Hitotsubashi Journal of Economics 64 (2023), pp.1-17.
https://doi.org/10.15057/hje.2023001

HOW PROGRESSIVE IS THE MOST POPULAR TAX SCHEME? THE CASE OF SOUTH KOREA*

Taejun Lim

Department of Economics, Dongguk University
Seoul 04620, Republic of Korea
limtaejun@gmail.com

AND

Aram Kim**

Korea University Institute for Political Research
Seoul 02841, Republic of Korea
polaramkim@gmail.com

Received October 2022; Accepted December 2022

Abstract

Using a structural model and the 2018 Korean economy data, we show that even the individuals with relatively low income do not always prefer greater tax progressivity due to reduced economic efficiency (i.e., decrease in aggregate output and consumption) it accompanies. Hence, the counterfactual analyses reveal that the most popularly supported tax and redistribution policy in this economy does not uphold the optimal degree of progressivity for social welfare maximization and sustains about 0.31 of after-tax Gini.

Keywords: Tax Progressivity, Optimal Tax, Political Economy, Redistribution
JEL Classification Codes: C68, D63, H21, H23

I. *Introduction*

The rising income and wealth inequality has been a major concern in most of developed countries. The canonical models (Meltzer and Richard 1981) expect an increase in the public demand for more progressive tax and redistribution. Yet, the extant policy packages are often insufficient to alleviate problems associated with rising inequality in the absence of corresponding expansion of tax and redistribution (Alt and Iversen 2017; Rehm 2011). In this

* We are grateful to anonymous referees for insightful comments and suggestions. All remaining errors are our own.
** Corresponding author.

paper, we present a structural model that provides the micro-foundation for the cause of such unmatched policy responses to rising inequality. Specifically, the model shows that individuals with relatively low income do not always prefer larger tax and redistribution, owing to the loss in economic efficiency (i.e., reduced aggregate output and consumption) that accompanies greater tax progressivity and reduces the amount of government transfers they would receive. As a result, using the model combined with the 2018 Korean economy data, we find that the most popularly supported tax and redistribution package in this economy is suboptimal in terms of social welfare maximization and sustains about 0.31 of after-tax Gini.

The relevant literature in political economy has turned to explanatory factors exogenous to the standard tax and redistribution model, in order to provide an answer to the suboptimality of the existing tax schedules in many of advanced economies. Some of these studies argue that a variety of economic factors, such as the reference point and the externality of public expenditure, should be taken into consideration when making an inquiry on the social choice for tax and redistribution (Charite et al. 2015; Heathcote et al. 2016; Weinzierl 2014). One strand of literature in political economy pays attention to increasing migration and ethnic heterogeneity that undermine “social affinity” (or altruism) between the middle class and the poor and contribute to decrease the amount of redistribution (Lupu and Pontusson 2011; Dahlberg, Edmark, and Lundqvist 2012; Finseraas 2012). Another focuses on individuals’ risk exposure that affects the demand for redistribution and is closely linked to their education and occupation (Alt and Iversen 2017; Barth, Finseraas, and Moene 2015; Moene and Wallerstein 2001; Rehm 2009).

Our structural model does without noneconomic factors yet characterizes a given economy with precision. More specifically, we model an economy consisting of individuals specified by their age, income and savings. Following some of the key studies, we assume log-linearity of the individual income tax schedule (Benabou 2002; Chang et al. 2018; Heathcote et al. 2016). The heterogeneous-agent model is fitted so that the major parameters of the model are calibrated to exactly match the actual features of 2018 Korean economy. Importantly, our model shows how, depending on the economic status of the given society (e.g., income distribution), a majority of individuals may support policies that are suboptimal in terms of maximizing social welfare and/or reducing inequality.

Using a structural model with heterogeneous agents, we calibrate the parameters of the model to reflect 2018 Korean economy in setting up a benchmark model. We, then, compute different stationary equilibria of experimental economy of which features are identical to the benchmark economy except the income tax scheme. The comparative statics of the model show the impact of a change in tax progressivity on various features of the economy, including the approval rate among the public.

First, we find that income tax progressivity plays a negative role in some key macroeconomic statistics, Notably, the counterfactual experimental models show that GDP drops monotonically with an increase in tax progressivity and that such an adverse impact of a more progressive tax measure stems from the distortions of individuals’ labor and savings decisions. Furthermore, greater tax progressivity monotonically decreases employment rate and aggregate consumption, which is a key factor to determine the level of social welfare. On the other hand, not only the after-tax but also the pre-tax income inequality improves by an increase in income tax progressivity since the increase in tax progressivity makes individuals with high labor productivity less likely to work and save.

Yet, we find that a higher degree of income tax progressivity does not necessarily antagonize society and individuals. We compute social welfare by the weighted average of expected lifetime utility of individuals and find that a more progressive tax would have improved the overall wellbeing of the individuals in 2018 Korea. Our model shows, however, that social welfare does not increase monotonically in tax progressivity; the overall wellbeing of individuals starts dropping past the optimal income tax. Importantly, we compute the approval rate among the individuals and find that the most approved degree of tax progressivity is suboptimal. More specifically, the most popular degree of tax progressivity is slightly greater than the benchmark point yet less than what maximizes social welfare of the population in 2018 Korea.

The rest of the paper is organized as follows. First, we provide a structural model that is characterized by (i) heterogenous individuals in terms of age, labor productivity (hence, wage income and savings), and medical expense, and (ii) progressive tax scheme. Then, we calibrate the parameters of our model in a way that the model economy closely reflects the economic situation and tax scheme in 2018 Korea. Finally, we compute experimental economies in order to examine the impacts of change in income tax progressivity on a set of key macroeconomic statics, social welfare, and voting results.

II. *Model*

To take into consideration of individuals' differential attitude toward the degree of tax progressivity, depending on their age, income, savings, and etc., we adopt a type of heterogeneous agents overlapping generation model.

1. Basic Setup

1) Population

There are infinitely many individuals in the model economy, whose measure is normalized by one. Individuals enter the model economy at the age of 25, get older year by year with a probability of dying, and die at the age of 100. The bequest motive is not considered in the model; we treat all bequests as accidental. When individuals die, their assets are equally distributed to the whole population.

Every year, each individual faces a pair of idiosyncratic shocks, namely, labor productivity shock, x, and medical expense shock, m. Both shocks are assumed to be independent of each other and to follow first-order Markov processes. In addition, the evolution of medical expense is dependent upon age.

The whole population is divided into two groups by the eligibility to work, which is solely determined by age. Those aged under 80, hereafter denoted by working age population, can participate in labor mark et. Those aged 80 and over are treated as retirees.[1] [2]

[1] Working age population is usually defined as those aged 15 to 64. However, it is known that those aged under 25 seldom participates in labor market in Korea and that a significant fraction of those aged over 65 do not leave the labor market. To take this into account, the working age population in this paper is defined as those aged 25 to 79.

2) Preference

The preference of an individual at age j is expressed by the following contemporaneous utility function:

$$u_j(c_t, h_t) = \frac{c_t^{1-\sigma}}{1-\sigma} - B_j h_t$$

That is, the utility of an individual at age j for the current period t is determined by the level of consumption, c_t, and working hours, h_t. The parameter σ measures the degree of relative risk aversion and B_j the level of disutility from working. Note that the disutility from working is age-dependent.

3) Production

Production sector consists of a single representative firm whose production technology is represented by a Cobb-Douglas production function:

$$Y_t = AL_t^{\alpha} K_t^{1-\alpha},$$

where Y_t denotes the level of output the firm produces at time t; L_t and K_t denote the levels of efficient labor and capital the firm employ into production at time t; and A and α represent the total factor productivity (TFP) and labor income share, respectively. Each period, given the levels of efficiency wage and capital rental rate, the firm chooses L_t and K_t to maximize its profit.

4) Government

Government levies tax on consumption goods and individuals' income. The consumption tax is linear, and the tax rate is denoted by τ_c. Following Heathcote et al. (2016), the progressive income tax is adopted. In particular, let ω denote an individual's income. Then, the disposable income, $D(\omega)$, and income tax to be paid, $T(\omega)$, are represented by:

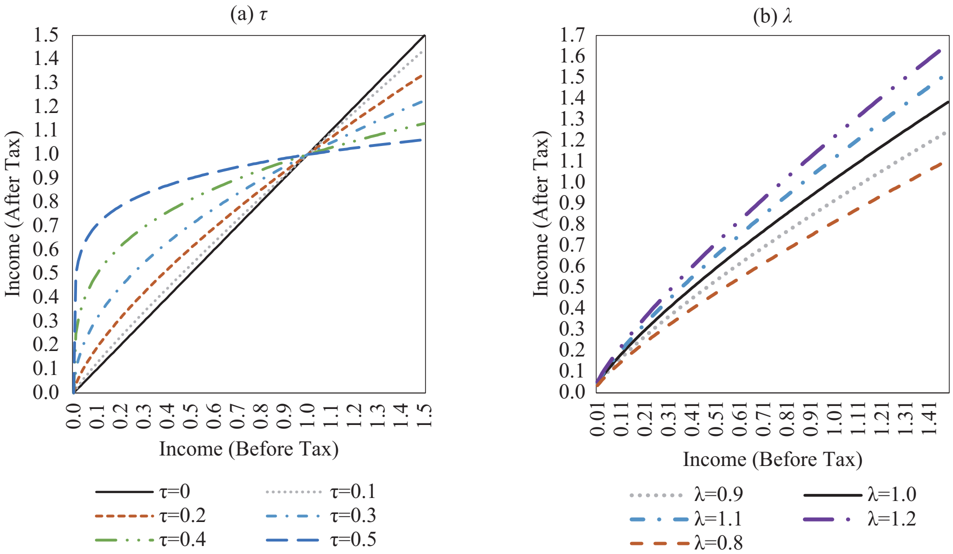
$$D(\omega; \lambda, \tau) = \lambda\omega^{(1-\tau)}$$
$$T(\omega; \lambda, \tau) = \omega - D(\omega; \lambda, \tau) = \omega - \lambda\omega^{(1-\tau)}$$

Figure 1 illustrates the role of τ and λ in our progressive tax scheme. As can be checked in Figure 1 (a), low-income individuals get a subsidy (the lower the more) while high-income individuals need to pay income tax (the higher the more), and such redistribution effect gets larger with a higher value of τ. Thus, τ can be understood as the degree of tax progressivity. On the other hand, Figure 1 (b) shows that λ is a parameter that shifts up or down the curve of after-tax income, which governs the average level of tax in our tax scheme.

In Each period, the collected tax is used for general government consumption, G_t, transfer payment to individuals, TR_t, and the subsidy to the National Health Insurance (NHI).

[2] Individuals aged 80 and over are assumed not to have an option to work. Hence, they are faced only with a single idiosyncratic shock—medical expense, but not labor productivity shock.

Figure 1. The Role of τ and λ in Progressive Tax Scheme



5) National Health Insurance

The NHI is a universal health care that covers a fraction, f, of medical expense of every individual; the out-of-pocket medical expense of an individual with medical expense m is $(1-f)m$. We assume that the NHI has its own balanced budget, independent of the government budget, and the NHI is financed by the NHI premiums collected from the whole population and the government subsidy. The way the NHI premiums are charged varies depending on the employment status. The employed pay the NHI premiums in proportion to their labor income while the non-employed—those who choose not to work among the working age population as well as the retirees—pay the NHI premiums in proportion to their assets. For later reference, let τ_{NHI}^{W} and τ_{NHI}^{R} denote the NHI premium rates for the former and the latter, respectively.

2. Individual's Decision

Given the levels of efficiency wage (w) and interest rate (r), tax scheme (τ, λ), NHI scheme (f, τ_{NHI}^{W}, τ_{NHI}^{R}), the lump-sum government transfer (TR), and bequest (b), individuals attempt to maximize their expected lifetime utility by making decisions on consumption, savings, and work. Notably, given that the stochastic processes of idiosyncratic shocks that individuals confront are first-order Markovian, the utility maximization problem of individuals are to be expressed in a recursive way using Bellman equation (or, value function).

1) Working Age Population

Individuals at the age under 80 have an option to work or not. To capture the age profiles of labor income observed in the data, we assume that the skill level, s_j, of a worker varies by age j. When an individual of age j and labor productivity x decides to provide her h hours to a firm, she earns wage income of $wxs_j h$ at the cost of disutility from working $B_j h$. Alternatively, she can choose not to work, without the disutility from working.

The utility maximization problem of an individual who belongs to the working age population is expressed as follows: for $j \in \{25, 26, ..., 78, 79\}$,

$$V_j(x, m_j, a) = \max_{c, h, a'} u_j(c, h) + \beta(1-\pi_j^d)\mathrm{E}[V_{j+1}(x', m_{j+1}, a') \mid x, m_j] \tag{1}$$

subject to

$$(1+\tau_c)c + (1-f)m_j + a' = \begin{cases} \{D_j(x, m_j, a) + TR + b - \tau_{NHI}^W wxs_j h\} + a, & \text{if } h = \bar{h} \\ \{D_j(x, m_j, a) + TR + b - \tau_{NHI}^R a\} + a, & \text{if } h = 0 \end{cases}$$

$$D_j(x, m_j, a) \equiv \lambda(wxs_j h + ra)^{1-\tau}$$

$$h \in \{0, \bar{h}\}$$

$$c, a' \geq 0$$

where π_j^d denotes the probability of dying of j-year old individual; and $D_j(x, m_j, a)$ represents the after-tax income, which depends on the working choice h.

The right-hand side of the budget constraint shows us her disposable income — the terms inside the braces — plus assets. Note that (i) the disposable income is the sum of the after-tax income, $\lambda(\cdot)^{1-\tau}$, the government transfer, TR, and bequest, b, minus the NHI premiums that she pays, $\tau_{NHI}^W wxs_j h$ when working or $\tau_{NHI}^R a$ when not working, and (ii) the source of after-tax income and the type of NHI premiums vary according to her working choice: when she works, the income tax is levied on both labor income and interest income, and the NHI premium is levied on her labor income; when she does not work, on the contrary, the income tax is levied only on interest income, and that NHI premium is levied only on her assets.

She pays her out-of-pocket medical expense, $(1-f)m_j$, out of her available resources, that is, the disposable income plus assets. She, then, splits the leftover into consumption, c, and saving, a', and at the same time makes her working choice, h, to maximize her (expected) lifetime utility — the sum of current period's utility and discounted (and expected) future value.[3] For simplicity, we assume that the labor choice is discrete in a sense that flexible working hours is disallowed implying that $h = \bar{h}$ when $h \neq 0$.

2) Retirees

Similar to the utility maximization problem of the working age population, the retirees' is expressed as follows: for $j \in \{80, 81, ..., 98, 99\}$,[4]

$$V_j(m_j, a) = \max_{c, a'} u_j(c, 0) + \beta(1-\pi_j^d)\mathrm{E}[V_{j+1}(m_{j+1}, a') \mid m_j] \tag{2}$$

subject to

$$(1+\tau_c)c + (1-f)m_j + a' = \{\lambda(ra)^{1-\tau} + TR + b - \tau_{NHI}^R a\} + a$$

$$c, a' \geq 0$$

[3] The expectation operator, E, is taken with respect to (x', m_{j+1}) given (x, m_j).

[4] The expectation operator, E, is taken with respect to m_{j+1} given m_j.

As can be checked from Equation (2), the retirees do not have an option to work and face a single source of idiosyncratic shock, medical expense m_j. The value function of the retirees resembles that of the working age population that chooses not to work. We hereby omit further explanation.

3. Steady State Equilibrium

Let ς_j denote a set of state variables of a j-year old individual: $\varsigma_j=(x, m_j, a)$ for $j<80$ and $\varsigma_j=(m_j, a)$ for $j\geq 80$. The steady state equilibrium consists of (i) the value functions, $\{V_j(\varsigma_j)\}_{j=25}^{99}$, and the policy function, $\{c(\varsigma_j), h(\varsigma_j), a'(\varsigma_j)\}_{j=25}^{99}$,[5] of the individuals, (ii) the firm's optimal choice on factors of production, (L, K), (iii) the prices of factors of production, (w, r), (iv), a NHI premium rate for workers, τ_{NHI}^{W}, (v) government consumption, G, and (vi) measures of individuals of all ages, $\{\Phi_j(\varsigma_j)\}_{j=25}^{99}$, such that:

A. The value function, $\{V_j(\varsigma_j)\}_{j=25}^{79}$, and the policy function, $\{c(\varsigma_j), h(\varsigma_j), a'(\varsigma_j)\}_{j=25}^{79}$, of the working age population solve the Bellman equation (1), and the value function, $\{V_j(\varsigma_j)\}_{j=80}^{99}$, and policy functions, $\{c(\varsigma_j), a'(\varsigma_j)\}_{j=80}^{99}$, of the retirees solve the Bellman equation (2),

B. L and K maximize the profit of the representative firm:

$$w=\alpha\left(\frac{K}{L}\right)^{1-\alpha}$$

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

C. Both labor and capital markets clear:

$$L=\sum_{j=25}^{79}\left\{\int xs_j h(\varsigma_j)\, d\Phi_j(\varsigma_j)\right\}$$

$$K=\sum_{j=25}^{99}\left\{\int a d\Phi_j(\varsigma_j)\right\}+b,$$

D. The NHI premium rate for workers, τ_{NHI}^{W}, ensures the NHI program budget balance:

$$\underbrace{f\int m_j d\Phi_j}_{\text{NHI Expenditure}}=(1+\tau_{NHI}^{G})\left[\underbrace{\tau_{NHI}^{W}wL+\tau_{NHI}^{R}\left\{\sum_{j=25}^{79}\int I_{h=0}(\varsigma_j)ad\Phi_j+\sum_{j=25}^{99}\int ad\Phi_j\right\}}_{\text{NHI Revenue}}\right]$$

where τ_{NHI}^{G} denotes the government subsidy rate; and $I_{h=0}(\varsigma_j)$ denotes an indicator function that informs whether an individual belonging to the working age population works or not:

$$I_{h=0}(\varsigma_j)=\begin{cases}1, & \text{if } h(\varsigma_j)=0\\ 0, & \text{if } h(\varsigma_j)=\bar{h}\end{cases}$$

[5] As the retirees do not have an option to work, $h(s_j)$ is set to 0 for $j\geq 80$.

E. The government budget is balanced:

$$\underbrace{G+TR+\tau_{NHI}^{G}\cdot\text{NHI Revenue}}_{\text{Gov't Expenditure}}$$
$$=\underbrace{\sum_{j=25}^{99}\left[\tau_c\int c(\varsigma_j)d\Phi_j+\int\left\{(wxs_jh+ra)-\lambda(wxs_jh+ra)^{1-\tau}\right\}d\Phi_j\right]}_{\text{Tax Revenue}},$$

F. The measures of individuals of all ages, $\{\Phi_j(\varsigma_j)\}_{j=25}^{99}$, are invariant over time.

III. *Calibration*

We set the values of parameters for our model so that the stationary equilibrium of the model resembles the Korean economy in 2018 closely. We calibrate the model to target a set of important data moments, such as the employment rate, capital-output ratio, (before- and after-tax) Gini coefficient, and etc. The parameters are grouped into two: ones whose values can be determined exogenously, without any consideration of the model equilibrium, and ones whose values should be determined endogenously. Table 1 lists the parameters belonging to the first group. For these parameters, we either borrow the values from previous studies or take the values directly from the data. The coefficient of relative risk aversion, σ, is set to 1.5, which is wildly adopted in the literature, and the working hours of the employees, $\bar{h}$, 1/3, which is translated to 8 hours a day. The probability of dying by age is taken directly from Korean Statistical Information Service. The values of the labor skill level by age, $\{s_j\}_{j=25}^{99}$, are set so that the average labor income by age that is calculated from the model matches the lifetime labor income profile from the data.[6] The NHI coverage rate, f, is set to 63.8%, as is reported in the NHI Service, and the consumption tax rate, τ_c, 10%, reflects the current rate of value-added tax. Finally, for the stochastic process of labor productivity, we assume that it follows AR(1) process: $\log x_{t+1}=\rho_x\log x_t+\epsilon_t$, where $\epsilon_t\sim N(0,\sigma_x^2)$. The persistency parameter, ρ_x, is set to 0.95, following the existing literature. The volatility parameter, σ_x, will be discussed shortly.

TABLE 1. EXOGENOUSLY CALIBRATED PARAMETERS

Parameter	Description	Source	Value
σ	Coefficient of relative risk aversion	Literature	1.5
$\bar{h}$	Working hours of the employees	Literature	1/3
π_j^d	Probability of dying of j-year	Kosis	-
s_j	Labor skill level by age	Lifetime labor income profile	-
f	Coverage rate of NHI	NHI Service	63.8%
τ_c	Consumption tax rate	Value-added tax rate	10%
ρ_x	Persistency of labor productivity shock	Literature	0.95

[6] In doing so, we normalize that $s_j=1$.

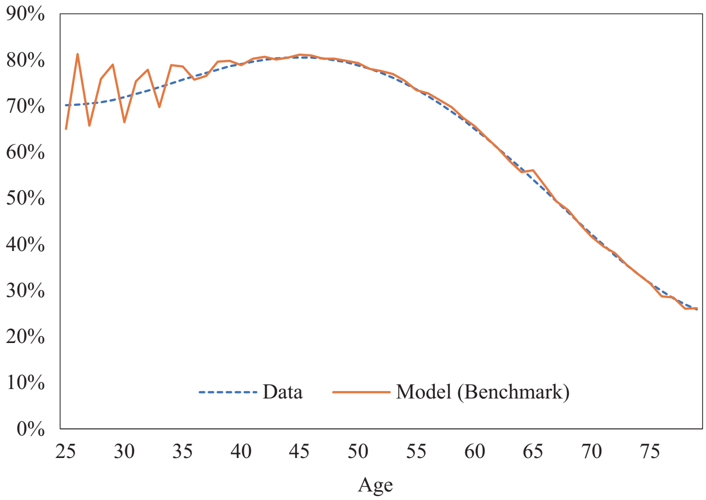
TABLE 2. ENDOGENOUSLY CALIBRATED PARAMETERS

Parameter	Description	Target Moment	Value
β	Subjective discount factor	Agg. Capital to GDP=3.9	0.971
B_j	Disutility from working by age	Employment rate by age	-
σ_x	Volatility of labor productivity shock	Pre-tax income Gini coefficient=0.406	0.141
τ	Degree of tax progressivity	After-tax income Gini coefficient=0.354	0.175
λ	Governing average level of income tax	General gov't consumption to GDP=0.196	0.831
A	Total Factor Productivity	Normalizing GDP: Y=1	1.323
TR	Government transfer	Gov't transfer to GDP=0.038	0.038
τ^R_{NHI}	NHI prem. rate for the non-employed	$\frac{\text{Agg. prem. for the non-employed}}{\text{Agg. prem. for the employed}}=0.175$	0.25%

Table 2 summarizes the parameters of which we set the values strictly within the framework of our model. Each parameter in this group is closely related to a certain moment. For example, the values of the disutility from working by age, $\{B_j\}_{j=25}^{99}$, determine the employment rates by age; a higher value of the disutility from working induces a lower employment rate. Thus, we set a corresponding target moment for each parameter and then determine the value of it to let the values of the model-generated moment and the corresponding data moment be equal.

The subjective discount factor, β, governs the savings motives of individuals: an individual with a higher β tends to save more as she is concerned more to secure against the future income uncertainty, which in turn affects the levels of aggregate savings and capital. As such, we attempt to set the value of β so that the capital-output ratio becomes 3.9. The values of $\{B_j\}_{j=25}^{99}$ are set to reflect the employment rates of those aged 25 to 99. As illustrated in Figure 2, the model-generating employment rate by age is able to closely match the employment rate by age in Korea. The parameter σ_x denotes the standard deviation of residual term of the AR(1)

FIGURE 2. EMPLOYMENT RATE BY AGE: DATA VS. BENCHMARK MODEL



process of labor productivity shock: the higher the value of σ_x, the greater is the dispersion of labor income. Thus, we set the value of σ_x to 0.141, so that we can match the pre-tax income Gini coefficient to the observed value in data, 0.406.

τ and λ are the two parameters that govern the scheme of income tax. The parameter for the degree of tax progressivity, τ, is set to 0.175 so that the after-tax income Gini coefficient is 0.354 as observed in the data. The parameter λ, governs the average level of income tax, and a higher value of λ results in a higher level of aggregate tax revenue, which is translated to a higher level of general government consumption in our model economy. The value of λ is set to 0.831, targeting the ratio of general government consumption to GDP, 19.6%. Total factor productivity, A, is set to 1.323 to normalize such that $Y=1$. The government transfer, TR, is set to 0.038, so that it is 3.8% of GDP.

The value of the NHI premium rate for the employed, τ_{NHI}^{W}, is endogenously determined to guarantee the balanced budget of the NHI. For the premium rate for the non-employed, we set its value so that the aggregate NHI premium collected from the non-employed becomes 17.5% of the aggregate NHI premium collected from the employed, as reported by the NHI service.

For the stochastic process of medical expense, we assume that the medical expense of an individual at any age j is either 0 or $\overline{m_j}$. To determine the values of $\{\overline{m_j}\}_{j=25}^{99}$, we obtain the average medical expense of individuals with positive medical expense at all ages. While keeping their relative values, we scale them up so that the aggregate medical expense to GDP is 7.5% to match the current medical expenditure to GDP reported in OECD data. Finally, to define the transition matrix for the medical expense shock, let p_j denote the probability of paying no medical expense for the next period of the j-year old individual who pays no medical expense, and similarly let q_j denote the probability of paying strictly positive medical expense for the next period of the j-year old individual who pays strictly positive medical expense. Using p_j and q_j, then, the transition matrix for the medical expense shock, Π_j^m, can be expressed as follows:

$$\Pi_j^m=\begin{bmatrix} p_j & 1-p_j \\ 1-q_j & q_j \end{bmatrix}$$

For each age cohort, we count how many individuals pay zero or strictly positive medical expense and how many individuals keep that status for the next period using Korea Health Panel Survey 2017-2018. Then we calculate p_j and q_j and construct the transition matrix Π_j^m.

IV. *Experiment: Measuring Impact of Change in Income Tax Progressivity*

To measure the impact of progressivity in taxation, we come up with experimental economies where all the model features but the income tax scheme are identical to the benchmark economy. More precisely, we compute five different stationary equilibria of experimental economies with the same values of parameters of the benchmark economy, except the values of income tax parameters, (τ, λ). For the five different experimental economies, the value of progressivity of income tax, τ, is altered to 0, 0.1, 0.2, 0.3, 0.4, and 0.5 while the total revenue of income tax is kept at the level of the benchmark economy with adjustment of the value of λ, which enables us to isolate the impact of change in the degree of progressivity of income tax. Our analysis of the impact of change in income tax progressivity is centered around a set of key macroeconomic statics, social welfare, and voting result.

1. Macroeconomic Statics

The shaded column of Table 3 summarizes a set of key macroeconomic statistics of the benchmark economy, which is the stationary equilibrium with the values of parameters calibrated as explained in the previous chapter. Importantly, the values for $(\tau, \lambda)=(0.175, 0.831)$ represent the current income tax scheme of Korea such that they capture the after-tax income inequality as well as the total revenue of income tax. The level of GDP in the benchmark economy is normalized to one to facilitate comparison with experimental economies. It is worth noting that the experimental economies share all the values of parameters with the benchmark economy, except the values of parameters that govern the income tax scheme. It therefore can be concluded that the differences in the key macroeconomic statistics across the model economies are driven solely from the difference in the income tax scheme, especially the degree of income tax progressivity.[7]

It is evident from Table 3 that the income tax progressivity plays a negative role in GDP. As the value of τ is decreased to 0.1 and 0 from the benchmark value of 0.175, the level of GDP increases by 3.7% and 7.5% respectively. As the value of τ is increased to 0.2, 0.3, 0.4, and 0.5, the level of GDP monotonically decreases by 1.4%, 7.8%, 16.2%, and 28.5%. Such negative impact of the increase in income tax progressivity on GDP results from the distortions incurred on individuals' labor and savings decisions. Since a higher degree of progressivity of income tax is translated to lower levels of after-tax labor and interest incomes, the individuals' incentives to supply labor and accumulate savings are reduced. According to Table 3, both the employment rate and aggregate labor decrease monotonically with an increase in the value of τ and so does the aggregate capital, which is constituted by the aggregate savings. Notably, the level of aggregate consumption, which is a key factor that determines the level of social

TABLE 3. MACROECONOMIC STATISTICS: BENCHMARK ECONOMY VS. EXPERIMENTAL ECONOMIES

τ	0.000	0.100	0.175	0.200	0.300	0.400	0.500
λ	0.807	0.823	0.831	0.832	0.833	0.826	0.812
GDP	1.075	1.037	1.000	0.986	0.922	0.838	0.715
Aggregate Labor	0.286	0.282	0.276	0.274	0.261	0.241	0.207
Employment Rate	68.7%	67.3%	65.8%	65.1%	61.7%	56.8%	50.5%
Aggregate Capital	4.452	4.156	3.900	3.811	3.453	3.054	2.580
Pre-tax Income Gini	0.411	0.408	0.406	0.405	0.401	0.398	0.399
After-tax Income Gini	0.411	0.379	0.354	0.345	0.308	0.271	0.234
Aggregate Consumption	0.547	0.536	0.524	0.519	0.498	0.470	0.432
Income Tax	0.188	0.188	0.188	0.188	0.188	0.188	0.188
- The employed	0.186	0.188	0.190	0.191	0.195	0.199	0.204
- The non-employed	0.001	0.000	-0.002	-0.003	-0.007	-0.011	-0.017

Note: the shaded column represents the benchmark economy.

[7] Note that the role of λ in our experiment is simply to keep the total revenue of income tax unchanged across the experimental economies.

welfare, also decreases as the degree of income tax progressivity increases.

There are a couple of interesting findings from Table 3. First, the pre-tax income inequality as well as the after-tax income inequality are improved as the degree of income tax progressivity increases although the decrease in the pre-tax income inequality is not as large as the decrease in the after-tax income inequality: the pre-tax (after-tax) income Gini decreases from 0.411 (0.411) at $\tau=0$ to 0.399 (0.234) at $\tau=0.5$. The reason is that although the policy that increases the progressivity of income tax is not directly intended to improve the pre-tax income inequality, the increase in the income tax progressivity makes individuals with high labor productivity less likely to work and less likely to save, which lowers the pre-tax income Gini. Second, changes in the income tax burden due to the changes in the income tax progressivity depend on the employment status. As the value of τ increases from 0 to 0.5, the aggregate income tax paid by the employed increases from 0.186 to 0.294 while the aggregate income tax paid by the non-employed decreases from 0.001 to -0.007.[8]

2. Social Welfare and Approval Rate

According to our earlier discussion, the increase in tax income progressivity lowers economic efficiency: both the aggregate output and the aggregate consumption decrease with the increase in the value of τ. It, however, does not necessarily mean that a higher degree of tax income progressivity antagonizes society and individuals.

We adopt the utilitarian approach to measure the level of social welfare — we compute the social welfare by the weighted average of expected lifetime utility of all individuals with an equal weight put on everyone. Table 4 shows that (i) as the degree of income tax progressivity decreases from the benchmark level ($\tau=0.175$) to 0.1 and 0, the social welfare decreases monotonically — it decreases from -68.26 to -68.68 and to -69.32 —, (ii) as the degree of income tax progressivity increases from the benchmark level ($\tau=0.175$), the social welfare improves, hitting the highest value of -67.37 at $\tau=0.4$, and (iii) as the degree of income tax progressivity further increases to 0.5, the social welfare decreases. This observation informs that there is an optimal degree of income tax progressivity in terms of social welfare: $\tau=0.4$ in our exercise.

Next, we calculate the approval rate for changing the degree of income tax progressivity from the benchmark level. As shown in Table 4, the approval rate drops dramatically when the income tax progressivity decreases from the benchmark level to 0.1 (from around 88% to 12%). On the other hand, the approval rate is higher for greater tax progressivity. For instance, 88% of the population show support at $\tau=0.2$ while 88.4% show support at $\tau=0.3$. Yet, the relationship is not monotonic, and the approval rate drops to 86.4% at $\tau=0.4$. The non-monotonicity, in particular, stems from the working age population. The approval rate of the population aged 25-79 shows a non-monotonic relationship with tax progressivity (employed and non-employed alike); it peaks at $\tau=0.3$ and drops at $\tau=0.4$. Figure 3 shows that the drop in support at $\tau=0.4$ is especially pronounced among the relatively young (between the late 20s and the early 40s). The population aged greater than 80, on the other hand, consistently show larger support for greater tax progressivity; as shown in Table 4, the support monotonically increases from the benchmark level (around 98%) to $\tau=0.5$ (99.5%).

---

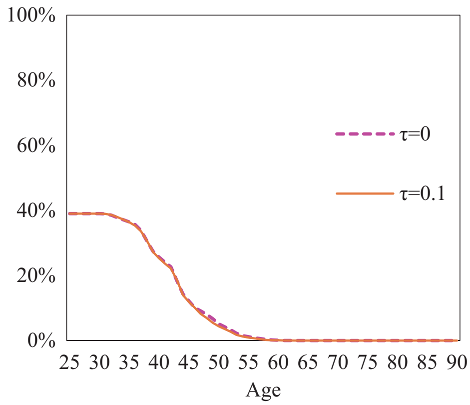
[8] The minus income tax indicates that the non-employed get subsidies from the government.

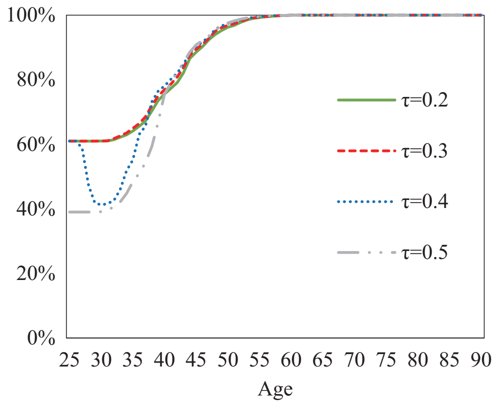
TABLE 4. SOCIAL WELFARE AND APPROVAL RATE FOR CHANGING DEGREE OF INCOME TAX PROGRESSIVITY

τ	0.000	0.100	0.175	0.200	0.300	0.400	0.500
λ	0.807	0.823	0.831	0.832	0.833	0.826	0.812
Social Welfare	-69.32	-68.68	-68.26	-68.13	-67.66	-67.37	-67.45
Approval Rate							
Whole Population	12.4%	12.3%	-	88.0%	88.4%	86.4%	84.0%
Aged 25-79	13.8%	13.6%	-	86.6%	87.0%	84.6%	81.8%
- Employed	18.8%	18.5%	-	81.9%	82.5%	79.5%	77.1%
- Non-employed	4.3%	4.3%	-	95.7%	95.8%	94.5%	90.9%
Aged 80+	2.7%	2.7%	-	98.1%	98.6%	99.1%	99.5%

Note: the shaded column represents the benchmark economy.

FIGURE 3. VOTING RESULTS (APPROVAL RATE) BY AGE





V. *Conclusion*

Using a structural model with heterogeneous agents and the 2018 Korean economy data, we performed counterfactual analyses. More specifically we provided a structural model characterized by (i) heterogenous individuals in terms of age, labor productivity, and medical expense, and (ii) progressive tax scheme. We calibrated the major parameters of the model to reflect 2018 Korean economy and set it up as a benchmark model. Then, we computed experimental economies of which features are identical to the benchmark economy except the degree of income tax progressivity.

From the experiments, we found that income progressivity plays a negative role in some of the key macroeconomic statistics such as GDP, employment rate, and aggregate consumption, due to the distortions incurred on individuals' labor and savings decisions. Tax progressivity, on the other hand, has an effect of improving pre-tax income inequality as an increase in income tax progressivity makes individuals with high labor productivity less likely to work and save. Importantly, our model showed that the most approved degree of tax progressivity among the individuals is not necessarily optimal in terms of maximizing social welfare. The most popular degree of tax progressivity was slightly greater than the benchmark point yet considerably less than the degree of tax progressivity that maximizes the social welfare of the population in 2018 Korea.

References

Alt, J. and Iversen, T. (2017), “Inequality, Labor Market Segmentation, and Preferences for Redistribution,” *American Journal of Political Science* 61(1), 21-36.

Barth, E., Finseraas, H., and Moene, K.O. (2015), “Political Reinforcement: How Rising Inequality Curbs Manifested Welfare Generosity,” *American Journal of Political Science* 59(3), 565-577.

Rehm, P. (2011), “Social Policy by Popular Demand,” *World Politics* 63(2), 271-299.

Benabou, R. (2002), “Tax and Education Policy in a Heterogeneous-Agent Economy: What Levels of Redistribution Maximize Growth and Efficiency?”, *Econometrica* 70(2), 481-517.

Chang, B.H., Chang, Y., and Kim, S. (2018), “Pareto Weights in Practice: A Quantitative Analysis across 32 OECD Countries,” *Review of Economic Dynamics* 28, 181-204.

Charite, J., Fisman, R., and Kuziemko, I. (2015), “Reference Points and Redistributive Preferences: Experimental Evidence,” *National Bureau of Economic Research Working Paper* No. 21009.

Dahlberg, M., Edmark, K., and Lundqvist, H. (2012), “Ethnic Diversity and Preferences for Redistribution,” *Journal of Political Economy* 120(1), 41-76.

Finseraas, H. (2012), “Poverty, Ethnic Minorities among the Poor, and Preferences for Redistribution in European Regions,” *Journal of European Social Policy* 22(2), 164-180.

Heathcote, J., Storesletten, K., and Violante, G.L. (2017), “Optimal Tax Progressivity: An Analytical Framework,” *The Quarterly Journal of Economics* 132(4), 1693-1754.

Lockwood, B.B. and Weinzierl, M. (2015), “De Gustibus non est Taxandum: Heterogeneity in Preferences and Optimal Redistribution,” *Journal of Public Economics* 124, 74-80.

Lockwood, B.B., Nathanson, C.G., and Weyl, E.G. (2017), “Taxation and the Allocation of Talent,” *Journal of Political Economy* 125(5), 1635-1682.

Lupu, N. and Pontusson, J. (2011), “The Structure of Inequality and the Politics of Redistribution,” *The American Political Science Review* 105(2), 316-336.

Meltzer, A.H. and Richard, S.F. (1981), “A Rational Theory of the Size of Government,” *Journal of Political Economy* 89(5), 914-927.

Mirrlees, J.A. (1971), “An Exploration in the Theory of Optimum Income Taxation,” *The Review of Economic Studies* 38(2), 175-208.

Moene, K. and Wallerstein, M. (2001), “Inequality, Social Insurance, and Redistribution,” *American Political Science Review* 95(4), 859-874.

Rehm, P. (2009), “Risks and Redistribution: An Individuall-Level Analysis,” *Comparative Political Studies* 42(7), 855-881.

Roberts, K.W.S. (1977), “Voting over Income Tax Schedules,” *Journal of Public Economics* 8(3), 329-340.

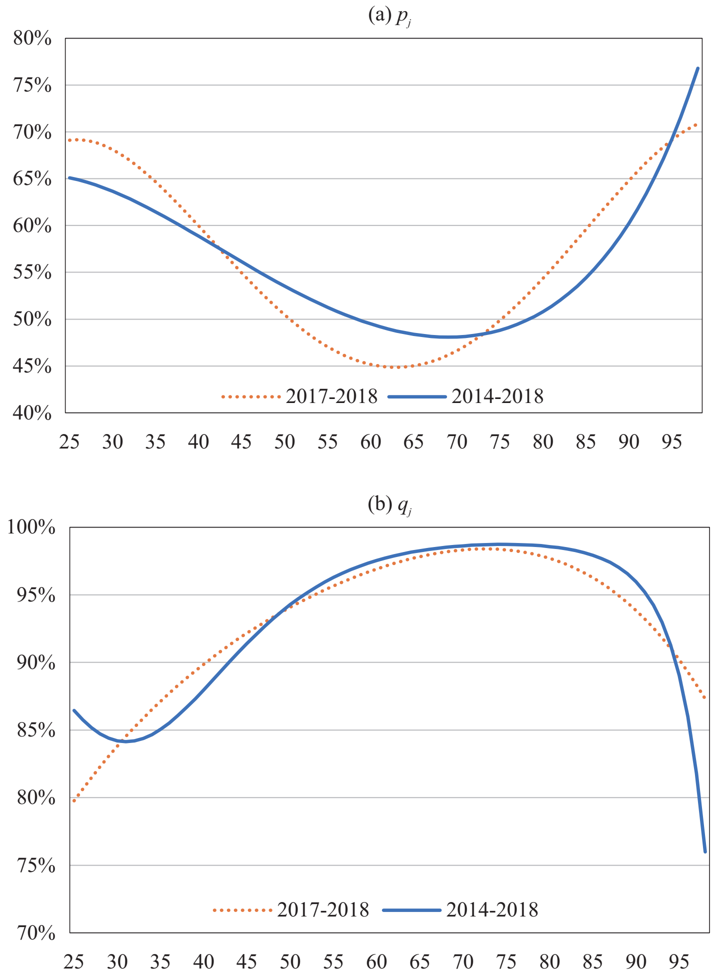
Romer, T. (1975), “Individual Welfare, Majority Voting, and the Properties of a Linear Income Tax,” *Journal of Public Economics* 4(2), 163-185.

VI. *Appendix: Robustness Checks*

The main analyses in this paper are based on the shock process of medical expense estimated from Korea Health Panel Survey 2017-2018. For robustness checks, we repeat the analyses with the data from Korea Health Panel Survey 2014-2018.

Figure 4 depicts and compares two different transition matrices for Medical Expense Shocks. p_j denotes the probability of paying no medical expense for the next period of the j-year old individual who currently pays zero medical expense; q_j denotes the probability of

Figure 4. Transition Matrix for Medical Expense Shock



Note: p_j denotes the probability of paying no medical expense for the next period of the j-year old individual who currently pays zero medical expense; and q_j denotes the probability of paying strictly positive medical expense for the next period of the j-year old individual who currently pays strictly positive medical expense.

paying strictly positive medical expense for the next period of the j-year old individual who currently pays strictly positive medical expense. The first panel (a) of Figure 4 depicts and compares the dimension p_j. The red dotted line represents p_j obtained from Korea Health Panel Survey 2017-2018; the blue solid line represents p_j obtained from Korea Health Panel Survey 2014-2018. Note that, with data from 2014-2018 surveys, p_j slightly flattens out across different age groups. Specifically, p_j is slightly lower for the population aged between 25 and 45 as well as between 75 and 95 whereas it is slightly higher for the population aged between 45 and 75. The second panel (b) depicts and compares the dimension q_j. The red dotted line represents q_j obtained from Korea Health Panel Survey 2017-2018; the blue solid line represents q_j obtained from Korea Health Panel Survey 2014-2018. The panel shows that with data from 2014-2018 surveys, q_j is slightly lower for the population aged between 30 and 45 while it is mostly higher for the rest of the population.

With these slight adjustments in the transition matrix for medical expense shock, the results of the analyses change only marginally. We conclude that the magnitudes of these changes are negligible, and the original analytic results as well as the implications drawn from them in the main article are robust. Table 5 shows that the macroeconomic statistics based on the data from 2014-2018 surveys stay identical to the original analytic results that are based on the data from 2017-2018 surveys (refer to Table 3 in the main article). As shown in Table 6 and Figure 5, the social welfare and the approval rate calculated from 2014-2018 surveys only marginally differ from the values of social welfare and approval rate obtained from 2017-2018 surveys (refer to Table 4 in the main article). For instance, at τ=0.0, the social welfare becomes lower by 0.03 (-69.32 vs. -69.29), and at $\tau=0.2$, the social welfare becomes lower by 0.02 (-68.13 vs. -69.11). The approval rate, on the other hand, stays mostly identical to the original analytic results; the only change detected is at τ=0.3, from 86.4% to 86.6%.

Table 5. Macroeconomic Statistics: Benchmark Economy vs. Experimental Economies

τ	0.000	0.100	0.175	0.200	0.300	0.400	0.500
λ	0.807	0.823	0.831	0.832	0.833	0.826	0.812
GDP	1.075	1.037	1.000	0.986	0.922	0.838	0.715
Aggregate Labor	0.286	0.282	0.276	0.274	0.261	0.241	0.207
Employment Rate	68.7%	67.3%	65.8%	65.1%	61.7%	56.8%	50.5%
Aggregate Capital	4.452	4.156	3.900	3.811	3.453	3.054	2.580
Pre-tax Income Gini	0.411	0.408	0.406	0.405	0.401	0.398	0.399
After-tax Income Gini	0.411	0.379	0.354	0.345	0.308	0.271	0.234
Aggregate Consumption	0.547	0.536	0.524	0.519	0.498	0.470	0.432
Income Tax	0.188	0.188	0.188	0.188	0.188	0.188	0.188
- The employed	0.186	0.188	0.190	0.191	0.195	0.199	0.204
- The non-employed	0.001	0.000	-0.002	-0.003	-0.007	-0.011	-0.017

Note: the shaded column represents the benchmark economy.

TABLE 6. SOCIAL WELFARE AND APPROVAL RATE FOR CHANGING DEGREE OF INCOME TAX PROGRESSIVITY

τ	0.000	0.100	0.175	0.200	0.300	0.400	0.500
λ	0.807	0.823	0.831	0.832	0.833	0.826	0.812
Social Welfare	-69.29	-68.65	-68.26	-68.11	-67.64	-67.34	-67.43
Approval Rate							
Whole Population	12.4%	12.3%	-	88.0%	88.4%	86.6%	84.0%
Aged 25-79	13.8%	13.6%	-	86.6%	87.0%	84.8%	81.8%
- Employed	18.8%	18.5%	-	81.8%	82.5%	79.6%	77.1%
- Non-employed	4.3%	4.3%	-	95.7%	95.8%	94.8%	90.9%
Aged 80+	2.8%	2.8%	-	98.1%	98.6%	99.1%	99.5%

Note: the shaded column represents the benchmark economy.

FIGURE 5. VOTING RESULTS (APPROVAL RATE) BY AGE