Does Taxation at the Unit of Household Increase the Demand for Risky Asset?

Yulin Liu and Min Zhang

***Abstract*—With the background of a fierce discussion in the tax reform of transforming the current individual income tax system from levying income tax at the unit of individual to the unit of household in China, this paper studies the implications of a tax reform for households' risky asset share. We observe that (I) levying taxes at the unit of household is helpful for reducing tax burdens, this, in turn, (II) in the short term, increases household disposable income and causes a wealth effect enhancing households enthusiasm to participate in the financial market and to hold a larger proportion of risky assets, (III) in the long term, affected by a crowding out effect caused on by labor income risk, the increase degree of household risky assets share is lower than that in the short term. Moreover, compared with the current tax system, the volatility of household risky asset holdings is smaller than that in the tax system where tax is levied at the unit of household, which benefit for enhancing households' financial portfolio stability.**

***Index Terms*—Income tax system, household tax burdens, labor income level, labor income risk, portfolio.**

I. Introduction

Carroll *et al*. (2003) [1] find that wealthier households tend to hold a larger proportion of risky assets than less wealthy households. As an institutional factor of income, personal income tax has an important impact on household asset allocation.

In 1944, Domar and Musgrave [2] did the pioneering work of incorporating income taxation into asset allocation, which opened a new chapter of research on portfolio composition. Later studies concentrate more on the effect of the marginal tax rate on portfolios [3]-[6]. Labor income tax has been ignored. Labor income plays a significant role in household financial portfolios and is very distinctive. On the one hand, labor income is an important source of household wealth, and the wealth effect brought on by the increase in the labor income level will encourage households to hold more risky assets. On the other hand, labor income is uncertain due to the lack of a private insurance market. Labor income risk causes households to save more as a precaution, thus producing a crowding out effect and reducing venture capital investment [7]-[9].

This paper gives a focus on the effect of labor income tax on household portfolio according to the recent fierce discussion about transforming the current individual income tax system (ITS) to the system where tax is levied at the unit of the household (HTS)[2]. In light of the fact that reform is still in discussion and that China has not yet introduced specific measures for household declaration of income, we must learn from the experience of other countries and previous studies. It defines that HTS should be on the basis of current tax system [3] and tax liabilities should be calculated with a household's per capita income[4] [10].

We firstly construct a model to calculate the household average tax rate in ITS and HTS, respectively, combining with the data from Chinese Household Income Project Survey (CHIP (2013)). We find that the household average tax rate and its variance ratio are both smaller in HTS than in ITS both in static and dynamic analyses. Moreover, the volatility of the tax burden is lower in HTS, which may well has an effect on household optimal portfolios [11]. From such a result, we deduce that HTS is a better tax system for reducing the tax burden, narrowing the income gap, reducing labor income risk and stabilizing household income levels in the long term.

Based on the conclusion above, we secondly construct an optimal portfolio model on the impact of the tax burden to examine the effect of the tax burden on household portfolios. Through a linear approximation, this paper presents an analytic solution to household optimal portfolios, which gives two paths for tax burdens affecting household risky asset holdings: labor income level path and labor income risk path. In detail, The previous one is "tax burden ↓ -disposable income ↑ -investors' risk aversion coefficient ↓ -a 'wealth effect'-proportion of risky assets ↑," and the latter one is "tax burden ↓ -labor income risk ↓ -investors' risk aversion coefficient ↓ -a negative 'crowding out effect'-proportion of risky assets ↑."

Finally, we carry out numerical tests on the model with baseline parameters and data from CHIP (2013). The results show that HTS is helpful in reducing the household tax burden and enhancing households' enthusiasm to both participate in the financial market and hold a larger proportion of risky assets, and there is a characteristic of "high income/high benefit and low income/low benefit" in

Manuscript received February 10, 2019; revised May 27, 2019.

Yulin Liu is with the School of Public Affairs, Chongqing University, Campus A, NO. 174 Sha Zheng Street, Shapingba District, Chongqing, China (e-mail: lylmx@cqu.edu.cn).

Min Zhang is with the Economics and Business Administration, Chongqing University, Campus A, NO. 174 Sha Zheng Street, Shapingba District, Chongqing, China (e-mail: lydiazm@163.com).

[2] In this article, China's current tax system where tax is levied at the unit of the individual is abbreviated as ITS; and the tax system where tax is levied at the unit of the household is abbreviated as HTS. And the income tax system changes from ITS to HTS we call it a tax reform.

[3] That is to ensure the tax deduction standard and the tax rate structure remain unchanged.

[4] The reason why we choose "per capita income" to calculate tax rather than the average income of husband and wife is that there is a "one-size-fits-all" drawback in the current tax exemption. Calculating tax with per capita income, to a certain extent, can achieve the same effect as the deduction in a country with a perfect household tax system.

doi: 10.18178/joebm.2019.7.4.599

the short term of this reform, but not in the long term.

The main contribution of this paper is to explore the effect of labor income tax on household demand for risky assets. Two forms of the individual income tax system-the system where tax is levied at the unit of individual, and the system where tax is levied at the unit of the household-are compared. We give two paths of tax burden in different tax systems affecting on household risky asset holdings-labor income level path and labor income risk path-by introducing the tax impact into the standard optimal portfolio model. The paper uses a unique micro dataset of China from CHIP (2013), which provide us a deeply insight of household tax burdens and portfolios.

The paper is organized as follows. The next section contains theoretical mechanism analysis. We compare the difference in household tax burdens between HTS and ITS and construct an optimal portfolio model considering the impact of tax. Section III is a numerical simulation, where we analyze the "wealth effect" and the "crowding out effect" of the average household tax burden on risk asset selection through the numerical simulation by using empirically plausible parameter values. Section IV concludes.

II. The Model

We introduce the tax impact into the standard optimal portfolio model. First, based on China's current seven-bracket progressive income tax system, we compare the average household tax burden between HTS and ITS to provide a reference for further research. Second, we add tax friction to the labor income process, which is also the place where the model in this article differs from the standard model. Finally, we define household investment decisions.

A. The Difference in Average Household Tax Burden between HTS and ITS

Assuming that the unit income of a representative individual is W_t, we can find the average tax rate θ_{it} in ITS is

$$\theta_{it}=\frac{[(W_tH_t-E)\tau_i-\varepsilon_i]L_t}{W_tH_tL_t}=(1-\frac{E}{W_tH_t})\tau_i-\frac{\varepsilon_i}{W_tH_t} \quad (1)$$

where the subscript t represents the different periods, H_t is human capital, L_t is the number of people with labor income in a household, and E is income tax deduction. The tax system in China is a seven-bracket progressive tax system, thus the subscript $i=1,2,...,7$ represents the different tax brackets, τ_i is the marginal tax rate of tax bracket i, and ε_i is the quick calculation deduction of tax bracket i. Further, we assume that the number of people in a household is N_t, then the average tax rate θ_{jt} in HTS is

$$\theta_{jt}=\frac{\left[(\frac{W_tH_tL_t}{N_t}-E)\tau_j-\varepsilon_j\right]N_t}{W_tH_tL_t}=(1-\frac{E}{W_tH_t}\frac{N_t}{L_t})\tau_j-\frac{\varepsilon_j}{W_tH_t}\frac{N_t}{L_t} \quad (2)$$

where $j=1,2,...,7$ represents the different tax brackets, τ_j is the marginal tax rate of tax bracket j, and ε_j is the quick calculation deduction of tax grade j. We take formula (1) minus (2), and we can calculate

$$\theta_{it}-\theta_{jt}=(\tau_i-\tau_j)+\frac{E}{W_tH_t}\left(\frac{N_t}{L_t}\tau_j-\tau_i\right)+\frac{1}{W_tH_t}\left(\frac{N_t}{L_t}\varepsilon_j-\varepsilon_i\right) \quad (3)$$

where $L_t/N_t\le 1$ is household labor participation rate[5]. Now, we analyze formula (3) in different conditions:

Situation 1. when personal income and household per capita income are in the same tax bracket or the household per capita income is under the exemption E, that is to say, $\tau_i=\tau_j$ and $\varepsilon_i=\varepsilon_j$, or $\theta_{jt}=0$, then $\theta_{it}-\theta_{jt}\ge 0\Rightarrow\theta_{it}\ge\theta_{jt}$;

Situation 2. when $\tau_i>\tau_j$ [6] and $\varepsilon_i>\varepsilon_j$, then the symbol of $\theta_{it}-\theta_{jt}$ depends on household labor participation rate and total household income. Based on data from CHIP (2013), we use the seven-bracket progressive income tax system as an example to make a comparative analysis. As Table I shows, $\theta_{it}-\theta_{jt}\ge 0$ is true in all conditions.

B. Specification of the Model

We conduct an analysis across the two dimensions of "labor income risk" and "labor income level." On the basis of Viceira (2001) [8], we construct an optimal portfolio model with the impact of tax burden to discuss the internal mechanism and effect of tax reform on a household financial asset portfolio.

We assume that the total household wealth consists of individual labor income and financial assets investment return, and then the final wealth of representative investor is

$$X_{t+1}=[X_t+W_t\mathrm{H}_t(1\text{-}\theta_t)-C_t]R_{p,t+1} \quad (4)$$

$$R_{p,t+1}=\alpha_t(R_{s,t+1}-R_f)+R_f \quad (5)$$

$$E[r_{s,t+1}-r_f]=\mu \quad (6)$$

where X_t, X_{t+1} is the final wealth, W_tH_t is the current labor income, C_t is the current consumption, $R_{p,t+1}$ is the one-period comprehensive return of risky and riskless assets, α_t is the proportion of risky assets, $R_{s,t+1}$ ($r_{s,t+1}=\log R_{s,t+1}$) and R_f ($r_t=\log R_f$) are yields of risky assets and riskless assets respectively, and μ is the expected excess log return on risky assets, which is constant.

1) Labor income risk

There is undiversifiable risk in labor income, which is subject to both permanent and transitory shocks [12]-[14]. Due to the short-term irreversibility of institutional reform, we ignore transitory shocks and take only permanent shocks into account in accordance with Carroll (1996, 1997). In

[5] Here, the "household labor participation rate" refers to the proportion of members with labor income in the total household population.

[6] The labor income of an individual is greater than per capita income in a household, though not strictly, so it is impossible for $\tau_i<\tau_j$.

addition, only individuals with labor income will be affected by income tax; thus, in this article, we assume that an individual is a fully employed adult. We then give the labor income process as:

$$Y_{t+1} = Y_t \exp(g + \xi_{t+1}) \tag{7}$$

where $\xi_{t+1} \sim NIID(0, \sigma_\xi^2)$ is permanent shocks. μ_{t+1} is the unexpected log return on risky assets, we assume that μ_{t+1} is contemporaneously correlated with innovations in log labor income with $Var_t(\mu_{t+1}) = \sigma_\mu^2$ and $Cov_t(\mu_{t+1}, \xi_{t+1}) = \sigma_{\xi\mu}$. Because the heavier the tax burden is, the farther the growth rate of disposable income deviates from the normal labor income growth rate g, we further consider the "tax multiplier influence" on labor income risk and extend the hedging process as $Cov_t(\mu_{t+1}, \theta_{t+1}\xi_{t+1}) = \theta_{t+1}\sigma_{\xi\mu}$.

TABLE I: CHANGES OF THE EXPECTED TAX BURDEN IN HTS

Tax level	income	Household labor participation rate					
		1/2	1/3	2/3	1/4	2/4	3/4
1	3501	>0 (0)	>0 (0)	>0 (0)	>0 (0)	>0 (0)	>0 (0)
	5000	>0 (0.009)	>0 (0.009)	>0 (0.009)	>0 (0.009)	>0 (0.009)	>0 (0.009)
2	5001	>0 (0.009)	>0 (0.009)	>0 (0.009)	>0 (0.009)	>0 (0.009)	>0 (0.009)
	8000	>0 (0.039)	>0 (0.043)	>0 (0.043)	>0 (0.043)	>0 (0.043)	>0 (0.043)
3	8001	>0 (0.039)	>0 (0.043)	>0 (0.043)	>0 (0.043)	>0 (0.043)	>0 (0.043)
	12500	>0 (0.072)	>0 (0.095)	>0 (0.082)	>0 (0.100)	>0 (0.100)	>0 (0.033)
4	12501	>0 (0.072)	>0 (0.095)	>0 (0.050)	>0 (0.100)	>0 (0.100)	>0 (0.033)
	38500	>0 (0.049)	>0 (0.099)	>0 (0.024)	>0 (0.132)	>0 (0.049)	>0 (0.016)
5	38501	>0 (0.049)	>0 (0.099)	>0 (0.024)	>0 (0.132)	>0 (0.049)	>0 (0.016)
	58500	>0 (0.049)	>0 (0.081)	>0 (0.033)	>0 (0.114)	>0 (0.049)	>0 (0.022)
6	58501	>0 (0.049)	>0 (0.081)	>0 (0.033)	>0 (0.114)	>0 (0.049)	>0 (0.022)
	83500	>0 (0.061)	>0 (0.087)	>0 (0.038)	>0 (0.109)	>0 (0.061)	>0 (0.027)
7	83501	>0 (0.064)	>0 (0.087)	>0 (0.038)	>0 (0.109)	>0 (0.061)	>0 (0.027)

Because the situation where individual income is the same as per capita income, that is "$L = N$" has been discussed in the text, here in the table we just give the result of "$L < N$". "> 0" refers to $\theta_{it} - \theta_{jt} > 0$, and the value in "()" is the value of $\theta_{it} - \theta_{jt}$. The unit of income is "Yuan" in the second column.

2) Labor income level

We depict the influence of the change in labor income level on investors' risk aversion degree. The higher the level of labor income is, the stronger the investor's ability to take a risk and the smaller the degree of risk aversion [15]; thus, we can show the improved, time separable, power instantaneous utility function as:

$$U(C_t) = \begin{cases} \dfrac{C_t^{1-\gamma[1-g(1-\theta_t)]}}{1-\gamma[1-g(1-\theta_t)]}, 0 < \gamma[1-g(1-\theta_t)] < 1 \\ \ln C_t, \gamma[1-g(1-\theta_t)] = 1 \end{cases} \tag{8}$$

where γ is the coefficient of standard relative risk aversion, and $\gamma[1-g(1-\theta_t)]$ is the coefficient of improved relative risk aversion in the situation where labor income is variable.

3) The investor's optimization problem

Given unchanging individual investment opportunities, we assume that individuals invest only in risky assets and riskless assets. We can describe the optimization problem as:

$$\underset{c_t,\alpha_t}{Max} \quad E\left[\sum_{t=0}^{\infty} \delta^t U(C_t)\right] \tag{9}$$

$$s.t. \quad X_{t+1} = (X_t + W_t H_t (1-\theta_t) - C_t) R_{p,t+1} \tag{10}$$

where $0 < \delta < 1$ is the discount rate.

Following Viceira (2001) [8], we use the method of undetermined coefficients to find an approximation to the optimization problem above. Formulas (9) and (10) can be transformed into:

$$1 = E_t[\delta^t (\frac{C_{t+1}}{C_t})^{-\gamma[1-g(1-\theta_t)]} R_{k,t+1}] \tag{11}$$

$$\begin{aligned} 0 &= \mathrm{t}\log\delta - \gamma[1-g(1-\theta_t)]E_t[c_{t+1} - c_t] + E_t[r_{k,t+1}] \\ &+ \frac{1}{2} Var_t\{r_{k,t+1} - \gamma[1-g(1-\theta_t)](c_{t+1} - c_t)\} \end{aligned} \tag{12}$$

$$\begin{aligned} x_{t+1} - w_{t+1}h_{t+1}(1-\theta_{t+1}) &\approx k + \rho_x(x_t - w_t h_t (1-\theta_t)) \\ &-\rho_c(c_t - w_t h_t(1-\theta_t))\Delta w_{t+1}h_{t+1}(1-\theta_{t+1}) + r_{p,t+1} \end{aligned} \tag{13}$$

where $k = s, f, p$ and

$$\rho_x = \frac{\exp\{E[x_t - w_t h_t(1-\theta_t)]\}}{1+\exp\{E[x_t - w_t h_t(1-\theta_t)]\} - \exp\{E[c_t - w_t h_t(1-\theta_t)]\}}$$

$$\rho_c = \frac{\exp\{E[c_t - w_t h_t(1-\theta_t)]\}}{1+\exp\{E[x_t - w_t h_t(1-\theta_t)]\} - \exp\{E[c_t - w_t h_t(1-\theta_t)]\}}$$

$$k = -(1-\rho_w+\rho_c)\log(1-\rho_w+\rho_c) - \rho_w\log(\rho_w) + \rho_c\log(\rho_c)$$

$$r_{p,t+1} = \alpha_t(r_{s,t+1} - r_t) + r_f + \frac{1}{2}\alpha_t(1-\alpha_t)\sigma_\mu^2$$

Substituting equation (12) for $k = f$ and $k = s$, we find the log excess return verifies the following equation:

$$E[r_{s,t+1}] - r_f + \frac{1}{2}Var_t(r_{s,t+1}) = \gamma[1-g(1-\theta_t)]Cov_t(r_{s,t+1}, c_{t+1}-c_t) \quad (14)$$

We gauge the functional form of the optimal policies as:

$$c_t - w_t h_t(1-\theta_t) = b_0 + b_1(x_t - w_t h_t(1-\theta_t)) \quad (15)$$

$$c_{t+1} - w_{t+1}h_{t+1}(1-\theta_{t+1}) = b_0 + b_1(x_{t+1} - w_{t+1}h_{t+1}(1-\theta_{t+1})) \quad (16)$$

Thus, based on equation (13), (15) and (16), we get:

$$\begin{aligned}\gamma[1-g(1-\theta_t)]Cov_t(r_{s,t+1}, c_{t+1}-c_t) &= \gamma[1-g(1-\theta_t)] \\ &\times[\alpha_t b_1\sigma_\mu^2 + (1-b_1)(1-\theta_t)\theta_t\sigma_{\xi\mu}]\end{aligned} \quad (17)$$

Combined with equation (14), we get:

$$\alpha_t = \underbrace{\frac{\mu+\sigma_\mu^2/2}{\gamma[1-g(1-\theta)]b_1\sigma_\mu^2}}_{path1:\ labor\ income\ level} - \underbrace{\frac{(1-b_1)(1-\theta)\theta\sigma_{\xi\mu}}{b_1\sigma_\mu^2}}_{path2:\ labor\ income\ risk} \quad (18)$$

where $0 < b_1 < 1, b_1 = (\rho_x - 1)/\rho_c$.

From the model, we draw two paths of tax burdens affecting household risky asset holdings. The first is the labor income level path: "tax burden ↓ -disposable income ↑ -investors' risk aversion coefficient ↓ -a 'wealth effect'-proportion of risky assets ↑," and the second is the labor income risk path: "tax burden ↓ -labor income risk ↓ -investors' risk aversion coefficient ↓ -a negative 'crowding out effect'-proportion of risky assets ↑." From formula (18), we can get the partial derivatives through two mechanisms:

Path 1. The effect of risk aversion $\gamma[1-g(1-\theta)]$ on α_t under the impact of a tax burden: setting $\gamma[1-g(1-\theta)] = \gamma^*$, we can get $\partial\alpha_t/\partial\gamma^* = -1/(\gamma^*)^2 \times (\mu+\sigma_\mu^2/2)/b_1\sigma_\mu^2$ and $\partial\gamma^*/\partial\theta = \gamma g$, since μ, b_1, γ and g are always greater than 0, so, $\partial\alpha_t/\partial\gamma^* < 0$ and $\gamma g > 0$. From this analysis, we can get:

Hypothesis 1: Given that other conditions remain unchanged, the heavier the tax burden is, the greater the coefficient of risk aversion γ^* and the smaller the proportion of investors' risky assets.

Path 2. The effect of covariance of risk assets return and labor income growth rate $\sigma_{\xi\mu}$ on α_t under the impact of a tax burden: setting $\theta\sigma_{\xi\mu} = \sigma_{\xi\mu}^*$, we can get $\partial\alpha_t/\partial\sigma_{\xi\mu}^* = -(1-b_1)(1-\theta)/b_1\sigma_\mu^2$ and $\partial\sigma_{\xi\mu}^*/\partial\theta = \sigma_{\xi\mu}$. Since $0<b_1<1$ and $0<\theta<1$, so $\partial\alpha_t/\partial\sigma_{\xi\mu}^* < 0$. If there is a negative correlation between risky assets' returns and labor income that $\sigma_{\xi\mu} < 0$, then investing into risky assets could block a negative impact on labor income, and in turn prompt investors to increase their share of risky assets. Because the increase in the average tax rate will result in a relatively low labor income, investors will hold more risky assets with tax burden increased. If there is a positive correlation between risky assets' returns and labor income that $\sigma_{\xi\mu} > 0$, investors will reduce their proportion of risky assets with the tax burden increased. From this analysis, we get:

Hypothesis 2: If other conditions remain unchanged in the situation $\sigma_{\xi\mu} < 0$, the heavier the tax burden is, the greater the labor income risk and proportion of risky assets; in the situation $\sigma_{\xi\mu} > 0$, the heavier the tax burden is, the greater the labor income risk but the smaller the proportion of risky assets.

III. A Calibrated Example

A. Individual Income Tax Reform: Short-Term Static Effects with Fixed Income

In the short term, labor remuneration remains unchanged; thus, this reform directly affects household relative disposable income. For easy analysis, we examine the short-term static effects caused by household tax burdens with the benchmark case and the household real average tax burdens.

Table II reports the results with the benchmark case and shows that as the average tax rate increases, investors with different risk preferences will reduce their share of risky assets. This is because that the increased tax burden will lead to a decrease in disposable income and in turn strengthen investors' liquidity constraints [16].

Based on the data from CHIP (2013), Fig. 1 reports the changes in the average tax burden and in proportion of risky assets caused by the individual tax reform. As predicted by Hypothesis 1, for a given income level, there is a lower average tax burden in HTS than in ITS, which brings a relative increase in disposable income. This, in turn, as Fig. 1(b) gives, results in a wealth effect enhancing investors' ability to undertake risk and thus increases the proportion of risky assets.

B. Individual Income Tax Reform: Long-Term Dynamic Effects with Income Variation

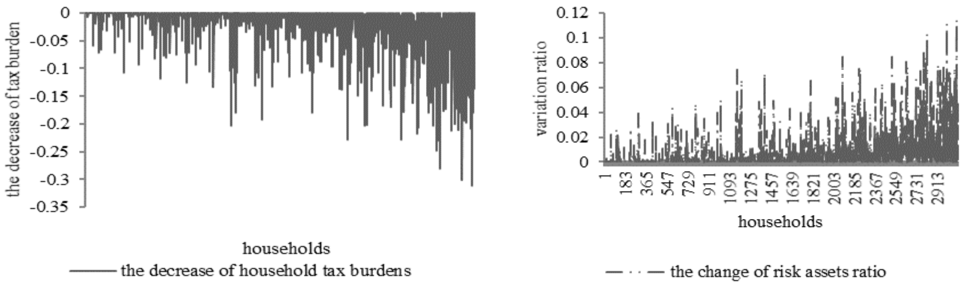
In the long run, household tax burdens change with income variation, and tax reform has a direct impact on the fluctuation rate of household tax burdens with income change, which thus affects the relative disposable income and the absolute labor income risk. Similarly, we also examine the long-term dynamic effects caused by tax reform with the benchmark case and the household real average tax burdens.

Traditional Chinese culture makes investors more conservative; therefore, we set the benchmark coefficient of relative risk aversion as 10. Table III reports the dynamic impact effect of the average tax burden and income variation with the benchmark case. This shows that when the average tax rate is given, the proportion of risky assets increases with income growth, and with the increase in tax burden, the growth rate of risky assets share reduces when income increases. From a vertical perspective, the greater the wage growth rate is, the greater the risky asset share will decrease as the average tax burden increases.

TABLE II: THE AVERAGE TAX BURDEN-PROPORTION OF RISKY ASSETS

	Coefficient of relative risk aversion (γ)					
θ	2	3	5	8	10	12
0.005	3.440698	2.293735	1.376165	0.832724	0.666141	0.555086
0.025	3.433166	2.288466	1.372706	0.830919	0.664548	0.553635
0.045	3.425691	2.283245	1.369288	0.829148	0.662989	0.552216
0.065	3.418273	2.278072	1.365912	0.827409	0.661462	0.55083
0.085	3.410912	2.272948	1.362577	0.825705	0.659968	0.549477

The numbers in the table report the portfolio shares of risky assets across different risk aversions and different household average tax rates. They are based on the following baseline parameter values: $g=0.09$, μ=0.2507, $b_1=0.9933$, σ_μ^2=0.0438, $\sigma_{\xi\mu}$=0.25, σ_ξ^2=0.02.



(a) (b)

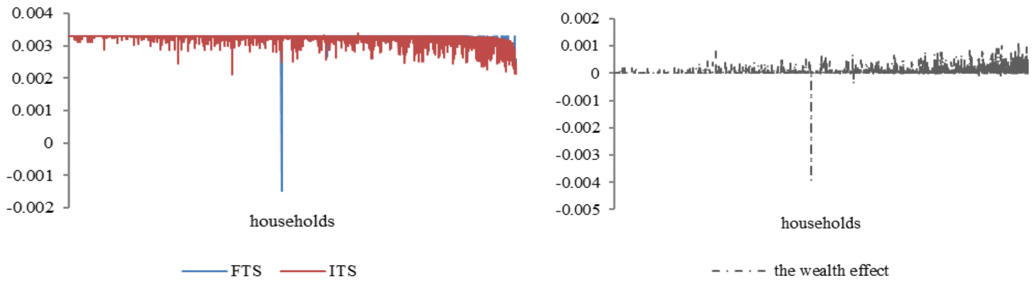
Fig. 1. The effect of tax reform based on the data from CHIP (2013) ($g=0.09$).

TABLE III: TAX BURDEN-PROPORTION OF RISKY ASSETS

	Coefficient of relative risk aversion (γ)					
θ	g =0.01	g=0.03	g =0.06	g =0.09	g =0.12	g =0.15
0.005	0.632658	0.645639	0.666141	0.687987	0.711315	0.736279
0.025	0.631787	0.644497	0.664548	0.685886	0.708638	0.732948
0.045	0.630946	0.643385	0.662989	0.683821	0.706002	0.729666
0.065	0.630137	0.642305	0.661462	0.681792	0.703407	0.726432
0.085	0.629358	0.641256	0.659968	0.679799	0.700853	0.723247

The numbers in the table report the portfolio shares of risky assets across different income growth rates and different household average tax rates. They are based on the following baseline parameter values: $\gamma=10$, μ=0.2507, $b_1=0.9933$, σ_μ^2=0.0438, $\sigma_{\xi\mu}$=0.25, σ_ξ^2=0.02.

Based on the data from CHIP (2013) and setting the income growth as 0.03 and 0.06 as an example, Fig. 2 reports the volatility of households' proportion of risky assets with income growth. Fig. 2(a) reports the wealth effect brought on by income growth in HTS and ITS, and 2(a') reports the wealth effect brought on by the tax reform. Fig. 2(b) reports the crowding out effect caused by labor income risk with income growth in HTS and ITS, and 2(b') reports a negative crowding out effect caused by the tax reform because the multiplicative influence from tax burden is weakened in HTS. Fig. 2(c) reports household share of risky assets in HTS and ITS, and Fig. 2(c') reports the volatility of the proportion of risky assets caused by income growth from the tax reform.As predicted by Hypothesis 2, household tax burdens decrease with the tax reform and in turn reduce the multiplicative influence on labor income risk. In addition, household disposable income increases simultaneously, which improves households' ability and willingness to take risks in the financial market under the double action of a negative crowding out effect and a wealth effect, thus prompting investors to hold more risky assets.



(a) (a')

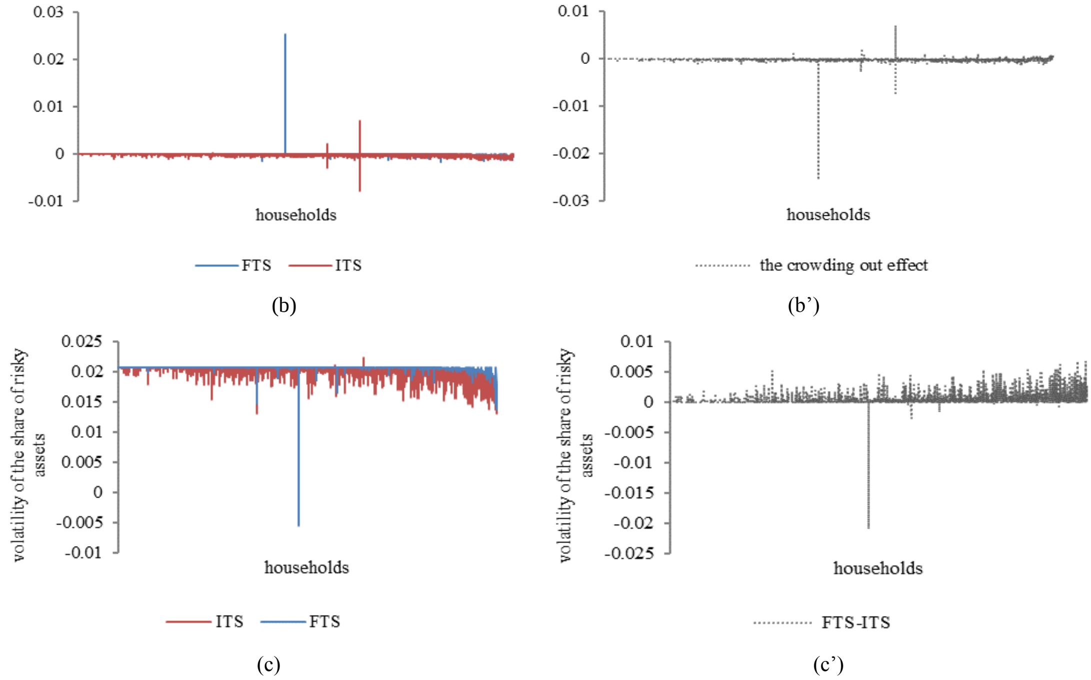


Fig. 2. Income growth: tax burden-volatility in share of risky assets.

These allocations are based on the following baseline parameter values: $g = 0.03, 0.06$ $\gamma = 10$, μ=0.2507 , $b_1 = 0.9933$, σ_μ^2=0.0438 , $\sigma_{\xi\mu}$=0.25 , σ_ξ^2=0.02 .

IV. Conclusion

Household asset allocation has been an enduring topic in the research about domestic finance. On the basis of existing literature, we examine the micro household effect of taxable units from the perspective of personal labor income tax for the first time, and we come to the following conclusions:

(I) In the situation of fixed income, the tax system where tax is levied at the unit of the household (HTS) is more conducive to reducing household tax burdens and narrowing the income gap, especially for households with low labor participation, large population size and heavy expenditure burden. Besides, the volatility of household tax burdens is lower in HTS than in the tax system where tax is levied at the unit of individual (ITS), which indicates that HTS has a long-term effectiveness in enhancing households' expected income stability and reducing income floating risk.

(II) There is both a wealth effect and a negative crowding out effect on the share of households' risky assets under the tax reform transition from ITS to HTS. In the short term, household tax burdens reduced in HTS, and there is an increase in relative disposable income. These results in a wealth effect that enhances households' willingness and ability to undertake financial market risks, and to, in turn, help to promote households' participation in financial markets and higher-investment in risky assets. In the long term, HTS can also reduce the multiplicative influence of the tax burden on labor income risk. Thus, the result of both the wealth effect and the negative crowding out effect increases household share of risky assets and enhances the stability of household financial portfolios.

In conclusion, the current unreasonable tax pattern is one of the important reasons why China's personal income tax has no lasting effective effect on regulating income distribution. Under the constraints of disposable income and labor income risk, Chinese households prefer precautionary savings investments. At present, the government is actively promoting individual tax reform. As an important part of this tax reform, the transformation of the tax unit is an effective measure to reduce household tax burdens and then increase the share of risky assets. Based on the conclusion of this article, HTS is an effective tax pattern to reduce household tax burdens and raise the proportion of household risky assets.

Considering tax directly effects only with labor income, we assume that the representative investor is an adult. However, individual life can be divided into adolescence, adulthood and old age, and an investor's labor income and attitude toward risk change with age. Thus, he may choose different portfolios at different stages of life. Moreover, since HTS can help to reduce household tax burdens, birth can be a means of tax avoidance. That is to say, investment in childbearing and offspring may squeeze out investment in risky assets caused by the lower tax burden lowering to a certain extent. We will explore these issues in future research.

Acknowledgment

We thank for the following funding: the surface of National Natural Science Fundation of China [grant no. 71773011]; the National "Four Batch" Talent Project; and the Fundamental Innovation Research Funds for the Central Universities [grant no. 2017CDJSK].

References

[1] C. D. Carroll, K. E. Dynan, and S. D. Krane, "Unemployment risk and precautionary wealth: Evidence from households' balance sheets," *Review of Economics & Statistics*, vol. 85, no. 3, pp. 586-604, 2003.

[2] E. D. Domar and R. A. Musgrave, "Proportional income taxation and risk-taking," *Quarterly Journal of Economics*, vol. 58, no. 3, pp. 388-422, 1944.

[3] M. A. King and J. I. Leape, "Wealth and portfolio composition: Theory and evidence," *Cepr Discussion Papers*, vol. 69, no. 2, pp. 155-193, 1985.

[4] J. M. Poterba and A. A. Samwick, "Taxation and household portfolio composition: US evidence from the 1980s and 1990s," *Journal of Public Economics*, vol. 87, no. 1, pp. 5-38, 2003.

[5] M. S. Jr and J. Ward-Batts, "The impact of separate taxation on the intra-household allocation of assets: Evidence from the UK," *Journal of Public Economics*, vol. 88, no. 9-10, pp. 1989-2007, 2004.

[6] S. Alan, K. Atalay, T. F. Crossley *et al*., "New evidence on taxes and portfolio choice," *Journal of Public Economics*, vol. 94, no. 11-12, pp. 813-823, 2010.

[7] L. Guiso, T. Jappelli, and D. Terlizzese, "Income risk, borrowing constraints, and portfolio choice," *American Economic Review*, vol. 86, no. 1, pp. 158-172, 1996.

[8] L. M. Viceira, "Optimal portfolio choice for long - Horizon investors with non-tradable labor income," *Journal of Finance*, vol. 56, no. 2, pp.433-470, 2001.

[9] X. Angerer and P. S. Lam, "Income risk and portfolio choice: An empirical study," *Journal of Finance*, vol. 64, no. 2, pp. 1037-1055, 2009.

[10] V. Larcinese, "Personal and household income taxation in a progressive tax system: Evidence from Italy," *Lse Research Online Documents on Economics*, vol. 8, no. 1, pp. 1-9, 2005.

[11] H. J. Tsai and Y. Wu, "Optimal portfolio choice for investors with industry-specific labor income risks," *Finance Research Letters*, vol. 11, no. 4, pp. 429-436, 2014.

[12] T. E. Macurdy, "The use of time series processes to model the error structure of earnings in a longitudinal data analysis," *Journal of Econometrics*, vol. 18, no. 1, pp. 83-114, 1982.

[13] J. M. Abowd and D. Card, "On the covariance structure of earnings and hours changes," *Econometrica*, vol. 57, no. 2, pp. 411-445, 1989.

[14] C. D. Carroll, R. E. Hall, and S. P. Zeldes, "The buffer-stock theory of saving: Some macroeconomic evidence," *Brookings Papers on Economic Activity*, no. 2, pp. 61-156, 1992.

[15] P. Bardhan, S. Bowles, and H. Gintis, "Chapter 10 wealth inequality, wealth constraints and economic performance," *Handbook of Income Distribution*, vol. 1, pp. 541-603, 2000.

[16] M. Haliassos and A. Michaelides, "Portfolio choice and liquidity constraints," *International Economic Review*, vol. 44, no. 1, pp. 143-177, 1999.

Yulin Liu was born in Yunnan, China, in 1966. She graduated from Southwestern University of Finance and Economics in 1986 with a bachelor's degree in economics, graduated from Chongqing University in 2002 with a master's degree in industrial economics, and graduated from Chongqing University in 2006 with a doctorate of technology economy and management.

Yulin is now the PhD supervision and vice president at School of Public Affairs, Chongqing University in Chongqing, China. Yulin's main research area is macroeconomic policy analysis, financial economics and management, government economy and management. Her works are: (1) Liu, Y., *Research on Discrimination Mechanism for Preventing Immiserizing Growth*, Beijing: Commercial press, 2014. (2) Liu, Y., Liu, Y., *Research on the Evaluation and Guarantee System of Chinese Off-Farm Workers' Living Quality*, Beijing: Publishing Company, 2010.

Prof. Liu is (1) one of the leading talents of the third batch of national "ten thousand person plan" in philosophy and social sciences, (2) one of the theoretical talents of national " four batches", (3) talents of the education ministry of the new century, (4) young and middle-aged experts with outstanding contributions in Chongqing.

Min Zhang was born in Sichuan, China, in 1992. She graduated from Chongqing University in 2015 with a bachelor's degree in economics, and now is a doctoral student of applied economics in Chongqing University.