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This study examines the macroeconomic effects of the introduction of a scheme to pay a basic income of approximately $900 per year to each citizen through land holding tax. In contrast to the existing literature, this study deals with the issue of whether household members decide to sell land due to a sharp increase in the land holding tax rate to raise funds for the payment of basic income. Furthermore, this study uses the relationship between holding assets and reservation wages to solve the problem of determining whether household members supply labor in accordance with the payment of basic income. Simulation results obtained using data for Korea show that the introduction of the scheme to pay the basic income decreases the real GDP, total labor demand, and social welfare by 1.3%, 0.3%, and 0.4%, respectively.

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1. Introduction

Political interest in basic income has recently been very high in Korea. In 2021, a plan to pay approximately $900 per year to each citizen of the country was proposed by one of candidates for the presidency of Korea. The COVID-19 pandemic, which has been ongoing since March 2020, has fueled discussion about basic income. Due to the pandemic, economic activity has been greatly reduced, meaning that many people are having difficulty maintaining a basic livelihood. Therefore, emergency disaster subsidies have been paid several times by the Korean government. The first emergency disaster subsidy was paid to the entire nation similar to a basic income.

The basic income system solves the problems of the existing welfare system. The existing welfare system has the problem of having to select the target and the need to separately operate the monitoring manpower to prevent illegal demand. The basic income system solves the above problems because the same income is paid to all citizens.

On the other hand, the basic income system requires huge financial resources, the procuring of which is a large task. In 2021, for both political and economic reasons, the presidential candidate referenced above suggested financing the basic income system through a land-holding tax. Politically, the Korean people were expected to be relatively

unlikely to criticize a land-holding tax. The previous government raised the housing holding tax too high, causing numerous complaints. According to the National Tax Service of Korea, the comprehensive housing holding tax increased by approximately 11 times from 2017 to 2021, resulting in the highest housing holding tax ever. The political prediction of scant popular resistance to a land-holding tax was also based on the fact that most land-holding taxpayers are corporations, not individuals. According to the National Tax Service of Korea, as of 2021, approximately 82% of the comprehensive real-estate holding taxes for land were paid by corporations. Economically, the land-holding tax is efficient because, unlike capital and labor income taxes, it does not distort the tax base (Kalkuhl et al., 2018; Schwerhoff et al., 2022). Some opponents of the basic income system argue that it pays money to people who do not work, thereby reducing their motivation to supply labor. Below, we discuss existing studies of the basic income system. Some opponents of the basic income system argue that it has a problem in that it pays money to people who do not work, thereby reducing their motivation to supply labor. Existing studies on the basic income system are described as follows.

Moutos and Scarth (2003) theoretically analyze the macroeconomic effects of the introduction of the basic income system in a closed economy and an open economy. In

the former case, as capital is given exogenously, the introduction of the basic income system does not affect the macroeconomy. In the latter case, capital is free to move abroad and is endogenously determined. Under such circumstances, if capital income tax is levied to finance the basic income system, the price of capital rises. Firms reduce wages to offset the increased cost of capital. Under low wages, productivity is low, which leads to a decrease in gross domestic product (GDP).

Van der Linden (2004) investigates how the basic income system affects participation in the labor market using the dynamic general equilibrium model, which determines wages through labor-management negotiations. He considers the case of providing basic income only to those who participate in the labor market and the case of providing basic income to everyone regardless of whether they participate in the labor market. In the former case, the labor market participation rate increases when the basic income is introduced. In the latter case, the labor market participation rate may decrease when the basic income is introduced because excessive taxation is required to provide basic income to everyone regardless of whether they participate in the labor market.

Fabre et al. (2014) compare the welfare effects of a basic income system and the

unemployment benefit system in the United States using the dynamic general equilibrium model. They find that unemployment benefit schemes are superior to basic income schemes because they can be more specific about who needs them. They also show that the introduction of the basic income system would increase the unemployment rate.

Nikiforos et al. (2017) examine the macroeconomic effects of the introduction of a basic income system in the United States by using a Keynesian-type Levy macroeconomic model. They introduce methods to finance the basic income system through government debt and taxation. They show that using government debt to pay every adult $1,000 a month would increase GDP by 12.56% after eight years and that using taxes to do this would increase GDP by 2.62%. The reason for the former is that the economy grows when basic income is paid to households due to an increase in aggregate demand; the reason for the latter is that the propensity to consume is greater in the low-income class (who pay less tax) than in the high-income class (who pay more tax), which stimulates the economy.

Using the cases of Indonesia and Peru, Hanna and Olken (2018) show that in developing countries, selective transfer income is more effective than basic income. In

developing countries, transfer income is provided by selecting recipients based on their income. However, it is difficult for the government to observe the income of a significant proportion of the population. Thus, the rich are often included among the beneficiaries of selective payments or those who must receive them are excluded. Nevertheless, selective payment is more effective than basic income because it can transfer more income to the poor on a per-person basis.

Luduvice (2019) derives the macroeconomic effects of the introduction of the basic income system in the United States using the dynamic general equilibrium model. He considers ways to use existing welfare funds and taxation to obtain the financial resources required for the basic income system. In the former case, GDP increases by 5.2% because the inefficiency caused by the qualifications required to receive the benefits of the existing welfare system disappears. In the latter case, GDP decreases by 13.1% because more taxes are required to obtain the financial resources required for the basic income system.

Magnani and Piccoli (2020) examine the effects of the introduction of the basic income system coupled with a flat income tax on the French economy using a micro-macro simulation model. They consider the way to use existing welfare funds to obtain

the financial resources required for the basic income system. They show that introducing a basic income system with a flat income tax not only significantly reduces income inequality and poverty but also has moderately positive macroeconomic effects. The reason for this finding is the very low elasticity of labor supply to net real wages and other non-labor incomes in France. Furthermore, because existing welfare funds replace the financial resources required for the basic income system, additional funds are not required.

Caamal-Olvera et al. (2022) simulate four scenarios for Mexico involving direct money transfers equal to $1,668 per month to individuals in multidimensional poverty, elderly people, families with children under 15 years old, and all populations, using the MEXMOD tax-benefit microsimulation. The best policy in terms of its distributive impacts is the unconditional transfer (basic income) policy. However, that scenario is also the most expensive and would cost 10.61% of GDP.

The present study extends the literature in several ways. First, previous studies do not deal with the issue of whether household members decide to sell the land endowed to them due to a sharp increase in the land holding tax rate to raise funds for the payment of basic income; however, this study reflects this decision endogenously. If

basic income—which requires huge financial resources—is provided through land holding tax, household members who cannot afford this tax will sell their land. It is reasonable to reflect this phenomenon in the model. Second, previous studies do not systematically deal with the relationship between holding assets and reservation wages in the analysis of basic income; however, this study introduces this relationship to solve the problem of determining whether household members supply their labor when receiving basic income. Third, existing studies do not explicitly consider housing, land, and mortgage loans when analyzing basic income; therefore, this study designs a more realistic model by reflecting these factors.

Thus, the objective of this study is to systematically examine what kind of economic ripple effect will occur if a scheme to pay a basic income of approximately $900 per year to each citizen through land holding tax that has recently been discussed in Korean political circles is introduced. Simulation results obtained using data for Korea show that the introduction of such a scheme would have negative macroeconomic effects because the land-holding tax rate would need to be significantly raised to obtain the financial resources to pay the basic income. Such an increase in the land-holding tax rate would increase the number of landowners selling land due to an inability to withstand the rapid increase in the land-holding tax rate. This reduction in the number

of landowners would lead to increased land-rental prices because of the decrease in the land-rental supply. This increased cost of renting land would lead to a decrease in the land demand of producing firms, resulting in a decrease in such firms' production and social welfare.

Interestingly, contrary to the arguments offered by opponents of the basic income system, we find that under such a system, the number of household members who want to supply labor increases. The reason for this finding is the decrease in net assets that follow a sharp increase in the land-holding tax rate.

The remainder of the study is organized as follows. Section 2 establishes a model that serves as the theoretical framework for the study. Section 3 provides the calibration strategy and quantitative results. Section 4 presents the conclusions.

2. Model

We consider a dynamic general equilibrium model to deal with the issue of whether household members sell their land or supply their labor in accordance with the payment of basic income. In the model economy, economic agents are divided into a household and a firm. Each household member decides whether to sell his or her land or to supply his or her labor in accordance with the payment of basic income. The

fraction α represents a general firm, and the fraction $1-\alpha$ represents a housing-producing firm.

2.1. Problem of the household

There is a single representative household in the economy with a continuum of members. Each household member is endowed with z_t units of labor productivity. A household member does not supply his or her labor if $z_t \in [\underline{z}, \tilde{z}_t)$ and supplies it if $z_t \in (\tilde{z}_t, \infty)$. Furthermore, he or she is endowed with e^s units of land. The price of land q_t is exogenously given, and a household member holds his or her land if $q_t \in [\underline{q}, \tilde{q}_t)$ and sells it if $q_t \in (\tilde{q}_t, \infty)$.[1]

The household, which has an infinite lifespan, faces the maximization problem:

$$\max_{\left\{c_t, l_t^s, h_{t+1}, a_{t+1}, m_{t+1}\right\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left\{ \ln(c_t^{\mu} h_t^{1-\mu}) - \frac{\left(\int_{\tilde{z}_t}^{\infty} z_t l_t^s g(z_t) dz_t \right)^{1+\psi}}{1+\psi} \right\}, \tag{1}$$

[1] If the land holding tax is raised to cover basic income, household members who cannot afford it will sell their land. To reflect this phenomenon, it is assumed that the land price is given exogenously and the critical land price is determined endogenously. Under this assumption, the number of landowners decreases when land is sold. However, assuming that the land price is determined endogenously, other household members can purchase land. In this case, the number of landowners does not change. Thus, the assumption that the land price is given exogenously can be seen to be excessive. However, the economic agent that buys land in equilibrium is a housing-producing firm that needs land to build housing. This is because other household members do not want to purchase and hold land due to the greatly increased land holding tax. Thus, even if the land price is determined endogenously, the number of landowners decreases when land is sold.

subject to

$$c_t + p_t[h_{t+1} - (1-\delta_h)h_t] + (a_{t+1} - a_t) + (1+r_m)m_t + \tau_h \phi p_t (1-\delta_h)h_t + \int_{\underline{q}}^{\tilde{q}_t} \tau_{e,t} q_t e^s f(q_t) dq_t$$
$$= w_t \int_{\tilde{z}_t}^{\infty} z_t l_t^s g(z_t) dz_t + r_t a_t + m_{t+1} + \int_{\tilde{q}_t}^{\infty} q_t e^s f(q_t) dq_t + \int_{\underline{q}}^{\tilde{q}_t} q_t (1+r_{e,t}) e^s f(q_t) dq_t + \int_{\underline{z}}^{\tilde{z}_t} t_o g(z_t) dz_t + t_b \quad (2)$$

and

$$m_{t+1} \le \theta p_t h_{t+1}, \quad (3)$$

where c_t, l_t^s, h_{t+1}, a_{t+1}, m_{t+1}, $g(z_t)$, and $f(q_t)$ respectively denote the consumption of general goods produced by the general firm at time *t*, the labor supply time, the housing services at time *t+1*, a claim on non-residential capital, mortgage borrowing, the density function of z_t, and the density function of q_t. p_t, $\tau_{e,t}$, w_t, r_t, and $r_{e,t}$ are respectively the housing price, the land holding tax rate, the wage per efficiency unit of labor, the rental rate of non-residential capital, and the rental rate of land. The parameters $\beta \in (0,1)$, $\mu \in (0,1)$, $\psi > 0$, δ_h, r_m, $\tau_h \in [0,1)$, $\phi \in (0,1]$, $\underline{q} > 0$, $\underline{z} > 0$, t_o, t_b, and $\theta \in (0,1]$ are respectively the discount factor, the share of the consumption of general goods, the inverse of the Frisch elasticity of the labor supply, the housing depreciation rate, the interest rate of the mortgage loan, the housing holding tax rate, the realization rate of the posted housing price, the minimum land price, the minimum value of labor productivity, other transfer income of a

household member, the basic income to all household members, and the loan to value ratio (LTV).

This study assumes a unit elasticity of substitution between general goods and housing services following Fernandez-Villaverde and Krueger (2011). The quantity of housing owned by each household member is assumed to provide the same number of housing services. This implies that h_t represents both the stock of housing and the flow of housing services from the stock. Additionally, it sets the general good as the numeraire, and its price is thus normalized to 1.

The right-hand side of constraint (2) is the household income. Its first term is wage income. Note that the wage is set based on labor services. This is to reflect the fact that the labor services vary in accordance with the labor productivity of household members even if the input hours are the same. Thus, the wage is the price for labor services provided by the combination of labor productivity and labor supply time. The second term is the rental income earned by leasing non-residential capital. The third term is the amount of mortgage borrowing. The fourth term is the income earned by selling land. The fifth term is the sum of the value of the land owned and the rental income earned by leasing the land owned. The sixth item is the other transfer income

from the government to household members who do not have wage income. The last term is the basic income for all household members. The left-hand side of constraint (2) is the household expenditure. The first term is the consumption expenditure on general goods. The second and third terms indicate how much to invest in housing and non-residential capital, respectively. The fourth term refers to the principal and interest of the mortgage loan to be repaid. The fifth and sixth terms are the housing holding tax and the land holding tax, respectively. Constraint (3) reflects the LTV regulation of household loans as shown in Sommer and Sullivan (2018) and Hong et al. (2020).

2.2. Problem of choosing whether to supply labor

Household members face the problem of deciding whether to supply labor. According to Bloemen and Stancanelli (2001) and Alexopoulos and Gladden (2006), reservation wages increase as holding assets grow. The problem of household members' choices to supply labor is addressed based on the relationships between them. The household member does not supply labor when their wage income is below a certain proportion of his or her net asset value; conversely, he or she supplies labor when their wage income is greater than this proportion of his or her net asset value. Thus, the critical labor productivity $\tilde{z}_t$ is determined by equation (4):

$$w_t \tilde{z}_t l_t^s = \eta\left\{(1-\tau_h\phi)p_t(1-\delta_h)h_t + (1+r_t)a_t + \tfrac{1}{2}q_t e^s + \tfrac{1}{2}(1+r_{e,t}-\tau_{e,t})q_t e^s + t_b - (1+r_m)m_t\right\}, \quad (4)$$

where η is the ratio of the wage income earned by a household member to his or her net asset value. The value of the household member's land can be the value of the land when it is sold or the value of the land owned. Thus, the average of these two values is used to represent the value of a household member's land in Equation (4).

2.3. Problem of determining whether to own land

Household members face the problem of choosing whether to hold or sell their endowed land. The comprehensive real estate holding tax on land in Korea was introduced in 2005. This newly-enacted tax policy greatly increased the tax burden on household members owning land and triggered the sales of their land. According to the statistics of the Korean Real Estate Board, the land area sold by individuals increased significantly immediately after the comprehensive real estate holding tax was introduced (see Figure 1). Jung and Park (2009) also show that the excessive tax burden caused by the comprehensive real estate holding tax in Korea increases the sales of the land owned by household members.

<Insert Figure 1>

Based on this observation, this study assumes that household members sell their land when the taxes (i.e., housing holding tax and land holding tax) are higher than their wage income.[2] A reasonable household member would sell their property if their wage income could not cover the property holding tax. Thus, the critical land price $\tilde{q}_t$ is determined by equation (5):

$$w_t z_t l_t^s = \tau_h \phi p_t (1-\delta_h) h_t + \tau_{e,t} \tilde{q}_t e^s , \tag{5}$$

2.4. Problem of the general firm

A general firm faces the profit-maximization problem:

$$\max_{l_t, k_t, e_t} \pi_t = \left\{ y_t - w_t l_t - (r_t + \delta_k) k_t - r_{e,t} e_t \right\}, \tag{6}$$

subject to

$$y_t = l_t^{1-\gamma-\rho} k_t^{\gamma} e_t^{\rho} , \tag{7}$$

where π_t, y_t, l_t, k_t, and e_t are respectively the profit, production, labor demand, non-residential capital demand, and land demand of the general firm. The parameters $\gamma, \rho \in (0,1)$, and δ_k are respectively the share of the non-residential capital demand, the share of the land demand, and the depreciation rate of the non-residential capital.

[2] Only land sales are considered because the issue of household members deciding whether to sell or own housing is not considered.

2.5. Problem of the housing-producing firm

A housing-producing firm faces the profit-maximization problem:

$$\max_{l_{h,t},k_{h,t}} \pi_{h,t} = \left\{ p_t h_t^s - w_t l_{h,t} - (r_t + \delta_k) k_{h,t} \right\}, \tag{8}$$

subject to

$$h_t^s = l_{h,t}^{1-\omega} k_{h,t}^{\omega}, \tag{9}$$

where $\pi_{h,t}$, h_t^s, $l_{h,t}$, and $k_{h,t}$ are respectively the profit, production, labor demand, and non-residential capital demand of the housing-producing firm. The parameter $\omega \in (0,1)$ is the share of the non-residential capital demand. The housing-producing firm buys rather than rents land to produce housing. However, there is no demand for land purchasing because there is no land purchase market in this study.

2.6. Governmental budget constraint

The government imposes taxes on the housing and land owned by household members. Using the taxes, it provides other transfer income to citizens who do not receive wage income and provides basic income to all household members. Thus, the land holding tax rate $\tau_{e,t}$ is determined by equation (10):

$$\int_{\underline{z}}^{\tilde{z}_t} t_o g(z_t)dz_t + t_b = \tau_h \phi p_t (1-\delta_h) h_t + \int_{\underline{q}}^{\tilde{q}_t} \tau_{e,t} q_t e^s f(q_t) dq_t \,, \tag{10}$$

2.7. Market clearing conditions

The general goods market, housing market, labor market, non-residential capital market, and land rental market are given in equations (11)–(15), respectively, as follows:

$$c_t + (a_{t+1} - a_t) + (1+r_m) m_t - m_{t+1} - \int_{\underline{z}}^{\tilde{z}_t} t_o g(z_t) dz_t - t_b = \alpha y_t \,, \tag{11}$$

$$h_{t+1} - (1-\delta_h) h_t = (1-\alpha) h_t^s \,, \tag{12}$$

$$\alpha l_t + (1-\alpha) l_{h,t} = \int_{\tilde{z}_t}^{\infty} z_t l_t^s g(z_t) dz_t \,, \tag{13}$$

$$\alpha k_t + (1-\alpha) k_{h,t} = a_t \,, \tag{14}$$

$$\alpha e_t = \int_{\underline{q}}^{\tilde{q}_t} e^s f(q_t) dq_t \,, \tag{15}$$

2.8. Equilibrium

It is now possible to define the steady-state equilibrium of the model. This equilibrium is characterized by the set $\begin{Bmatrix} c, l^s, h, a, m, \tilde{z}, \tilde{q}, l, k, e, y, \pi, \\ l_h, k_h, h^s, \pi_h, \tau_e, p, w, r, r_e \end{Bmatrix}$, given that the constraint conditions, first-order conditions, and market clearing conditions hold. The

steady-state value of each endogenous variable is regarded as the initial value of the variable.

3. Calibration

3.1. Parameters

The parameters of the model are calibrated to match observations made in Korea. For this purpose, a model that covers one year is proposed. Furthermore, functional forms of the density function $f(q_t)$ and the density function $g(z_t)$ are needed for the calibration. This study introduces Pareto distributions for these two density functions:[3]

$$f(q_t) = \varepsilon_q \underline{q}^{\varepsilon_q} q_t^{-(1+\varepsilon_q)},\ q_t \geq \underline{q} > 0,\ \varepsilon_q > 1 \tag{16}$$

and

$$g(z_t) = \varepsilon_z \underline{z}^{\varepsilon_z} z_t^{-(1+\varepsilon_z)},\ z_t \geq \underline{z} > 0,\ \varepsilon_z > 1, \tag{17}$$

where ε_q and ε_z denote respectively a parameter determining the shape of the Pareto distribution for land price and one determining the shape of the Pareto distribution for labor productivity. Table 1 gives the parameter values.

[3] The main results do not change when the lognormal distributions are considered as the distributions of land price and labor productivity. In the same way as when using the Pareto distributions, if $900 per year of basic income is paid to each citizen through the land holding tax, then the real GDP, total labor demand, and social welfare decrease by 1.4%, 0.3%, and 0.4%, respectively.

The inverse of the Frisch elasticity of the labor supply ψ is set at 1.25 following Chari et al. (2000). The depreciation rate for housing δ_h is set at 0.0317 following Seok and You (2021). The interest rate for mortgage loans r_m is set at 0.0218 following Hong et al. (2020).

According to the Korea Research Institute for Human Settlements, the realization rates of the posted price for apartment houses and detached houses in 2020 were 0.69 and 0.536, respectively (the realization rate of the posted price means the ratio of the posted price to the market price). The realization rate of the posted price ϕ is set at 0.613, that is, the average of these two values.

According to the Korea Institute of Public Finance, the effective rate of real estate holding tax in 2018 was 0.0016 (this refers to the ratio of the real estate holding tax to the privately held real estate assets). The effective rate of real estate holding tax in the model is $\tau_h\phi$. Therefore, the housing holding tax rate τ_h is 0.00261 (since ϕ = 0.613).

The depreciation rate for non-residential capital δ_h is set at 0.04 following Kim and Kim (2010). According to the Banking Supervision Regulations of the Financial Services Commission of Korea, the collateral recognition ratio for housing mortgage

loans in speculative areas and overspeculation districts is 40%. Thus, the LTV θ is set at 0.4.

According to Statistics Korea, in 2019, the average net worth of households and the average annual wage income were approximately $320,736 and $34,373, respectively. Thus, the ratio of the wage income earned by a household member to his or her net asset value η is set at 0.1.

According to the 2015 Economic Census conducted by Statistics Korea, the number of firms in all industries in the country is 3,874,156 and the number of firms in the construction industry is 133,797; that is, the proportion of construction firms is 0.03. Thus, the proportion of general firms excluding construction firms α is set at 0.97.

According to data obtained from the Bank of Korea, the country's capital share in 2019 was 0.33. Following this value, the share of non-residential capital demand of a housing-producing firm ω is set to 0.33.

Meanwhile, a value of 0.005, which is the minimum value allowed by the model, is applied to the minimum land price $\underline{q}$ and the minimum labor productivity $\underline{z}$.

The discount factor β, the quantity of land e^s, the share of non-residential capital

demand of a general firm γ, the share of land demand of a general firm ρ, the parameter determining the shape of the Pareto distribution for land price ε_q, the share of the consumption of general goods μ, the basic income paid to all household members t_b, the parameter determining the shape of the Pareto distribution for labor productivity ε_z, and the other transfer income of a household member t_o are all difficult parameters to observe. Thus, their values are derived indirectly using targeted data as shown in Table 2.

According to Hong and Kang (2015), the ratio of the total real capital to the real GDP in Korea is 3. Additionally, the Bank of Korea states that, in 2019, the ratio of the real facility investment to the real GDP was 0.1. The discount factor β, the quantity of land e^s, the share of non-residential capital demand of a general firm γ, the share of the land demand of a general firm ρ, and the parameter determining the shape of the Pareto distribution for land price ε_q are respectively set at 0.958, 0.5, 0.23, 0.1, and 1.004 to match the two above ratios. Furthermore, the value of the discount factor β considers the 2019 real interest rate of 4.4% obtained from the World Development Indicators. The discount factor β is closely related to the total real capital, the real facility investment, and the real interest rate. The remaining parameters affect real GDP. The ratio of the total real capital to the real GDP, the ratio of the real facility investment

to the real GDP, and the real interest rate derived from the model are 3, 0.1, and 0.044, respectively.

According to the statistics of for-profit corporations from Statistics Korea, in 2019, the ratio of sales in the construction industry to sales in all industries was 0.1. The share of the consumption of general goods μ is set to 0.9 to match this observation; this parameter affects sales in the construction industry. The ratio derived from the model is also 0.1.

According to census data of Statistics Korea, the total population in 2019 was 51,779,203. Based on this number, the total annual amount required to pay $900 per year to each citizen is $46.6 billion. According to the International Monetary Fund, Korea's nominal GDP in 2019 was $1,646.7 billion. Thus, the ratio of the basic income to the nominal GDP is 0.03. The basic income t_b is set to 0.0217 to match this ratio. The ratio derived from the model is 0.03.

According to the Ministry of Economy and Finance, the current transfer expenditure to all households in 2019 was approximately $76.4 billion. This expenditure does not include the basic income. It can be regarded as the total other transfer income excluding the basic income. Thus, the ratio of the basic income to the total other

transfer income is 0.6. The parameter determining the shape of the Pareto distribution for labor productivity ε_z and the other transfer income to a household member t_o are respectively set at 1.004 and 0.035 to match this ratio. These two parameters are closely related to the total other transfer income. The ratio derived from the model is also 0.6.

<Insert Table 1>

<Insert Table 2>

3.2. Results

We examine the steady state of a model economy to pay a basic income of approximately $900 per year to each citizen through land holding tax in comparison with the steady state of a model economy without this event.

We first examine changes in individual variables. The introduction of the scheme to pay a basic income of approximately $900 per year to each citizen produces a 110.3% hike in the land holding tax rate.[4] This is because the land holding tax rate needs to be raised to fund financial resources to pay the basic income. The increase in the land

[4] The introduction of the scheme regarding the basic income implies a change in the value of the parameter t_b from 0 to 0.0217 in the model.

holding tax rate causes a 53.2% reduction in the critical land price, which determines whether or not household members choose to own land. In other words, the number of household members selling land increases. This is because household members who are unable to withstand the rapid increase in the land holding tax rate sell land. The reduction in the number of landowners leads to a 1.7% hike in the land rental rate. This is because the reduction in the number of landowners causes a decrease in the land rental supply. The hike in the land rental rate leads to a 3.1% decrease in the land demand of a general firm in accordance with the land rental demand function. The reduction in the land demand decreases the labor demand and non-residential capital demand of the general firm by 0.4% and 1.4%, respectively, as it is complementary to them. Furthermore, the production of general goods decreases by 1.4% owing to the reduction in the inputs. Additionally, the reduction in the production of general goods results in a 0.6% decrease in the consumption of general goods.

Basic income can cause an increase in the number of household members who do not want to provide labor. However, due to a decrease in net assets following a sharp increase in the land holding tax rate, the number of household members who want to supply labor increases. In other words, the critical labor productivity, which determines whether or not household members supply labor, decreases by 42.0%. The increase in

the number of labor providers leads to a 1.0% reduction in the wage per efficiency unit of labor.

The wage reduction causes a 0.4% hike in the labor demand of a housing-producing firm in accordance with the labor demand function. Note that the labor demand of the general firm decreases even with the wage reduction. This is because the effects of the reduction in the land demand of the general firm are stronger than those of the wage reduction. Additionally, the wage reduction leads to a 0.5% decrease in the labor supply time in accordance with the labor supply function.

The rental rate of non-residential capital does not change because it is not affected by any variable in the long-run equilibrium. If the rental rate of non-residential capital is unchanged, the reduction in the non-residential capital demand of the general firm results in a 1.3% decrease in the claim on non-residential capital. This is because the reduction in the non-residential capital demand of the general firm accompanies the decrease in the non-residential capital supply to fix the rental rate of non-residential capital in the non-residential capital market. Additionally, the reduction in the non-residential capital supply causes a 0.6% decrease in the non-residential capital demand of a housing-producing firm. This is because the demand and supply of non-

residential capital move in the same direction when the rental rate of non-residential capital is fixed.

As the labor demand of a housing-producing firm contributes more to the production of housing than its non-residential capital demand, the housing production also increases by 0.1%. The hike in housing production causes a 0.7% reduction in the housing price. The decrease in the housing price leads to a 0.1% increase in housing services in accordance with the housing service demand function. Additionally, the reduction in the housing price produces a 0.6% decrease in mortgage borrowing. This is because the decline in the housing price causes the value of housing collateral to decrease.

<Insert Table 3>

Next, we examine changes in macro-variables based on the changes in the above variables. The introduction of the scheme to pay a basic income of approximately $900 per year to each citizen through land holding tax decreases the real GDP, total labor demand, real facility investment, total real capital, and total real consumption by 1.3%, 0.3%, 1.3%, 1.3%, and 0.6%, respectively. We define a change in social welfare due to the introduction of the basic income system as the percentage change in per-period

consumption which household members in the initial steady state should receive to give them the same utility they would obtain if the basic income system is introduced. This measure is the value ν that solves:

$$\sum_{t=0}^{\infty} \beta^t u\left((1+\nu)C^*\right) = \sum_{t=0}^{\infty} \beta^t u\left(C^{**}\right), \tag{18}$$

where $C^* = (c^*)^{\mu}(h^*)^{1-\mu}$. * and ** denote the initial steady state and the new steady state, respectively. The introduction of the basic income system decreases social welfare by 0.4%.

<Insert Table 4>

4. Conclusion

This research makes several important contributions. Previous studies do not address the issue of whether household members decide to sell their endowed land following a sharp increase in the land-holding tax rate caused by the basic income program. Our study explicitly confronts this issue in the theoretical general equilibrium model. Furthermore, it introduces the relationship between holding assets and reservation wages to solve the problem of determining whether household members supply their labor in accordance with the payment of basic income, whereas previous

studies do not systematically deal with this relationship in the analysis of basic income. Additionally, our study designs a more realistic model than previous studies by reflecting housing, land, and mortgage loans.

Simulation results obtained using data for Korea show that the introduction of the scheme to pay a basic income of approximately $900 per year to each citizen through an increase in the land-holding tax decreases real GDP, total labor demand, and social welfare by 1.3%, 0.3%, and 0.4%, respectively. The main reason for these negative macroeconomic effects is that landowners who are unable to withstand the rapid tax increase sell their land—a fact that Korean policymakers overlook. Our study highlights this consideration, which is important to the recent political debate on the introduction of basic income in Korea.

We provide a theoretical model of the macroeconomic effects of basic income funded by an increase in the land-holding tax while leaving room for further research. We develop our model under the assumption that financial resources for the payment of basic income will be funded by land-holding tax. The development of a model in which a basic income scheme is funded by a robot tax, as proposed by several commentators, is left for the future.

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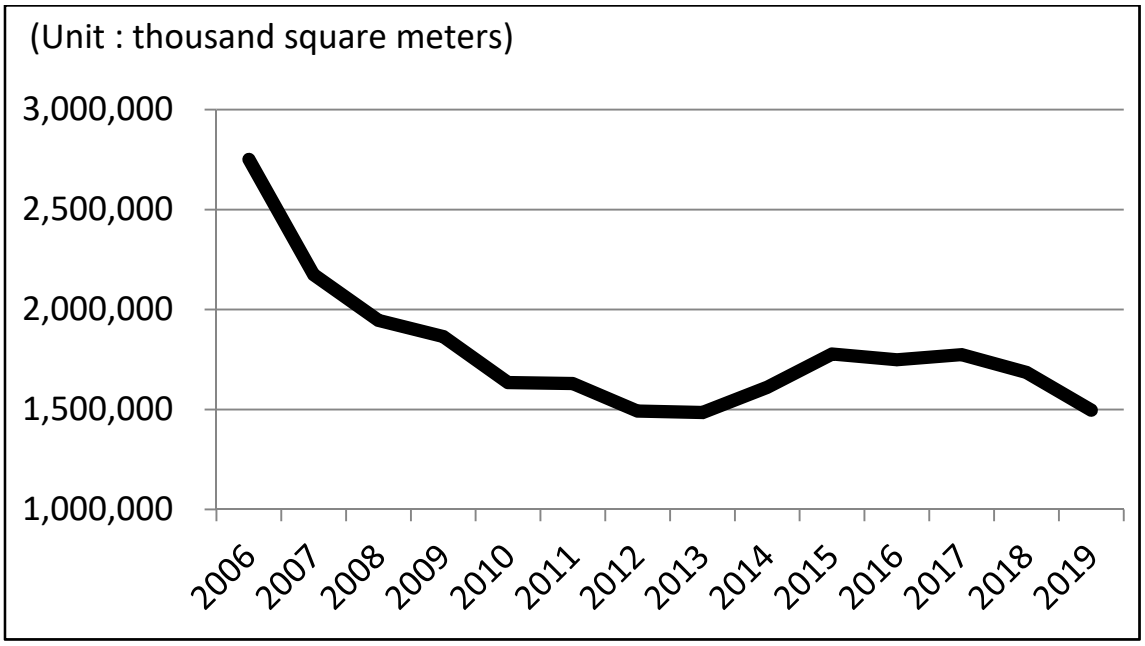
Figure 1 Land area sold by individuals in Korea



Source: Korea Real Estate Board

Table 1 Parameter definitions and values

Parameter	Definition	Value
ψ	Inverse of the Frisch elasticity of labor supply	1.25
δ_h	Depreciation rate for housing	0.0317
r_m	Interest rate for mortgage loan	0.0218
ϕ	Realization rate of posted price for housing	0.613
τ_h	Housing holding tax rate	0.00261
δ_k	Depreciation rate for non-residential capital	0.04
θ	Loan to value ratio	0.4
η	Ratio of wage income earned by a household member to his or her net asset value	0.1
α	Proportion of general firms	0.97
ω	Share of non-residential capital demand of a housing-producing firm	0.33

$\underline{q}$	Minimum value of land price	0.005
$\underline{z}$	Minimum value of labor productivity	0.005
β	Discount factor	0.958
e^s	Quantity of land	0.5
γ	Share of the non-residential capital demand of a general firm	0.23
ρ	Share of the land demand of a general firm	0.1
ε_q	Parameter determining the shape of the Pareto distribution for land price	1.004
μ	Share of the consumption of general goods	0.9
t_b	Basic income to all household members	0.0217
ε_z	Parameter determining the shape of the Pareto distribution for labor productivity	1.004
t_o	Other transfer income of a household member	0.035

Table 2 Calibration targets

Statistic	Data	Model
Ratio of total real capital to real GDP	3	3
Ratio of real facility investment to real GDP	0.1	0.1
Real interest rate	0.044	0.044
Ratio of sales in the construction industry to sales in all industries	0.1	0.1
Ratio of basic income to nominal GDP	0.03	0.03
Ratio of basic income to total other transfer income	0.6	0.6

Table 3 Changes in individual variables when a basic income of approximately $900 per year is paid to each citizen through land holding tax

Variable	Change rate (%)
Land holding tax rate	110.3
Critical land price	-53.2
Land rental rate	1.7
Land demand of a general firm	-3.1

Labor demand of a general firm	-0.4
Non-residential capital demand of a general firm	-1.4
Production of general goods	-1.4
Consumption of general goods	-0.6
Critical labor productivity	-42.0
Wage per efficiency unit of labor	-1.0
Labor demand of a housing-producing firm	0.4
Labor supply time	-0.5
Rental rate of non-residential capital	0.0
Claim on non-residential capital	-1.3
Non-residential capital demand of a housing-producing firm	-0.6
Production of housing	0.1
Price of housing	-0.7
Housing services	0.1
Mortgage borrowing	-0.6

Table 4 Changes in macro-variables

Variable	Change rate (%)
Real GDP	-1.3
Total labor demand	-0.3
Real facility investment	-1.3
Total real capital	-1.3
Total real consumption	-0.6
Social welfare	-0.4