steady state. Aggregate consumption initially increases as the economy starts dissaving but eventually falls below the original level as production is reduced due to lower investment. Overall welfare falls by more than 5% (in terms of consumption equivalents). The decomposition shows a positive aggregate effect but a much bigger negative redistribution effect. This can also be seen in the individual welfare effects where households at the bottom of the wealth distribution are the ones suffering welfare losses whereas those at the top see welfare gains. In terms of political support, we find that approximately 20% of the population would be in favor of the reform.

Our work is closely related to the work of Domeij and Heathcote (2004) and Abraham and Carceles-Poveda (2009), who study the effects of capital income and labor income taxes. Our main difference is in modelling firms as the owners of capital and thus being able to disaggregate the different forms of capital income. We can thus study the differing effects of dividend and capital gains taxes. The idea that different types of capital income taxation could have different effects is not novel. McGrattan (2009) makes this point forcefully in a study of the Great Depression. She shows that, even though changes in corporate profits taxes had a small impact on the Great Depression, as Cole and Ohanian (1999) showed, changes in dividend taxes had a much more significant effect on investment and growth. In particular, it is shown that an anticipated increase in dividend tax rates leads to a reduction in investment. We differ from this work in two dimensions. First, we only consider unanticipated changes in dividend taxes. Second, we depart from the representative agent assumption and consider an economy with heterogeneous households and incomplete markets.

Gourio and Miao (2008, 2010) also study frameworks in which dividend and capital gains taxes can be separately modelled. In the first paper, they consider an economy with a representative household and a representative firm and point out the importance of temporary versus permanent tax cuts as well as expected versus unexpected tax cuts. In the second paper, they consider an economy with a representative household but firm heterogeneity and show that firm heterogeneity is important in understanding the effects of dividend tax cuts. Their model provides a rationale for why a permanent dividend tax cut can increase investment in the presence of firm heterogeneity. Our paper is complementary to this work in that we consider household heterogeneity but no firm heterogeneity. We find this framework to be better suited to the questions relating to welfare which we are interested in. Given that the effects of permanent dividend tax cuts on investment are opposite under the two setups, it would be interesting (although computationally challenging) to combine household and firm heterogeneity.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 presents the calibration of the benchmark model together with the solution method. Section 4 analyzes the welfare implications of the tax reforms both in the long run and throughout the transition. Finally, Section 5 summarizes and concludes.

2. THE MODEL

We consider an infinite horizon economy with endogenous production and uninsurable labor income risk. The economy is populated by a continuum (measure 1) of infinitely lived households that are indexed by $i \in I$, a representative firm that maximizes its market value and a government that maintains a balanced budget. Time is discrete and indexed by $t = 1, 2, \dots$

2.1. Households. Households have identical additively separable preferences over sequences of consumption $c_i \equiv \{c_{it}\}_{t=0}^{\infty}$ of the form:

$$U(c_i) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}), \quad (1)$$

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 $u(\cdot) : \mathbb{R}_+ \rightarrow \mathbb{R}$ is assumed to be strictly increasing, strictly concave and continuously differentiable, with $\lim_{c_i \rightarrow 0} u'(c_i) = \infty$ and $\lim_{c_i \rightarrow \infty} u'(c_i) = 0$.

Each period, households can only trade in stocks of the firm to insure against uncertainty. We denote by s_{it-1} the number of stocks held at the beginning of period t . Stocks can be traded between households at a competitive price of p_t and the ownership of stocks entitles the shareholder to a dividend per share of d_t . We assume that there is no aggregate uncertainty, implying that dividends, the stock price and hence the return on the stock are certain.

In addition to asset income, household $i \in I$ earns labor income. We assume that all households supply a fixed amount of labor (equal to one) but their productivity, ϵ_{it} , varies stochastically. This productivity is i.i.d. across households and follows a Markov process with transition matrix $\Pi(\epsilon'|\epsilon)$ and S_ϵ possible values. Individual labor income is thus equal to $w_t \epsilon_{it}$, where w_t is the aggregate wage rate.

The government levies proportional taxes on labor income, dividend income and capital gains income at the rates of τ_l , τ_d and τ_g respectively. Households can use their after-tax income from all sources to purchase consumption goods or to purchase additional stocks. The households' budget constraint can thus be expressed as:

$$c_{it} + p_t s_{it} = (1 - \tau_l) w_t \epsilon_{it} + ((1 - \tau_d) d_t + p_t) s_{it-1} - \tau_g (p_t - p_{t-1}) s_{it-1}. \quad (2)$$

Note that we have simplified in assuming capital gains taxes are paid on an accrual basis

and that capital losses are subsidized at the same rate². At each date, household $i \in I$ also faces a no short-selling constraint on stocks:

$$s_{it} \geq 0 \quad (3)$$

The presence of this constraint allows us to have a well-defined firm objective, on which all the shareholders agree, despite the market incompleteness.³ Individuals choose how much to consume and how many stocks to buy in each period given prices, dividends and tax rates $\{p_t, w_t, d_t, \tau_d, \tau_l, \tau_g\}_{t=0}^\infty$.

Before proceeding with the description of the firm, we derive the price dividend mapping, which is the relationship between stock prices and future dividends. This will be useful later for defining the value of the firm as well as for deriving the relationship between physical capital and the stock price. To do this, we use the optimality conditions of the households. The optimal choice of stocks by any unconstrained household $i \in I$ with $s_{it} > 0$ requires the following optimality condition to hold:

$$p_t u_{c,it} = \beta E_t u_{c,i,t+1} [(1 - \tau_d) d_{t+1} + p_{t+1} - \tau_g (p_{t+1} - p_t)] \quad (4)$$

where $u_{c,it}$ represents the marginal utility of the agent. As usual, the expected marginal rates of substitution for all unconstrained households are equalized and they are equal to the reciprocal of the gross return from the stock between t and $t + 1$

$$1 + r_{t+1} \equiv \frac{[(1 - \tau_d) d_{t+1} + p_{t+1} - \tau_g (p_{t+1} - p_t)]}{p_t} = \frac{u_{c,it}}{\beta E_t u_{c,i,t+1}}$$

Using this relationship, the absence of aggregate uncertainty and assuming that there are no-bubbles, the stock price can then be written as a function of dividends as follows⁴

$$p_t = \sum_{j=1}^{\infty} \left(\prod_{i=0}^{j-1} \frac{1}{1 + \frac{r_{t+1+i}}{1 - \tau_g}} \right) \frac{1 - \tau_d}{1 - \tau_g} d_{t+j} \quad (5)$$

2.2. The Firm. The representative firm owns the capital stock K_t , hires labor and combines these two inputs to produce consumption goods using a constant returns to scale technology:

$$Y_t = AF(K_t, L_t)$$

where K and L are the aggregate capital and effective labor, while A is the total factor productivity, which is assumed to be constant. The total number of stocks outstanding is normalized to one and we assume that the firm has no access to additional sources of external

²For a way to model capital gains taxes on a realization basis see Kydland, Gavin and Pakko (2007).

³See Carceles-Poveda and Coen-Pirani (2009) for a discussion of shareholder unanimity when markets are incomplete.

⁴See Appendix A for a derivation of this expression.

finance, namely, it cannot issue new equity or debt. Thus the total wage bill and investment as well as the distributions of dividends to shareholders have to be financed solely using internal funds. The firm's financing constraint is therefore:

$$d_t + K_{t+1} - (1 - \delta) K_t + w_t L_t = AF(K_t, L_t) \quad (6)$$

where $\delta \in [0, 1]$ is the capital depreciation rate.

The firm's objective is to maximize its market value for the shareholders. In general, when markets are incomplete, maximizing the value of the firm is not an objective to which all shareholders would agree. However, Carceles-Poveda and Coen-Pirani (2009) show that even under incomplete markets, shareholder unanimity can be obtained if the technology exhibits constant returns to scale and short-selling is not allowed. We maintain these two assumptions throughout the paper. Using the price-dividend mapping (5), the value of the firm at t can be written as:

$$V_t = \frac{1 - \tau_d}{1 - \tau_g} d_t + p_t = \sum_{j=0}^{\infty} \left(\prod_{i=0}^{j-1} \frac{1}{1 + \frac{r_{t+1+i}}{1 - \tau_g}} \right) \frac{1 - \tau_d}{1 - \tau_g} d_{t+j}$$

Maximizing this objective subject to (6) leads to the aggregate labor demand equation:

$$w_t = AF_L(K_t, L_t) \quad (7)$$

Moreover, optimal investment dynamics are described by the capital Euler equation:

$$1 = \frac{1}{1 + \frac{r_{t+1}}{1 - \tau_g}} (1 - \delta + AF_K(K_{t+1}, L_{t+1})) \quad (8)$$

This last expression implies the following relation between aggregate capital and the stock price:⁵

$$p_t = \frac{1 - \tau_d}{1 - \tau_g} K_{t+1} \quad (9)$$

2.3. Government. In each period t , the government consumes the amount G_t and taxes labor, dividends and capital gains at the rates τ_l , τ_d and τ_g respectively. The government budget constraint is therefore given by

$$G = \tau_d d_t + \tau_l w_t L_t + \tau_g (p_t - p_{t-1}) \quad (10)$$

2.4. Recursive Competitive Equilibrium. In the present framework, the aggregate state of the economy is given by the aggregate capital stock K and by the joint distribution Ψ of consumers over individual stock holdings s and idiosyncratic productivity status ϵ . Households perceive that Ψ evolves according to:

$$\Psi' = \Gamma(K, \Psi)$$

⁵See Appendix A for a derivation.

where Γ represents the transition function from the current aggregate state into tomorrow's wealth-productivity distribution. The aggregate capital stock evolves according to:

$$K' = \Phi(K, \Psi)$$

Since the individual state vector includes the individual labour productivity and stock holdings (ϵ, s) , the relevant state variables for a household are summarized by the vector $(\epsilon, s; \Psi, K)$.⁶

Definition: Given the transition matrix Π , as well as an initial value for the aggregate capital stock K_0 and for the initial distribution of stocks and productivity Ψ_0 , a *recursive competitive equilibrium* relative to a government policy $(\tau_d, \tau_g, \tau_l, G)$ consists of laws of motion Γ and Φ , stock price and wage functions $p(K')$ and $w(K)$, firm choices K' , $L(K)$ and $d(K, K')$ and individual household policy functions $c(\epsilon, s; K, \Psi)$, $s(\epsilon, s; K, \Psi)$ and $l(\epsilon, s; K, \Psi)$, as well as the associated value function $V(\epsilon, s; K, \Psi)$ such that:

- *Optimal Household Choice:* Given prices and aggregates, the individual policy functions and the value function $c(\epsilon, s; K, \Psi)$, $s(\epsilon, s; K, \Psi)$ and $V(\epsilon, s; K, \Psi)$ solve the problem of the households:

$$V(\epsilon, s; K, \Psi) = \max_{c, s', l} \left\{ u(c) + \beta \sum_{\epsilon' | \epsilon} \Pi(\epsilon' | \epsilon) V(\epsilon', s'; K', \Psi') \right\} \text{ s.t.} \quad (11)$$

$$\begin{aligned} c + p(K') (s' - s) &= (1 - \tau_l) w(K) \epsilon + (1 - \tau_d) d(K, K') s - \tau_g (p(K') - p(K)) s \\ s' &\geq 0 \end{aligned}$$

$$\begin{aligned} \Psi' &= \Gamma(K, \Psi) \\ K' &= \Phi(K, \Psi) \end{aligned}$$

- *Firm Value Maximization:* Given prices, K' , $L^D(K)$ and $d(K, K')$ satisfy firm optimality:

$$\begin{aligned} p(K') &= \frac{1 - \tau_d}{1 - \tau_g} K' \\ w(K) &= AF_L(K, L(K)) \\ d(K, K') &= AF(K, L(K)) + (1 - \delta) K - K' - w(K) L(K) \end{aligned}$$

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

$$G = \tau_l w(K) L(K) + \tau_d d(K, K') + \tau_g (p(K') - p(K))$$

⁶Note that, contrary to a framework where households own the capital directly, the aggregate capital K contains additional information on top of Ψ . The additional information consists essentially of the past stock price, which could equivalently be used as a state variable instead of K .

- *Market Clearing:* p and w are such that all markets clear:

$$\begin{aligned} \int s(\epsilon, s; K, \Psi) d\Psi(\epsilon, s) &= 1 \\ \int \epsilon d\Psi(\epsilon, s) &= L(K) \\ \int c(\epsilon, s; K, \Psi) d\Psi(\epsilon, s) + K' + G &= AF(K, L(K)) + (1 - \delta)K \end{aligned}$$

- *Consistency:* Γ and Φ are consistent with the agents' optimal decisions.

3. QUANTITATIVE RESULTS

This section uses a calibrated version of the model described above to study the effects of different tax reforms. First, we discuss the calibration and solution method for the benchmark economy. Next, we study the effects of a reduction in taxes both in the steady state and during the transition.

3.1. Calibration and Solution Method. One of the main objectives of the calibration is that the model's steady state matches the earnings and wealth distribution in the US. In addition, we target several aggregate statistics, such as the labor share and the investment or capital to output ratios in the US data.

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 $\mu = 2$ for comparison with the literature. The production function is Cobb-Douglas, $F(K, L) = AK^\alpha L^{1-\alpha}$, where $\alpha = 0.36$ is chosen to match the labor income share of 0.64 in the US data and the technology parameter A is normalized so that output is equal to one in the steady state of the deterministic economy. The depreciation rate is set to $\delta = 0.08$ to match the annual investment to capital ratio in the US and the discount factor $\beta = 0.887$ is set to match a capital to output ratio of around 3.32, which is the value reported for the US in Cooley and Prescott (1995).

We consider alternative tax reforms described in detail in the following section. Our benchmark economy assumes a labor income tax rate of $\tau_l = 0.28$ and tax rates for dividends and capital gains of $\tau_d = 0.35$ and $\tau_g = 0.2$ respectively. The latter two tax rates correspond to the statutory rates for the highest income brackets before the reform of 2003. With these taxes, the government to output ratio is equal to 23% in the benchmark economy, which is very close to the government to output ratio of 19% in the US data. We then study the impact of a revenue neutral tax reform that reduces both taxes to $\tau_d = \tau_g = 0.15$ at the expense of higher labor income taxes.

Table 1 describes the earnings process, which is a three state Markov chain. The table displays the shock values, the stationary distribution and the transition matrix. We use

the calibration of Davila et al (2007), which generates inequality measures for earnings and wealth close to U.S. data.⁷

Table 1: Earnings Process

$$\begin{aligned} \boldsymbol{\epsilon} &= \begin{bmatrix} 1.00 & 5.29 & 46.55 \end{bmatrix} \\ \boldsymbol{\Pi}^* &= \begin{bmatrix} 0.498 & 0.443 & 0.059 \end{bmatrix} \\ \boldsymbol{\Pi}(\boldsymbol{\epsilon}'|\boldsymbol{\epsilon}) &= \begin{bmatrix} 0.992 & 0.008 & 0.000 \\ 0.009 & 0.980 & 0.011 \\ 0.000 & 0.083 & 0.917 \end{bmatrix} \end{aligned}$$

3.2. Solution Method. To find the solution, we use a policy function iteration algorithm that is described in detail in Appendix B. In order to evaluate the welfare effect of tax reforms, we have also computed the transition of our economy between stationary distributions due to changes in the tax code. The extra difficulty of this exercise is that factor prices (due to the accumulation of aggregate capital) and the distribution of individuals over asset holdings and labor income change during the transition.

4. WELFARE EFFECTS OF TAX REFORMS

4.1. Long Run. This section analyzes the long run welfare implications of several revenue neutral tax reforms that reduce dividend and or capital gains taxes at the expense of higher labor income taxes. The Jobs and Growth Tax Relief Reconciliation Act of 2003 stipulated a reduction of both the dividend tax rates and the capital gains tax rates to $\tau_d = 0.15$ and $\tau_g = 0.15$.

To build some intuition, we start by analyzing a reduction in dividend taxes and capital gains taxes separately. First, we consider the effects of a reduction in the dividend tax rate while maintaining the capital gains tax at $\tau_g = 0.2$ (reform 1). Next, we consider a reform that reduces capital gains taxes while keeping dividend taxes at the original level of $\tau_d = 0.35$ (reform 2). Finally, we consider the full tax reform in which both the dividend and the capital gains taxes are reduced to 15% (reform 3). In all the reforms we consider, the government is required 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 (see reform 2). Later on, we will also study an alternative reform in which labor taxes are kept fixed and the size of the government is reduced instead.

Table 2: Long run effects of reform 1 (only dividend tax change)

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

	Benchmark	After Reform 1
(τ_d, τ_g, τ_l)	(0.35, 0.2, 0.28)	(0.15, 0.2, 0.35)
$\frac{G}{Y}$	0.23	0.25
r	0.043	0.058
K	3.75	3.04 (-19%)
p	3.04	3.23 (+6.3%)
w	0.159	0.148 (-6.9%)
$w * (1 - \tau_l)$	0.115	0.097 (-16%)
d	0.20	0.22 (10%)
$d * (1 - \tau_d)$	0.13	0.19 (46%)
ce total λ	0	-12.00%
ce aggregate $\hat{\lambda}$	0	-5.71%
ce redistribution $\tilde{\lambda}$	0	-6.66%

The steady state results for reform 1 are displayed in Table 2. The first column displays the results in the benchmark economy and the second displays the same results after the reform. The different rows display the tax rates (τ_d, τ_g, τ_l) , the government to output ratio $\frac{G}{Y}$, the stock return r , the aggregate capital K , the stock price p , the aggregate wage rate and dividends before (w, d) and after taxes $(w(1 - \tau_l), d(1 - \tau_d))$ as well as three measures of the long run welfare effects of the reform. First, we compute the welfare change λ , in consumption equivalent terms, based on a utilitarian social welfare function. Second, we follow Domeij and Heathcote (2004) and decompose the total consumption equivalent variation into an aggregate component $\hat{\lambda}$ and a distributional component $\tilde{\lambda}$.⁸

The first thing that is reflected on the table is that reform 1 leads to a considerable welfare reduction overall, which is equivalent to a reduction in consumption of around 12%. To get more intuition for this result, we can decompose the overall effect into the aggregate and the distributional component.

As reflected by the table, both effects are negative after the decrease in dividend taxes. The aggregate effect being negative seems surprising at first sight, but can be explained as follows. The reduction in dividend taxes leads to a decrease in the aggregate capital stock and thus in the aggregate investment. This is caused by the fact that the uncertain part of income (labor) is now smaller. In other words, households face less uncertainty and this reduces the incentives for precautionary savings. In turn, this induces firms to invest less, since they act in the interest of shareholders. Lower aggregate capital leads to a decrease in aggregate consumption, which in turn leads to a negative aggregate effect of around 5.7% in consumption equivalent terms. Note that this negative aggregate effect is in sharp contrast with standard capital taxation results. We also see that a lower dividend tax rate leads to a

⁸See Domeij and Heathcote (2004) for more details and see Appendix C for a derivation.

higher stock return and a higher stock price.

As to the distributional effect, we obtain the standard result that it is negative due to the redistribution (of consumption) from the rich to the poor, whose marginal utility is higher⁹. This is due to several effects. First, a lower aggregate capital stock decreases the aggregate wage rate w . Second, the lower dividend tax implies that there is a reduction in government revenue that has to be compensated with a higher labor income tax of $\tau_l = 0.35$. While the tax changes imply that households receive a higher asset income, the higher labor income tax leads to a further decrease in the after tax wage rate $w(1 - \tau_l)$. Given that poor households rely more heavily on labor income, these redistribution effects favor the rich.

In sum, both the aggregate and the distributional effects of a reduction in dividend taxes are negative. We also find that they are roughly equal in size, with the redistribution effect being slightly larger. As noted earlier, finding that redistribution effects of lowering capital income taxes can be welfare reducing is not a surprising result. In particular, it has already been pointed out in studies where the firm is modelled as a static profit maximizer who rents capital from the households¹⁰. However, the fact that the aggregate effects of such a reform can also be negative is a novel finding and it illustrates that not all the results from capital taxation can be readily transferred to real world tax instruments, such as dividend or capital gains taxes. On the other hand, we already know that in a representative agent framework any positive and constant dividend tax is non-distortionary, whereas any positive capital income tax is distortionary. This is shown, for example, in Gourio and Miao (2007), who report that dividend tax changes (whether temporary or permanent) do not have long-run effects on a firm's capital formation. In this sense, our findings are not so surprising.

In what follows, we study the effects of reducing capital gains taxes to $\tau_g = 0.15$, while leaving dividend taxes unaffected. The results are reported in Table 3. The table reflects that the effects of reducing capital gains taxes are more similar to the standard capital taxation results. The reduction in the tax leads to an increase in the aggregate capital stock and thus in dividends per share. This implies that the aggregate effects of such a reform are positive. The important difference with a standard capital tax reform, however, is that no capital gains taxes are collected by the government in the steady state due to the fact that stock prices are constant. At the same time, the government has a higher dividend tax revenue, implying that labor income taxes actually decrease. As a result, the redistribution effects of the reform are also positive and so is the overall effect. Note that these effects are quantitatively very small given the relatively small changes in the tax rate.

⁹Strictly speaking, the terms rich and poor refer to households with high and low consumption respectively. Given that consumption is strictly increasing in wealth, the distinction can also be thought of in terms of wealth.

¹⁰See, for example, Aiyagari (1994), Domeij and Heathcote (2003) or Abraham and Carceles-Poveda (2009).

Table 3: Long run effects of reform 2 (only capital gains tax change)

	Benchmark	After Reform 2
(τ_d, τ_g, τ_l)	(0.35, 0.2, 0.28)	(0.35, 0.15, 0.27)
$\frac{G}{Y}$	0.23	0.22
r	0.043	0.041
K	3.75	3.98 (+6%)
p	3.04	3.05 (+0.3%)
w	0.159	0.163 (+2.5%)
$w * (1 - \tau_l)$	0.115	0.118 (+2.6%)
d	0.20	0.192 (-4%)
$d * (1 - \tau_d)$	0.13	0.125 (-3.8%)
ce total λ	0	2.33%
ce aggregate $\hat{\lambda}$	0	1.59%
ce redistribution $\tilde{\lambda}$	0	0.72%

We are now ready to analyze the effects of the full reform, in which both the dividends and the capital gains taxes are reduced to 15%. The results are displayed in Table 4.

Table 4: Long run effects of reform 3 (full reform)

	Benchmark	After Reform 3	Alternative Reform 3
(τ_d, τ_g, τ_l)	(0.35, 0.2, 0.28)	(0.15, 0.15, 0.34)	(0.15, 0.15, 0.28)
$\frac{G}{Y}$	0.25	0.24	0.20
r	0.043	0.056	0.053
K	3.75	3.25 (-13%)	3.40 (-9.3%)
p	3.04	3.25 (+6.9%)	3.40 (+12%)
w	0.159	0.152 (-4.4%)	0.154 (-3%)
$w * (1 - \tau_l)$	0.115	0.100 (-13%)	0.111 (-3.4%)
d	0.20	0.215 (+7.5%)	0.210 (+5%)
$d * (1 - \tau_d)$	0.13	0.183 (+40%)	0.179 (-37%)
ce total λ	0	-9.42%	-0.78%
ce aggregate $\hat{\lambda}$	0	-3.80%	3.59%
ce redistribution $\tilde{\lambda}$	0	-5.84%	-4.22%

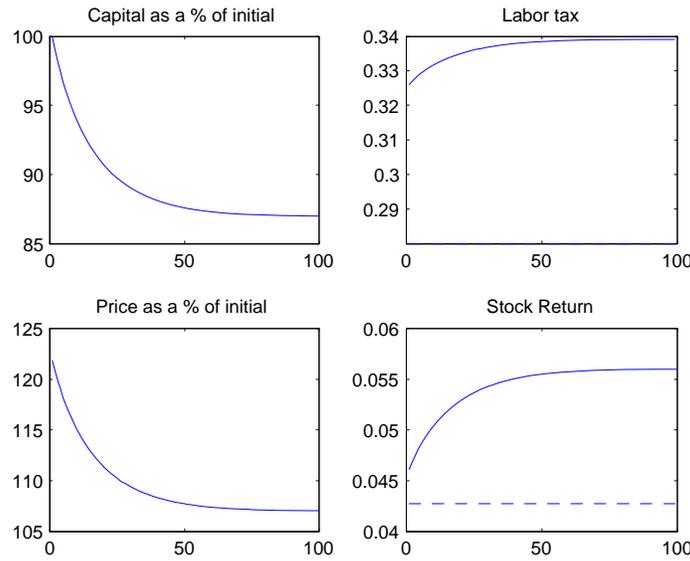
The full reform yields very similar results to those under reform 1. In particular, aggregate capital decreases and both the aggregate and the distributional effects are negative. Clearly, the effects of reducing dividend taxes dominates the effects of reducing capital gains taxes, a result that is not surprising given that the reduction in the latter tax rate is much smaller and the fact that there are no capital gains at steady state.

We also consider an alternative scenario in which labor income taxes are kept fixed after the reform and report the results in the third column of Table 4 (under Alternative Reform 3). In this case, the reduction in dividend taxes is absorbed by a reduction in government spending. Note that, in our model, government spending is a waste. This means that any reduction in overall tax revenues/spending could be used to increase private consumption and therefore should be welfare improving. In the present model, however, there is a counteracting force because the dividend tax cut has a negative effect on investment and the capital stock. This latter effect is smaller than the first and therefore the aggregate component of welfare is positive and equal to 3.59%. On the other hand, the reduction in the capital stock reduces the aggregate wage rate and this leads to a negative redistribution effect, which outweighs the aggregate effect and leads to an overall negative impact of the reform. In other words, the assumption that a lower dividend taxation is picked up by higher labor taxes is not necessary to obtain the result that dividend taxes are desirable, a result that is in sharp contrast with the standard capital taxation results.

While looking at steady states provides some preliminary intuition for the mechanisms taking place in our model, it is important to take into account the transitional effects of the tax reforms we consider. In fact, it is well known that results about the long run are often mitigated and sometimes even reversed when the short run effects are included. In our case, this could clearly arise, since the reduction in the aggregate capital stock arising from the reform will reduce aggregate consumption in the long run but increase it in the short run. We investigate this further in the next section.

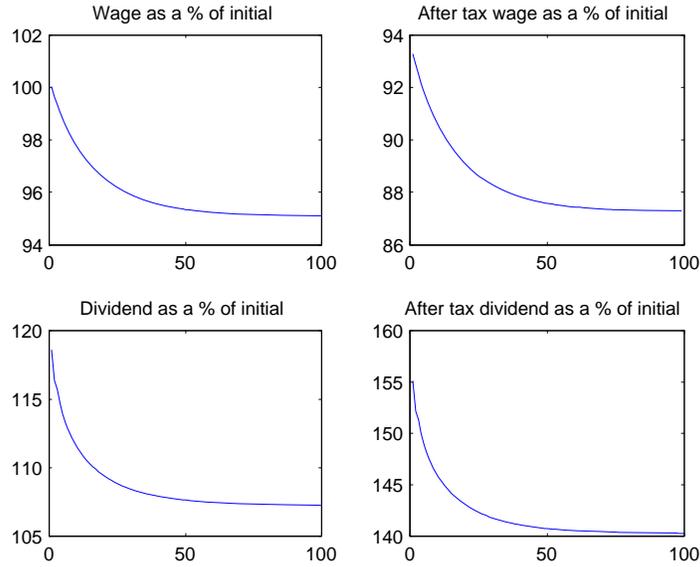
4.2. Transition. This section studies the effects of reform 3 throughout the transition. We assume that the economy begins at a steady state with dividend taxes that are equal to 35% (corresponding to the tax rate of the top income bracket before the reform) and capital gains taxes that are equal to 20% (the top bracket before the reform). These taxes are then reduced to 15% and 15% respectively and we assume that they are unexpected and perceived as permanent and the economy is simulated until convergence to the new steady state. Moreover, we assume budget balance at every period of the transition.

Figure 1: Aggregate paths in the full reform



The paths for some of the key aggregate variables, expressed as a percentage of their initial value, are displayed in Figures 1 and 2. The transitional path is as expected. Aggregate capital decreases smoothly to the new steady state. Aggregate consumption initially increases as the economy starts dissaving but eventually falls below the original level as production is reduced due to lower investment. The initial response of stock prices is large, as investors face the same capital and lower taxes. As the economy reduces its capital stock, stock prices fall towards a new steady state, which is higher than the old one. The aggregate wage rate follows a decreasing path, similar to the aggregate capital stock. The same is true for the after tax wage, but the decrease in this is bigger due to the higher labor income tax rate.

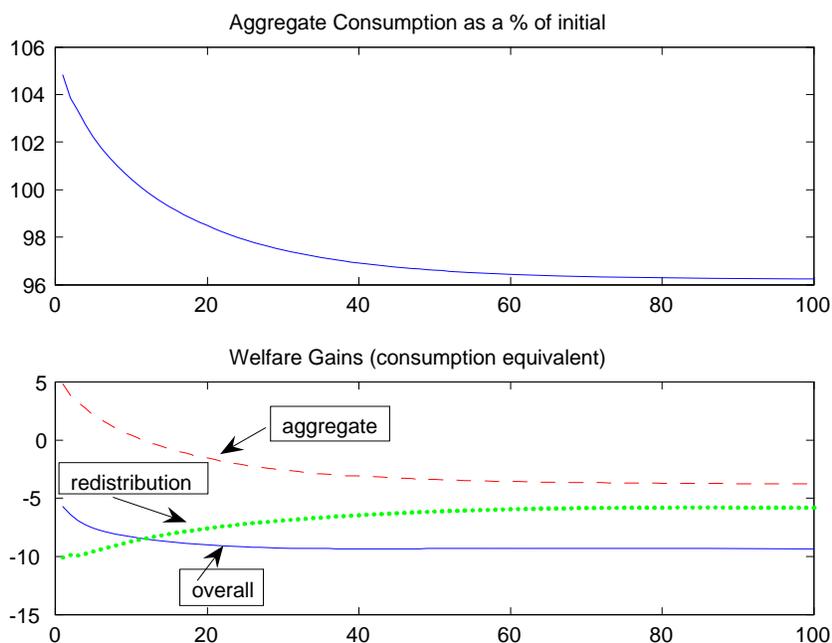
Figure 2: Aggregate paths in the full reform



The upper panel of Figure 3 displays the time path of aggregate consumption. Aggregate consumption increases initially by approximately 5% as investment is curtailed. Subsequently, and as the capital stock starts depreciating, aggregate consumption falls monotonically. Eventually, aggregate consumption falls below the original steady state by about 4%.

The lower panel of Figure 3 presents consumption equivalents along the transition. The solid line shows the overall amount and the dashed and dotted lines represent the aggregate and distributional components respectively. As already shown before, both components are negative and similar in size in the long run. However, to evaluate the welfare impact of the reform, we should look at the two components at impact (period 1). As we see in the graph, the reform leads to an overall decrease in welfare of around 5% when the whole transition is taken into account. This is the sum of a big negative distributional component (-10%) that offsets the positive aggregate component ($+5\%$).

Figure 3: Aggregate Consumption and Welfare gains in the full reform



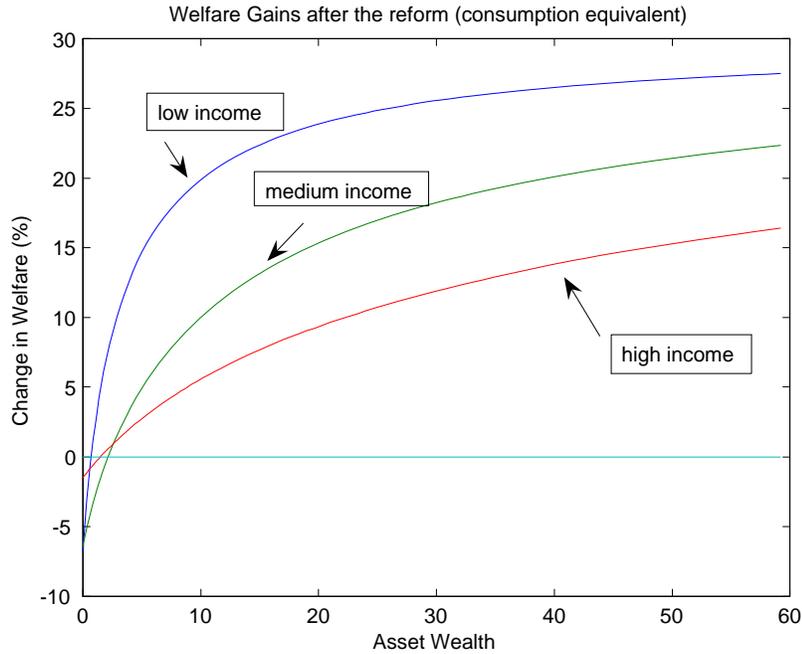
Note that the negative distributional component arises due to the decrease in labor income at impact when the labor income taxes are increased. This is the type of income that poor households rely on more heavily. Note that the distributional component rises in the long run as the increase in asset income arising from stock prices and dividends (held by the wealthy) falls faster than labor income. As to the aggregate component, it is driven by the aggregate consumption behavior. As reflected by the upper panel of the figure, aggregate consumption increases at impact and stays above the initial level for a significant amount of time. This is due to the initial increase in asset income due to the lower dividend and capital gains taxes. The subsequent evolution over time is explained by the monotonic decrease in the capital stock, which implies that the aggregate component falls as production falls.

Figure 4 displays the welfare gains in consumption equivalent terms due to the full reform for individuals with different income shocks and asset levels. This figure is important for two reasons. It shows who are the agents who would be in favour and against the reforms. Also, it indicates whether these reforms could have public support or not.

Several important observations emerge from the figure. First, we see that the higher is the asset wealth of a given individual, the more he/she prefers any of the two reforms. This is not surprising, as agents with a higher asset wealth benefit from a higher stock return after the reform. Second, for agents with high asset levels, the lower is the labor income of a given individual, the more he/she favours the reform. This is because among agents with the same asset level, agents with lower income levels rely less on labor income in relative

terms and therefore the increase in labor income taxes hurts them the least.

Figure 4: Individual Welfare Gains in the Full Reform



We also notice that agents with a low level of assets do not support the reform. This is due to the fact that for these agents labor income is practically the only source of income and hence the increased labor income taxes will hurt them significantly. When we aggregate over the population across asset levels and income levels using the stationary distribution of the pre-reform steady state, we find that the overall political support for the reform is of 20 percent. In sum, this reform would not get wide political support, mostly because of the strong redistribution effects from the poor to the rich.

5. CONCLUSION

This paper studies the effects of a revenue neutral tax reform that reduces dividend and capital gains taxes at the expense of higher labor income taxes. Similarly to the standard results in capital taxation, a reduction in dividend taxes leads to a redistribution of wealth from the rich to the poor, who rely mostly on labor income. However, in contrast to the standard results, the decrease in dividend taxes leads to a lower capital stock and a lower investment. The reason is that a reduction in dividend taxes decreases the uncertain part

of income relative to the certain part and this decreases the incentives for precautionary savings. While this implies that the aggregate effects of the tax reform are positive, they are outweighed by the negative redistribution effects and the overall effect of the reform is negative both in the long run and when the whole transition is taken into account, obtaining a political support of only 20%.

Several interesting extensions would involve introducing progressive taxation for labor and capital income and studying reforms that are financed by government debt rather than labor income taxes. In addition, capital gains should be modelled as a realization base. These are extensions that we leave for further research.

APPENDIX

Appendix A: The Relationship between the Stock Price and the Capital Stock

Using the definition of the risk-free return, together with the stock Euler condition (4), we can write the stock price at time t as:

$$p_t (1 + r_{t+1}) = [(1 - \tau_d) d_{t+1} + p_{t+1} - \tau_g (p_{t+1} - p_t)]$$

Solving for the current stock price p_t yields

$$p_t = \frac{1}{1 + \frac{r_{t+1}}{1 - \tau_g}} \left(\frac{1 - \tau_d}{1 - \tau_g} d_{t+1} + p_{t+1} \right)$$

and repeated forward substitution, along with a no-bubble condition, yields the price dividend mapping (5). The capital Euler condition (8) can be manipulated to write capital as a function of dividends as follows:

$$\begin{aligned} 1 &= \frac{1}{1 + \frac{r_{t+1}}{1 - \tau_g}} (1 - \delta + AF_K(K_{t+1}, L_{t+1})) \Rightarrow \\ K_{t+1} &= \frac{1}{1 + \frac{r_{t+1}}{1 - \tau_g}} ((1 - \delta) K_{t+1} + AF_K(K_{t+1}, L_{t+1}) K_{t+1}) \end{aligned}$$

Using the constant returns to scale assumption, we can write:

$$K_{t+1} = \frac{1}{1 + \frac{r_{t+1}}{1 - \tau_g}} ((1 - \delta) K_{t+1} + AF(K_{t+1}, L_{t+1}) - w_{t+1} L_{t+1})$$

and replacing the right hand side from the firm's financing constraint, we obtain:

$$K_{t+1} = \frac{1}{1 + \frac{r_{t+1}}{1 - \tau_g}} (d_{t+1} + K_{t+2})$$

Repeated forward substitution (with the use of the transversality condition) leads to the following expression:

$$K_{t+1} = \sum_{j=1}^{\infty} \left(\prod_{i=0}^{j-1} \frac{1}{1 + \frac{r_{t+1+i}}{1 - \tau_g}} \right) d_{t+j} \quad (12)$$

Comparing (12) to (5) gives the relationship between capital and stock price in equation (9).

Appendix B: Numerical Algorithm

B.1 Computing the Stationary Competitive Equilibrium

We use a generalized policy function iteration which relies on the first-order conditions (mainly the Euler equation) of the model. Further, we approximate all the relevant policy and value functions with linear interpolation over a finite but endogenous grid on assets. To solve the individual problem with policy iterations, we proceed as follows. Given the aggregate capital K , the stock price p , dividends d , the wage rate w and a tax vector (τ_d, τ_g, τ_l) , we let h be the vector consisting of the individual policy functions of interest, i.e., $h = [c, s']$. Let T be a non-linear operator such that $T[h; d, K, p, w, \tau_l]$ satisfies the individual optimality conditions given taxes. To approximate the fixed point, we follow the steps below.

Step 1: Guess an initial vector $[h^0; p^0, \tau_l^0]$, where $h^0 = [c^0, s'^0]$. Using p^0 we can calculate d^0, w^0 and K^0 .

Step 2: For each iteration $n \geq 1$, use the previous guess h^{n-1} and $[d^{n-1}, K^{n-1}, w^{n-1}, \tau_l^{n-1}, p^{n-1}]$ to compute the new vector h^n that satisfies the individual equilibrium conditions.

Step 3: Using h^n and the distribution for the idiosyncratic shock Π , calculate Ψ , the joint (stationary) distribution of assets and income. Next, use Ψ to calculate the aggregate demand for stocks by the firm to get the new stock price p^n .

Step 4: The new tax rate on labor τ_l^n is calculated given Ψ and h^n to satisfy the government's budget constraint.

Step 5: Repeat Steps 2-4 until convergence.

Note that our setting requires the introduction of some notable differences with respect to the standard procedure to solve models with uninsurable income shocks.

B.2 Computing the Transition Between Steady States

When we calculate the transition between steady states we need to adjust the above procedure in the following way. First, for the sake of the exposition assume that convergence to the new steady state takes place in T periods. Then we follow the steps below.

Step 1: Guess a time series for the variables $\{h_t^0; K_t^0, p_t^0, d_t^0, w_t^0, \tau_{l,t}^0\}_{t=1}^T$, together with the time series for the distribution of individuals $\{\Psi_t^0\}_{t=1}^T$. Again, knowing $\{p_t^0\}_{t=1}^T$ we can calculate $\{K_t^0, d_t^0, w_t^0\}_{t=1}^T$. We then initialize the first period with stationary distribution of the first steady state ($\Psi_1^0 = \Psi_{SS1}$ and $p_1^0 = p_{SS1}$) and we assume that at time T we are already in the second steady state ($\Psi_T^0 = \Psi_{SS2}$ and $p_T^0 = p_{SS2}$).

Step 2: For each iteration $n \geq 1$ and for each time period $1 \leq t \leq T - 1$, we use the previous guess for the next period h_{t+1}^{n-1} and $[K_t^{n-1}, p_t^{n-1}, d_t^{n-1}, w_t^{n-1}, p_t^{n-1}, \tau_{l,t}^{n-1}]$ to compute the new vector h_t^n that satisfies the individual equilibrium conditions.

Step 3: Using h^n and Π , we calculate Ψ_{t+1}^n , the joint distribution of assets and income and then use Ψ_{t+1}^n to calculate the demand of stocks and the new price p_t^n . These two variables are compared the initial guesses Ψ_{t+1}^{n-1} and p_t^{n-1} for all $1 \leq t \leq T - 1$.

Step 4: The new tax rate on labor for each time period $1 \leq t \leq T - 1$ is calculated given Ψ_t^{n-1} and h_t^n to satisfy the government's budget constraint at each period.

Step 5: Repeat Steps 2-4 until convergence for all periods $1 \leq t \leq T - 1$.

Appendix C: Welfare Computation and Decomposition

Let $x = (\epsilon, s)$ be a point in the state space of the steady state economy (note that this is only the index of households). Let the maximized utility for an individual household at x be denoted by $V(x)$, where V is the value function and the corresponding consumption policy function be $c(x)$. The welfare of an individual household with an initial state x_0 is given by

$$V(x_0) = \sum_{t=0}^{\infty} \beta^t \sum_{x_t|x_0} \pi(x_t|x_0) u(c(x_t))$$

where $\pi(x_t|x_0)$ is the probability of state x_t given x_0 . Then we define a utilitarian aggregate welfare as the average of individual welfare functions over the initial distribution of households $\mu(x_0)$:

$$W = \sum_{x_0} \mu(x_0) V(x_0)$$

To compare aggregate welfare across steady states before and after the reform, we use W^{old} and W^{new} to represent the welfare functions in the old and in the new steady state. Using the CRRA utility form we can write:

$$\begin{aligned} W^{old} &= \sum_{x_0} \mu^{old}(x_0) \sum_{t=0}^{\infty} \beta^t \sum_{x_t|x_0} \pi^{old}(x_t|x_0) \frac{c^{old}(x_t)^{1-\sigma} - 1}{1 - \sigma} \\ &= \sum_{x_0} \mu^{old}(x_0) \sum_{t=0}^{\infty} \beta^t \sum_{x_t|x_0} \pi^{old}(x_t|x_0) \frac{c^{old}(x_t)^{1-\sigma}}{1 - \sigma} - \frac{1}{(1 - \sigma)(1 - \beta)} \end{aligned}$$

Similarly,

$$W^{new} = \sum_{x_0} \mu^{new}(x_0) \sum_{t=0}^{\infty} \beta^t \sum_{x_t|x_0} \pi^{new}(x_t|x_0) \frac{c^{new}(x_t)^{1-\sigma}}{1 - \sigma} - \frac{1}{(1 - \sigma)(1 - \beta)}$$

The equivalent variation in consumption, λ , is defined as the percent increase in consumption in every date/event of the old equilibrium that is required to make the old and the new aggregate welfare equal. Therefore, λ satisfies

$$\begin{aligned} & \sum_{x_0} \mu^{new}(x_0) \sum_{t=0}^{\infty} \beta^t \sum_{x_t|x_0} \pi^{new}(x_t|x_0) \frac{c^{new}(x_t)^{1-\sigma}}{1-\sigma} \\ = & \sum_{x_0} \mu^{old}(x_0) \sum_{t=0}^{\infty} \beta^t \sum_{x_t|x_0} \pi^{old}(x_t|x_0) \frac{[(1+\lambda)c^{old}(x_t)]^{1-\sigma}}{1-\sigma} \end{aligned}$$

Straightforward manipulation gives

$$1 + \lambda = \left(\frac{W^{new} + \frac{1}{(1-\sigma)(1-\beta)}}{W^{old} + \frac{1}{(1-\sigma)(1-\beta)}} \right)^{\frac{1}{1-\sigma}}$$

Clearly, if $\lambda < 1$, then consumption in the old equilibrium would need to be decreased, indicating that aggregate welfare is lower in the new equilibrium.

To decompose the overall welfare effect into the aggregate and the distributional components. More precisely, let W^{old} and W^{new} be the values of aggregate welfare before and after the reform respectively. Similarly, we let C^{old} and C^{new} be the values for aggregate consumption before and after the reform. In order to calculate the aggregate consumption equivalent effect $\hat{\lambda}$, we fix the distribution of consumption to the pre reform one and allow aggregate consumption to change from C^{old} to C^{new} . This implies that each household's consumption is adjusted by a factor of $\frac{C^{new}}{C^{old}}$. We then compute the aggregate welfare implied by the new consumptions, which we denote by \widehat{W}^{new} , and we define the aggregate component of the consumption equivalent $\hat{\lambda}$ by comparing W^{old} and \widehat{W}^{new} . Since the consumption distribution is the same across the two expressions, the following analytical expression can be derived for $\hat{\lambda}$:

$$1 + \hat{\lambda} = \frac{C^{new}}{C^{old}}$$

Finally, the redistribution component of the welfare equivalent $\tilde{\lambda}$ can be calculated from:

$$(1 + \hat{\lambda})(1 + \tilde{\lambda}) = (1 + \lambda)$$

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