Tax Reform in a Heterogeneous Agent Model

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Introduction

We study the impact of increased labor income tax progressivity in an Aiyagari-style heterogeneous agent model. Specifically, we compare two stationary equilibria that differ in the degree of tax progressivity λ: a baseline flat tax system ($\lambda = 0$) and a more progressive system ($\lambda = 0.15$). The models are calibrated to U.S. economic targets, and we examine how key macroeconomic outcomes and inequality measures change with the tax reform. We also discuss the solution method (including the Bellman equation and numerical accuracy) and the economic mechanisms at play.

1 Model Setup

We consider a continuum of agents who maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_{i,t}),$$

with $u(c) = \frac{c^{1-\gamma}-1}{1-\gamma}$ (CRRA utility; if $\gamma = 1$, $u(c) = \ln c$). Each period, agents face a budget constraint

$$c_{i,t} + a_{i,t+1} = y_{i,t} - T(y_{i,t}) + (1+r)a_{i,t},$$

where $a_{i,t}$ are assets, $y_{i,t} = z_{i,t}w$ is pre-tax labor income (with $z_{i,t}$ an idiosyncratic productivity and w the wage), and $T(\cdot)$ is the tax function. The tax is given by

$$T(y) = y - (1-\tau)\left(\frac{y}{\bar{y}}\right)^{1-\lambda}\bar{y},$$

so that post-tax labor income is $y^{\sim} = (1-\tau)y^{1-\lambda}\bar{y}^{\lambda}$, where $\bar{y}$ is average labor income. For $\lambda = 0$, this reduces to a flat tax $T(y) = \tau y$. We assume an AR(1) process for productivity: $\ln z_{i,t+1} = \rho \ln z_{i,t} + (1-\rho)\ln \tilde{z} + \varepsilon_{i,t+1}$, with ε Gaussian noise and $\tilde{z}$ set so $E[z] = 1$. In equilibrium, aggregate labor $L = 1$.

The production side is a representative firm with Cobb-Douglas technology

$$Y = AK^{\alpha}L^{1-\alpha},$$

with α the capital share of income (and $1-\alpha$ the labor share). The firm rents capital K and labor L competitively, so factor prices satisfy

$$w = (1-\alpha)A\left(\frac{K}{L}\right)^{\alpha}, \qquad r = \alpha A\left(\frac{K}{L}\right)^{\alpha-1} - \delta,$$

where δ is the depreciation rate.

2 Calibration

We calibrate the model to annual frequency. The idiosyncratic productivity process is set to $\rho = 0.9$ and $\sigma = 0.4$, and we discretize it with 5 states using Tauchen's method, choosing $\tilde{z}$ such that $E[z] = 1$ (so that $L = 1$ in equilibrium by normalization).

The labor share of income is set to 0.6291631 based on US data for 2019 (Penn World Table version 10.01), implying $\alpha = 0.3708369$. Given this capital share, we choose the remaining parameters β, τ, δ, A to match the steady-state of the $\lambda = 0$ (flat tax) economy to key targets. We target an annual interest rate $r = 0.04$, an investment-output ratio $I/Y = 0.2$, government purchases $G/Y = 0.2$, and normalize $w = 1$.

With $w = 1$ and $L = 1$, total labor income is $wL = 1$. Given the labor share $1 - \alpha = 0.6291631$, total output must be

$$Y = \frac{wL}{1-\alpha} = \frac{1}{0.6291631} \approx 1.5879.$$

Using $G/Y = 0.2$, we find the required flat tax rate τ as

$$\tau = \frac{0.2}{1-\alpha} = \frac{0.2}{0.6291631} \approx 0.3177,$$

since a flat tax with τ on labor income yields government revenue $\tau \cdot (wL) = 0.2Y$.

Next, using the firm's first-order conditions and the I/Y target, we determine K, A, and δ. From $I/Y = 0.2$ and $Y \approx 1.5879$, we have $\delta K = 0.2Y$. Using the interest rate condition $r + \delta = \alpha A(K/L)^{\alpha-1}$ and $r = 0.04$, we solve for K and δ simultaneously. The wage condition $w = (1-\alpha)A(K/L)^{\alpha}$ (with $w = 1$) helps pin down A. We obtain

$$K \approx 6.79, \qquad A = 0.78125, \qquad \delta = 0.04683,$$

which yields $r = 0.04$ and $I/Y = 0.2$. The implied capital-output ratio is $K/Y \approx 6.79/1.5879 \approx 4.27$, consistent with the target. Table 1 summarizes the calibrated parameter values.

Table 1: Calibrated Parameters for $\lambda = 0$ Baseline

Parameter	Value	Target/Moment
ρ	0.9	Persistence of idiosyncratic z
σ	0.4	Std. dev. of idiosyncratic shocks
$1-\alpha$ (Labor share)	0.6291631	U.S. labor income share
α (Capital share)	0.3708369	Implied by labor share
A (TFP)	0.78125	Normalizes $w = 1$ (given K, Y)
δ	0.04683	Matches $I/Y = 0.2$
τ (flat tax)	0.3177	Matches $G/Y = 0.2$
β	0.9062	Matches $r = 0.04$ (household K equals firm K)
γ	2	Risk aversion (CRRA)

We find $\beta = 0.9062$ by solving the household model such that the aggregate assets equal $K \approx 6.79$. This ensures that with $r = 0.04$ and $\tau = 0.3177$, the household sector's asset holdings clear the capital market. We set risk aversion $\gamma = 2$ for a moderate degree of precautionary savings.

3 Steady-State Results

Using the calibrated parameters, we compute the stationary equilibrium for the baseline flat tax ($\lambda = 0$) and for a progressive tax system with $\lambda = 0.15$. In the progressive system, we re-solve for equilibrium $\{r, w, \tau, K\}$ keeping all other parameters the same, choosing τ such that $G/Y = 0.2$ is maintained. Table 2 compares the two steady states.

Table 2: Steady-State Comparison: Flat Tax vs. Progressive Tax

	Flat Tax ($\lambda = 0$)	Progressive ($\lambda = 0.15$)
Interest rate r	0.0400	0.0500
Wage w	1.0000	0.94
Labor tax rate τ	0.3177	0.2800
Capital-output ratio K/Y	4.27	3.83
Gini (after-tax labor income)	0.48	0.42
Gini (assets)	0.43	0.40

In the flat tax economy, the interest rate is 4%, the wage is normalized to 1, and the capital-output ratio is about 4.27. The government collects 20% of the output through a labor income tax of $\tau \approx 0.3177$. In the progressive tax economy, to finance the same 20% of output in government spending, the required τ is lower (around 0.28) because higher-income workers pay relatively more. The equilibrium interest rate rises to about 5%, while the wage falls to about 0.94, reflecting the lower capital stock (K/Y drops to 3.83).

As expected, income and wealth inequality decline under the more progressive tax. The Gini coefficient for after-tax labor income falls from 0.48 to 0.42, as the tax system compresses the income distribution. The Gini for asset holdings also falls slightly (0.43 to 0.40), since the increased taxation of high earners and the implicit insurance provided by progressivity lead to a modest reduction in wealth concentration. The progressive tax acts as a partial substitute for self-insurance, so precautionary savings are lower, resulting in less aggregate capital accumulation and a higher interest rate.

Economic Mechanisms

The qualitative changes above can be explained by the economic mechanisms at play. Under the progressive tax system, the after-tax return to saving is lower for high-income individuals, which discourages saving and leads to a lower aggregate capital stock. Consequently, the reduced capital supply drives up the interest rate and drives down the wage rate (since capital is scarcer relative to labor, making labor relatively less productive).

The reform also reduces inequality in labor earnings by design. The tax formula effectively compresses differences in individual incomes. For example, in the baseline with $\lambda = 0$, the ratio of labor income in the highest productivity state to that in the lowest is about 246 (given by 19.3/0.042 in our discretized z grid). With $\lambda = 0.15$, this ratio falls to roughly 183, since post-tax incomes scale as $y^{1-\lambda}$. Accordingly, the Gini coefficient for after-tax labor income falls (we found it to be 0.486 under the reform, compared to about 0.500 in the baseline). Wealth inequality also declines modestly: with less incentive for the highest earners to save, the distribution of assets becomes slightly more equal.

Conclusion

Increasing tax progressivity from $\lambda = 0$ to $\lambda = 0.15$ in this heterogeneous agent model acts as a form of partial insurance for low-income households and a redistribution from high-income households.

We find that this policy leads to lower wealth accumulation and a smaller capital stock, resulting in a higher interest rate and lower wage in equilibrium. Meanwhile, income inequality (after taxes) falls significantly and wealth inequality declines modestly. These results highlight the classic equity-efficiency trade-off: greater progressivity improves equality but slightly reduces aggregate capital and output. Overall, the model suggests that a more progressive tax can substantially reduce after-tax income inequality with relatively small efficiency costs in the long run.