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Nonlinear taxation in an economy with heterogeneous firms and heterogeneous households

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Abstract

In an economy with heterogeneous firms and heterogeneous consumers, we describe a general equilibrium where firm equity is priced by a supply and demand process. With a model robust to arbitrary, nonlinear tax functions, we investigate the efficiency of replacing the current U.S. tax regime with a policy of no corporate taxes and taxation of capital distributions to the household at progressive personal income tax rates. We find that this policy reduces wealth inequality and increases total welfare.

Keywords: Heterogeneous households; heterogeneous firms; capital taxation; asset-pricing in incomplete markets
JEL Codes: E6

1 Introduction

The U.S. levies one of the world's highest corporate tax rates with a top marginal tax rate of 35%. After corporate income has been taxed at the firm level, shareholders face additional taxes on capital distributions in what is termed "double taxation." The first round of taxation happening at the corporate level falls uniformly on all shareholders, while the second round of taxation depends on the shareholder's unique personal income tax situation. In this paper, we argue that a shift away from corporate taxation and towards an individualized capital income tax reduces wealth inequality and improves social welfare.

Current U.S. law allows certain corporations to elect tax treatment under sub-chapter S of the tax code. Under this alternative tax treatment, corporate income accrues tax liability to the shareholder's personal income tax; no federal corporate profit tax is assessed. In this paper, we investigate the effect of applying this type of tax treatment to all firms while maintaining government budget neutrality. This policy offers an increase in total welfare by shifting the capital tax burden toward wealthier households in line with progressive personal income tax rates. Rather than taxing corporate income and capital distributions (such as dividends and capital gains) under separate, complicated tax treatments, corporate income taxes and preferential capital taxes could be largely eliminated. This policy direction has been proposed by Toder and Viard [22] (and revised in [21]) who discuss eliminating or reducing the corporate tax and shifting the tax burden onto shareholders.

We find that eliminating U.S. corporate taxes and taxing capital distributions to shareholders as ordinary income increases total social welfare under existing personal income tax rates. One reform, where business income is inflated and added to ordinary income, raises welfare by 1.22%, while a reform with higher marginal income tax rates but no inflator raises total welfare by 0.95%. We also look at policies which tax capital distributions to households under a separate progressive tax and find the optimal tax under the functional form of Heathcote, Storesletten, and Violante [14]. This exercise shows a welfare gain of 2.02% and demonstrates that much of the gain comes from simply shifting capital income into the existing personal income tax system, though substantial additional gains derive from a separate optimized shareholder tax.

To solve the model, we use a firm discount factor based on the asset market return available to the firm as an outside investment option. This choice of discount factor allows for arbitrary, nonlinear taxation at both the firm and household level. Existing approaches tend to use a discount factor based on the after-tax return to households, but this approach relies on linear capital taxes on the household in order to force shareholder agreement on the discount factor which the firm then internalizes. We argue that using the actual asset return is justified by the investment options available to the firm. Our work thereby contributes to the computational macroeconomics literature on agent heterogeneity and incomplete insurance markets in the context of an asset pricing framework. In addition, our policy analysis contributes to literature on the welfare implications of capital taxation in an incomplete-market model.

The model economy consists of infinitely-lived households who face uninsurable, idiosyncratic productivity shocks, as in Huggett [17] and Aiyagari [2], with labor productivity shock calibration taken from Domeij and Heathcote [11]. Instead of choosing over capital, however, households take expected dividends as given and choose over shares of an asset, as in Lucas [19]. The asset is a mutual fund which owns all firms in the economy; the asset is riskless as there are no aggregate shocks. Firms are heterogeneous in their capital stocks and idiosyncratic productivity shocks, as in Cooper and Haltiwanger [9]. Corporate taxes are levied on firms' profits, net of partial investment expensing. Firms also hire labor from households, who supply it inelastically. In the benchmark economy, households pay progressive income taxes on labor income and linear dividend taxes on capital distributions. In the counterfactual policy experiments, dividends are exposed to various levels of progressive taxation while total tax revenue is maintained at the same level as in the benchmark economy.

Modeling heterogeneity is crucial to understanding policies which impact different types of agents non-uniformly. Agents face different intertemporal marginal rates of substitution due to varying levels of stock, such as personal wealth and firm capital, and due to non-linear tax treatments. Our work follows the literature on heterogeneous firms and households in a dynamic general equilibrium with incomplete markets using an asset-pricing framework to connect firm and household decisions. Household and firm sectors connect through the price of the mutual fund asset where households determine how much to save based on the implied return in the asset market and firms derive the discount factor in the firm's maximization problem from the market return on investment. In general equilibrium, capital taxes in this economy affect asset price through a change in demand for the asset induced by a change in after-tax returns to shareholders.

Asset-pricing in incomplete markets goes back to Weil [23], and the concept of aggregating heterogeneous firm equity into a mutual fund asset relates to work by Hopenhayn and Rogerson [15] and Restuccia and Rogerson [20]. Restuccia and Rogerson underline the importance of studying firm heterogeneity by pointing out that allocation of capital within an economy may explain cross-country differences in measured total factor productivity.

In a work related to ours, Anagnostopoulos, Atesagaoglu, and Carceles-Poveda [4] investigate corporate tax policy in an incomplete markets economy with heterogeneous firms and households. In that paper, the authors restrict attention to linear tax functions as a way to generate unanimous shareholder agreement on the firm's discount factor. Our approach, in contrast, allows us to consider progressive tax functions.

The argument against corporate taxation has a long history in the literature, such as the Chamley-Judd [18, 6] optimality of zero capital taxation. More recent work, such as Conesa, Sagiri, and Kreuger [7], has argued that life-cycle effects may imply a welfare benefit from positive capital tax. Optimal capital taxation in incomplete markets has been studied in works such as [3, 11, 7]. Our study differs in that we explicitly model taxation within an asset-pricing framework. Looking at capital taxation in an incomplete markets economy with heterogeneous households and a single firm, the study by Anagnostopoulos, Carceles-Poveda and Lin [5] shows that lowering dividend taxes increases the price of equity and reduces total investment in the economy. In a contrasting result, Guorio and Miao [12] show that, in a general equilibrium with heterogeneous firms and a representative household, lowering dividend taxes increases output and aggregate capital stock. By implementing both heterogeneous households and heterogeneous firms in our model, we resolve the ambiguity of the response to capital taxation found under partial heterogeneity.

Section 2 of the paper describes the model and Section 3 describes the calibration. Section 4 provides the results of the policy experiments. Real-world policy implications are discussed in Section 5. Section 6 concludes.

2 Model

The model economy consists of a unit measure of infinitely-lived heterogeneous firms and a unit measure of infinitely-lived heterogeneous households. There is no aggregate uncertainty. All firms are owned by a mutual fund, which is, in turn, owned by households. Households supply labor inelastically to firms and choose shares of the mutual fund to own. Firms hire labor from households and choose investment to maximize net present value. The government taxes corporate income, dividends, and household income to finance an exogenous stream of expenditures.

2.1 Household problem

Households take as given wages w, the current dividend d delivered by the mutual fund, the ex-dividend price υ of the mutual fund, and household taxes τ_y. They choose future shares of the mutual fund to maximize their utility $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ as follows:

$$V(s, \varepsilon) = \max_{c, s'} u(c) + \beta E_{(\varepsilon' | \varepsilon)} \left[V(s', \varepsilon') \right] \tag{1}$$

subject to

$$c = w\varepsilon + s(d + \upsilon) - s'\upsilon - \tau_y(w\varepsilon, sd) \quad \text{(Budget constraint)} \tag{2}$$

$$s' \geq 0 \text{ (Borrowing constraint)} \tag{3}$$

where c is consumption, ε is a persistent, idiosyncratic labor productivity shock, s is the share of the mutual fund owned by the household, and s' is the share owned at the end of the period. We assume households cannot borrow, and one unit of effective labor is supplied inelastically by each household. Let $\Gamma_h(x_h)$ denote the stationary distribution over the household's state space x_h with support $\mathcal{X}_\text{h}$.

The government taxes labor income $w\varepsilon$ and capital income sd according to $\tau_y(\cdot)$. This tax function is defined as

$$\tau_y (w\varepsilon, sd) = \tau_{pit} (w\varepsilon + \psi sd) + \tau_d (sd) \tag{4}$$

where $\tau_{pit} (\cdot)$ is the personal income tax function and $\tau_d(\cdot)$ is the dividend tax function. The parameter ψ, which is set to zero in the benchmark case, allows taxing a fraction of the capital income base at personal income tax rates. We specify the tax functions to have the form described by Heathcote, Storesletten, and Violante [14]:

$$\tau_x (y) = y - \lambda_1^x y^{1-\lambda_2^x} \tag{5}$$

where x is pit for the personal income tax and d for the dividend tax. Setting $\lambda_2^d = 0$ gives a linear dividend tax rate of $1 - \lambda_1^d$. The progressivity parameter λ_2^{pit} is taken from [14] to match U.S. tax rates.

We abstract from capital gains taxation, but the model is robust to capital gains and other additional tax treatments. Since the model does not allow for strategic timing of capital gains realizations, we choose not to impose a capital gains tax. In steady-state equilibrium, price does not change so the issue of capital gains does not arise. One could impose a per period flow of tax revenue from capital gains taxation by adding inflation to the model, but non-strategic capital gain realization becomes effectively a wealth tax. Real world tax implication are further discussed in section (5).

2.2 Firm problem

Firms experience idiosyncratic productivity shocks z and incur capital adjustment costs $C(i)$, where i is investment. Taking as given wages w, the discount factor $M(r)$, and corporate tax policy $\{\tau_c, \phi\}$, firms choose current effective labor n and future capital k' to maximize net present value as follows:

$$W (k, z) = \max_{k'} \pi (k', k, z) + M (r) E_{(z'|z)} [W (k', z')] \tag{6}$$

subject to

$$\begin{aligned}\pi\left(k',k,z\right) &= F\left(k,n^*,z\right)-i-C\left(i\right)-wn^* \\ &\quad -\tau_c\left[F\left(k,n^*,z\right)-\phi i-C\left(i\right)-wn^*\right] \qquad (7)\end{aligned}$$

where

$$F\left(k,n,z\right)=zk^{\alpha_k}n^{\alpha_n} \text{ (Production function),} \qquad (8)$$

$$\alpha_k,\alpha_n>0,\alpha_k+\alpha_n<1 \qquad (9)$$

$$i=k'-k\left(1-\delta\right) \text{ (Investment)} \qquad (10)$$

$$C\left(i\right)=\frac{\eta i^2}{2k} \text{ (Capital adjustment cost),} \qquad (11)$$

The firm's operating profit in the current period is given by $\pi\left(k',k,z\right)$ which equals the firm's revenue from total production minus new capital investment, capital adjustment, labor costs, and corporate income taxes. The capital depreciation rate δ reduces the firm's stock of capital. To simplify the problem, we note that optimal, current period effective labor n^* can be derived from first order conditions as

$$n^*=\left[\frac{w}{\alpha_n zk^{\alpha_k}}\right]^{\frac{1}{\alpha_n-1}} \qquad (12)$$

With this substitution, the choice of labor is removed from the firm's problem as written above.

The firm pays a proportionate tax τ_c on its current period operating profit and fully deducts labor and capital adjustment costs as expenses. In addition, the firm deducts the cost of capital investment (which includes replacing depreciated capital) at a rate of ϕ. The distribution of firms is given by $\Gamma_f(x_f)$ which denotes the stationary distribution over the firm's state space x_f with support $\mathcal{X}_\mathrm{f}$.

Discussion of the firm's objective function as it relates to the interests of shareholders has a long history (e.g., Grossman and Stiglitz [13]). We take the customary position that the firm maximizes net present value since this objective unambiguously increases the consumption frontier for all shareholders when there are no impediments to trading assets.

When a firm has positive investment, it acquires new capital at a cost of 1 per unit, receives a tax subsidy equal to $\tau_c\phi$ per unit of new capital, and pays a total installation cost of $C(i)$. When a firm has negative investment, it pays a de-installation cost $C(i)$ and sells the uninstalled capital. We assume that old capital can only be sold to another firm. Old capital competes with new capital[1] and is therefore priced at $1-\tau_c\phi$ per unit. Although we write the firm's problem as if the selling firm pays the government $\tau_c\phi$ per capital unit sold, we think of the seller giving a discount of $\tau_c\phi$ per capital unit to the purchasing firm in order to make old capital competitive with new capital. The government merely serves as a pass-through for this transaction; it collects the subsidy from the selling firm and pays it to the purchasing firm which is equivalent in effect to the purely private transaction we have in mind.

2.3 Discount factor

Current approaches to specifying the firms' discount factor $M(r)$ assume that firms internalize shareholders' marginal rate of intertemporal substitution and discount the future at this rate. The channel through which shareholders communicate their preferences to the firm is unspecified in that approach. Consequently, it is unclear how to arrive at $M(r)$ when shareholders are not unanimous in their desired rates. We propose an alternative modeling approach where the firm has a choice to invest in its own future capital or in the equity of other firms. In this way, shareholders do not directly influence the firm's discounting, rather the discount factor arises from the alternative investment option of the firm.

In a competitive asset market, the return on equity of any particular firm cannot deviate from the return of other firms, so we think of the firm's outside investment option as being equivalent to purchasing shares of the mutual fund. Denote by m the firm's share ownership in the fund and next period's choice of shares by m'. To explicitly model the firm's allocation choice of capital between itself and an investment in the mutual fund, we write the firm's problem to be:

[1] If aggregate investment is positive, uninstalled capital supply is less than demand for capital, so old capital is priced at the shadow price of new capital. However, if aggregate investment is negative, then the supply of uninstalled capital exceeds demand, so the price of old capital is less than the shadow price of new capital. To simplify our modeling, we make the assumption that old capital can be sold outside the economy at the shadow price of new capital.

$$W(k,m,z)=\max_{k',m'}\pi(k',k,z)+m(d+\nu)-m'\nu+M(r)E_{(z'|z)}[W(k',m',z')] \quad (13)$$

subject to the same constraints as in the specification of the firm's problem above. (Note that no constraint is required on m.)

Denote $\frac{d'+\nu'}{\nu}=1+r$. First, it is clear that the firm invests in whichever investment option gives the higher expected future marginal return. Since $\frac{\partial}{\partial m'}E_{(z'|z)}[W(k',m',z')]=1+r$, the firm optimally sets k' so that $\frac{\partial}{\partial k'}E_{(z'|z)}[W(k',m',z')]=1+r$ when an interior solution exists. Thus, the firm's marginal return on optimal investment is $1+r$.

If $M(r)(1+r)>1$, then optimally $m'=\pi(k',k,z)+(d+\nu)m$, and if, $M(r)(1+r)<1$ then $m'=0,k'=0$. In the first case, the firm invests all cashflows and has infinite valuation. In the second case, the firm returns all funds to shareholders and effectively ceases operations. Thus, for an interior solution, it must be that $M(r)=\frac{1}{1+r}$.

In equilibrium of an interior solution, firms are indifferent between investing in the mutual fund and investing in their own capital. Furthermore, since firm investment in the mutual fund is equivalent to a pass-through investment for the fund back into itself, we can assume that firms immediately distribute any acquired mutual fund shares as a dividend back to the fund. Therefore, we can safely remove the choice of m' from the firm's problem.

2.4 Mutual fund

The mutual fund owns all firms, allowing the model to abstract from household portfolio allocation decisions. Because the fund owns the entire measure of firms, idiosyncratic shocks offset in the aggregate, and the mutual fund serves as a single risk-free asset. One can think of the fund as competitive so that it seeks to maximize its own net present value taking the asset market return as exogenous.

We normalize the supply of mutual fund shares to be 1. Individual firms may retain earnings for investment rather than pay out dividends or even have negative cash flow (issue equity) in order to finance growth. The fund handles financing transfers internally as cash flow from some firms finances investment at others. Since new equity issuance is handled internally within the fund, there is no need for the fund to change the amount of shares outstanding. A particular firm can increase or decrease its future capital by any amount subject only to paying (a) the cost of capital and (b) capital adjustment costs. Firm financing, whether from retained earnings or external sources, is frictionless. Imposing financing costs is straightforward. However, we abstract from this issue to simplify exposition and since, empirically, most investment comes from retained earnings, and external financing frictions primarily affect small, growing firms.

The mutual fund construct also provides an abstraction of firm entry and exit. If a particular firm's continuation value is too low even after downsizing its capital, then no household will want to own the firm and the firm exits (see, for example Hopenhayn [16]). We simplify by assuming that the mutual fund continues owning the firm. Given a competitive asset market, each firm's future expected return must meet the expected market return. A firm unable to meet this return for future operations adjusts its future capital lower in order to increase marginal productivity in future periods. The firm incurs a downsizing cost. In a model with entry and exit, such a firm may have low (or negative) value and be driven out of the market rather than downsize. Since the fund owns all firms, we can think of the fund as taking a loss on the old firm and investing in a new smaller firm (ignoring any auto-correlation in the firm's shocks). Downsizing costs can be considered as related to a cost of entry and/or exit.

Each period, the fund aggregates the firms' operating profits and issues a fund dividend. The dividend (per the one share) is therefore

$$d = \int_{x_f \in \mathcal{X}_\mathrm{f}} \pi^* \left(x_f\right) d\Gamma_f(x_f) \tag{14}$$

for all firms, where $\pi^* \left(x_f\right)$ is the firm's optimal dividend policy. It is important to note that this "dividend" refers to a firm's operating profit and not the discretionary payment firms make to shareholders in the real world. A more detailed discussion of real world issues relating to payments to households appears in section (5).

Because of its outside investment option, the marginal firm sets the ex-dividend price of the mutual fund as

$$\upsilon = \frac{1}{1+r} \int_{x'_f \in \mathcal{X}_\mathrm{f}} W_f \left(x'_f\right) d\Gamma_f(x'_f) \tag{15}$$

and households face an asset market price of υ in equilibrium. Although they can trade the fund asset, we assume that if firms acquire shares of the fund, they immediately issue a stock dividend to households. Thus, households explicitly own all equity at the end of the period.

For tractability, we restrict households to trading only the mutual fund asset. Government bonds are ruled out since we do not allow government borrowing. Other assets possible in the model include (a) establishing another entity (firm) which holds assets, (b) ownership of a subset of firms, (c) firm to household loans, and (d) inter-household loans. Household preference for these assets derives from potentially more favorable tax treatments and tax-arbitrage. With (a), a household could establish a firm which owns other firms and pays no dividends so that all gains are channeled through capital gains. Since growth firms, by definition, reduce dividends to fund higher future value, some households may prefer to own a subset of firms, as in (b), for a similar reason–exchanging current dividend income for capital gains. Loans from firms, as in (c), also offer tax advantages depending on the tax treatment. For a household to evade dividend tax payment, a firm could structure its dividend payment as a loan backed by the household's claim to the firm's equity. Finally, for (d), inter-household bonds can provide benefits from tax evasion through income sharing under a progressive tax, as a way to get around a household's no-borrowing constraint, or as a way to diversify risk from labor productivity shocks.

2.5 Government

We restrict the government to a balanced budget in every period so there is no government borrowing or bonds. Additionally, we assume that government expenditures have no direct value to either households or firms. Define aggregate tax revenues and expenditures as

$$\begin{aligned} G = & \int_{x_h \in \mathcal{X}_\mathrm{h}} \tau_y \left(s(x_h) d, w\varepsilon(x_h) \right) d\Gamma_h(x_h) \\ & + \int_{x_f \in \mathcal{X}_\mathrm{f}} \tau_c [F\left(k(x_f), n(x_f), z(x_f)\right) - \phi i(x_f) - C\left(i(x_f)\right) - wn(x_f)] d\Gamma_f(x_f). \end{aligned} \tag{16}$$

2.6 Equilibrium

We define equilibrium as follows:

Definition. *The recursive competitive equilibrium is defined as prices* $\{r, w\}$*, household functions*

$\{s'(r,w), V(r,w)\}$, and firm functions $\{k'(r,w), W(r,w)\}$ such that firms optimize according to (6) *to* (11)*, households optimize according to* (1) *to* (3)*, and the following market clearing conditions hold:*

$$\int_{x_h \in \mathcal{X}_h} s'(x_h) d\Gamma_h(x_h) = 1 \text{ (Savings)}, \tag{17}$$

$$\int_{x_f \in \mathcal{X}_f} n(x_f)^* d\Gamma_f(x_f) = \int_{x_h \in \mathcal{X}_h} \varepsilon(x_h) d\Gamma_h(x_h) \text{ (Labor)} \tag{18}$$

$$\begin{aligned} &\int_{x_f \in \mathcal{X}_f} F\left(k(x_f), n(x_f), z(x_f)\right) - C\left(k(x_f), k'(x_f)\right) d\Gamma_f(x_f) \\ &\qquad = G + \int_{x_f \in \mathcal{X}_f} i(x_f) d\Gamma_f(x_f) + \int_{x_h \in \mathcal{X}_h} c(x_h) d\Gamma_h(x_h) \text{ (Goods)} \end{aligned} \tag{19}$$

where G comes from (19)*.*

The solution to the optimization problem of household x_h implies the following condition for pricing the asset when the household is unconstrained:

$$\frac{u'(c_h)}{\beta E u'(c_h')} = \frac{d' + \upsilon'}{\upsilon} - \frac{\frac{\partial}{\partial s'} \tau_y(s_h' d', w' \varepsilon_h')}{\upsilon}, \tag{20}$$

If $\tau_d(\cdot)$ is linear and $\psi = 0$ as in the benchmark, then $\frac{\partial}{\partial s'} \tau_y(s_h' d', w' \varepsilon_h') \equiv \tau_d d'$ and (20) becomes

$$\frac{u'(c_h)}{\beta E u'(c_h')} = \frac{d' + \upsilon'}{\upsilon} - \frac{\tau_d d'}{\upsilon} = 1 + r_{(A)}. \tag{21}$$

In this case, the right-hand-side of (20) is common to all households. Since constrained households own zero shares, shareholders all agree on the discount factor for the firm. Conventional approaches define the right-hand-side of (21) to be $1 + r_{(A)}$, where $r_{(A)}$ is the equilibrium after-tax net return to households. Denoting the after-tax model by "(A)", in that specification, the firms' discount factor is $M_{(A)}\left(r_{(A)}\right) = \frac{1}{1+r_{(A)}}$ because firms do not invest directly in the asset market and take their discount factor through some mechanism from their shareholders.

When the tax rate on dividends is not linear, the conventional approach breaks down because after-tax returns vary across households. To define the model at all in that case, it becomes necessary to specify additional mechanisms by which shareholders arrive at a single rate, for instance, through some weighted average across shareholder after-tax returns. In our model, firms can invest directly in the asset market and face an external investment return $\frac{d'+\upsilon'}{\upsilon}$, so we rearrange (20) as:

$$\frac{u'(c_h)}{\beta Eu'(c'_h)} + \frac{\frac{\partial}{\partial s'}\tau_y(s'_h d', w'\varepsilon'_h)}{\upsilon} = \frac{d'+\upsilon'}{\upsilon} = 1+r \tag{22}$$

The right-hand-side is then the untaxed asset market gross return $1+r$ consistent with the firms' discount factor. The left-hand-side implies an optimal consumption-savings allocation for household h given asset prices d and υ which takes account of the marginal tax on dividend income faced by that particular household.

Although the unconstrained households' optimization conditions (21) and (22) look the same under linear taxes, the two model specifications yield different equilibrium allocations.

Proposition 1. *Suppose* $\frac{\partial}{\partial s'}\tau_y(s'd', \cdot) = \tau_d d'$. *In the described model economy, (i) the specification where firms internalize household preferences (indicated by the "(A)" subscript) and (ii) the specification where firms invest in the asset market directly, have different steady-state equilibrium allocations.*

Proof. For equilibrium allocations to be identical between the two model specifications, it is necessary that firms allocate identically, so $M_{(A)}\left(r_{(A)}\right) = M(r)$ which implies $r(d,\upsilon) = r_{(A)}(d_{(A)}, \upsilon_{(A)})$. Substituting into 21 and 22 gives the condition for household allocations to be identical across the two specifications:

$$\frac{u'(c_h)}{\beta Eu'(c'_h)} + \frac{\tau_d d'}{\upsilon} = \frac{u'(c_{(A),h})}{\beta Eu'(c'_{(A),h})}. \tag{23}$$

This equation implies that $c_h = c_{(A),h}$ and $Eu'(c'_h) = Eu'\left(c'_{(A),h}\right)$ if and only if $\tau_d d' = 0$. □

When the two equilibiria differ, one would expect that the (A) equilibrium has higher household welfare since firms internalize household intertemporal substitution.

Even under linear taxation, the incidence of the same tax on corporate profits versus household dividends can lead to different steady-state equilibrium allocations. Consider imposing a linear tax τ on either the household's dividend or the firm's operating profit with full expensing.

Although intuition may suggest that the incidence of the tax does not affect equilibrium allocation, this result holds only in the after-tax specification. The proposition below explains this point under the described simplifying assumptions.

Proposition 2. *Suppose production from a one-factor production function with decreasing returns and no depreciation, no adjustment costs, and full expensing. Consider a representative household, representative firm economy with no shocks and consider imposing a tax rate τ on corporate profits, scenario (C), or on household dividends, scenario (D).*

(i) Under the assumption (M) that firms invest in the asset market, (C) and (D) yield different steady-state equilibrium allocations. Denote these by "(C,M)" and "(D,M)".

(ii) Under the assumption (A) that firms internalize household preferences, (C) and (D) yield the same steady-state equilibrium allocations. Denote these by "(C,A)" and "(D,A)".

Proof. With a representative household, the household's optimization yields the Euler equations $\frac{1}{\beta} = (1-\tau)\frac{d_{(D)}}{v_{(D)}} + 1$ for (D) and $\frac{1}{\beta} = \frac{d_{(C)}}{v_{(C)}} + 1$ for (C). For (i), from the household optimization and the definition $r = \frac{d}{v}$, we have

$$r_{(C,M)} = \frac{1-\beta}{\beta}, r_{(D,M)} = \frac{1-\beta}{\beta(1-\tau)}$$

and so, $r_{(D,M)} > r_{(C,M)}$. The firm's optimization gives

$$k^*_{(C,M)} = f'^{-1}\left(1 + r_{(C,M)}\right), k^*_{(D,M)} = f'^{-1}\left(1 + r_{(D,M)}\right)$$

Therefore, capital allocation differs across (C,M) and (D,M). The decreasing returns production function $f(k)$ has $f'(k) > 0$ and $f''(k) < 0$. Therefore, the inverse function f'^{-1} is positive and decreases in its argument. So, the firm's optimal capital decreases in r and (D,M) has lower steady-state capital in relation to (C,M).

For (ii), $r = \frac{d(1-\tau_d)}{v}$ and the household's optimization gives

$$r_{(C,A)} = \frac{1-\beta}{\beta}, r_{(D,A)} = \frac{1-\beta}{\beta}$$

since (C,A) has $\tau_d = 0$ and (D,A) has $\tau_d = \tau$. The firm's optimization is the same as in (i), so optimal capital in steady-state is the same across (C,A) and (D,A). □

A linear corporate tax with full expensing does not distort the firm's allocation. Distortion arises from the household in our model. The household demands a higher rate of pre-tax return when dividend taxes increase. Higher pre-tax return filters to the firm through the asset market and reduces the firm's discount factor. In a model where firms internalize household preferences, the firm's discount factor remains unchanged under varying dividend taxes because households' optimal after-tax return remains the same and the firm uses this return for its discount factor.

Using the above described representative agent economy, we illustrate how the model specification affects asset price. In the conventional approach, dividends in the two scenarios have the relationship $d_{(C,A)} = (1-\tau)\, d_{(D,A)}$. Using the specification $r = \frac{d(1-\tau_d)}{\upsilon}$ gives the relationship $\upsilon_{(C,A)} = \upsilon_{(D,A)}$. In the market-based model (M), the fund's asset price in equilibrium is the continuation value,

$$\upsilon_{(M)} = \sum_{t=1}^{\infty} M\,(r)^t \int_{x_f \in \mathcal{X}_{\mathrm{f}}} (1-\tau_c)\, E\left[\pi\left(k^*_{f,t}, k^*_{f,t}, z_{f,t}\right)\right] d\Gamma_f(x_f) \tag{24}$$

This equation implies that $\upsilon_{(C,M)} \neq \upsilon_{(D,M)}$ since $\upsilon_{(M)}$ is affected by the corporate tax rate τ_c. In the conventional approach, households are restricted to be the only traders in the asset market, the marginal household sets the asset price as $\upsilon_{(C,A)} = \upsilon_{(D,A)}$, the after-tax returns are the same, and so the two equilibirium allocations are identical. In our model, we relax the restriction that only households can trade assets. Firms find it optimal to trade in the asset market because firms are not subject to household taxes on investment returns. Therefore, firms can realize higher (pre-tax) returns and these returns set the firms' discount rate.

3 Calibration

We calibrate the model using deep parameter values commonly found in the incomplete-markets literature. The parameterization of the household follows Heathcote and Domeij [11], while the firm parameters follow Cooper and Haltiwanger [9] and Anagnostopoulos, Atesagaoglu, and Carceles-Poveda [4]. The government policy parameters are generally chosen to match aggregate shares of GDP in 2016. Deep parameter values are summarized in Table 1, while policy parameters are included in Table 2.

The parameters of the labor productivity process (both the productivity shocks and transition probabilities) follow the inelastic labor supply case described in Heathcote and Domeij [11]. The coefficient of relative risk aversion σ is set to 2, and the household's annual discount factor β is set to 0.96.

Coefficients of the firm's productivity shock process

$$\ln z_t = \rho \ln z_{t-1} + e_t, \quad e_t \sim N(0, \sigma^2) \tag{25}$$

are $\rho = 0.767$ and $\sigma^2 = 0.211$, and the adjustment cost parameter $\eta = 0.05$ following Cooper and Haltiwanger [9]. This AR(1) process is discretized into a 5-state Markov process using the method described in Adda and Cooper [1]. Finally, the annual depreciation rate is set to $\delta = 0.085$, and the production function coefficients are $\alpha_k = 0.311$ and $\alpha_n = 0.65$ as in [4].

The functional forms corresponding to household personal income taxation τ_y and τ_d are described in section 2.1. The parameter λ_2^{pit}, which captures the progressivity of the U.S. federal income tax, is set to 0.181, following [14]. The value $\lambda_1^{pit} = 1.113$ is chosen to match federal income tax revenue as a share of GDP of 9%. The tax rate on distributions $1 - \tau_1^d = 0.20$ corresponding to the top dividend tax rate in 2016.

The corporate income tax rate $\tau_c = 0.121$ is chosen so that aggregate corporate tax revenue is 2% of total output. Finally, the expense ratio $\phi = 0.74$ is determined by the ratio of tax depreciation deductions to investment as described in Table 3 of [10].

4 Results

Moments of the benchmark and counterfactual economies are summarized in Table 2. To understand the potential benefits of a policy which applies a pass-through tax treatment similar to sub-chapter S to all firms, we consider three different implementations of the policy reform. In each case, we eliminate the corporate income tax and apply a progressive tax on distributions to households. Eliminating the corporate tax also has the effect of rendering the investment deduction immaterial to firms. We find that shifting dividend income entirely into the existing progressive personal income tax generates too little revenue in relation to the benchmark. Therefore, for the first two reforms, we shift household dividend income from the proportional dividend tax into income taxable by the personal income tax and apply either (1) an inflation factor for business income or (2) an across-the-board increase in tax rates. In the third reform, we shift dividend income into a separate progressive dividend tax function. In all three reforms, we maintain the functional form of the progressive income tax function τ_y.

In the first reform, we tax all business income as ordinary income. To maintain budget neutrality, we choose the fraction (not necessarily bounded above by 1) of the dividend base that clears the government budget constraint at the benchmark revenue. We find that a value of $\psi = 1.1810$ satisfies the constraint, and the reform increases average utility by 1.22%. In other words, we find that full expansion of sub-chapter S treatment combined with roughly a 18% inflation factor on all business income at the household level improves aggregate welfare by more than one percent.

The second reform repeats the first reform but without an inflation factor on business income. Business income is fully taxed (i.e., $\psi = 1$), and we choose λ_1^{pit} to clear the government budget constraint. We find that $\lambda_1^{pit} = 1.1023$ clears the budget constraint, as compared to the benchmark value of $\lambda_1^{pit} = 1.1133$, meaning an increase in the level of tax on all personal income. Welfare improves by 0.95%. The smaller increase in social welfare in the this reform, relative to the first reform, results from the increase in taxes paid by all income which accrues to all tax-paying households.

Finally, in the third reform, we tax all business income separately through a separate progressive dividend tax function τ_d. We search over the combinations of λ_1^d and λ_2^d that clear the government budget constraint and choose the pair of values which maximizes aggregate social welfare. We find that the combination $\lambda_1^d = 0.7038$ and $\lambda_2^d = 0.1286$ maximizes welfare and improves baseline social welfare by 2.02%. The higher welfare gain in the third reform results from choosing the parameter pair that maximizes welfare. We note, however, that the additional gain in welfare of this reform is not large in comparison to the welfare gain resulting from simply shifting business income taxation to the existing progressive income tax.

Welfare improvements can be explained by the sharp reduction in wealth inequality. Table 2 shows that the first reform reduces the wealth Gini index by nearly 7 points, while the second reform reduces the index by roughly 5 points. The third reform, which allows for the greatest flexibility to maximize welfare, reduces the wealth Gini index by over nine points. The policies also motivate savings by the poorest households as evidenced by the decline in the percentage of households with binding savings constraints.

In each of the reforms, dividends payments to households rise substantially (on the order of 25%) because dividends arrive to households as untaxed corporate distributions whereas the benchmark case has double taxation of business income. Meanwhile, the increase in effective dividend taxes paid by high earners in each reform leads to a decline in equity demand, pushing r up. The resulting decrease in the firm's discount factor reduces equilibrium investment and therefore capital, notwithstanding efficiency gains from eliminating the corporate tax. Since aggregate labor is fixed, wages decline as firms use less capital. Aggregate output and consumption decline.

5 Policy implications

Arguments for eliminating the corporate income tax often emphasize the allocative distortions caused by that tax. Furthermore, many argue that in a global economy having a low corporate tax rate induces capital formation in the low tax country and thereby increases national income. In this paper, our policy experiments highlight the social welfare benefit of shifting the capital income tax burden onto a progressive tax on shareholders. All these arguments appear to make corporate tax reform proposals such as Toder and Viard [22] very compelling. However, policymakers who consider shifting the capital tax burden more directly onto shareholders face real world considerations. The primary issue concerns the strategic channeling of capital income towards tax treatments such as capital gains taxation thereby allowing shareholders to evade the intended capital tax rate.

In the real world, capital income is transferred to households in a variety of ways. Because a firm's operating profit is generally not paid out entirely as a dividend, real world dividend taxation does not correspond to dividend taxation as in our model. Rather, a real world dividend is a discretionary direct payment from the corporation to the shareholder. Corporations have various considerations in setting the size of the dividend payment. By taxing dividend payments, current law encourages a variety of strategic tax reduction behaviors. For instance, the strategy of increasing the price of the firm's equity, by retaining earnings and buying back shares, reallocates the capital tax burden from dividend taxes to capital gains taxes. With capital income shifted into equity, households can realize capital gains strategically, thereby reducing, delaying, or even avoiding tax entirely.

Multiple tax strategies to avoiding capital gains taxation exist. For instance, wealthy households can use their capital equity as collateral for a loan in order to effectively sell their holdings without incurring a capital gains tax. Also, by simply holding and re-investing retained earnings (possibly forever), a corporation can allow shareholders to avoid capital income taxation[2] until death. At death, equity can be transferred to a charity or an inheritor at a stepped up cost basis, in effect rendering all capital income from the holding period to be untaxed.

Current U.S. law allows corporations to elect tax treatment under sub-chapter S of the tax code. Under this alternative tax treatment, corporate free cash flow accrues tax liability to the shareholder's personal income tax; no federal corporate profit tax is assessed. In this "pass-through" tax treatment, business losses can offset personal income instead of being used as loss carry-forwards for the firm. Currently, eligibility to become a sub-chapter S corporation is restricted to small, domestic entities[3]. This type of pass-through entity offers some businesses (and their shareholders) tax advantages over the alternative structure of double taxation and a high marginal corporate tax rate. According to Cooper et al. [8], pass-through entities have become increasing popular as over half of U.S. business income comes through pass-throughs such as S corporations and partnerships. The authors estimate average effective tax rate on business income as: 22.7% on corporations (which goes up to 31.6% when accounting for double taxation), 25.0% for S corporations, 15.9% for partnerships, and 13.6% for sole proprietors.

Our policy experiments effectively apply a pass-through tax treatment, similar to sub-chapter S, to the firms in the model. This approach is a simplification of the proposal by Toder and Viard. The current corporate tax could be greatly reduced or eliminated. Reducing or eliminating the

[2]The Berkshire-Hathaway corporation, under its manager Warrent Buffett, has never paid a dividend and has grown to have a market capitalizaiton of over $400B at the time of this writing. Moreover, Berkshire-Hathaway reinvests earnings into acquisitions, thereby avoiding corporate tax payment. Warren Buffett famously bemoaned that his effective tax rate (as the CEO and major shareholder) is lower than his secretary's. See, *e.g.*, "Warren Buffett's Nifty Tax Loophole," *Barron's,* April 11, 2015.

[3]See https://www.irs.gov/businesses/small-businesses-self-employed/s-corporations

capital gains tax may also be desirable since channeling capital income through equity price would be more difficult under the proposed tax treatment. The firm's capital income would be taxable to the shareholder regardless of whether the corporation issued a direct dividend to the shareholder, bought back shares, retained equity, and so on. Shareholders would be allowed to offset capital income from other sources and could potentially be allowed to carry-forward any capital income losses. Toder and Viard address the issue of capital gains through a mark-to-market tax on company shares (which restricts their proposal to public companies). Under our policy direction, capital income incurs tax liability when it is earned by the firm and this tax liability is passed on to shareholders.

Some complications require attention. Since business entities may be owned by other business entities, the policy must handle capital income paid to a corporate entity rather than a household, and the policy must address the treatment of capital income paid to tax-exempt and tax-deferred entities such as pension funds. For the first issue, if a shareholder is a corporation, that shareholder's tax liability must be passed through to the shareholder corporation's shareholders. In this way, capital income becomes ultimately allocated to household shareholders regardless of any intermediate ownership structures. For the second issue, capital income to tax-exempt and tax-deferred entities may be treated as under current law. In the case of tax-deferred entities, this income is eventually taxed at personal income tax rates. Policymakers may decide to impose some taxation on capital distributions to these entities if the delay in tax revenues is seen to be problematic. Similarly, policy makers may decide that the subsidy to tax-exempt entities is too large when corporate taxes are eliminated and may decide to impose some tax on capital income earned by tax-exempt organizations.

Under this policy direction, the issue of channeling capital income through capital gains is reduced when corporations assign their free cash flow to their shareholders for tax purposes. This policy (1) simplifies the tax code and does away with the cornucopia of special treatments of capital, (2) directly taxes capital income when it is earned, (3) reduces allocative distortions on the corporate sector, and so (4) increases total welfare in the U.S. economy.

Unfortunately, a straightforward implementation of the proposed policy hinges on a closed economy. With an open globalized economy, we must consider foreign firms and foreign shareholders. There are two tax situations to consider: (1) U.S. shareholders of foreign firms and (2) foreign shareholders of U.S. firms.

The first problem is that a well-resourced U.S. household can escape taxes on U.S.-sourced capital income under the proposal by establishing a foreign corporation which invests in U.S. capital markets. Having evaded U.S. capital taxation, this household could use the resulting foreign asset abroad (subject to any foreign tax treatments) or use the foreign asset as collateral for a loan (from, for instance, a multinational bank). While a U.S. corporation with U.S. shareholders can be legally required to assign capital income and its shareholders required to pay taxes on this income, non-resident corporations cannot be practicably coerced into assigning capital income to U.S. shareholders. This loophole argues for keeping the parts of the current tax system which impose taxes on foreign-sourced dividends and capital gains to U.S. residents. Nonetheless, more U.S. households may be incentivized to hold foreign assets in order to avoid progressive capital taxation, even with the frictions of foreign asset ownership.

The second problem is that capital income to foreign shareholders of U.S.-resident firms would not be taxed at all under the proposal. One could argue that taxation is meant to be a transfer and mutual insurance program within the home country, so foreign capital should not be taxed at all, inasmuch as it increases the home country's income and does not draw on the home country's resources. Alternatively, one could consider imposing a tax on the portion of the firm's free cash flow which is assigned to foreign shareholders. The firm would then be responsible for paying tax directly to the U.S. government on the foreign shareholder's behalf. This adjustment would effectively reimpose a corporate tax on a portion of a firm's free cash flow. As it stands, current law imposes a variety of tax treatments on foreign-owned firms, such as the branch profits tax[4] and a 30% tax on dividends [5], and these treatments can be retained.

Although these concessions to the main policy proposal retain some of the complexity and inefficiency of the current capital income tax system, our policy experiments indicate that a reform of this type is likely to significantly increase total welfare in U.S.

[4]See https://www.irs.gov/pub/int_practice_units/RPWCUP_08_2_01.PDF

[5]See https://www.irs.gov/uac/publication-515-withholding-of-tax-on-nonresident-aliens-and-foreign-entities

6 Conclusion

In this paper, we put forward a model economy with heterogeneous households and heterogeneous firms in an asset-pricing framework where firms invest in the asset market as an outside option. This approach allows us to impose non-linear tax functions in contrast to existing approaches which restrict attention to linear taxes. We calibrate our model to match the U.S. economy and compute equilibrium. With this model, we explore tax reforms which eliminate corporate taxes and shift the capital tax burden onto shareholders via a progressive tax. These types of reforms increase total welfare in the economy.

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A Computational Algorithm

The following is an overview of the computational algorithm used to solve the model:

1. Guess a wage w and net interest rate r. Pick an upper bound of the interest rate such that the market discount factor is never less than the household's discount factor (as in Huggett 1993).

2. Solve the firm's problem given (r, w). This gives fund price and dividend: v and d. Note: should solve the firm problem first, since v and d enter into household budget constraint.

3. Solve household optimization by choosing s' shares of the mutual fund.

4. Iterate over (r, w) until aggregate demanded shares of the mutual fund sum to one and the labor market clears.

B Tables

DESCRIPTION	PARAMETER	VALUE
Household		
risk-aversion	σ	2
time discount	β	0.96
Firm		
shock persistence	ρ	0.767
variance of shock innovation	σ^2	0.211
capital share	α_k	0.311
labor share	α_n	0.65
depreciation	δ	0.085
adjustment cost parameter	η	0.05

Table 1: Preference and technology parameters.

	Benchmark	Reform 1	Reform 2	Reform 3
τ_c	0.1207	0.0000	0.0000	0.0000
ϕ	0.7422	1.0000	1.0000	1.0000
λ_1^{pit}	1.1133	1.1133	1.1023	1.1133
λ_2^{pit}	0.1810	0.1810	0.1810	0.1810
ψ	0.0000	1.1810	1.0000	0.0000
λ_1^d	0.8000	1.0000	1.0000	0.7038
λ_2^d	0.0000	0.0000	0.0000	0.1286
Percent Binding	0.0184	0.0126	0.0136	0.0115
Wealth Gini	0.7387	0.6701	0.6867	0.6471
$\frac{1}{1+r}$	0.9712	0.9629	0.9652	0.9624
w	1.0000	0.9832	0.9915	0.9813
Y	1.0000	0.9831	0.9915	0.9812
C	1.0000	0.9929	0.9965	0.9986
K	1.0000	0.9452	0.9723	0.9389
I	1.0000	0.9452	0.9723	0.9389
d	1.0000	1.2710	1.2405	1.2780
v	1.0000	0.9878	1.0273	0.9792
$\%\Delta W$	0.0000	1.2218	0.9492	2.0227

Table 2: Results. Note here that Y, C, K, and I represent aggregate output, consumption, capital, and investment, respectively. Each of these aggregates, as well as wages, dividends, and asset prices are represented as a percentage of the baseline value. W is aggregate welfare, and it is measured as a percent change from the baseline value.