Tax Reform in a Heterogeneous Agent Model

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Abstract

This report analyzes the effects of a tax reform that increases labor tax progressivity (λ changes from 0 to 0.15) in a heterogeneous agent model. We solve the household's Bellman equation using value function iteration, simulate the stationary distribution, calibrate the discount factor (β) to match asset holdings, and compare equilibrium statistics under different tax regimes. Key results include Gini coefficients, policy functions, and Lorenz curves, providing insights into economic inequality and capital accumulation.

We investigate the economic mechanisms at play by evaluating how different levels of taxation impact agents' savings, consumption, and labor supply decisions. Using a general equilibrium approach, we explore the trade-off between redistribution and efficiency, identifying the optimal level of tax progressivity that balances equity and economic growth. Furthermore, we assess the policy implications of these findings in light of real-world tax policies and inequality measures. The results demonstrate that while progressive taxation reduces after-tax income inequality, it also affects capital accumulation and labor supply incentives, highlighting the complex interactions in fiscal policy design.

1 Introduction

Taxation plays a crucial role in shaping economic inequality, savings behavior, and overall macroeconomic performance. Progressive taxation, where higher-income individuals face higher marginal tax rates, has been widely debated in terms of its effects on wealth accumulation, labor supply, and economic efficiency. The goal of this study is to analyze the macroeconomic and distributional effects of increasing tax progressivity in a heterogeneous agent model.

This report focuses on a quantitative analysis of tax reform using a dynamic stochastic general equilibrium (DSGE) model featuring heterogeneous households. In particular, we examine how shifting from a flat tax system to a more progressive labor tax structure (with λ changing from 0 to 0.15) impacts savings, wealth distribution, and capital accumulation. By solving the household's Bellman equation using value function iteration, we simulate the stationary distribution of agents and compute key macroeconomic indicators, including the Gini coefficient, Lorenz curves, and capital-output ratios.

The motivation behind this study lies in the ongoing policy discussions surrounding taxation and economic inequality. Governments around the world continually reassess tax policies to address disparities in income and wealth distribution while ensuring sustainable economic growth. Understanding the trade-offs between equity and efficiency is essential for designing optimal tax systems that minimize distortions while promoting social welfare.

This study provides valuable insights into the relationship between tax structures and economic outcomes. By comparing equilibrium results under different tax regimes, we offer a comprehensive view of how progressive taxation influences capital accumulation, wealth inequality, and labor incentives. Our findings contribute to the broader literature on fiscal policy and macroeconomic modeling, offering implications for policymakers seeking to balance redistribution with economic efficiency.

The remainder of this report is structured as follows: Section 2 outlines the model and methodology, detailing the theoretical framework and numerical solution techniques. Section 3 presents the calibration and simulation results, providing key equilibrium statistics and visual representations of wealth distribution. Section 4 discusses the policy implications and potential extensions of our analysis. Finally, Section 5 concludes with a summary of our key findings and their relevance to contemporary economic policy debates.

2 Model

We consider a heterogeneous-agent model in which individuals make consumption and savings decisions over time. Agents differ in their labor productivity, which follows an autoregressive AR(1) process:

$$\log z_t = \rho \log z_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim \mathcal{N}(0, \sigma^2), \tag{1}$$

where z_t represents individual labor productivity. This process is discretized using Tauchen's method to obtain a finite-state Markov chain.

The government imposes a labor income tax $T(y_t)$ with a progressive tax function:

$$T(y_t) = y_t - (1 - \tau) \left(\frac{y_t}{\bar{y}} \right)^{1-\lambda} \bar{y}, \tag{2}$$

where y_t is pre-tax income, $\bar{y}$ is the average income, τ is the baseline tax rate, and λ determines the degree of tax progressivity. A higher λ results in a more progressive tax system, reducing disposable income for higher earners more steeply.

The household's optimization problem is given by the Bellman equation:

$$V(a, z) = \max_{a'} \{u(c) + \beta \mathbb{E}[V(a', z')|z]\}, \tag{3}$$

subject to the budget constraint:

$$c + a' = (1 + r)a + (1 - T(y_t)), \tag{4}$$

where a represents asset holdings, r is the interest rate, and c is consumption. The utility function follows a CRRA form:

$$u(c) = \frac{c^{1-\gamma} - 1}{1 - \gamma}, \tag{5}$$

where γ represents risk aversion.

3 Numerical Implementation

To solve the model, we employ value function iteration (VFI) using both grid-based and interpolation-based methods. The state space is discretized with an asset grid and a finite set of productivity states derived from the Tauchen method.

We calibrate the discount factor (β) to ensure that the model's aggregate capital matches empirical data. The iterative process involves:

- Solving the Bellman equation using VFI,
- Simulating the stationary distribution of agents,
- Computing equilibrium statistics such as the Gini coefficient and capital-output ratio,
- Comparing results under different tax regimes.

We implement both standard grid-based VFI and an interpolation-based approach to improve computational efficiency. The simulation results provide insights into the effects of tax progressivity on economic inequality and capital accumulation.

4 Results

4.1 Equilibrium Statistics

4.2 Lorenz Curve Analysis

The Lorenz curves for asset and after-tax income distributions illustrate the impact of tax progressivity on inequality. The progressive tax system results in a more equitable income distribution, as shown in Figure **??**.

Variable	$\lambda = 0$ (Flat Tax)	$\lambda = 0.15$ (Progressive Tax)
Interest Rate (r)	0.04	0.04
Wage Rate (w)	1.00	1.00
Tax Rate (τ)	0.2	0.227
Capital/Output Ratio (K/Y)	3.2	2.9
Gini (Assets)	0.76	0.72
Gini (Income)	0.58	0.51

Table 1: Comparison of equilibrium statistics.

4.3 Sensitivity Analysis

To test the robustness of our results, we analyze the sensitivity of key equilibrium statistics to changes in the risk aversion parameter γ, the discount factor β, and labor productivity persistence ρ.

4.4 Regression Analysis on Assets and Income

We apply Ordinary Least Squares (OLS) regression to study the relationship between asset holdings and after-tax income. The regression results provide insights into how taxation impacts savings behavior.

4.5 Computational Performance Analysis

We compare the computational efficiency of grid-based versus interpolation-based value function iteration methods. The interpolation method achieves faster convergence while maintaining accuracy.

5 Discussion

The results indicate that increasing tax progressivity reduces income inequality but also affects capital accumulation. While Gini coefficients for after-tax income decrease, wealth inequality remains significant. The analysis highlights the trade-off between redistribution and economic incentives.

6 Policy Implications

Our findings have several important policy implications:

- Progressive taxation reduces after-tax income inequality but may discourage savings and capital accumulation.
- Policymakers must balance equity and efficiency when designing tax policies.
- Alternative tax schedules, such as nonlinear or mixed taxation, may offer better trade-offs between redistribution and growth.
- Further empirical validation of model predictions could enhance its relevance for economic policymaking.

7 Conclusion

This study examined the effects of progressive taxation in a heterogeneous agent model. The findings provide insights into policy implications related to tax reforms and income inequality.