Optimal Income tax rates with non-democratic political constraints: case of Armenia

Vardan Baghdasaryan[*] Hayk Hambardzumyan[†]

Abstract

Tax is the main source for a government to finance its expenditures when implementing its functions. The progressivity of taxes affects social welfare and income inequality. Yet, in Armenia the progressivity of the tax and transfer system, particularly the progressivity of the income taxes, is poorly studied. We aim to compute the optimal tax rates for labor income for the Armenian economy based on a quantitative, heterogeneous agent general equilibrium model with incomplete market structure. In this model individuals face uninsured idiosyncratic risk because of productivity shocks. Progressive taxation is the main mechanism that insures people against these shocks so that they can smooth their consumption. With this model we look for the progressivity of the income tax function that maximizes utilitarian social welfare, and explore who will be better off or worse off from the fiscal reform that adopts the optimal tax rates. We find that a less progressive tax system increases the social welfare of the society; particularly, average household member gains welfare of 1.11% of steady-state consumption (approximately 500 drams per year in 2013 values).

Key Words: Heterogeneous agent general equilibrium, income tax, idiosyncratic risk, productivity shocks, copula, Gini coefficient, value function iteration.

JEL codes: E25, E62, H21

[*] American University of Armenia, 40 Marshall Baghramyan ave., 0019 Yerevan, Armenia and CERGE-EI Affiliate Fellow (Prague, Czech Republic), Tel.: +374-60-612567, email: vbaghdasaryan@aua.am

[†] American University of Armenia, 40 Marshall Baghramyan ave., 0019 Yerevan, Armenia

I. Introduction

The question of an optimal tax, particularly income tax progressivity, is often debated in economic literature. Governments encounter a difficult trade-off when deciding the degree of progressivity of the tax system. The incompleteness of private risk-sharing is the main reason for tax system progressivity. Empirical studies exploring the shocks of earnings into consumption show that private risk-sharing is limited (Cochrane 1991; Attanasio 1996). A progressive tax and transfer system enables social hedging against income uncertainty (e.g., Varian 1980; Eaton 1980) and reallocation of initial resources.

Meanwhile, high progressivity at extreme leads to distortions to labor supply. The motivation to work more and to enhance skills decreases with increased marginal tax rates (e.g., Heckman 1998; Guvenen 2014). Furthermore, a very progressive tax system reduces work incentives and decreases investments in skills, therefore even increasing the pre-tax inequality (e.g., Feldstein 1969; Stiglitz 1982).

Since January 1, 2013, Armenian government adopted the current system of progressive taxation of income. According to latter, the lowest bound of income tax rate is 24.4% of taxable income, and the upper bound – 36%. Also within the application of mandatory pension system 5 more percent are deducted from income. The purpose of our article is to investigate the influence of Armenian current tax system on social welfare. In particular, we explore the optimal income tax rates for Armenia, and show how they affect inequality. The computation of optimal tax rates will contribute the government to orientate in choosing the income tax rate progressivity, and will answer the following two questions: (i) What are the labor income tax rates that maximize the average utilitarian welfare of the society? (ii) Who will be better off or worse off from the fiscal reform that adopts the tax rate that maximizes average welfare?

Our model is an extension to the model by Chang 2007. Instead of finding a time-varying gap between the marginal rate of substitution and labor productivity without using productivity shocks, we incorporate the aggregate individual preferences by using a quantitative general equilibrium model with heterogenous agents. We examine the above mentioned questions through the lens of the Aiyagari (1994) model augmented with endogenous labor supply. In his model a continuum of agents, subject to individual risks, interact in market to result in aggregate behaviour: Agents try to smooth their consumption by trading assets. Empiric results along with formal evidence signalize that individual consumptions are much more volatile than aggregate consumption (Zeldes, et al. 1986; Angus 1991). Progressive taxation is the main mechanism that insures people against these shocks so that they can smooth their consumption.

In our model we introduce the tax for income and examine how income tax progressivity affects the inequality. Households operate in progressive income tax environment. Particularly, for individual income tax schedule we use the function developed by Heathcote, Storesletten and Violante (2014) (HSV) to capture the progressive tax formula. Using data for disposable and market incomes HSV method reveals the progressivity (τ) and average level of taxation (λ) of the income taxes empirically. So our first objective is to estimate the two parameters (τ, λ) for Armenia based on cross-sectional data of Household's Integrated Living Conditions Survey (2013) and Labor Force

Survey (2013)[‡]. One immediate difficulty we face in the estimation of parameters is that we have data for monthly salaries of workers for individuals, but transfers from government, total salary incomes and expenditures for the same individuals on household level. So we reconstruct the individual market income from reported individual after-tax income from Labor Force Survey by respective tax rates, and sum over household members to get the market income of a household. Then we compute total disposable income of a household by including transfers from government, such as pension, benefit for a child, stipendium, unemployment benefit, etc., and estimate τ and λ coefficients by a simple OLS regression. However, there is a problem with this strategy because some of the household members may not want to reveal their income, therefore missing values are generated. We solve this problem by excluding the reported individual salaries from the after-tax salary income of the household, and dividing the rest of the household income from salary on the number of remaining workers (or on the number of worker in the household who did not report their salary). This allows us to compute the average salary of the remaining workers and reconstruct their market incomes.

In heterogeneous agent general equilibrium model with incomplete market structure individuals face uninsured idiosyncratic risk because of productivity shocks. We use an AR(1) process with persistence (ρ) and standard error (σ) parameters to reveal the stochastic process for the idiosyncratic productivity shocks. We use annual data of average wages for 1996 – 2015 to estimate these parameters empirically.

[‡] National Statistical Service of RA

Results show that under new tax system average household member increases its welfare by as much as 1.11% of steady-state consumption, which is approximately 500 drams per year in 2013 values, and that high-income households benefit from the reform.

The rest of the article is organized in three sections. We describe our theoretical framework in Section II, calibration to Armenian data and computation of the optimal tax reform under utilitarian social welfare function in Section III, and the conclusion in Section IV.

II. Theoretical Framework

To construct a benchmark economy we extends Aiyagari's (1994) model by introducing progressive income tax.

II.A. Households

In our model the households have identical preferences and face an idiosyncratic productivity shock x, which is an AR(1) process. The variable a_t describes the amount of assets of household t which increase at annual real rate r_t. Labor income of a household with labor productivity x_t is $w_t x_t h_t$, where w_t is the wage rate for the particular unit of labor and h_t is the number of hours worked. Labor incomes are liable to progressive taxes of the HSV (2014) tax function (see the graph for HSV tax function under the calibrated parameters and the scatter plot from data in Appendix, A2 and A3, respectively):

$$\text{Tax} \quad T(y_i) = y_i - \lambda {y_i}^{1-\tau} \tag{1}$$

$$\text{Disposable income} \quad D(y_i) = \lambda {y_i}^{1-\tau} \tag{2}$$

$$log\ D(y_i) = log\lambda + (1-\tau)y_i \tag{3}$$

Note that the HSV tax function includes transfers as well as taxes.

Households maximize their lifetime utilities:

$$\max_{\{c_t, h_t\}_{t=0}^{\infty}} \quad E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{c_t{}^{1-\sigma} - 1}{1-\sigma} - B \frac{h_t^{1+1/\gamma}}{1+1/\gamma} \right\} \tag{4}$$

subject to

$$c_t = \frac{\lambda(w_t x_t h_t)^{1-\tau} + (1-\tau_k) r_t a_t + a_t - a_{t+1}}{1+\tau_c} \tag{5}$$

$$a_{t+1} \geq \underline{a}$$

where c_t is consumption. Parameters σ, γ and β represents relative risk aversion, elasticity of labor supply and utility discount factor, respectively. $\underline{a}$ is a borrowing constraint of a household. As physical capital is the only available asset for households to insure against idiosyncratic shocks to their productivity in this sense capital markets are incomplete.

Households that own assets pay capital taxes at the rate τ_k separately. In our model firms yield zero profits as the assumption of a competitive market is made. The market structure for the firm's perspective is simplified as the market is assumed to be competitive.

II.B. Recursive Representation

In the recursive representation let $V(a_t, x_t)$ denote the value function of a household with productivity x_t and asset holdings a_t. The value function V is represented as follows:

$$V(a_t, x_t) = \max_{c,h} \left\{ \frac{c_t{}^{1-\sigma} - 1}{1-\sigma} - B \frac{h_t^{1+1/\gamma}}{1+1/\gamma} + \beta E[V(a_{t+1}, x_{t+1})|x] \right\} \tag{6}$$

subject to

$$a_{t+1} = \lambda(w_t x_t h_t)^{1-\tau} + (1-\tau_k) r_t a_t + a_t - c_t(1+\tau_c) \tag{7}$$

II.C. Firms

In the model we take the Cobb-Douglas representation for production function, where and effective units of labor, L_t, and capital measure, K_t, are used. The product technology follows a constant-return-to-scale technology. Firms maximize their profits:

$$\max_{L_t, K_t} L_t^{\alpha} K_t^{1-\alpha} - w_t L_t - (r_t + \delta) K_t \tag{8}$$

subject to

$$K_{t+1} = (1 - \delta) K_t + I_t \tag{9}$$

where I_t is the amount of investment and δ is the capital depreciation rate.

When firm maximizes its profit, the first order conditions are

$$w_t = \alpha \left(\frac{K_t}{L_t}\right)^{1-\alpha} \tag{10}$$

and

$$r_t + \delta = (1 - \alpha) \left(\frac{K_t}{L_t}\right)^{-\alpha} \tag{11}$$

II.D. Government

The government expenditure G should be equal to the amount of taxes it collects from households to balances its budget every period:

$$\int \{\tau_c c_t + T(y_t) + \tau_k r_t a_t\} d\mu(a_t, x_t, e) = G \tag{12}$$

The collected taxes from income and capital are equal to

$$T(y_t) = w_t x_t h_t - \lambda (w_t x_t h_t)^{1-\tau} \tag{13}$$

II.E. Equilibrium

The value function, V(a,x) along with the set of decision rules for consumption, asset holdings, and labor supply, c(a,x), a'(a,x), h(a,x) and the invariant joint distribution of assets and productivity shocks for each household, μ(a,x), constitute the stationary equilibrium so that:

1. Individual households solve the Bellman equation by choosing c(a,x), a'(a,x), h(a,x) and V(a,x).

2. A representative firm solves the maximization problem:

$$w_t = \alpha \left(\frac{K_t}{L_t}\right)^{1-\alpha} \tag{14}$$

and
$$r_t + \delta = (1-\alpha)\left(\frac{K_t}{L_t}\right)^{-\alpha} \tag{15}$$

3. The government balances its budget:

$$\int \{wxh - \lambda(wxh)^{1-\tau} + \tau_k ra + \tau_c c\} d\mu = G \tag{16}$$

4. An equilibrium is also achieved in factor markets:

$$L = \int xh(a,x)d\mu \tag{17}$$

$$K = \int a d\mu \tag{18}$$

5. An equilibrium is established in the goods market:

$$\int \{a'(a,x) + c(a,x)\} d\mu + G = F(L,K) + (1-\delta)K \tag{19}$$

6. The joint distribution of assets and productivity shocks for each household is in steady state. For all $A^0 \subset \mathbb{A}$ *and* $X^0 \subset \mathbb{X}$:

$$\mu(A^0, X^0) = \int_{A^0, X^0} \left\{ \int_{\mathbb{A},\mathbb{X}} 1_{a'=a'(a,x)} d\pi_x(x'|x) d\mu \right\} da' dx' \tag{20}$$

Thus the equilibrium can be described by this set of decision rules for consumption and asset holdings, $c(a,x), a'(a,x)$; as well as aggregate inputs, K, L, such that individual households and representative firms optimize and the government balances its budget.

III. Quantitative Analysis

III.A. Calibration

The labor income share parameter α and government consumption output ratio G are obtained from National Statistical Service of RA. The disutility parameter B, the discount factor β and the average level of taxation λ are chosen to match the given annual rate of return of 8.89%, the average hours worked (2256 hours[§]) and the average levels of taxation of 20.8%, respectively, and so that a steady state equilibrium is obtained.

Table 1. Calibration

Parameters	Values	Description
(Preference)		
α	0.38	Labor income share (2013)
β	0.919	Discount factor (to match r = 8.88%)
γ	3	Frisch elasticity
B	0.0002	Disutility parameter for working
σ	0.57	Risk-aversion parameter
$\underline{A}$	0	Borrowing constraint: no borrowing
(Income process)		
ρ_x	0.939	Persistence of idiosyncratic shock
σ_x	0.076	Standard deviation of innovation
(Taxes and Expenditures)		
τ	0.368	Tax progressivity
τ_c	0.200	Consumption tax rate (value-added tax rate = 20%)
τ_k	0.100	Capital tax rate
λ	0.795	Average level of taxation
G	0.124	Government consumption/Output

[§] National Statistical Service of RA

The risk-aversion parameter σ is obtained from Gandelman and Hernández-Murillo (2014).

Tax progressivity is estimated by the simple OLS method using HSV functional form for taxes.

Table 2. OLS estimates for the HSV function

	Log(λ)	1-τ	τ	R^2
Coefficient	4.272	0.632	0.368	0.493
S.D.	0.129	0.011		

Source: Household's Integrated Living Conditions Survey (2013) and Labor Force Survey (2013)

Compared to the tax progressivity parameter for the Korean economy (0.1371) in Chang, Kim and Chang (2015), the parameter for the Armenian economy indicates more progressivity mainly because of support to socially insecure families and not due to the highly differentiated income tax rates.

III.B. Optimal Tax Reform

In the previous section, we calculated the individual and aggregate variables for the current progressivity parameter of income tax in Armenia. Now we want to find the optimal tax rate that maximizes the social welfare function. To aggregate the individual preferences, we use utilitarian criteria – a social welfare function that averages the utility of the population with equal weights. The aggregation of individual preferences is calculated according to the following function:

$$W(\tau) = \int V(a_0, x_0; \tau) d\mu(a_0, x_0; \tau) \tag{21}$$

where $V(a_0, x_0; \tau)$ is the discounted sum of the lifetime utility of a household. It is calculated for each household with asset holdings a_0 and productivity x_0 in the steady state given tax progressivity τ:

$$V(a_0, x_0; \tau) = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{c(a_t, x_t; \tau)^{1-\sigma} - 1}{1-\sigma} - B \frac{h(a_0, x_0; \tau)^{1+1/\gamma}}{1+1/\gamma} \right\} \tag{22}$$

Under the current tax progressivity (τ) we hold the assumption that the economy is in steady state. We then search a new τ*, that maximizes $W(\tau^*)$, while fixing consumption and capital tax rates τ_c and τ_k at 0.2 and 0.1, respectively.

In the discounted sum of the utility function we input consumption-equivalence units, Δ, to compute the social welfare gains under the new tax progressivity (τ) as:

$$\int \sum_{t=0}^{\infty} \beta^t U\big((1+\Delta)c_0, h_0\big) d\mu_0(a,x) = \int \sum_{t=0}^{\infty} \beta^t U(c_1, h_1) d\mu_1(a,x) \tag{23}$$

where c_0, h_0, μ_0 are computed using the initial tax progressivity parameter and c_1, h_1, μ_1 are those computed after the reform in steady state.

The welfare gains in consumption equivalents under different progressivity parameters are computed in Table 3. The welfare gain is greatest—a 1.11% increase in permanent consumption – when $\tau^* = 0.2$.

Table 3. Welfare gains in consumption equivalents

	Progressivity (τ)					
	0.02	0.1	0.2	0.3	0.4	0.8
% increase in consumption	-1.73	-0.43	**1.11**	0.59	-8.39	-22.48

When converted into 2013 drams, the consumption of all household members increases by 408 drams each year.

Table 4 shows the relative incomes and the tax rates imposed on each decile group for the current state of the economy and under optimal tax reform.

Table 4. Current and optimal tax rates

Decile points	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Current State										
Relative Income Before Tax	0.46	0.72	0.85	0.94	1.01	1.08	1.14	1.22	1.33	1.42
Relative Income After Tax	0.48	0.64	0.72	0.76	0.81	0.84	0.87	0.91	0.95	0.99
Net Tax Rate (%)	-3.57	10.59	15.78	18.74	21.07	22.85	24.37	26.17	28.24	29.88
Optimal Tax Reform										
Relative Income Before Tax	0.45	0.70	0.81	0.88	0.94	0.99	1.02	1.08	1.14	1.19
Relative Income After Tax	0.41	0.59	0.67	0.72	0.76	0.79	0.81	0.84	0.89	0.92
Net Tax Rate (%)	7.561	14.60	17.10	18.47	19.51	20.31	20.96	21.75	22.62	23.28

The Gini coefficients for the model has increased from 0.103 to 0.106 under the optimal tax reform.

IV. Conclusion

We elaborate a heterogenous agent general equilibrium model and calibrate it to match the characteristic features of the Armenian economy. We find the progressivity parameter of the HSV tax function that maximizes utilitarian social welfare. The results state that a less progressive income tax schedule increases the average welfare of the society. Under optimal tax reform, the average household member gains welfare by as much as 1.11% of steady-state consumption, which is approximately 500 drams per month in 2013 values (the average expenditure per capita is 36,787 AMD): The average household gains 21,060 AMD per year.

As the progressivity of income tax decreases, the high-income households face a lower net tax rates under current state. The Gini income coefficient for the model has increased from 0.103 to 0.106 under the optimal tax reform.

References

Aiyagari, S. Rao. “Uninsured Idiosyncratic Risk and Aggregate Savings.” *Journal of Economics*, 1994: 109 (3), 659-684.

Angus, Deaton. “Saving and Liquidity Constraints.” *Econometrica*, 1991: LIX, 1221-1248.

Attanasio, O., and S. J. Davis. “Relative Wage Movements and the Distribution of Consumption.” *Journal of Political Economy*, 1996: 104(6), 1227–1262.

Chang, Yongsung, and Sun-Bin Kim. “Heterogeneity and Aggregation: Implications forLabor-Market Fluctuations.” *American Economic Review*, 2007: 97 (5), 1939 - 1956.

Chang, Yongsung, Sun-Bin Kim, and Bo Hyun Chang. “Optimal Income Tax Rates for the Korean Economy.” *KDI Journal of Economic Policy*, 2015.

Cochrane, J. H. “A Simple Test of Consumption Insurance.” *Journal of Political Economy*, 1991: 99(5), 957–976.

Eaton, J., and H. S. Rosen. “Optimal Redistributive Taxation and Uncertainty.” *Quarterly Journal of Economics*, 1980: 95(2), 357–364.

Feldstein, M. S. “The Effects on Taxation on Risk Taking.” *Journal of Political Economy*, 1969: 77(5), 755–764.

Gandelman, Néstor, and Rubén Hernández-Murillo. “Risk Aversion at the Country Level.” *Working Paper: Federal Reserve Bank of St. Louis*, 2014.

Guvenen, F., B. Kuruscu, and S. Ozkan. “Taxation of Human Capital and Wage Inequality: A Cross-Country Analysis.” *Review of Economic Studies*, 2014.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante. “Optimal Tax Progressivity: An Analytical Framework .” *Working Paper*, 2014.

Heckman, J., L. Lochner, and C. Taber. "Explaining Rising Wage Inequality: Explorations with a Dynamic General Equilibrium Model of Labor Earnings with Heterogeneous." *Review of Economic Dynamics,* 1998: 1(1), 1–58.

Stiglitz, J. E. "Utilitarianism and Horizontal Equity: The Case for Random Taxation." *Journal of Public Economics*, 1982: 18(1), 1–33.

Varian, H. R. "Redistributive Taxation as Social Insurance." *Journal of Public Economics*, 1980: 14(1), 49–68.

Zeldes, Stephen P., N.Gregory Mankiw, B. Robert, and Barsky. "Ricardian Consumers with Keynesian Propensities." *American Economic Review,* 1986: LXXVI, 676-691.

Appendix

Computational Procedures

1. Steady-State Equilibrium

We use a modified algorithm by José-Víctor Ríos-Rull (1999) to find the time invariant joint distribution of assets and productivities for households μ. We change (i) the average levels of taxation λ to match net income tax rates, 0.792%; (ii) the disutility parameter B to match the average hours worked, 0.410; and (iii) the discount factor β that clears the capital market at the given annual rate of return of 8.88%:

1) For idiosyncratic productivity, we construct a vector of length 100 (this is done to ease the computational processes and to have a square matrix when computing copula) whose elements, $\ln x_j$'s, are equally spaced on the interval $[\pm 3\sigma_x/\sqrt{1-\rho_x^2}\,]$ (according to the formula in Tauchen's (1986) algorithm). Next, we calculate the transition matrix of probabilities for idiosyncratic productivity using Tauchen's algorithm. Then, we use a log-normal distribution to create the asset holdings of households. By using the amount of asset holdings a_i for each household, we construct the points of joint distribution μ(a,x) by copula method (figure A1);

2) Initialize the parameters β, B, and λ. Given β, B , ρ_x, σ_x, and λ, we maximize the individual value functions V at each point of individual statesby changing next period's asset holdings $a'(a_i, x_j)$ and labor supply $h(a_i, x_j)$. We following these steps:

   (a) Pick initial values for $V_0(a_i, x_j)$ for each individual state;

   (b) Update value functions by evaluating the discretized versions:

$$V_1(a_i,x_j) = \max_{a',h}\{u\left(\frac{\lambda(w_t x_t \mathrm{h_t})^{1-\tau} + (1-\tau_k)r_t a_t + a_i - a'}{1+\tau_c}, h(a_i,x_j)\right)$$

$$+\beta \sum_{j'=1}^{100} V_0(a_i{}', x_{j'})\pi_x(x_{j'}|x_j)\},$$

where the transition probabilities of x, $\pi_x(x_{j'}|x_j)$, are approximated using Tauchen's algorithm;

(c) If V_1 and V_0 are close enough for all individual states, then the value functions are found. Otherwise, set $V_0 = V_1$, and go back to step 2(b);

3) Find the joint distribution of assets and productivities, $\mu(a_i, x_j)$ as follows:

(a) Fit a copula to the *cdf*-s of series of assets and productivities;

(b) Using the correlation between series construct a copula;

(c) Find the joint probabilities from the following equation:

$$c = \frac{\mu(a,x)}{\mu(a)\mu(x)},$$

where $\mu(a)$ and $\mu(x)$ are the individual *pdf*-s of assets and productivities, and c is the copula;

4) After obtaining $\mu(a,x)$ and decision rules, we calculate the aggregate variables L, K, G, etc., find the real interest rate, wage rate, and other variables of interest. If the calculated variables are close to the assumed ones, we have found the steady state. Otherwise, we change β, B, λ, and go back to step 2.

2. Optimal Tax Reform

The steps to find the progressivity parameter τ that maximizes the social welfare are as follows:

1) Assume that the economy is in steady state under the current progressivity parameter and compute the initial steady state by using the algorithm for the steady-state equilibrium;

2) Choose new tax parameter (progressivity τ) and compute the new steady state;

3) Choose a tax parameter that yields the highest social welfare. This is the optimal tax rate under the utilitarian criteria.

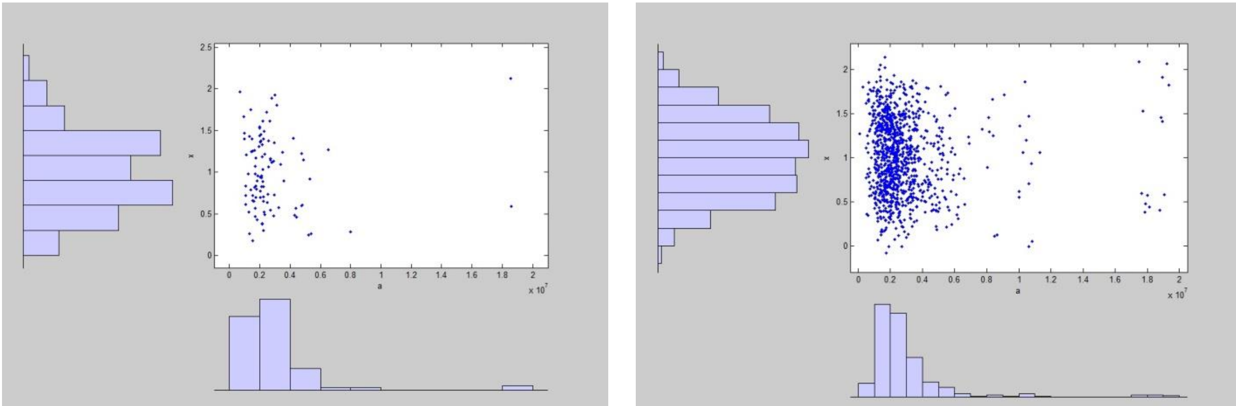
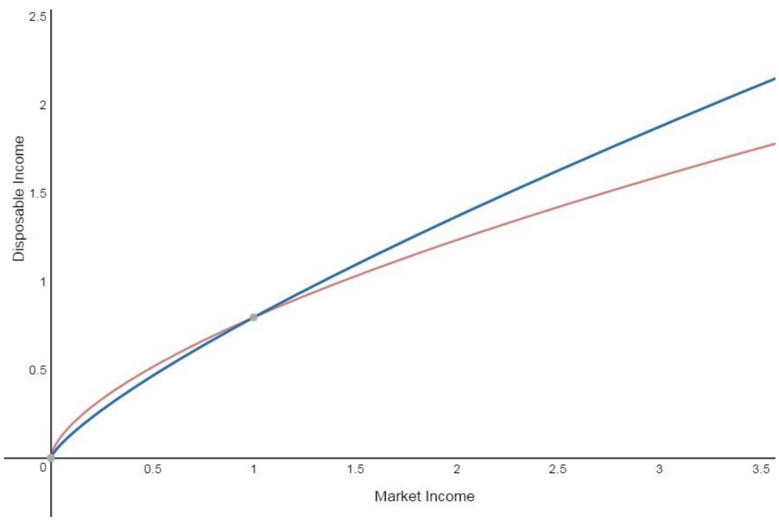


Figure A1. Copula (the left one represents the 100 households used in computation process, and in the right one more values are generated by copula to show the relationship and the distribution of the two variables)



Red: $D(y_i) = 0.795{y_i}^{(1-0.368)}$ Blue: $D(y_i) = 0.795{y_i}^{(1-0.200)}$

Figure A2. HSV tax function

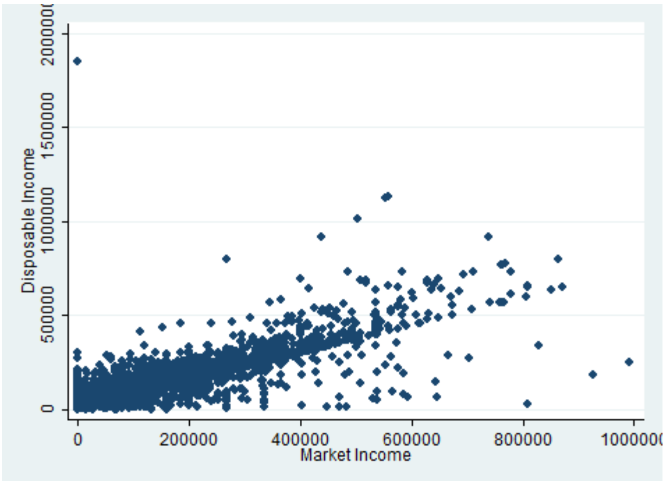


Figure A3. Scatter plot (Household's Integrated Living Conditions Survey and Labor Force Survey)