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On the Long-Term Effect of Recent Housing Policies in Korea*

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This paper explores the long-term effect of recent housing policies in Korea. Using a two-sector general equilibrium model with heterogeneous agents, we conduct three policy experiments: i) a reduction in the loan-to-value (LTV) ratio; ii) an increase in the house acquisition tax rate; iii) an increase in the property tax rate. We find that all three policies increase the relative price of housing structures in the long run, yet their quantitative effect is small, and that the reduced LTV ratio is effective in reducing the household debt. Heterogeneous responses to these policies depending on household wealth are crucial in these results.

JEL Classification: E65, H31, R21, R31
Keywords: Housing Policies, House Prices, Household Debt, Heterogeneous Agents

I. Introduction

After the 2008-2009 global financial crisis, household debt increased sharply in Korea. As Figure 1 shows, the household debt to GDP ratio rose from 62% in 2011 to 78% in 2019, while about three quarters of this increase occurred after 2013 as house prices picked up. Figure 2 presents trends in real house prices in Korea over the same period.[1] All three indices showed significant declines until 2013, when they reversed their trends.

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[1] The figure shows the house transaction price index published by the Korea Appraisal Board, deflated by the consumer price index. This index is 1 in November 2017.

In response to the rapidly increasing household debt coupled with the rise in house prices, the Korean government announced a series of housing policies beginning in August 2017. These policies include a tighter lending rule for house purchases, an increase in the real estate tax rate, and a rise in housing transaction costs. These policies are developed to suppress the demand for housing structures and hence stabilizing house prices while reducing household debt. In this study, we attempt to examine the long-term effect of these housing policies on the overall economy and the distribution of income, wealth, and consumption.

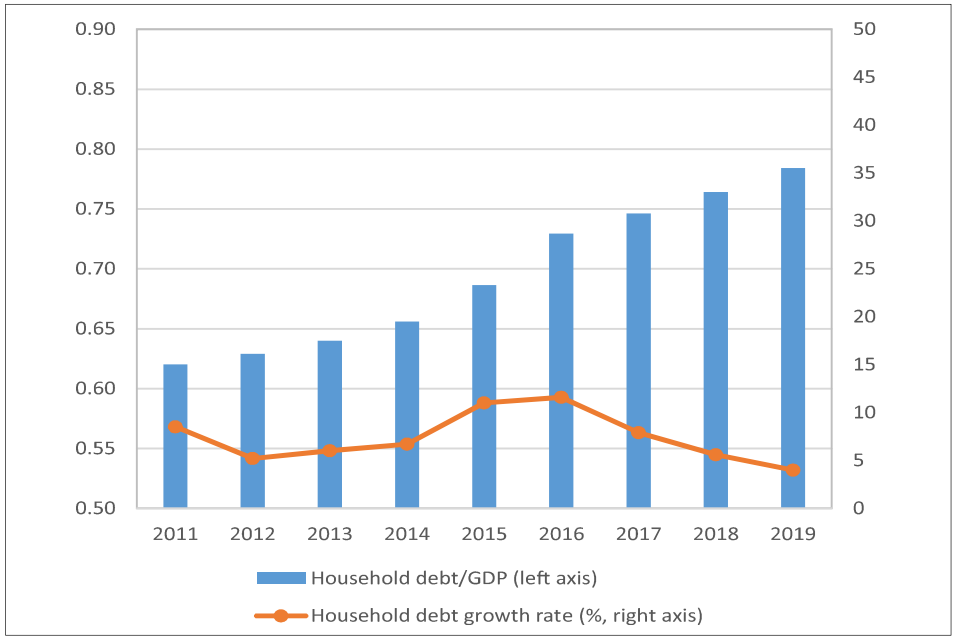
To this aim, we build up a two sector general equilibrium model with heterogeneous agents. Households in this model economy are subject to idiosyncratic labor productivity shocks and have two options for saving, liquid financial assets and illiquid housing structures. Illiquidity of housing structures is due to costs associated with housing transactions. We calibrate this model economy to the 2017 Korean economy. We then solve for a new steady state where the government implements housing policies to suppress the demand for housing structures, and compare this new steady state with the benchmark economy to examine the long-term effect of these policies. The housing policies considered in this study include a reduction in the loan-to-value (LTV) ratio, an increase in the house acquisition tax rate, and a rise in the property tax rate.

We find that all three housing policies suppress the demand for housing structures first, yet the supply of housing structures ultimately declines even more. Consequently, the relative price of houses increases in the long run, although it is quantitatively small. However, these policies are fairly effective in reducing the household debt. The tighter lending rule is crucial in reducing the household debt-to-GDP ratio. Reducing the LTV ratio from 70% to 40% decreases the household debt-to-GDP ratio almost by half. However, this policy causes the demand for housing structures by wealthier households to increase due to a general equilibrium effect, helping expand the construction sector in the long run. On the other hand, increasing tax rates associated with transactions and possession of housing structures reduces both demand for and supply of housing structures, lessening the share of construction in total employment by 1.4%−1.6% in the long run.

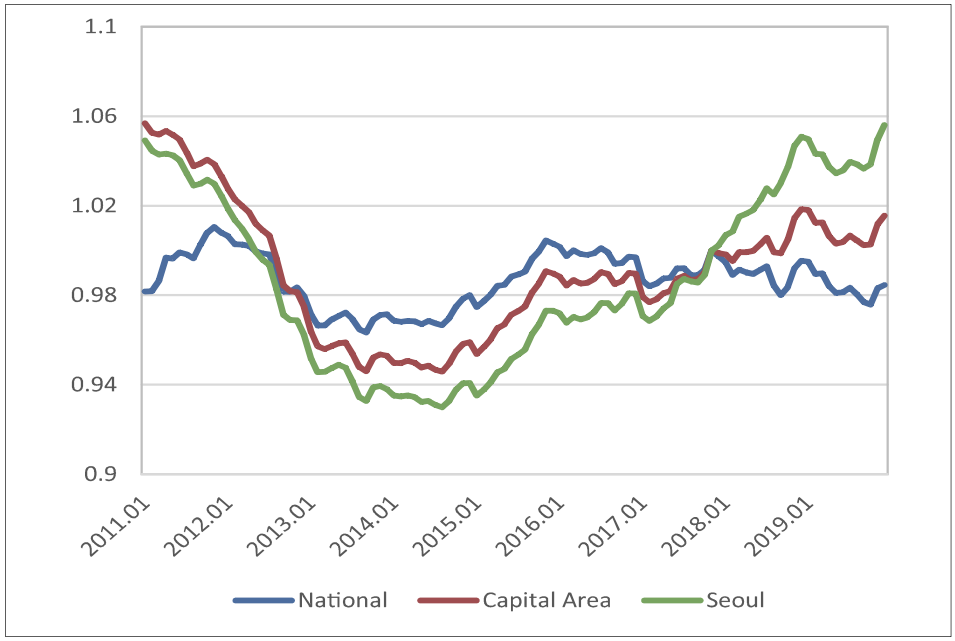
This paper can relate to many previous studies that explore the effect of housing institutions and policies on housing markets using a general equilibrium model of housing with heterogeneous agents, such as Favilukis et al. (2017), Sommer and Sullivan (2018), and Seok and You (2019). Favilukis et al. (2017) explores the effect of relaxing financing constraints on house prices in a business cycle context. Sommer and Sullivan (2018) study the effect of the mortgage interest rate deduction on the house price, rents, and homeownership. Seok and You (2019) examine the impact of declines in both housing transaction costs and downpayment requirements as well as a rise in earnings risks on relative price and quantity of housing structures. Like these studies, we use a dynamic general equilibrium model

of housing with heterogeneous agents to explore the impact of recent housing policies in Korea.

[Figure 1] Trends in Household Debt in Korea



[Figure 2] Trends in Real House Prices in Korea



There are a few recent studies on housing markets in Korea based on a structural model. Song (2014) estimates the relation between house prices, LTV ratio, and household consumption in Korea using a general equilibrium model with a representative agent. Unlike this study, we consider a model with heterogeneous households, which is necessary to examine the heterogeneous effect of housing policies depending on household income and wealth. Song and Hong (2019) study the impact of macroeconomic shocks on household debt and the risks of debt adjustments in Korea, and Hong et al. (2020) explore the effect of macroeconomic fundamentals and housing policies on house prices and rent in Korea since 2001. Both studies consider a housing rental market separately and hence have rich implications for rents and homeownership as well as house prices. However, these studies take either the real interest rate or the supply of housing structures as exogenous. Our work differs from theirs in that our model allows for endogenous responses of the real interest rate and the supply of housing structures to recent housing policies, which play an important role in our quantitative result.

The remainder of this paper is organized as follows. Section II describes the two sector general equilibrium model and section III presents our calibration strategy. In section IV, we report main quantitative results from policy experiments. Section V discusses policy implications of the model further, and section VI concludes the paper.

II. Model

We build a two-sector general equilibrium model with heterogeneous agents as in Seok and You (2019). In this model, households are subject to idiosyncratic labor productivity shocks, due to which ex-ante identical households end up with different income, asset, and consumption profiles. The two goods, final goods and housing structures, are produced separately in two sectors.

2.1. Households

There is a continuum of one-person households of measure one. Households derive utility from consumption aggregates $C = c^{1-\phi} h^{\phi}$, where c and h denote final goods and housing services, respectively.[2] The quantity of the housing structure owned by each household is assumed to provide the same amount of housing services. This implies that h represents both the stock of housing structures and the flow of housing services from the stock. We abstract from housing

[2] We assume a unit elasticity of substitution between final goods and housing services following Fernandez-Villaverde and Krueger (2011).

rental markets, so every household is a homeowner. We make this choice because this model is one of the most parsimonious one that can address the effect of housing policies on household asset portfolio and hence on house prices.

Households are subject to idiosyncratic labor productivity shocks (x) in every period. We assume that the labor productivity shock, x, follows $\log(x_{t+1}) = (1-\rho_x)\upsilon_x + \rho_x \log(x_t) + \eta_{t+1}$, where $\eta_{t+1} \sim (0, \sigma_x^2)$. A household's labor income is then determined by the labor productivity shock multiplied by the real wage (w) per efficiency unit of labor. Households can invest in financial assets (a) and housing structures (h). The financial asset is a claim on non-residential capital, and the rental rate of non-residential capital is denoted by r. The price of housing structures relative to final goods is denoted by q. In this model, financial assets are liquid in that they are not subject to any transaction costs. In contrast, housing structures are illiquid because whenever households move from h to h', they should pay transaction costs $\tau_b q h'$, where τ_b is the house acquisition tax rate.

Households can also use housing structures as collateral. When buying a housing structure (h') for the next period, a household should make a downpayment for fraction θ of its market value. This restriction sets each household's borrowing limit or loan-lo-value (LTV) ratio at $(1-\theta)qh'$. No unsecured debt is allowed in this model.[3] On the other hand, each household pays the maintenance cost and the property tax for her housing structure at the end of the period. The maintenance cost is given by $q\delta_h h$, where δ_h is the depreciation rate of housing structures. The property tax burden for each household is $\tau_p q(1-\delta_h)h$, where τ_p is the property tax rate.

Given prices, q, w, and r, the utility-maximization problem of a household can be summarized by the following value function:

$$
\begin{aligned}
&V(a,h,x) = \max_{c,h'} \{u(c^{1-\phi}h^{\phi}) + \beta \mathbb{E}[V(a',h',x') \mid x]\} \\
&\text{s.t.} \quad c + a' + qh' + qT(h,h') = wx + (1+r)a + q(1-\delta_h)h, \\
&a' \geq -(1-\theta)qh', \\
&T(h,h') = \begin{Bmatrix} \tau_p(1-\delta_h)h + \tau_b h', & \text{if } h \neq h' \\ \tau_p(1-\delta_h)h, & \text{if } h = h' \end{Bmatrix},
\end{aligned}
$$

where β is a time discount factor.

[3] Due to both the lack of unsecured debt and the presence of precautionary savings motive, the model fails to match the debt-to-GDP ratio or the distribution of household debt in the data. Thus, this study focuses on changes in the debt-to-GDP ratio instead of its level, and the distributional features of household assets rather than household debt.

2.2. Firms

In this model economy, there are two production sectors: one sector produces final goods, while the other sector produces housing structures. In each sector, there is a representative firm, which, for given total factor productivity (λ), combines non-residential capital (K) and labor (L) to produce goods. Each firm's production technology is assumed to be a Cobb-Douglas type. Let f and h denote the final goods sector and the housing sector, respectively. The production functions of both sectors are given by

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

Here, we assume that housing production is more labor intensive than final goods production, which implies that $\alpha > \kappa$.

A representative firm in each sector maximizes profits by choosing capital and labor optimally given market prices, q, r, and w, as follows:

$$\max_{L_f, K_f} \{F(K_f, L_f; \lambda_f) - (r + \delta_k) K_f - wL_f\},$$
$$\max_{L_h, K_h} \{qG(K_h, L_h; \lambda_h) - (r + \delta_k) K_h - wL_h\},$$

where δ_k is the depreciation rate of capital.

2.3. The Government

In this model economy, the government imposes property taxes and house acquisition taxes on households, and uses the tax revenue to finance government consumption purchases (G). For given distribution of households, $\mu(a,h,x)$, the government is assumed to balance its budget in every period. This implies that the government satisfies the following budget constraint:

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

2.4. Steady State Equilibrium

A steady state equilibrium for the model economy is a value function $V(a,h,x)$, a set of optimal policy functions $\{c(a,h,x), a'(a,h,x), h'(a,h,x)\}$, a set of aggregate inputs $\{K_f, K_h, L_f, L_h\}$, a set of prices $\{q, r, w\}$, a set of government policies

$\{T(h,h'),G\}$, and a distribution of households $\mu(a,h,x)$ such that:

1. Households maximize lifetime utility: for given a set of prices $\{q,r,w\}$ and a set of government policies $\{T(h,h'),G\}$, a value function $V(a,h,x)$ solves households' Bellman equation, and the optimal policy functions are given by $c(a,h,x), a'(a,h,x)$, and $h'(a,h,x)$.

2. Firms maximize profits: for given a set of prices $\{q,r,w\}$, the firm in each sector determines the demand for capital and labor so that the following optimality conditions are satisfied:

$$r+\delta_k = \alpha\lambda_f K_f^{\alpha-1}L_f^{1-\alpha} = q\kappa\lambda_h K_h^{\kappa-1}L_h^{1-\kappa},$$
$$w = (1-\alpha)\lambda_f K_f^{\alpha}L_f^{-\alpha} = q(1-\kappa)\lambda_h K_h^{\kappa}L_h^{-\kappa}.$$

3. The final goods market clears:

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

4. The housing market clears:

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

5. Factor markets clear:

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

6. The government satisfies the following budget constraint:

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

7. Let Φ be the transition rule of the distribution of households $\mu(a,h,x)$ implied by optimal policy functions $c(a,h,x), a'(a,h,x), h'(a,h,x)$, and the law of motion for x. The distribution of households is time-invariant, that is, $\mu = \Phi(\mu)$.

III. Calibration

In this section, we describe how we set the values of model parameters. A few model parameters are determined based on the related literature and a priori information. The remaining parameters are calibrated so that the benchmark economy is consistent with various target moments.

3.1. Preference and Technology

We calibrate the model economy so that the initial steady state of the model replicates the 2017 Korean economy. We make this choice because the Korean government began to announce a series of housing policies to stabilize house prices and reduce household debt in 2017. When we choose data moments to calibrate the model, however, we use statistics for about 10 years around 2017 instead of a single year of 2017. These data moments are then not sensitive to year-specific effects.

The model period is a year. We set the time discount factor, β, so that the real interest rate in the model is 3%. For the preference structure of households, we use a constant relative risk aversion (CRRA) utility function:

$$u(C)=\frac{C^{1-\gamma}-1}{1-\gamma}.$$

The relative risk aversion, γ, is set to 2, which is standard in the related literature. The parameter ϕ indicating the relative importance of housing services in household utility is picked by targeting the average share of expenditure on housing, water, electricity, gas and other fuels in the final consumption expenditure by households between 2008 and 2017, which is 17.7%. The stochastic process for idiosyncratic labor productivity shocks is parameterized according to Chang and Kim (2008) who estimate a labor income process using Korean Labor Income Panel Study (KLIPS): $\rho_x=0.0800$ and $\sigma_x=0.354$.

The TFPs in both final goods and housing sectors are normalized to 1 in the benchmark economy. The depreciation rates for non-residential capital and housing structures are set to $\delta_k=0.0611$ and $\delta_h=0.0317$, respectively, based on the estimates in Cho et al. (2012). The capital income shares in both final goods and housing sectors are obtained by subtracting the estimates for labor income shares in manufacturing and construction sectors in Lee (2015) from 1. Specifically, $\alpha=0.450$ and $\kappa=0.038$. Table 1 lists the values of these parameters.

[Table 1] Utility and Technology Parameters

Parameter	Note
$\beta = 0.956$	Time discount factor (targeting the real interest rate of 3%)
$\gamma = 2$	Relative risk aversion
$\phi = 0.011$	The share of expenditure on housing and fuels in final consumption expenditure of 17.7%
$\rho_x = 0.800$	Persistence (Chang and Kim (2008))
$\sigma_x = 0.354$	Standard deviation (Chang and Kim (2008))
$\lambda_f = 1$	TFP in the final goods sector
$\lambda_h = 1$	TFP in the housing sector
$\alpha = 0.450$	1-labor income share in manufacturing sector in Lee (2015)
$\kappa = 0.038$	1-labor income share in construction sector in Lee (2015)
$\delta_k = 0.0611$	Annual rate of depreciation of physical capital (Cho et al. (2012))
$\delta_h = 0.0317$	Annual rate of depreciation of houses (Cho et al. (2012))

3.2. Housing Policy

In this model, we allow secured loans only, while the borrowing limit is given by fraction $(1-\theta)$ of the market value of housing structures. This implies that the LTV ratio is capped at $1-\theta$. The Korean government set the nationwide maximum LTV ratio at 70% in September 2014. In August 2017, the Korean government, as a part of housing market stabilization package, reduced the upper limit on the LTV ratio to 40% for major divisions in Seoul and other regions, designated as overheated speculative districts. Based on this change, we set the downpayment requirement in the benchmark economy to $\theta = 0.3$, and then implement a policy experiment where θ is raised to 0.6.

Housing transactions in Korea involve a variety of costs including house acquisition taxes, realtor commissions, local taxes, etc. Among these, house acquisition taxes form the largest portion, which is 1% of the purchase price of a house. In the model, housing transaction costs households pay are submitted to the government in the form of house acquisition taxes. Thus, the tax rate τ_b is set to 0.01 in the benchmark economy. We implement an experiment where this tax rate is increased to 2% hypothetically.

There are two types of taxes imposed on homeowners in Korea. One is a property tax, which is a local tax levied on all types of land and buildings. The other is a real estate tax, a national tax levied on all types of land and residential buildings whose market values are above certain thresholds. According to Park (2019), the average property and real estate tax payment relative to household income is 1.0268% and the average house value relative to household income is 8.52 from the 2016 Korean

National Survey of Tax and Benefit (NasTaB) panel data. These stats imply that the average property and real estate tax payment relative to house value is 0.1205%, so we set the property tax rate in the model to 0.1205%. We then increase the property tax rate by 0.1%p in a policy experiment, following the housing policy announced by the Korean government in September 2018.[4] Table 2 summarizes the values of housing policy parameters in the benchmark economy and policy experiments.

[Table 2] Parameterizing Housing Policies

Parameter	Benchmark Economy	Policy Experiment
θ	0.3	0.6
τ_b	0.01	0.02
τ_p	0.001205	0.002205

IV. Results

This section presents key statistics for the benchmark economy, followed by main results from housing policy experiments. The housing policies considered in this section include a decline in the LTV ratio, an increase in the house acquisition tax rate, and a rise in the property tax rate.

4.1. Benchmark Economy

We parameterize the model economy so that its initial steady state can replicate the 2017 Korean economy and consider the initial steady state as the benchmark economy. Table 3 presents the values of key macroeconomic variables in the model along with their data counterparts.

The benchmark model can exactly replicate both the real interest rate (3%) and the share of housing services consumption in household consumption expenditures (17.70%) in the data because these two values are used as target moments in calibrating parameters β and ϕ. Although the ratio of consumption expenditure to GDP is not targeted in calibration, the model does a decent job in matching the statistic. In the model, the consumption expenditure is about 69% of GDP, while it is slightly over 62% in the data. The capital-to-GDP ratio in the model is 4.92, overstating its data counterpart.

[4] In Sep. 2018, the Korean government announced another set of housing policies to stabilize house prices. As a part of this policy package, the government increased the real estate tax rate by 0.1%p–1.2%p. The tax burden increased more prominently for households with multiple houses and/or more expensive houses.

[Table 3] Key Macroeconomic Variables: Model vs. Data

Variable	Data	Model
Real interest rate (r)	3%	3%
Consumption to GDP ratio (C / Y)[1)]	62.36%	69.51%
Share of housing services in consumption expenditures (qH / C)	17.70%	17.70%
Capital to GDP ratio (K / Y)	3.40	4.92

Notes: 1) Note that the model abstracts from net exports and government expenditures not financed by house acquisition and property taxes. For a fair comparison, we calculate the consumption-to-GDP ratio in the data by dividing aggregate consumption by the sum of aggregate consumption and aggregate investment for years 2008 to 2017, and take the average. 2) The capital stock to GDP ratio is the average over the 2008-2017 period.

Table 4 presents how income and assets are distributed in the benchmark economy. For each variable, we calculate its fraction owned by households in a particular quintile and present these numbers. For instance, the first earnings quintile holds 7.267% of aggregate earnings, while the fifth earnings quintile holds 40.648%. The earnings of the top earnings quintile is more than 5 times those of the lowest earnings quintile. The earnings Gini coefficient in the model is 0.34, close to the earnings Gini coefficient for homeowners in the 2018 Korea Housing Survey, taken from Oh (2020). This shows that the model approximates the earnings in equality in the data well.

In the benchmark economy, housing assets are more equally distributed than earnings. The highest housing quintile owns about 30% of aggregate housing assets, which is less than three times those owned by the lowest housing quintile. The Gini coefficient for housing assets is 0.20, significantly lower than that for earnings.

[Table 4] The Distribution of Household Income and Wealth in the Benchmark Economy

Variable	1	2	3	3	5	5/1	Gini-Model	Gini-Data
Earnings	7.267	11.858	16.198	24.028	40.648	5.594	0.34	0.33[2)]
Housing Assets	11.220	15.568	19.682	23.074	30.456	2.714	0.20	..
Net Worth	2.956	8.920	15.752	25.239	47.133	15.943	0.44	0.44[2)]

Notes: 1) Each quintile represents the fraction of the variable owned by households in the particular quintile. 2) These numbers are for homeowners only, and have been taken from Oh (2020).

On the other hand, net worth is more unequally distributed than both earnings and housing assets. Net worth is the sum of financial and housing assets net housing debt. Note that the net worth of all households is positive because unsecured debt is not allowed in the model. The first net worth quintile owns only 2.9% of aggregate wealth, which is about one sixteenth of net worth owned by the top net worth quintile. The Gini coefficient for net worth is 0.44 in the model. Even if we do not target this moment in our calibration, the model replicates the net

worth inequality we observe for homeowners in the 2018 Korea Housing Survey (Oh (2020)).

Table 5 presents the distribution of consumption relative to income and housing assets relative to both income and net worth by household net worth quintile. By looking into the detailed consumption and asset structure of households, we can have a clue about the heterogeneous effect of each housing policy by household income and wealth. The first notable feature is that households spend an increasing fraction of their income on consumption as net worth increases. This feature is most pronounced among top net worth quintile. The gap in the household consumption-to-income ratio between the fourth and the fifth net worth quintiles is the largest compared with any other two consecutive net worth quintiles. The ratio of housing assets relative to household income also increases as net worth rises. The first net worth quintile hold housing assets equivalent to 2.65% of their household income, while this ratio increases to 6.25% for the highest net worth quintile. To the contrary, the share of housing assets in household net worth falls with household net worth. For the lowest net worth quintile, their housing assets are more than 9% of household net worth, while housing assets for the highest net worth quintile are only 1.5% of their net worth. This implies that the wealthier a household is, the larger fraction of their wealth is in the form of financial assets.

[Table 5] Consumption and Housing Assets by Wealth Quintile

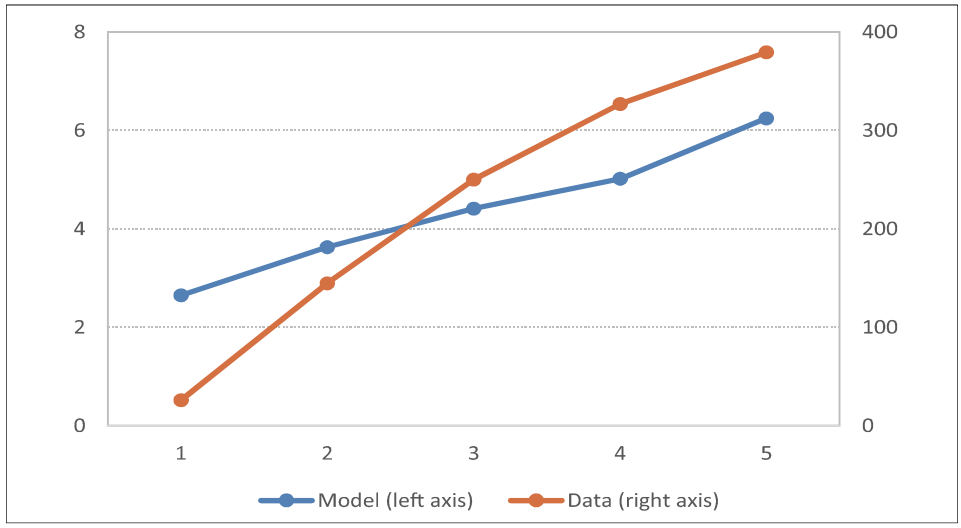
Variable	1	2	3	4	5
Consumption to Income (C/I , %)	30.31	32.53	34.78	37.61	43.16
Housing Asset to Income (H/I , %)	2.65	3.63	4.412	5.016	6.248
Share of Housing Assets in Net Worth (H/W , %)	9.40	4.33	3.04	2.21	1.56

Note: Numbers in this table indicate 100 times the ratio of the average value of the numerator variable to that of the denominator variable for households in the corresponding net worth quintile.

We also compare the distributional features of housing assets in the model with their data counterparts. We take data on household income, housing assets, and net worth from 2017 Survey of Household Finances and Living Conditions to compute the housing asset-to-income ratio and the share of housing assets in household net worth by net worth quintile. Housing assets here indicate the value of the main residence. Figure 3 shows that the housing asset-to-income ratio in the data increases with household net worth as it does in the model. Figure 4 also shows the declining share of housing assets in household net worth in the data, consistent with what the model in this paper generates. This confirms that the model replicates the distribution of housing assets by household net worth in the data fairly well.[5]

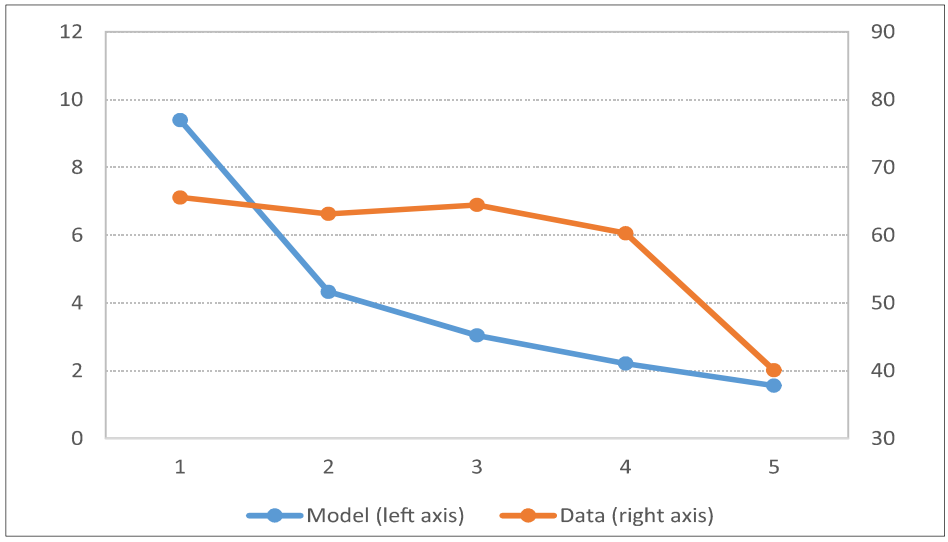
[5] Please note that the variable h represents both the stock of housing structures and the flow of

[Figure 3] Housing Asset-to-Income Ratio by Net Worth Quintile



Note: Data source is 2017 Survey of Household Finances and Living Conditions. Housing assets from the data indicate the value of the main residence.

[Figure 4] The Share of Housing Assets in Net Worth by Net Worth Quintile



Note: Data source is 2017 Survey of Household Finances and Living Conditions. Housing assets from the data indicate the value of the main residence.

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housing services from the stock in the model. Since we use the ratio of housing services to final goods consumption to calibrate the utility function, there is no guarantee that the level of housing assets in the model matches the stock of housing structures in the data. However, comparing the distribution of housing assets relative to income or net worth across net worth quintiles with their data counterparts makes sense because housing services move in line with the stock of housing structures.

4.2. Policy Experiments

In this subsection, we examine the long-term effect of major housing policies the Korean government announced or may consider in future. These policies include a reduction in the LTV ratio, an increase in the house acquisition tax rate, and a rise in the property tax rate. We first analyze the economic impact of each policy separately and then consider the joint effect of all three policies.

A Reduction in the LTV Ratio The Korean government announced a tougher lending rule in major counties in Seoul and two other cities where home prices were rapidly rising. Under the new rule, the LTV ratio for home buyers in these regions was reduced from 70% to 40%. In order to analyze the long-term effect of this policy on the economy, we increase the downpayment requirement in the model from $\theta = 0.3$ to $\theta = 0.6$. The second column of Table 6 presents changes in key macroeconomic variables induced by this policy.

[Table 6] Effects of Housing Policies on Key Macroeconomic Variables

Variable	LTV↓	Acquisition Tax↑	Property Tax↑	All
Real Inerest Rate (r)	-0.023	-0.043	-0.013	-0.087
Relative Price of Housing (q / P)	0.006	0.011	0.003	0.021
Housing Services to Final Goods Consumption (qH / C)	0.244	-1.593	-1.415	-2.847
Residential Investment to GDP (qI_{resid} / Y)	0.256	-1.590	-1.385	-2.846
Share of Construction in Total Employment (L_h / L)	0.262	-1.584	-1.393	-2.834
Capital Stock to GDP (K / Y)	0.003	0.020	0.006	0.036
Household Debt to GDP ($Debt / Y$)	-46.667	8.571	-1.905	-40.952
Real Wage (w / P)	0.006	0.012	0.004	0.023

Note: Numbers are percentage changes compared with the benchmark economy.

In the model economy, housing debt is the only type of debt allowed. Households can use this housing debt as a buffer if they are hit by a series of bad productivity shocks. If the LTV ratio is reduced, then households' borrowing limit is tightened, so they may have difficulty in smoothing consumption by relying on borrowing. Consequently, households attempt to increase precautionary savings by investing more in financial assets. This effect is likely to be strong for poorer households whose asset position is close to the borrowing limit, while wealthier households are rarely affected. This increases the aggregate capital relative to GDP by 0.003% in the long run, which reduces the real interest rate by 0.023%. This capital deepening raises the marginal product of labor, increasing the real wage by 0.006%.

The increased real wage raises production costs of labor-intensive housing

production and hence the supply of housing structures is curtailed. On the other hand, the decline in the real interest rate reduces the rate of return on financial assets. This effect is more pronounced for wealthier households because they put a larger share of their wealth in financial assets compared with poorer households. Thus, wealthier households have incentives to reallocate their asset portfolio in a way that the share of housing assets increases. This general equilibrium effect caused by the change in the real interest rate increases the aggregate demand for housing assets. This dominates the decline in the supply of housing structures, helping the construction sector expand in the long run. Both residential investments relative to GDP and the labor share of the housing sector rise by 0.256% and 0.262%, respectively, while the ratio of housing services consumption relative to final goods consumption increases by 0.244%.

This increased demand for housing structures also increases its relative price by 0.006%, compared with the benchmark economy. Even if the tightened lending rule fails to lower house prices, it is successful in reducing the amount of household debt. The debt-to-GDP ratio declines almost by half due to the decline in the LTV ratio.[6]

Table 7 shows how heterogeneous this policy effect is on household consumption and housing assets. Households in the first and the second wealth quintiles, directly affected by the tightened borrowing limit, decrease the share of housing assets in their asset portfolio. This causes these households to reduce housing services consumption while increasing final goods consumption relative to their income. On the other hand, wealthier households reallocate their assets towards housing assets due to the general equilibrium effect. Households in the fifth wealth quintile increase their housing assets relative to both household income and wealth significantly. As a result, their final goods consumption is partly substituted by housing services consumption, reducing the consumption-to-income ratio for these households. These results imply that adopting heterogeneous agent model is crucial in understanding the key mechanism through which the housing policy affects the economy.

[6] If a rental market exists in the model, housing policies to reduce demand for housing structures discourage homeownership, causing households to rent home rather than own one. Lowering the upper limit on the LTV ratio causes low wealth households to give up homeownership and enter the rental market. These low-wealth households are the main contributor to high debt-to-GDP ratio in the benchmark economy, so making them give up homeownership through the LTV regulation may reduce the debt to-GDP ratio even more than in the economy without a rental market.

[Table 7] The Effect of a Tighter Lending Rule by Wealth Quintile

Variable	1	2	3	4	5
Consumption to Income (C / I)	0.036	0.011	0.040	-0.038	-0.013
Housing Asset to Income (H / I)	0.407	-0.179	0.415	-0.054	0.592
Share of Housing Assets in Net Worth (H / W)	-0.178	-0.314	0.408	-0.036	0.614

Note: Numbers are percentage changes compared with the benchmark economy.

An Increase in the House Acquisition Tax Rate In this experiment, we increase the house acquisition tax rate from 1% to 2%, holding all other parameters of the model constant at their values in the benchmark economy. Even if the Korean government hasn't implemented this policy yet, it actually considered this as a plausible policy option. From this experiment, we can examine the quantitative effect of an alternative policy option the Korean government might adopt in future.

The third column of Table 6 shows how key macroeconomic variables change in response to the rise in the house acquisition tax rate. If the house acquisition tax rate increases, it raises transaction costs for housing structures, worsening their liquidity. Households subject to idiosyncratic labor productivity shocks readjust their asset portfolio by reducing the share of housing assets in their wealth. This switch from housing assets to financial assets helps accumulate a larger stock of physical capital in the long run. The capital-to-GDP ratio increases by 0.02% in the new steady state, compared with the benchmark economy, while it reduces the real interest rate by 0.043%. This also increases the marginal product of labor, raising the real wage by 0.012%.

The effect of the increased house acquisition tax rate on market prices such as the real interest rate and the real wage is double that of the reduced LTV ratio. If the LTV ratio is reduced from 70% to 40%, the decline in the real interest rate induces wealthier households to increase their demand for housing structures, which dominates the housing market. In case that the house acquisition tax rate increases and hence housing assets become even more illiquid, wealthier households do not increase their demand for housing structures even if the rate of return on their financial assets drops. On the other hand, the rise in the real wage adversely affects the housing sector more than the final goods sector. Thus, the relative supply of housing structures is reduced. This supply effect dominates the housing market in the long run, reducing the relative quantity of housing structures and increase their relative price. In the new stead state, the residential investment relative to GDP and the labor share in the housing sector diminish by 1.590% and 1.584%, respectively. The housing services consumption relative to final goods consumption also declines by similar magnitude. In contrast, the relative price of housing structure increases by 0.011%.

Although the aggregate demand for housing structures declines, the debt-to-GDP ratio increases by 8.571%. In order to understand what type of households

hold more housing debt compared with the benchmark economy, we examine the distribution of housing assets by net worth quintile. Table 8 shows this distribution. We find that households in top three net worth quintiles decrease housing assets relative to both income and wealth in response to the rise in the house acquisition tax rate. In contrast, households in the first and the second wealth quintiles expand their housing assets as the interest burden from the housing debt declines with the lower real interest rate. Households in the second wealth quintile increase their housing assets relative to both income and wealth. As they own more housing assets, their housing services consumption increases, replacing their final goods consumption. As a result, the consumption-to-household income ratio for these households declines. Households in the first wealth quintile also increase their housing structures, but their income and wealth turn out to increase more.

[Table 8] The Effect of an Increase in the Housing Acquisition Tax Rate by Wealth Quintile

Variable	1	2	3	4	5
Consumption to Income (C/I)	-0.004	-0.006	0.057	-0.015	0.022
Housing Asset to Income (H/I)	-0.087	1.287	-2.201	-1.738	-3.147
Share of Housing Assets in Net Worth (H/W)	-0.128	1.292	-2.194	-1.726	-3.129

Note: Numbers are percentage changes compared with the benchmark economy.

An Increase in the Property Tax Rate This experiment is designed to analyze the long-term effect of an increase in the property tax rate. To this aim, we increase the property tax rate from 0.1205% to 0.2205% by 0.1%p. The fourth column of Table 6 presents changes in the key macroeconomic variables caused by the increased property tax rate, compared with the benchmark economy. The higher property tax rate increases the cost of possessing housing structures, causing households to reduce housing assets in their asset portfolio. As households invest in financial assets more, the aggregate capital stock increases in the long run. The aggregate capital stock relative to GDP increases by 0.006%. The larger capital stock increases the marginal product of labor, while reducing the marginal product of capital. As a result, the real wage increases by 0.004% and the real interest rate declines by 0.013%.

The increased real wage reduces the supply of housing structures as it does in other policy experiments. A decline in the rate of return on financial assets or a decline in the interest burden for housing debt due to the lower real interest rate might have increased the demand for housing assets. However, this effect turns out not large enough to offset the significant decline in the demand for housing structures caused by the increased property tax rate. Thus, both the supply and the demand for housing structures drop following the rise in the property tax rate. This reduces the quantity of housing production in the long run, while raising the

relative price of housing structures only slightly. The ratio of residential investment to GDP and the labor share of the housing sector decline by 1.385% and 1.393%, respectively. The housing services to final goods consumption also diminishes by 1.415%. However, the relative price of housing structures increases only by 0.003%. As households reduce their housing assets, the debt-to-GDP ratio declines by 1.905%.

Table 9 presents how this policy affects household consumption and wealth structure by net worth quintile. We find that the increase in the property tax rate has fairly uniform effects on all households by reducing their final goods consumption relative to households income, yet the effect is quantitatively small. The more pronounced feature from Table 9 is that both housing services consumption relative to household income and the share of housing assets in household net worth decline across all wealth quintiles. Given the small increase in the property tax rate, its quantitative effect on households' asset portfolio and housing services consumption is quite large.

[Table 9] The Effect of an Increase in the Property Tax Rate by Wealth Quintile

Variable	1	2	3	4	5
Consumption to Income (C/I)	-0.004	-0.002	-0.014	-0.011	-0.011
Housing Asset to Income (H/I)	-1.369	-1.094	-1.664	-1.465	-1.341
Share of Housing Assets in Net Worth (H/W)	-1.318	-1.059	-1.635	-1.446	-1.325

Note: Numbers are percentage changes compared with the benchmark economy.

The Effect of All Three Housing Policies In this experiment, we examine how the model economy is affected if all three housing policies previously considered are jointly conducted. The joint implementation of these three policies causes key macroeconomic variables to change as shown in the last column of Table 6.

In response to these housing policies, households tend to invest in financial assets more, which leads to capital deepening in the long run. Compared with the benchmark economy, the capital stock to GDP ratio increases by 0.036%. This reduces the real interest rate by 0.087%. Among the three policies, the increased house acquisition tax rate is the most responsible for these changes in the capital-to-GDP ratio and the real interest rate. On the other hand, these policies reduce the size of the construction sector significantly, mostly due to increases in house acquisition and property tax rates. Both the share of residential investment in GDP and the employment share of the housing sector decline by about 2.8%. This also accompanies a similar decrease in the housing services-to-final goods consumption ratio. As the construction sector shrinks, the relative price of housing structures increases by 0.021% compared with the benchmark economy. Although these policies do not reduce house prices dramatically, it turns out that they are very effective in decreasing household debt. Relative to GDP, the amount of housing

debt declines by 40.95%. This policy effect is mainly driven by the reduction in the LTV ratio.

Table 10 shows how heterogeneous the joint effect of these housing policies is across net worth quintiles. The final goods consumption-to-household income ratio does not change much due to these policies, which implies that household consumption of final goods changes almost in lockstep with household income. Particularly, among wealthier households, the effect of these housing policies on their consumption-to-income ratio is very small. In contrast, these housing policies have significant effect on households' consumption of housing services and their asset portfolio. Housing services consumption-to-household income ratio declines for most households except for the second wealth quintile. The decline in the housing services consumption-to-household income ratio is more pronounced among wealthier households. This ratio declines by 4.229% for households in the top wealth quintile, while it declines by 1.670% for households in the lowest wealth quintile. The same feature appears in the share of housing assets in household wealth. The top three wealth quintiles reduce the share of housing assets by at least more than 3.5%, yet the lowest wealth quintile reduces the share by 2.278% and the second lowest wealth quintile actually increases the share.

[Table 10] The Joint Effect of All Three Housing Policies by Wealth Quintile

Variable	1	2	3	4	5
Consumption to Income (C/I)	0.028	-0.029	0.048	-0.006	-0.009
Housing Asset to Income (H/I)	-1.670	1.069	-3.674	-3.563	-4.229
Share of Housing Assets in Net Worth (H/W)	-2.278	0.969	-3.644	-3.510	-4.172

Note: Numbers are percentage changes compared with the benchmark economy.

V. Discussion

This section examines policy implications of the model further. First, we present the welfare impact of recent housing policies. We then analyze the effect of a progressive property tax rate change on the housing market.

5.1. Welfare Analysis

From the experiments implemented in the previous section, we find that recent housing policies have significant long-term effects on the housing market, with these effects heterogenous across households. How would these policies then affect consumer welfare? We define a change in consumer welfare due to a housing policy as the percentage change in per-period consumption households in the initial steady state should receive to give them the same utility they would obtain if the policy is

implemented. This measure is the value ω that solves:

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

where * and ** denote the initial steady state and the new steady state, respectively. We calculate this measure for each policy experiment implemented and present the result in Table 11. The reduction in the LTV ratio turns out to be welfare-improving. With the tightened borrowing limit, the lifetime consumption increases by 0.007%. This result may seem counterintuitive, given that the lower LTV ratio is expected to reduce the budget set of households, especially credit-constrained ones. We find that endogenous changes in the real interest rate caused by the reduction in the LTV ratio have dominant effects on the consumer welfare, more than offsetting the direct negative effect of tightened borrowing constraint. The lower LTV ratio induces a substantial increase in the precautionary savings, lowering the real interest rate by 0.023%. The lower interest rate makes households with housing debts better off by reducing their interest payment. This interest rate effect, especially on poorer households, dominates the direct effect of tightened borrowing limit. Consequently, the consumer welfare increases slightly with the lower LTV ratio. Campbell and Hercowitz (2009) show a symmetric example to this result. In their study, they consider a model economy where the borrowing constraints are relaxed, and show that the indirect effect of endogenous price changes dominates the direct effect of relaxed constraints.

[Table 11] The Welfare Impact of Recent Housing Policies

Housing Policy	Welfare Change (%)
A reduction in LTV:	0.007
An increase in the housing acquisition tax rate	-0.010
An increase in the property tax rate	-0.021
All three policies	-0.023

Note: Numbers are percentage changes compared with the benchmark economy.

In contrast, increased tax rates on either house acquisition or house possession reduce consumer welfare in the long run. These higher tax rates have a positive impact on capital accumulation and hence the aggregate output in the long run. However, the government takes a larger pie by leaving less resources available for household consumption. With the increase in housing transaction costs associated with a rise in the house acquisition tax rate, the consumer welfare declines by 0.010%. If the property tax rate increases, the consumer welfare drops even more, by 0.021%. If all these three policies are implemented jointly, the welfare loss from higher house-related tax rates dominates the welfare gain from the lower LTV ratio,

reducing the lifetime consumption of households by 0.023%.

5.2. Progressive Tax Changes

In the benchmark model, we adopt a flat property tax rate. We also consider the same change in the property tax rate for all households regardless of their housing wealth. In reality, the comprehensive real estate holding tax, which we use to calibrate the property tax rate in the model, is progressive in the sense that tax rates increase with the published land price. Moreover, the Korean government recently increased tax rates to a larger extent for more expensive houses. The policy effect we analyze in the main result may be partly attributed to this progressivity of property tax rate increases. In order to examine how crucial this effect is in the main result, we implement an experiment where the property tax rate increases only for households whose housing assets exceed the average house value in the initial steady state.

[Table 12] The Effect of Property Tax Rate Increases on Key Variables by Policy Target

Variable	All households	Households with $h > E(h)$
Real Inerest Rate (r)	-0.013	-0.017
Relative Price of Housing (q / P)	0.003	0.004
Housing Services to Final Goods Consumption (qH / C)	-1.415	-2.591
Residential Investment to GDP (qI_{resid} / Y)	-1.385	-2.564
Share of Construction in Total Employment (L_h / L)	-1.393	-2.560
Capital Stock to GDP (K / Y)	0.006	0.012
Household Debt to GDP ($Debt / Y$)	-1.905	-0.952
Real Wage (w / P)	0.004	0.004

Note: Numbers are percentage changes compared with the benchmark economy.

Table 12 presents the effect of the increased property tax rates on key variables of interest by policy target. The result shows that if the property tax rate increases for households with more than average housing assets in the initial steady state, the housing market shrinks more than it does if the property tax rate increases uniformly for all households. The relative price of housing assets also rises more with the progressive increase in the property tax rate. This is because the targeted property tax rate increase causes households, especially wealthier ones, to reduce their housing assets below the threshold level of housing assets above which households are subject to the higher property tax rate. This reduces the aggregate demand for housing structures and facilitates portfolio switches towards financial assets.

These responses of households ultimately suppress the supply of housing structures and hence the aggregate stock of housing structures even further. This effect is quantitatively large. The residential investment-to-GDP ratio and the share of construction in total employment decline by 2.564% and 2.560%, respectively. Housing services consumption relative to final consumption also decreases by 2.591%. These declines are almost twice those with a uniform increase in the property tax rate for all households. The impact of this progressive increase in the property tax rate on the relative price of housing structures is also slightly larger than what we obtain in the baseline experiment. The relative price of houses increases by 0.004%. Based on this result, it is conceivable that the quantitative result from Section 4.2 can be considered as the lower bound of the long-term impact on the housing market of the recent change in the property tax rate that increased the tax burden of households with larger housing assets more heavily.

VI. Conclusion

This paper examines the long-term effect of housing policies implemented by the Korean government in recent years to reduce household debt and stabilize house prices. Beginning in August 2017, the Korean government announced a series of housing policies that tightened the housing debt limit and made housing transactions and possession more costly. To evaluate the long-term effect of these housing policies, we build up a two sector general equilibrium model with heterogeneous agents and conduct three policy experiments: i) reducing the LTV ratio by 30%p; ii) increasing the housing acquisition tax rate by 1%p; iii) increasing the property tax rate by 0.1%p. Using a general equilibrium model developed in this study, we can understand the long-term effect of such policies on the economy through endogenous responses of demand for and supply of housing structures. Moreover, we can investigate how the effects of such housing policies vary by income and wealth of households.

We find that all three housing policies suppress the demand for housing structures first, yet the supply of housing structures ultimately declines even more, increasing the relative price of houses slightly in the long run. Despite the unintended effect on house prices, these policies are fairly effective in reducing the household debt. The tighter lending rule is crucial in reducing the household debt-to-GDP ratio. Lowering the LTV ratio from 70% to 40% decreases the household debt to GDP ratio almost by half. However, this policy causes the demand for housing structures by wealthier households to increase due to a general equilibrium effect, helping expand the construction sector in the long run. On the other hand, increasing tax rates associated with transactions and possession of housing

structures reduces both demand for and supply of housing structures, lessening the share of construction in total employment by 1.4%−1.6% in the long run. We find that the tighter lending rule increases consumer welfare slightly, while increased tax rates for either transactions or possession of housing structures lead to welfare losses.

Our work contributes to the literature by providing a quantitative evaluation of recent housing policies in Korea. Incorporating both demand-side and supply-side endogenous responses to these housing policies helps improve our understanding of the long-term effect of such policies. The model also highlights the heterogeneous effect of housing policies that critically relies on the level and the composition of household wealth. However, the model abstracts from a housing rental market. Adding a rental market will enrich the current model, enabling us to analyze the effect of recent housing policies on housing rental rates and homeownership rates. We leave this as future research agenda.

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최근 한국 주택 정책의 장기 효과에 대한 연구*

석 병 훈** · 유 혜 미***

논문초록

이 논문에서는 최근 한국 주택 정책의 장기 효과를 탐구하였다. 이를 위해 이질적 경제주체가 존재하는 이부문 일반균형 모형을 이용하여 담보 인정 (LTV) 비율 축소, 주택 취득세 인상, 주택 보유세 인상의 세 가지 정책 실험을 시행하였다. 분석 결과 세 가지 정책 모두 장기적으로 주택의 상대가격을 상승시키는 것으로 나타났으나 그 크기는 작았다. 또한 담보 인정 비율의 축소는 가계 부채를 줄이는 데 효과적인 것을 확인하였다. 이런 결과는 개별 가계들이 재산의 많고 적음에 따라 주택 정책에 이질적으로 대응하는 데 주로 기인하는 것으로 밝혀졌다.

핵심 주제어: 주택 정책, 주택 가격, 가계 부채, 이질적 경제주체
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