# Dyanmic General Equilibrim Tax Scoring with Micro Tax Simulations *

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**Abstract**

This paper ...

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# 1 Introduction

# 2 Details of the Macro Model

We use a model based heavily on Zodrow and Diamond (2013) which we refer to hereafter as the DZ model.

## 2.1 Households

Households differ along two dimensions: age and earnings ability, indexed by $a$ and $\gamma$. Households enter the model at age $a = 1$ and all die at age $a = T$. In the DZ model $T = 55$ and households enter the labor force at age twenty-three. This implies that all households die at age seventy-eight.

Earnings ability is divided into ten deciles, the top and bottom of which are further subdivided into the top two and bottom two pecent and the remaining eight percent for that decile. This gives us values for $\gamma \in \{\gamma_1, \gamma_2, \ldots, \gamma_{12}\}$.

We therefore have $T \times 12$ different households alive each period. This is 660 for the DZ model.

Lifetime utility is given by the equation below.

$$LU_t(a,\gamma) = \frac{1}{1-1/\sigma_U}\left[\sum_{s=t}^{t+T-a-1} \frac{U_s(a,\gamma)^{1-1/\sigma_U}}{(1+\rho)^{s-t}} + \frac{1}{(1+\rho)^{T-a-1}}\alpha_B(\gamma)B_{t+T-a-1}(a,\gamma)^{1-1/\sigma_U}\right] \tag{2.1}$$

where $LU_t(a,\gamma)$ is total remaining lifetime utility for a household of age $a$ and ability level $\gamma$ in period $t$, $U_t(a,\gamma)$ is within-period utility for a household of age $a$ and ability level $\gamma$ in period $t$, $B_{t+T-a-1}(a,\gamma)$ is the bequest left by a houshold of age $a$ and ability level $\gamma$ when it dies in period $t+T-a-1$. $\sigma_U$ is the intertemporal elasticity of substitution for utility across periods, and $rho$ is the pure rate of time preference.

Within-period utility depends on consumptions of composite goods $(CH)$ and leisure ($LE$).

$$U_s(a,\gamma) = \left[\alpha_u^{1/\sigma_u} CH_s(a,\gamma)^{1-1/\sigma_u} + (1-\alpha_u)^{1/\sigma_u} LE_s(a,\gamma)^{1-1/\sigma_u}\right]^{\frac{\sigma_u}{\sigma_u-1}} \tag{2.2}$$

Composite goods are made up of housing goods ($HR$) and non-housing goods ($CN$).

$$CH_s(a,\gamma) = \left[\alpha_H^{1/\sigma_H} CN_s(a,\gamma)^{1-1/\sigma_H} + (1-\alpha_H)^{1/\sigma_H} HR_s(a,\gamma)^{1-1/\sigma_H}\right]^{\frac{\sigma_H}{\sigma_H-1}} \tag{2.3}$$

Non-housing goods are made up of those produced by the corporate secotor ($C$) and non-corporate sector ($N$).

$$CN_s(a,\gamma) = \left[\alpha_N^{1/\sigma_N}[C_s(a,\gamma) - b_s^C(a,\gamma)]^{1-1/\sigma_N} + (1-\alpha_N)^{1/\sigma_N}[N_s(a,\gamma) - b_s^N(a,\gamma)]^{1-1/\sigma_N}\right]^{\frac{\sigma_N}{\sigma_N-1}} \tag{2.4}$$

Housing goods are made up of owner-occupied housing ($H$) and rental housing ($R$).

$$HR_s(a,\gamma) = \left[\alpha_R 1/\sigma_R[H_s(a,\gamma) - b_s^H(a,\gamma)]^{1-1/\sigma_R} + (1-\alpha_R)^{1/\sigma_R}[R_s(a,\gamma) - b_s^R(a,\gamma)]^{1-1/\sigma_R}\right]^{\frac{\sigma_R}{\sigma_R-1}} \tag{2.5}$$

This completes the description of the household's utility function. There are four fundamental goods consumed: $C$, $N$, $H$ and $R$ along with consumption of leisure, $LE$. The utility parameters are: $\rho$, $\sigma_U$, $\sigma_C$, $\sigma_H$, $\sigma_N$, $\sigma_R$, $\alpha_B$, $\alpha_C$, $\alpha_H$, $\alpha_N$, $\alpha_R$, $\{b_s^C(a,\gamma_i)\}_{a=1,i=1}^{T,12}$, $\{b_s^N(a,\gamma_i)\}_{a=1,i=1}^{T,12}$, $\{b_s^H(a,\gamma_i)\}_{a=1,i=1}^{T,12}$, $\{b_s^R(a,\gamma_i)\}_{a=1,i=1}^{T,12}$.

The households remaining lifetime budget constraint is given by the equation below.

$$TDW_t(a,\gamma) = TDE_t(a,\gamma) \tag{2.6}$$

where $TDW$ stands for total discretionary wealth and $TDE$ is total discretionary expenditure.

$$TDE_t(a,\gamma) = \sum_{s=1}^{t+T-1-a} \sum_{j\in\{C,N,H,R\}} p_s^j(1+\tau_{vs}^j) j_s D_s \tag{2.7}$$

$\tau^j_{vs}$ is the value added tax (VAT) on good $j$ in period $s$.

$$D_s = \begin{cases} \prod_{u=t+1}^{s} \frac{1}{1+r_u} & \text{if } s > t \\ 1 & \text{otherwise} \end{cases} \tag{2.8}$$

$$\tau^j_{vs} = \tau_{vs} f^j_{vs}; j \in \{C, N, H, R\} \tag{2.9}$$

where $f^j_{vs}$ is the proportion of goods in category $j$ subject to the VAT

$$\begin{aligned} TDW_t(a,\gamma) = {} & A_t(a,\gamma)(1+r_t) + TRA_t(a,\gamma)(1+i_t) \\ & + \sum_{s=t}^{t+T-1-a} D_s w_s(a,\gamma)[HT_s(a,\gamma) - LE_s(a,\gamma)] - D_s LIT_s(a,\gamma) - D_s SST_s(a,\gamma) \\ & + \sum_{s=t}^{t+T-1-a} D_s SSB_s(a,\gamma)[1 - \tau_{bs}(\gamma)] - D_s RS(\gamma) \\ & + \sum_{s=t}^{t+T-1-a} D_s WD_s(a,\gamma)[1 - s_d \tau_{rs}(\gamma)] + D_s TR_s(a,\gamma) + D_s LSR_S(a,\gamma) \end{aligned} \tag{2.10}$$

$LIT$ is the labor income tax, $SST$ is the social security tax, $SSB$ is social security benefits, $\tau_{bs}$ is the tax rate on social security benefits is period $s$, $RS$ is retirement savings which is a constant amount each year the household is not retired, $WD$ is withdrawls from retirement accounts, $TR$ is transfers received, $LSR$ is lump sum rebates received.

$$r_u = i_u(1 - \tau_{iu}) \tag{2.11}$$

where $\tau iu$ is the tax on interest income in period $u$.

$$TRA_s(a,\gamma) = TDA_s(a,\gamma) + TPA(a,\gamma) \tag{2.12}$$

where $TDA$ is tax-deferred assets and $TPA$ is tax-prepaid assets.

$$WD_s(a,\gamma) = \begin{cases} 0 & \text{if } a \leq R \\ \frac{1}{T+1-a} TRA_s(a,\gamma) & \text{otherwise} \end{cases} \tag{2.13}$$

$$LIT_s(a,\gamma) = \psi_s LIB_s(a,\gamma) + \frac{\chi_s}{2} LIB_s(a,\gamma)^2 \tag{2.14}$$

where $LIB$ is the labor income base, defined below.

$$LIB_s(a,\gamma) = w_s(a,\gamma)[HT_s(a,\gamma) - LE_s(a,\gamma)] - DED_s(a,\gamma) - s_d RS(\gamma) \tag{2.15}$$

### 2.2 Firms

### 2.3 Market Clearing

## 3 Incorporating Feedbacks with Micro Tax Simulations

Follow this algorthim:

- Period 1
  - Use current IRS public use sample.
  - Run the following within-period routine
    * Do the static tax analysis of this sample, save the results
    * Summarize the public use sample by aggregating into bins over age and earnings ability
    * Use this as a starting point for the dynamic macro model
    * Get values for fundamental interest rates and effective wages for next period
- Period 2

- Age the public use data demographically by one year.
- Let wages and interest rates rise by the amounts predicted in the macro model.
- Rerun the within-period routine

• Iterate over periods until end of forecast period is reached.

# 4 Calibration

## 4.1 Tax Bend Points

We use IRS data which summarizes individual tax returns for 2011 by 19 income categories and 4 filing statuses. For each filing status we fit the mapping from reported income into adjusted gross income (AGI) using a sufficiently high-order polynomial. We then use this function to solve for the income level which corresponds to each of the five bend points in the tax code for each filing type.

**Table 1:** AGI and Income Bend Points

AGI Bend Points

| Tax rate | Married Joint | Married Separate | Head of Household | Single |
|---|---|---|---|---|
| 10% | 17,400 | 8700 | 12,400 | 8700 |
| 15% | 70,700 | 35,350 | 47,350 | 35,350 |
| 25% | 142,700 | 71,350 | 122,300 | 85,650 |
| 28% | 217,450 | 108,725 | 198,050 | 178,650 |
| 33% | 388,350 | 194,175 | 388,350 | 388,350 |

Corresponding Reported Income Bendpoints

| Tax rate | Married Joint | Married Separate | Head of Household | Single |
|---|---|---|---|---|
| 0% | 5850 | 91 | 756 | 1435 |
| 10% | 22,932 | 8591 | 12,911 | 9956 |
| 15% | 75,181 | 34,592 | 47,023 | 36,021 |
| 25% | 145,866 | 69,768 | 120,200 | 85,244 |
| 28% | 219,162 | 106,245 | 194,176 | 176,270 |
| 33% | 386,798 | 189,674 | 380,043 | 381,524 |

We then fit a bivariate probabililty density function over income and filing type from the data. For each bendpoint we calculate the probability density at that bendpoint and use these as weights in a weighted average over filing types to generate an aggregate bendpoint.

**Table 2:** Aggregated Bend Points

| Tax rate | Bend Point |
|---:|---:|
| 0% | 2889 |
| 10% | 15,116 |
| 15% | 52,580 |
| 25% | 114,552 |
| 28% | 196,201 |
| 33% | 380,657 |

# 5 Conclusion

# TECHNICAL APPENDIX

# References

**Zodrow, George R. and John W. Diamond**, *Handbook of CGE Modeling - Vol. I*, North Holland,