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An Analysis of the Macroeconomic Effects of Property Tax Reform*

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Abstract This study analyzed the macroeconomic effects of property tax reform using a two-sector general equilibrium model with heterogeneous households. This study found that increasing the property tax rate by 0.1 % points only for households owing homes with a value in the top 20% in the benchmark economy leads to the largest reduction in housing asset inequality compared to the benchmark economy. However, welfare decreased when the property tax rate is raised. In most cases, the welfare loss is lower when the excess tax revenue is distributed equally to all households through transfers, as opposed to using it for government spending.

Keywords Property tax, inequality, welfare, heterogeneous households.

JEL Classification E62, H31, R21, R31.

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1. INTRODUCTION

Due to the government's relaxation of real estate market regulations to prevent a hard landing, housing prices have shifted upward. According to the Korea Real Estate Board, the weekly apartment transaction prices in Seoul have continuously increased for 16 weeks from the fourth week of May 2023 to the first week of September, and the Greater Seoul area has also been on the rise since the first week of June. This upward trend in apartment prices has expanded nationwide, with the national apartment transaction prices rising continuously for 8 weeks from the third week of July 2023. Despite the Bank of Korea raising the benchmark interest rate from 0.5% to 3.0% over 10 times starting from August 2021 in an effort to suppress inflation, housing prices have begun to rise. Figure 1 illustrates the year-on-year changes in real housing transaction prices and real housing Jeonse[1] prices, along with the temporal variations in the real interest rate[2]. According to Figure 1, housing prices do not always decrease during periods of the Bank of Korea base interest rate increases. There have been four instances of base rate hikes highlighted in gray from January 2008 to May 2023. Excluding the periods from January to September 2008, July 2010 to March 2011, and August 2022 to May 2023, real housing prices increased compared to the previous year.[3]

Glaeser and Sinai (2013) pointed out that while housing prices tend to rise with a decrease in interest rates, the interest rate elasticity of housing prices varies depending on factors such as household borrowing constraints, the price elasticity of housing supply, and households' expectations regarding housing prices. According to Glaeser and Sinai (2013), the impact of interest rate cuts on housing prices increases when there are fewer households affected by borrowing constraints, when housing supply is less elastic to price changes, and when households expect continued upward movement in housing prices. Korea has various restrictions on new housing supply, such as the excess profit recapture system for reconstruction and the price ceiling system for new housing prices, reducing the price elasticity of housing supply. Additionally, financial author-

[1]Jeonse is a unique housing lease agreement in Korea where tenants provide a lump-sum deposit to landlords instead of paying monthly rent.

[2]The time series data for real interest rates ends one year prior because I adjusted the 3-year government bond yield for real value using post-inflation based on the Consumer Price Index (CPI).

[3]If the year-on-year change in the real housing transaction price index and the real housing Jeonse price index is greater than 0, it indicates that prices have increased compared to the previous year.

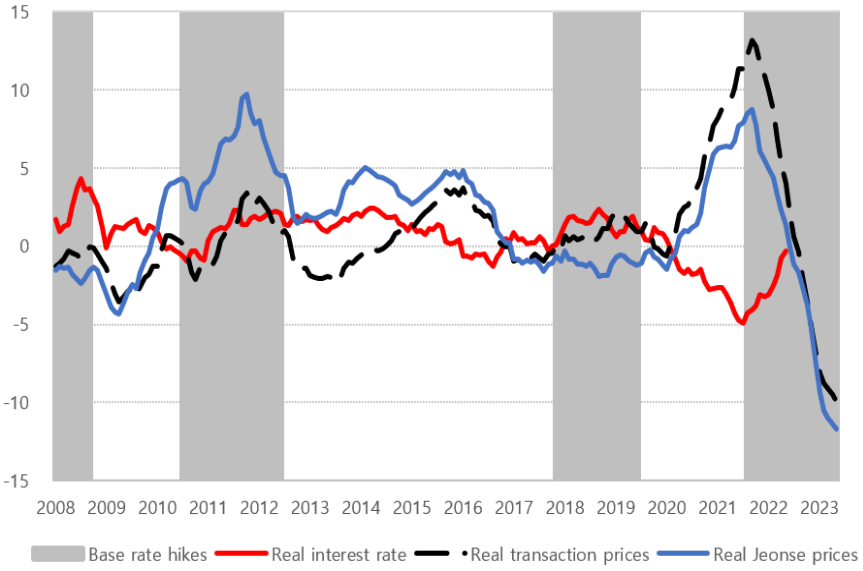

Figure 1: REAL INTEREST RATES AND YEAR-ON-YEAR CHANGE IN REAL HOUSING TRANSACTION PRICE INDEX. Realization using CPI and post-inflation based on CPI. Data: KB Housing Transaction Price and Jeonse Price Indices, Bank of Korea Consumer Price Index, Base Rates, and Government Bond 3-Year Yields.

ities have relaxed borrowing constraints by expanding exceptions to the Debt-Service-Ratio (DSR) regulations, such as the special home loan for purchasing homes priced below 900 million won, allowing borrowers to receive up to 500 million won in mortgage loans regardless of income. Moreover, recent expectations regarding housing prices have become more optimistic. Figure 2 illustrates the trend of the Housing Price Outlook Consumer Survey Index (CSI) released monthly by the Bank of Korea. The Housing Price Outlook CSI has increased for nine consecutive months since its low point in November 2022. In August, the Housing Price Outlook CSI reached 107, exceeding the baseline of 100. This indicates that the number of households expecting an increase in housing prices one year from the present is greater than the number of households anticipating a decline. Therefore, as suggested by Glaeser and Sinai (2013), Korea may experience a significant increase in housing prices when inflation stabilizes, and benchmark interest rates decline in the future.

Seok (2022) demonstrated that the effect of base interest rate hikes on real housing prices is not substantial. When the central bank raises the base rate, borrowing households and firms reduce consumption and investment, respectively,

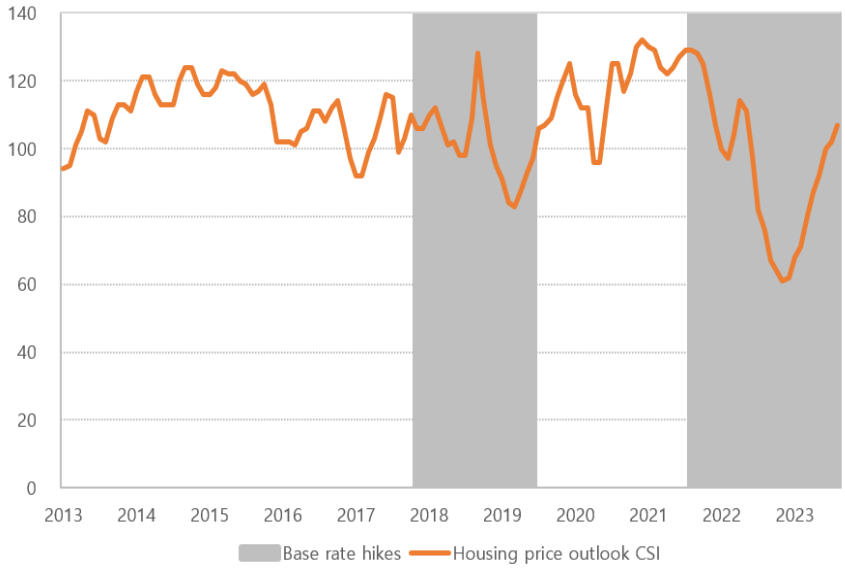

Figure 2: TREND OF HOUSING PRICE OUTLOOK CONSUMER SURVEY INDEX (CSI). The Housing Price Outlook CSI is based on a survey of 2,500 households in cities nationwide. If the index is greater than 100, it indicates that more households responded that housing prices will rise in one year compared to the present than those who responded that prices will fall. Conversely, if the index is below 100, it indicates the opposite. Data: Bank of Korea.

to repay debts, leading to a decrease in overall debts and real Gross Domestic Product (GDP) in the economy. Consequently, the reduced income of borrowing households decreases housing demand, resulting in a decline in real housing prices. However, saving households benefit from an increase in interest income due to the interest rate hike, leading to an expansion of housing demand. Therefore, real housing prices experience a slight decline before rebounding quickly. The decline in real housing prices since the second half of 2022 can be attributed to property tax increases on multiple-home owners[4] and additional house acquisition tax burdens on multiple-home owners in regulated areas. This is because high-net-worth households, facing increased interest income during a period of rising interest rates, refrained from making additional purchases of homes. The government's easing of property tax on multiple-home owners and the release of regulations in designated areas facilitated home purchases for high-net-worth

[4]According to Poghosyan (2016), an increase in property tax rates has the effect of reducing housing price volatility.

households with increased interest income during the interest rate hike period, preventing a sharp decline in housing prices and contributing to achieving a soft landing in the housing market. However, this policy poses a significant risk of increasing wealth inequality as housing prices rise in the future. Therefore, this study seeks ways to minimize social welfare losses and suppress the increase in wealth inequality through a reform of property tax.[5]

The increase in property tax rates has varying effects depending on the income and asset levels of individual households. Therefore, to analyze the economic effects of the increase in property tax rates, a heterogeneous agent model should be employed, considering households with heterogeneous income and asset levels. Additionally, an increase in property tax rates is typically implemented to suppress housing demand. However, since it also influences the supply of new housing by altering equilibrium housing prices in the long run, an analysis employing a general equilibrium model capable of capturing such effects should be utilized. This study, therefore, employed a two-sector general equilibrium model incorporating households with heterogeneous labor productivity affecting labor income and varying asset levels. It also considered the production sector for final goods and the construction sector producing new housing, allowing for the analysis of the macroeconomic effects of changes in property tax rates. Since the supply of new housing changes over the long term, this study compared the benchmark economy's steady state, aligning with key data moments in the Korean economy in 2017, with the experimental economy's steady state reflecting changes in property tax rates. Analyzing the long-term effects of changes in property tax rates, the study compared policies that increase property tax rates for all households and only for households holding high-value housing assets, as well as policies utilizing property tax revenue for government spending or transfers.[6] The aim was to find policies that reduce wealth inequality while minimizing social welfare losses in Korea.

According to the results of this study, when the property tax rate is increased by 0.1 percentage points only for households owning homes larger than the top

[5]In order to stabilize housing prices and alleviate wealth inequality, the Korean government has been utilizing increases in property taxes as one of the policy tools. A representative instance of this is the increase in comprehensive real estate holding tax rates on September 13, 2018, aimed at stabilizing housing prices. Therefore, this study also analyzes methods to achieve housing price stability and alleviate wealth inequality through the reform of property taxes.

[6]This study analyzes the long-term effects of the reform of property taxes. Monetary policy only affects real aggregate variables when prices are sticky. In the long run, as prices become fully flexible, monetary policy becomes neutral. Therefore, this study does not consider monetary policy, which adjusts the base interest rate.

20% in the benchmark economy, the Gini coefficient of housing assets decreases by the largest margin compared to the benchmark economy. In other words, in this scenario, the inequality of housing assets decreases most substantially. On the other hand, raising the property tax distorts household decision-making, resulting in a decrease in welfare compared to the benchmark economy.[7] When the excess tax revenue from the increase in the property tax rate is used for government spending or evenly distributed to all households as transfers[8] , all households experience a loss of welfare. This ultimately suggests that not increasing the property tax rate would maximize the welfare of households.

There are few studies that analyze the long-term macroeconomic effects of property tax reform using a two-sector general equilibrium model with heterogeneous agents in terms of labor productivity and asset levels, as done in this study. Song (2013) utilized a model with representative households and thus could not analyze the effects of property tax reform on households with heterogeneous income and asset levels. Song and Hong (2019) considered heterogeneous households but did not account for general equilibrium effects as they used a partial equilibrium model. Hong *et al.* (2020) considered heterogeneous households but could not analyze the impact of property tax reform on new housing supply, as housing supply was exogenously given. Seok and You (2021) used a two-sector general equilibrium model similar to this study. They considered households with heterogeneous labor productivity and asset levels to analyze the long-term macroeconomic effects of loan-to-value ratio (LTV) regulations, as well as the increase in property and housing acquisition taxes. They also analyzed the joint effect of all three policies. This study differentiates itself from Seok and You (2021) by analyzing the effects of policies that increase property tax rates only for households holding high-value housing assets and policies using property tax revenue for transfers, which were not considered in Seok and You (2021).

The rest of the paper is organized as follows: Section 2 describes the property tax system in Korea. In Section 3, a two-sector general equilibrium model is introduced, considering heterogeneous households with varying levels of labor productivity, financial assets, and housing assets. Section 4 explains the methodology for setting the parameter values of this model. Section 5 analyzes the

[7]Just because an increase in property taxes has led to a decrease in welfare does not mean that the current tax system is optimal. In the model economy, where market failures do not exist, the imposition of taxes leads to distortions and a decrease in welfare.

[8]The Democratic Party of Korea, the majority party in the Korean National Assembly, advocated for implementing a landholding tax following Yoo *et al.* (2021) and using it to fund universal basic income during the presidential election campaign in 2022. According to the analysis of this study, such a policy was found to decrease welfare.

results of the benchmark economy and policy experiments. Finally, Section 6 concludes.

2. PROPERTY TAX SYSTEM IN KOREA

In Korea, homeowners pay property tax at rates ranging from 0.1% to 0.4% based on the taxable value of their property. Households with significant housing assets pay an additional comprehensive property tax: for households with up to two properties, the rate is between 0.5% and 2.7%, while for those with three or more properties, the rate ranges from 0.5% to 5.0%. When calculating the comprehensive property tax, a deduction of 900 million won is applied to the value of housing assets, while households with only one property can benefit from a deduction of 1.2 billion won. If a household owns a newly acquired house that has not been held for more than three years, an inherited house that has not been held for more than five years, or one low-cost housing unit located in rural areas, it is treated as a one-property household. Additionally, one-property households aged 60 or older or those who have owned their home for more than five years receive a partial deduction on the comprehensive property tax.

3. MODEL

3.1. OUTLINE

This study utilizes an extended model that incorporates the government into the two-sector general equilibrium framework developed by Seok and You (2019), which accounts for households with heterogeneous labor productivity, financial assets, and housing assets. In this model, households are exposed to idiosyncratic labor productivity shocks, leading to differences in labor income levels, asset portfolio compositions, and consumption levels among households. As changes in the property tax rate have varied effects based on individual households' income, financial assets, and housing asset levels, an analysis using a model that considers heterogeneous households is essential. Furthermore, the model introduces two goods, final goods, and housing, each produced by two separate firms with distinct production technologies. Consequently, the model allows for an analysis of how changes in property tax policies influence the relative price of houses to final goods. Households, subject to budget and borrowing constraints, make decisions to maximize lifetime utility by consuming final goods and housing services each period, as well as determining the composition of their portfolios between financial and housing assets. The firms produce final

goods and new houses using labor and capital to maximize profit. The government imposes property and housing acquisition taxes on households and utilizes the revenue for government spending or distributes it equally among all households as transfers.

3.2. ECONOMIC AGENTS

3.2.1. Households

In this model economy, there exist infinitely many one-person households of measure one. Each individual household obtains utility from the consumption of final goods (c) and housing services (h)[9]. The model, designed to analyze the macroeconomic effects of changes in property tax policies, is the most parsimonious and, therefore, does not consider the rental housing market[10]. Therefore, all households in the model own a house. Households are exposed to idiosyncratic labor productivity shocks (x) each period, and these labor productivity shocks follow an AR(1) process:

$$\log(x_{t+1}) = (1-\rho_x)\nu_x + \rho_x \log(x_t) + \eta_{t+1}, \quad \eta_{t+1} \sim N(0, \sigma_x^2).$$

In the model, households inelastically supply 1 unit of labor each period. This is based on previous studies like Nam (2007) and Moon and Song (2016), which found low wage elasticity of labor supply in Korea.[11] Household labor income is obtained by multiplying the labor productivity by the real wage per unit of labor productivity (w). Households can save in financial assets (a) and housing assets (h). Financial assets and housing assets represent the shares of non-residential capital and residential capital stocks, respectively, existing in the model economy. The real rental rate of non-residential capital is denoted by r, and the relative price of housing compared to the final goods is represented by q. Financial assets are liquid assets with no transaction costs, while housing is an illiquid asset incurring transaction costs. In this model, households incur a transaction cost represented by $\tau_b q h'$ when trading a house h' chosen for the next period with a house h of a different size in the current period. This $\tau_b q h'$ represents the housing acquisition tax.[12] Here, τ_b is the housing acquisition tax rate paid when purchasing a house.

[9] In this economic model, 'h' represents both the size of the house and housing services.

[10] Tenants in reality are represented as the smallest-sized homeowners in this model economy.

[11] Nam (2007) estimates the elasticity at 0.1, while Moon and Song (2016) estimate it at 0.23.

[12] In reality, when trading houses, transaction costs such as realtor fees, housing acquisition tax, and local taxes are incurred. Since this model is the most parsimonious form designed to analyze the macroeconomic effects of changes in property tax policies, it assumes that transaction

Households can offer their homes as collateral and can obtain loans, but they must pay a down payment of $\theta_v \in (0,1)$ of the home value. Therefore, the loan amount cannot exceed $1-\theta_v$ of the home value. In this model, unsecured loans are not possible, and default is assumed to be impossible. Each period, households pay maintenance costs and property tax for the owned house. The maintenance cost is given by $\delta_h qh$, where δ_h is the depreciation rate, and the property tax is determined by multiplying the depreciated home value by the property tax rate τ_p or $\tau_h (> \tau_p)$ resulting in $\tau_p q(1-\delta_h)h$ or $\tau_h q(1-\delta_h)h$.[13] If the home value is greater than or equal to $q\bar{h}$, a higher property tax rate of τ_h is applied compared to the case where the home value is less than $q\bar{h}$. All households receive the same transfers Φ from the government each period.

In this model, the household's problem of maximizing lifetime utility is summarized by the following Bellman equation:

$$V(a,h,x) = \max_{\{c,h'\}} \left\{ u(c,h) + \beta E[V(a',h',x') \mid x] \right\},$$

$$\text{subject to } c + a' + qh' + qT(h,h') = wx + (1+r)a + q(1-\delta_h)h + \Phi;$$

$$a' \geq -(1-\theta_v)qh';$$

$$T(h,h') \equiv \begin{cases} \tau_h(1-\delta_h)h + \tau_b h', & \text{if } h \neq h',\ h \geq \bar{h} \\ \tau_h(1-\delta_h)h, & \text{if } h = h',\ h \geq \bar{h} \\ \tau_p(1-\delta_h)h + \tau_b h', & \text{if } h \neq h',\ h < \bar{h} \\ \tau_p(1-\delta_h)h, & \text{if } h = h',\ h < \bar{h} \end{cases}.$$

3.2.2. Firms

In this model economy, there exist a final goods-producing firm representing the manufacturing sector and a new housing-producing firm representing the construction sector. Each firm uses capital and labor to produce final goods or new houses, and higher total factor productivity (λ) allows them to produce more goods using the same amount of production factors. The production sectors for final goods and houses are denoted by subscripts f and h, respectively.

costs only occur when purchasing a house. These transaction costs are assumed to be represented by housing acquisition tax, which typically constitutes the most significant portion of transaction costs when buying a house in reality.

[13] Even if the property tax is imposed on the non-depreciated value of the house, it only changes the numerical level of the results without affecting the main mechanism of this study.

The production functions for each sector, commonly used in previous studies in the standard Cobb-Douglas form[14], are as follows:

$$F(L_f, K_f; \lambda_f) = \lambda_f K_f^{\alpha} L_f^{1-\alpha};$$
$$G(L_h, K_h; \lambda_h) = \lambda_h K_h^{\kappa} L_h^{1-\kappa};$$
$$\alpha > \kappa.$$

According to empirical evidence, the production process in the construction sector is more labor-intensive than that in the final goods-producing sector. Therefore, reflecting this, it is assumed that the capital income share in the final goods-producing sector is higher than in the construction sector ($\alpha > \kappa$).

Given the real wage (w) and the real rental rate of capital (r), the profit maximization problems for representative firms in the final goods-producing sector and the construction sector are as follows:

$$\max_{\{K_f, L_f\}} \left[\lambda_f K_f^{\alpha} L_f^{1-\alpha} - wL_f - (r + \delta_k) K_f \right];$$
$$\max_{\{K_h, L_h\}} \left[q\lambda_h K_h^{\kappa} L_h^{1-\kappa} - wL_h - (r + \delta_k) K_h \right].$$

3.2.3. Government

In this model economy, the government imposes property taxes and housing acquisition taxes on the houses owned by households. It utilizes the collected tax revenue as government expenditure (G) or distributes it equally to all households as transfer payments (Φ). If we denote the distribution function of heterogeneous households as $\mu(a, h, x)$, the government satisfies the following government budget constraint each period:

$$\int [qT(h, h')] \, d\mu(a, h, x) = G + \Phi.$$

[14] In reality, the supply of land may be limited, and there might be constraints on the preferred locations for people. Therefore, the supply function for new housing may exhibit decreasing returns to scale. However, since this study aims to analyze long-term macroeconomic effects, it is assumed that, in the long run, the government can increase land supply through changes in land use, and new housing supply can be expanded in preferred locations through relaxation of redevelopment regulations. Thus, this study assumes a Cobb-Douglas production function with constant returns to scale for the new housing supply function, considering the potential for increased land supply in the long term.

3.3. STEADY STATE EQUILIBRIUM

This model economy's steady-state equilibrium is defined by the value function $V(a,h,x)$, the set of optimal decision rules $\{c(a,h,x),a'(a,h,x),h'(a,h,x)\}$, the set of production factors $\{K_f,K_h,L_f,L_h\}$, the set of prices $\{q,r,w\}$, the set of government policies $\{T(h,h'),G,\Phi\}$, and the distribution function of households $\mu(a,h,x)$, satisfying the following conditions:

A. Given prices $\{q,r,w\}$ and government policies $\{T(h,h'),G,\Phi\}$, the value function $V(a,h,x)$ is the solution to the household's Bellman equation, and $\{c(a,h,x),a'(a,h,x),h'(a,h,x)\}$ are the optimal decision rules.

B. Under given prices $\{q,r,w\}$, each sector's representative firm determines the demand for labor and capital such that the marginal product of labor equals the real wage, and the marginal product of capital equals the real rental rate of capital plus depreciation rate of capital:

$$w=(1-\alpha)\lambda_f K_f^{\alpha}L_f^{-\alpha}=q(1-\kappa)\lambda_h K_h^{\kappa}L_h^{-\kappa};$$

$$r+\delta_k=\alpha\lambda_f K_f^{\alpha-1}L_f^{1-\alpha}=q\kappa\lambda_h K_h^{\kappa-1}L_h^{1-\kappa};$$

C. The final goods market clears:

$$\int[c(a,h,x)+a'(a,h,x)]\,d\mu(a,h,x)+G=\lambda_f K_f^{\alpha}L_f^{1-\alpha}+(1-\delta_k)(K_f+K_h);$$

D. The housing market clears:

$$\int[h'(a,h,x)-(1-\delta_h)h]\,d\mu(a,h,x)=\lambda_h K_h^{\kappa}L_h^{1-\kappa};$$

E. Each production factor market clears:

$$K_f+K_h=\int a\,d\mu(a,h,x),$$

$$L_f+L_h=\int x\,d\mu(a,h,x);$$

F. The government satisfies the budget constraint:

$$\int[qT(h,h')]\,d\mu(a,h,x)=G+\Phi.$$

G. Let Ω be the transition rule of the distribution of households $\mu(a,h,x)$ implied by the households' optimal decision rules $\{c(a,h,x),a'(a,h,x),h'(a,h,x)\}$, and the law of motion for the idiosyncratic labor productivity x. Then, $\mu(a,h,x)=\Omega[\mu(a,h,x)]$, indicating that the distribution of households is time-invariant.

4. CALIBRATION

This study assumes that the South Korean economy was in a steady state in 2017 and sets it as the benchmark economy. In this model economy, one period is equal to one year. The parameter values of the model economy were determined using key aggregate variables and statistical moments of the South Korean economy.

4.1. PARAMETERS RELATED TO HOUSEHOLDS AND FIRMS

The parameters related to the utility function of households and the production function of firms are set based on values used in previous studies. The remaining parameters are determined to align with the statistical moments targeted by the model economy.

This study follows relevant previous literature by assuming a constant relative risk aversion (CRRA) utility function with a unit elasticity of substitution between the consumption of final goods and housing services, and a relative risk aversion coefficient denoted as γ. The utility derived from household consumption of final goods c and housing services h is represented as $u(c,h) = \frac{(c_t^{1-\phi} h_t^{\phi})^{(1-\gamma)}}{1-\gamma}$ where the parameter ϕ reflects the weight on housing services consumption. The relative risk aversion coefficient is set to a standard value commonly used in previous studies, $\gamma = 2$.

The time discount factor β is set to match an equilibrium real interest rate of 3.5% per annum in the model economy. The parameter ϕ, indicating the weight on housing services consumption, is determined to match the model economy with the 10-year average share of housing, water, gas, electricity, and fuel expenses in total household consumption expenditure, which is approximately 17.6% around 2017. The parameters governing the idiosyncratic labor productivity shock process, represented by $\rho_x = 0.7024$ and $\sigma_x = 0.4106$, are based on the estimation results from Han *et al.* (2018), utilizing annual income microdata from the Korean Labor and Income Panel Study.

Among the production function parameters, the total factor productivities λ_f and λ_h for the final goods production sector and the construction sector are both set to 1, assuming no difference in total factor productivities between the two sectors. The depreciation rates for capital δ_k and housing δ_h are determined using estimates from Cho *et al.* (2012) for fixed asset depreciation (6.11%) and residential building depreciation (3.17%), respectively, resulting in $\delta_k = 0.0611$ and $\delta_h = 0.0317$. The parameters for capital income share in each sector are set based on labor income share estimates for manufacturing (0.550) and construc-

tion (0.962) sectors in 2011 provided by Lee (2015). Subtracting these labor income share estimates from 1, the capital income shares for the final goods production sector and the construction sector are set as $\alpha = 0.450$ and $\kappa = 0.038$ respectively. Table 1 shows the values of the parameters set up in this manner.

Parameter	Description
$\gamma = 2$	Relative Risk Aversion
$\beta = 0.955$	Time Discount Factor (Set to achieve a real interest rate of 3.5%)
$\phi = 0.012$	Weight on Housing Services (Set to match 17.6% of total consumption expenditure)
$\rho_x = 0.7024$	Persistence of Idiosyncratic Labor Productivity Shock (Han *et al.* (2018))
$\sigma_x = 0.4106$	Standard Deviation of Idiosyncratic Labor Productivity Shock (Han *et al.* (2018))
$\lambda_f = 1$	Total Factor Productivity in Final Goods Sector
$\lambda_h = 1$	Total Factor Productivity in Construction Sector
$\alpha = 0.450$	1−Labor Income Share in Manufacturing Sector (Lee (2015))
$\kappa = 0.038$	1−Labor Income Share in Construction Sector (Lee (2015))
$\delta_k = 0.0611$	Annual Depreciation Rate of Capital (Cho *et al.* (2012))
$\delta_h = 0.0317$	Annual Depreciation Rate of Housing (Cho *et al.* (2012))

Table 1: HOUSEHOLD AND FIRM-RELATED PARAMETER VALUES.

4.2. POLICY RELATED PARAMETERS

In this model economy, the upper limit of the loan-to-value (LTV) ratio is $1-\theta_v$. Since the LTV limit in Korea was 70% from September 2014 to July 2017, the parameter θ_v is set to 0.3. Additionally, the housing acquisition tax, representing the transaction cost of housing in this model economy, is 1% of the purchased housing value. Therefore, the parameter τ_b for the housing acquisition tax rate is set to 0.01.

The average property tax as a percentage of income, calculated by Park (2019), is 1.0268%. Considering that, as of the end of 2016, the average housing value-to-income ratio is 8.52, the property tax-to-value ratio is only 0.1205%. Using this information, the property tax rate in the benchmark economy of this study is set to 0.1205%. The comprehensive property tax rate increase, resulting from the real estate market stabilization measures announced on September 13, 2018, varies depending on the taxable standard. Among them, for owners of three or more houses with a taxable standard of 300 million won or less, the tax

rate increased by 0.1 percentage points. Based on this, a policy experiment was conducted in the benchmark economy, where the property tax rate was increased by 0.1 percentage points only for households owning houses with a certain value or more. The values of policy-related parameters are summarized in Table 2.

Parameter	Description
$\theta_v = 0.3$	$1-$ LTV Limit
$\tau_b = 0.01$	Housing Acquisition Tax Rate
$\tau_p = 0.001205$	Property Tax Rate If $h < \bar{h}$
$\tau_h = 0.002205$	Property Tax Rate If $h \geq \bar{h}$

Table 2: POLICY-RELATED PARAMETER VALUES.

5. QUANTITATIVE RESULTS

5.1. BENCHMARK ECONOMY

In this study, we assume that the Korean economy is in a steady state in 2017 and use it as the benchmark economy. Table 3 compares the average values of key macroeconomic variables over the 10 years before and after 2017 with the values of these variables in the benchmark economy. The real interest rate and the share of housing service consumption in household consumption are consistent between the data and the model because we targeted these moments when setting the parameters, using the time discount factor β and the utility function parameter ϕ. However, the ratios of total consumption to GDP and capital stock to GDP, which were not used as target moments in parameter setting, do not match between the data and the model. The ratio of total consumption to GDP is similar in both data (62.36%) and the model (71.08%), indicating that the model effectively represents the real economy. However, the ratio of capital stock to GDP is 3.40 in the data and 4.67 in the model, showing a larger discrepancy compared to the ratio of total consumption to GDP. Nevertheless, this is a common phenomenon in models with heterogeneous economic agents, such as Aiyagari (1994), where precautionary saving motives lead to such differences.

Table 4 illustrates the distribution of earnings and assets in the benchmark economy. For each variable, I calculated the proportion that each quintile occupies among the total quantity of that variable in the entire economy and recorded it. Households corresponding to the 1st quintile of earnings account for 7.672%

Variable	Data	Model
r	3.5%	3.5%
C/Y	62.36%	71.08%
qH/C	17.60%	17.60%
K/Y	3.40	4.67

Table 3: KEY MACROECONOMIC VARIABLES. In the data, the ratio of total consumption to GDP is the average value of the proportion of total consumption to the sum of total consumption and total investment from 2008 to 2017. The ratio of capital stock to GDP is the average value from 2008 to 2017.

of the total earnings, while the earnings of the 5th quintile constitute 39.539% of the economy's earnings. Therefore, the labor income earned by the 5th quintile exceeds five times that of the 1st quintile. Calculating the Gini coefficient, which measures earnings inequality, reveals a value of 0.33 in the benchmark economy, comparable to the Gini coefficient of 0.32 observed in the 2016 Korean Labor and Income Panel Study data. Thus, the benchmark economy of the model adequately reflects the real distribution of earnings.

In the benchmark economy, the Gini coefficient for housing assets is 0.17, indicating a more equal distribution compared to the Gini coefficient for earnings (0.33). However, when considering net worth (total assets minus total loans), the Gini coefficient rises to 0.41, signifying higher inequality in net worth compared to both housing assets and earnings. Nevertheless, this Gini coefficient is lower than the Gini coefficient for net worth in the 2018 Survey of Household Finances and Living Conditions data (0.58), indicating that the model does not precisely approximate the inequality of net worth in the real economy. This discrepancy is attributed to the absence of unsecured debts in the model, as the study excluded them to create the most parsimonious model for analyzing the long-run macroeconomic effects of property tax reform.

5.2. POLICY EXPERIMENTS

In this section, we conduct policy experiments to compare and analyze the results of the new steady state after increasing the property tax rate by 0.1 percentage points for all households and households owning homes in the top 50%, 30%, 20%, and 10% by value in the benchmark economy. Through this, we aim to understand the long-run macroeconomic effects of an increase in the property tax rate in Korea. We compare the macroeconomic effects when the excess tax

Quintile	1	2	3	4	5	Gini-Model	Gini-Data
Earnings	7.672	12.340	16.511	23.938	39.539	0.33	0.32
Housing Assets	12.416	16.494	19.732	22.328	29.030	0.17	-
Net Worth	3.603	9.846	16.481	25.334	44.736	0.41	0.58

Table 4: DISTRIBUTION OF INCOME AND ASSETS. The numbers in the table indicate the proportion each quintile occupies in the total quantity of each variable in the entire economy. The data source for the Gini coefficient of earnings is the Korean Labor and Income Panel Study 2016. The data source for the Gini coefficient of Net Worth is the Survey of Household Finances and Living Conditions 2018.

revenue from the property tax rate increase is used for government spending to stimulate the economy and when it is evenly distributed to all households in the model economy as transfers.

5.2.1. Changes in Key Macroeconomic Variables

Table 5 illustrates how major macroeconomic variables change in the experimental economy where the excess tax revenue from the increase in the property tax rate is used for government spending, compared to the benchmark economy. When the property tax rate increases, households subject to the increased tax rate adjust their asset portfolios by reducing savings for housing assets and increasing savings for financial assets, as the return on housing assets decreases. This leads to an increase in the capital stock within the model economy. The outstanding balance of mortgage loans depends on changes in housing demand for households not subject to the increased tax rate. However, the total housing demand within the model economy is mainly determined by households in the top 50%, 30%, 20%, and 10% by value in the benchmark economy, which are relatively asset-rich. Therefore, in all policy experiments in Table 5, the share of housing services in consumption decreases, and the ratio of capital stock to GDP increases. The increase in the model economy's capital stock leads to a decrease in the real interest rate and an increase in the marginal product of labor, raising real wages. In the construction sector, which relies heavily on labor, the increase in real wages leads to increased labor costs, resulting in reduced labor input and a decrease in new housing production. This is evident in Table 5, which shows a decrease in the proportion of construction workers and a decrease in the ratio of residential capital investment to GDP. Although the increased property tax rate reduces demand for housing, the more significant reduction in new housing supply results in an increase in the relative price of housing. Table 5 illustrates

these outcomes. According to Table 5, these long-run effects do not monotonically increase with the growth of households subject to the increased tax rate. The debt-to-GDP ratio decreases when the property tax rate is increased by 0.1 percentage points for all households and households owning homes in the top 30% by value in the benchmark economy. In other cases, it increases or remains unchanged, as households not subject to the increased tax rate increase mortgage loans using the lowered real interest rate to purchase larger homes, given the model economy's conditions.

Table 6 shows how major macroeconomic variables change in the experimental economy where the excess tax revenue from the increase in the property tax rate is equally distributed to all households within the model economy for transfers, compared to the benchmark economy. The results and directions are similar to those in Table 5, but households receive the transfers from the government and increase savings in financial assets. Therefore, the capital stock relative to GDP increases more significantly than when the excess tax revenue is used for government spending, leading to a larger decrease in the real interest rate and a more substantial increase in real wages. In other words, the mechanism is strengthened more when excess tax revenue is used for transfers. However, in the case where households owning homes in the top 20% and 10% by value in the benchmark economy experience a 0.1 percentage point increase in the property tax rate, the difference between using excess tax revenue for government spending and transfers is not significant because the excess tax revenue is not substantial.

Main Macroeconomic Indicators	All	Top 50%	Top 30%	Top 20%	Top 10%
r	-0.011	-0.011	-0.020	-0.011	-0.009
q/P	0.003	0.003	0.005	0.003	0.002
qH/C	-1.510	-2.429	-2.721	-1.674	-1.041
qI_{resid}/Y	-1.538	-2.446	-2.723	-1.689	-1.059
L_h/L	-1.516	-2.423	-2.710	-1.659	-1.039
K/Y	0.009	0.012	0.016	0.010	0.007
$Debt/Y$	-3.448	3.448	-1.149	1.149	0
w/P	0.003	0.003	0.005	0.003	0.002

Table 5: LONG-RUN EFFECTS OF PROPERTY TAX INCREASE (GOVERNMENT SPENDING). Unit:%. r is the real interest rate, q/P is the relative price of housing, qH/C is the share of housing services in consumption, qI_{resid}/Y is the residential capital investment as a share of GDP, L_h/L is the share of construction workers in employment, K/Y is the capital stock as a share of GDP, $Debt/Y$ is the debt-to-GDP ratio, and w/P is the real wage.

Main Macroeconomic Indicators	All	Top 50%	Top 30%	Top 20%	Top 10%
r	-0.049	-0.034	-0.029	-0.017	-0.011
q/P	0.013	0.009	0.008	0.004	0.003
qH/C	-1.506	-2.424	-2.720	-1.675	-1.043
qI_{resid}/Y	-1.513	-2.421	-2.723	-1.689	-1.034
L_h/L	-1.504	-2.411	-2.698	-1.659	-1.039
K/Y	0.023	0.021	0.020	0.011	0.007
$Debt/Y$	-4.598	2.299	-1.149	1.149	0
w/P	0.014	0.010	0.009	0.005	0.003

Table 6: LONG-RUN EFFECTS OF PROPERTY TAX INCREASE (TRANSFERS). Unit:%. r is the real interest rate, q/P is the relative price of housing, qH/C is the share of housing services in consumption, qI_{resid}/Y is the residential capital investment as a share of GDP, L_h/L is the share of construction workers in employment, K/Y is the capital stock as a share of GDP, $Debt/Y$ is the debt-to-GDP ratio, and w/P is the real wage.

5.2.2. Changes in Inequality of Housing Assets and Net Worth

Table 7 illustrates how the Gini coefficient of housing assets and the Gini coefficient of net worth change in the experimental economy where the excess tax revenue from the property tax increase is used for government expenditure, compared to the benchmark economy. According to Table 7, when the property tax rate is increased by 0.1 percentage points only for households owning homes with a value in the top 20% or more, the Gini coefficient of housing assets decreases the most significantly compared to the benchmark economy. In other words, in this case, the inequality of housing assets decreases the most. On the other hand, the Gini coefficient of net worth does not change, as the reduction in the inequality of housing assets, compared to the benchmark economy, is offset by an increase in the inequality of financial assets. When the property tax rate is increased by 0.1 percentage points for households owning homes with a value in the top 50% or more, the Gini coefficient of housing assets slightly increases. However, the Gini coefficient of financial assets and the Gini coefficient of net worth decrease.

Table 8 illustrates how the Gini coefficients for housing assets and net worth change in the experimental economy where the excess tax revenue from the property tax increase is distributed to households through transfers. According to Tables 7 and 8, the extent of the reduction in the Gini coefficient for housing asset is the same in comparison to the benchmark economy, whether the excess

	All	Top 50%	Top 30%	Top 20%	Top 10%
Housing Asset Gini Coefficient	-0.301	0.120	-6.386	-7.108	-4.458
Net Worth Gini Coefficient	0	-0.024	-0.024	0	0

Table 7: UTILIZATION OF EXCESS TAX REVENUE THROUGH GOVERNMENT EXPENDITURE. Unit:%.

	All	Top 50%	Top 30%	Top 20%	Top 10%
Housing Asset Gini Coefficient	-0.301	0.120	-6.386	-7.108	-4.458
Net Worth Gini Coefficient	-0.024	-0.024	-0.048	-0.024	-0.024

Table 8: UTILIZATION OF EXCESS TAX REVENUE THROUGH TRANSFERS. Unit:%.

tax revenue is used for government spending or distributed through transfers. However, the Gini coefficient of net worth decreased more significantly relative to the benchmark economy when the excess tax revenue was distributed to all households as transfers rather than used as government spending.

5.2.3. Changes in Household Welfare

In this study, changes in household welfare are measured using the following method. The superscript * represents the benchmark economy, and the superscript ** represents the experimental economy. By finding the scaling factor that makes the sum of households' lifetime utilities equal in both economies, we can measure the changes in household welfare in annual consumption units between the two economies.

$$\int \sum_{t=0}^{\infty} \beta^t u((1+\omega)C_t^*)\, d\mu^*(a,h,x) = \int \sum_{t=0}^{\infty} \beta^t u(C_t^{**})\, d\mu^{**}(a,h,x)$$

Table 9 illustrates the extent to which household welfare changes in the experimental economy compared to the benchmark economy, measured in annual consumption units using the method described above. According to Table 9, household welfare decreases in all cases compared to the benchmark economy. In other words, increasing the property tax distorts household decision-making, leading to a reduction in welfare compared to the benchmark economy. However, it is observed that the loss in household welfare is less when distributing the excess tax revenue, obtained from the increase in the property tax, through

Target of Property Tax Increase	Change in Welfare (%)	
	(1)	(2)
All	-0.021	-0.014
Top 50%	-0.020	-0.017
Top 30%	-0.015	-0.013
Top 20%	-0.008	-0.007
Top 10%	-0.003	-0.003

Table 9: CHANGES IN HOUSEHOLD WELFARE. (1) represents the change in welfare (%) when excess revenue is used for government spending. (2) represents the change in welfare (%) when excess revenue is distributed through transfers.

transfers compared to using it for government spending. Therefore, this result suggests that when increasing the property tax, distributing the excess tax revenue to households through transfers minimizes the loss in welfare. However, when households owning homes with values in the top 20% and 10% in the benchmark economy experience 0.1% points increase in the property tax rate, the excess tax revenue is not substantial. Therefore, there is not a significant difference in the outcome between using the excess tax revenue for government spending and transfers.

6. CONCLUSION

This study analyzed the macroeconomic effects of changes in property tax rates using a two-sector general equilibrium model with heterogeneous households characterized by disparate levels of labor productivity and assets. The model includes a final goods-producing sector and a construction sector responsible for producing new housing. Given the long-run nature of changes in new housing supply, this study compared the steady state of the benchmark economy, calibrated to key statistical moments of the 2017 Korean economy, with the steady state of the experimental economy, where property tax rates were altered. The study aimed to identify policies that reduce housing asset inequality while minimizing societal welfare losses in Korea. Considered policies include raising property tax rates for all households and specifically for households holding high-value housing assets, as well as policies allocating excess property tax revenue to government spending or distributing it through transfers.

According to the results, increasing property tax rates by 0.1 percentage

points only for households holding housing assets in the top 20% leads to the largest reduction in housing asset inequality compared to the benchmark economy. However, raising property tax rates distorts household decision-making and generally decreases welfare compared to the benchmark economy. In most cases, redistributing excess property tax revenue through transfers results in lower household welfare losses than using it for government spending. The findings suggest that not increasing property tax rates is the most favorable policy as it avoids additional losses in household welfare.

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