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The Mathematical Simulation of South Korea's Financial and Economic Impacts from Real Estate Bubbles: Lessons from the China Evergrande Collapse

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Abstract: This study investigates the macroeconomic and financial repercussions of a real estate bubble burst in South Korea through the application of Bayesian estimation and impulse response function analysis. By utilizing this approach tailored to the specific economic conditions of South Korea, the research effectively captures the complex ripple effects across a range of financial and macroeconomic variables. The results demonstrate that a real estate bubble burst markedly increases financial market risks, leading to heightened liquidity demands within the banking sector and necessitating adjustments in both deposit rates and bond yields. The study also emphasizes the differentiated impacts on patient and impatient households, where wealth losses drive significant shifts in consumption and labor supply behaviors, further constrained by prevailing labor market conditions. Additionally, the broader economic implications are examined, revealing the adverse effects on corporate output and investment, as well as the dynamics of international capital flows that impact foreign exchange reserves and exchange rates. These findings highlight the urgent need for proactive monitoring and policy interventions to mitigate the detrimental effects of real estate bubbles, ensuring financial stability and fostering sustainable economic growth in South Korea.

Keywords: real estate bubble burst; Bayesian estimation; impulse response function analysis; financial market risks; macroeconomic variables

MSC: 91B02; 91B51; 91B64; 91B84

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1. Introduction

The global economy has recently faced significant disruptions in the real estate sector, highlighted by the collapse of major Chinese property developers, such as the Evergrande Group, which exposed vulnerabilities in economies heavily reliant on real estate. These events have reverberated through global financial systems, drawing attention to the systemic risks posed by real estate bubbles. This issue is particularly relevant for South Korea, where real estate constitutes a substantial portion of household wealth, and the sector plays a critical role in the national economy. Similar to China, South Korea's real estate market is characterized by high household debt levels, speculative investment behaviors, and a pronounced reliance on real estate for economic activity. Given these parallels, the potential bursting of a real estate bubble in South Korea could result in severe financial and economic repercussions, echoing the patterns observed in China, where the ripple effects have extended across multiple sectors, including construction and banking. This study employs impulse response function analysis, supported by Bayesian estimation techniques, to model and assess the macroeconomic and financial impacts of a potential real estate bubble burst in South Korea. By integrating theoretical insights from key literature, including Kim [1], Kim and Song [2], Jang et al, [3] and Shim and Kim [4], with empirical data specific to South Korea, the research elucidates the propagation mechanisms of real estate-induced shocks across financial systems. The findings contribute to ongoing academic discourse by offering critical insights into how such disruptions affect household consumption, corporate investment, and economic stability, while also providing actionable policy recommendations for managing the associated risks in real estate-dependent economies.

Given the recent and significant disruptions in global real estate markets, epitomized by the collapse of major Chinese property developers such as Evergrande, this study rigorously examines the potential ramifications of a real estate bubble burst within the South Korean economy. South Korea's heavy reliance on the real estate sector, coupled with elevated household debt levels and speculative investment behaviors, presents substantial risks that could severely impact financial stability and economic growth. To address these concerns, this research employs a robust analytical framework, integrating impulse response function analysis with Bayesian estimation techniques to simulate the macroeconomic and financial effects of potential real estate market disruptions. The findings provide crucial insights into how real estate shocks can propagate across various economic sectors, including household consumption, corporate investment, and international capital flows. These results not only contribute significantly to academic discourse but also yield practical policy recommendations designed to safeguard South Korea's economic stability. The study underscores the urgent need for proactive regulatory measures and economic diversification strategies to mitigate the risks associated with real estate market fluctuations, thereby enhancing the resilience of South Korea's economy in an increasingly volatile global environment.

This study makes three pivotal contributions to the existing literature on real estate-induced financial instability, with a particular emphasis on the South Korean economy. First, it presents a novel dynamic stochastic general equilibrium (DSGE) model specifically calibrated to reflect the distinct characteristics of South Korea's economic structure, integrating real estate market dynamics into the broader macroeconomic framework. This tailored approach allows for a more accurate depiction of how real estate shocks propagate through the South Korean economy, impacting both financial stability and growth. By offering a region-specific analysis, this study addresses a critical gap in the literature, delivering insights that capture the unique features of the local market. Second, the research provides an innovative examination of the differentiated impacts of real estate bubbles on patient and impatient households. By analyzing distinct behavioral responses in consumption patterns, labor supply, and asset allocation, the study sheds light on how different household segments contribute to, and are affected by, macroeconomic fluctuations. This nuanced analysis enriches the literature by offering a more granular understanding of the socio-economic repercussions of real estate crises, extending beyond aggregate-level outcomes to incorporate heterogeneity across households. Finally, the study explores the global spillover effects of domestic real estate shocks, with a particular focus on capital flows, exchange rates, and foreign reserves. By linking domestic real estate disruptions to broader international financial markets, it highlights the interconnectedness of national and global economies. This global perspective not only advances the theoretical understanding of real estate-induced financial instability but also provides actionable insights for policymakers who must navigate both domestic and international economic risks. In sum, the study's contributions extend beyond theoretical advancements, offering practical policy recommendations aimed at bolstering economic resilience to real estate shocks. These findings are particularly valuable for policymakers focused on strengthening regulatory frameworks and managing vulnerabilities in both domestic and global financial systems. The study thus adds significant value to ongoing academic discussions on financial stability and macroeconomic management in real estate-dependent economies.

The structure of the paper is organized as follows: Section 2 reviews the pertinent literature that informs this study; Section 3 details the development and formulation of the model; Section 4 offers a comprehensive evaluation and analysis of the empirical findings; and Section 5 concludes by summarizing the key insights and implications derived from the research.

2. Literature Review

The relationship between real estate markets and macroeconomic stability has been the subject of extensive scholarly inquiry, yet the complexities and specificities of these dynamics within particular economies, such as South Korea, remain underexplored. The expanding corpus of literature on real estate-induced financial instability underscores the pivotal role that real estate markets play in determining economic trajectories. This section critically reviews the seminal and contemporary studies that have shaped the current understanding of these issues, with a particular emphasis on the implications of real estate market volatility for financial stability and economic growth in the South Korean context.

A foundational contribution to this field is Reinhart's [5] comprehensive historical analysis of financial crises, which underscores the recurrent role of real estate bubbles in precipitating systemic instability. Their work highlights the critical need to understand the conditions under which real estate bubbles form and subsequently burst, often triggering widespread economic crises. Building on this foundation, Mian and Sufi [6] have advanced the discourse by elucidating the link between real estate markets and household leverage, demonstrating how fluctuations in real estate prices can exacerbate financial vulnerabilities. This insight is particularly pertinent to South Korea, where household debt levels have escalated to unprecedented heights, thereby amplifying the risks associated with downturns in the real estate market. The South Korean real estate market, in particular, has been scrutinized by Kim and Lim [7] and Jang et al. [8], who identify key factors contributing to real estate price volatility, including speculative investment and regulatory shortcomings. Their findings suggest that South Korea's real estate market is exceptionally prone to bubbles, driven by speculative behavior and fueled by both domestic and international capital flows. This aligns with the broader literature on speculative bubbles, as explored by Brzezicka [9], Vergara-Perucich [10], and Goldstein and Knight [11], who investigate the psychological and behavioral factors underlying speculative dynamics in real estate markets.

The complex interplay between real estate markets and financial institutions is a critical factor in understanding broader economic stability. A growing body of literature underscores the pivotal role that banks play in either amplifying or mitigating the impacts of real estate shocks through their lending practices. For instance, Cerutti et al. [12] and Wang et al. [13] provide compelling evidence that the nature and extent of bank exposure to real estate significantly influence the transmission of these shocks to the broader economy. Their findings suggest that during periods of real estate market volatility, banks with high levels of real estate-related assets are particularly vulnerable to destabilizing feedback loops, where declining property values lead to tighter credit conditions, which in turn exacerbate economic downturns. In the context of South Korea, the research conducted by Lee et al. [14] and Lee et al. [15] sheds light on the heightened systemic risks associated with the substantial exposure of South Korean banks to the real estate sector. Their studies demonstrate that during periods of economic uncertainty, such as those triggered by real estate market fluctuations, the high concentration of real estate assets on bank balance sheets can lead to significant financial instability. This systemic risk is further compounded by the procyclical nature of bank lending in South Korea, as highlighted by Jung and Lee [16] and Choi and Park [17]. These studies argue that during periods of economic expansion, banks tend to increase lending to the real estate sector, driven by rising property values and perceived low risk. However, this procyclicality can exacerbate economic downturns when the market reverses, as banks simultaneously tighten credit conditions, leading to a contraction in economic activity. The combination of these factors—high exposure to real estate and procyclical lending behavior—suggests that the South Korean financial system is particularly vulnerable to real estate market shocks, underscoring the need for robust macroprudential policies and regulatory oversight to mitigate these risks and ensure financial stability.

Numerous studies have explored the broader macroeconomic implications of real estate shocks, offering valuable insights into how these disruptions propagate through the economy. Bahadir and Gumus [18], Zhang and Pan [19], and Varadi [20] present theoretical frameworks that elucidate the transmission mechanisms of real estate shocks, with a particular focus on the credit channel. These frameworks underscore how fluctuations in real estate markets can significantly affect credit availability, thereby influencing broader economic variables. In the context of South Korea, Al-Yahyaee et al. [21] and Seok and You [22] have employed simulation models to assess the impacts of real estate market disruptions on key macroeconomic indicators such as GDP, consumption, and investment. Their findings reveal that real estate shocks can exert profound and enduring effects on economic stability, especially in economies characterized by elevated levels of household debt and substantial exposure to the real estate sector. The international ramifications of real estate bubbles have also garnered significant scholarly attention. Research by Bago et al. [23], Agyemang et al. [24], and Yamaka et al. [25] highlights the potential for real estate bubbles in one country to trigger spillover effects in global financial markets, particularly through channels such as capital flows and exchange rate fluctuations. This issue is especially pertinent for South Korea, given its deep integration into the global financial system. Further, studies by Ohno and Shimizu [26] and Liow and Newell [27] delve into the specific mechanisms through which real estate shocks in South Korea can reverberate across global markets. These studies emphasize the critical roles of foreign exchange reserves and international capital flows in transmitting the effects of domestic real estate disruptions to the broader global economy. This body of research underscores the importance of understanding both domestic and international dimensions of real estate shocks in formulating effective macroeconomic policies.

The literature underscores the critical importance of policy interventions in mitigating the risks associated with real estate bubbles. Notably, Ono et al. [28], Li et al. [29], and Deng et al. [30] advocate for the implementation of macroprudential policies aimed at curbing excessive borrowing and speculative investments within the real estate sector. In the context of South Korea, Kim and Oh [31] and Suh [32] have examined the effectiveness of specific policy tools, such as loan-to-value and debt-to-income ratios, in stabilizing the real estate market. While these measures have shown efficacy in the short term, Bierut et al. [33], Duca et al. [34], and De Araujo et al. [35] caution that they may not fully address the underlying drivers of real estate speculation, such as persistently low interest rates and insufficient regulatory oversight. Recent scholarship has increasingly emphasized the necessity of robust macroeconomic and financial stability frameworks to effectively manage the risks associated with real estate market volatility. Borio et al. [36] and Yum et al. [37] highlight the imperative of integrating regular stress testing of financial institutions' exposure to real estate risks into a comprehensive financial stability framework. Similarly, Baek et al. [38] and Kim et al. [39] advocate for the inclusion of real estate market dynamics within broader macroeconomic models, such as dynamic stochastic general equilibrium models, to enhance the prediction and management of potential real estate shocks. These advancements in policy frameworks are essential for maintaining economic stability in the face of evolving real estate market challenges.

The extant literature offers a robust framework for comprehending the intricate interplay between real estate markets and macroeconomic stability. Nevertheless, there remains a pressing need for region-specific analyses that address the distinctive characteristics of individual economies, such as those of South Korea. This study makes a meaningful contribution to this ongoing discourse by providing a comprehensive analysis of the South Korean real estate market, contextualized within the broader framework of financial stability and economic growth. By building on the insights garnered from existing scholarship, this research not only addresses a significant gap in the current knowledge base but also delivers actionable policy recommendations aimed at mitigating the risks associated with real estate-induced financial instability.

3. Theoretical Framework

3.1. Household Sector

The resident household can be classified into two distinct categories: patient residents and impatient residents. Both groups derive utility from consumption, labor, and the holding of money and property, though their behaviors and financial strategies differ significantly. Patient residents, characterized by a higher utility discount factor compared to their impatient counterparts, refrain from borrowing to finance early consumption. Instead, patient residents generate labor income through employment, earn returns on investments by holding deposits and bonds, maintain liquidity to address unforeseen needs, and acquire real estate for its potential appreciation. These behaviors align with the findings of Jesus et al. [40] and Ben-Gad et al. [41], who documented the differential saving and consumption patterns among residents with varying degrees of patience. In maximizing their intertemporal utility, patient residents are subject to specific constraints and considerations. They strategically balance current consumption with future benefits, aiming to enhance their overall utility over time. This optimization problem can be formally expressed through an intertemporal utility maximization function that accounts for their income sources, investment returns, and asset holdings. The literature, including insights from Yukhov [42] and Cardani et al. [43], underscores the importance of these factors in shaping the consumption and saving decisions of residents. Consequently, patient residents' consumption choices are driven by their goal to optimize utility, leveraging labor income, investment gains, and real estate appreciation to secure long-term financial well-being and stability. Therefore, the intertemporal utility function faced by the patient resident sector is as follows:

$$U = \sum \beta_1^t \{\ln[C_t^1 + \Omega\ln(\frac{M_t^1}{P_t}) + \varphi\ln(E_t^1) + \Theta(1 - L_t^1)]\}. \tag{1}$$

In Equation (1), β signifies the discount factor, which influences the intertemporal trade-offs made by patient residents. t denotes time, and the subscript 1 specifically identifies patient residents. C_t^1 represents the consumption level of patient residents. Ω captures the adjustment cost associated with real money holdings, reflecting the expenses incurred when patient residents adjust their nominal money balances, denoted as M_t^1. P_t indicates the prevailing price level. Furthermore, φ represents the weight assigned to housing consumption for patient residents, a crucial component in their utility function. E_t^1 signifies the housing holdings of patient residents. The elasticity parameter Θ measures the responsiveness of labor supply to changes in labor conditions, thus indicating the sensitivity of patient residents' labor supply, denoted as L_t^1. Patient residents' optimization behavior is inherently subject to a budget constraint, which is shown as follows:

$$P_tC_t^1 + P_t^EE_t^1 + S_t + M_t^1 + B_t^1 + Q_t^1 = W_tL_t^1 + P_t^EE_{t-1}^1 + M_{t-1}^1 + B_{t-1}^1(1 + r_t^b) + S_{t-1}(1 + r_t^s). \tag{2}$$

In Equation (2), P_t^E denotes the prevailing housing price level, which influences the value of real estate holdings for patient residents. S_t represents the deposits held by patient residents, serving as a component of their liquid assets. B_t^1 indicates the bonds held by patient residents, contributing to their investment portfolio. $Q_t^1 = \frac{\chi(B_t^1 - B_{t-1}^1)}{2}$ denotes the bond adjustment cost of the patient resident sector. The wage level, denoted by W_t, reflects the earnings from labor for patient residents. The deposit interest rate, r_t^s, signifies the return on savings held in deposit accounts, while the bond interest rate, r_t^b, represents the yield on bonds within their investment holdings. These financial parameters collectively shape the income and investment decisions of patient residents, impacting their overall economic behavior and financial well-being.

Impatient residents secure funds through borrowing to facilitate early consumption, leveraging loans to meet their immediate financial needs. Their primary income source is wages earned through labor. In addition, they invest in bonds to obtain returns, maintain liquid assets for unexpected contingencies, and own real estate with the expectation of capital appreciation. Furthermore, impatient residents actively manage their liabilities by applying for loans and servicing the associated interest payments. These financial behaviors and decisions are driven by the objective of maximizing their utility over time. Consequently, their intertemporal utility function incorporates these various aspects, reflecting the trade-offs and optimization strategies employed by impatient residents to balance consumption, investment, and debt management. The formal expression of this intertemporal utility function for the impatient resident sector is as follows:

$$U = \sum \beta_2^t \{\ln[C_t^2 + \Omega \ln(\frac{M_t^2}{P_t}) + \varphi \ln(E_t^2) + \Theta(1 - L_t^2)]\}. \quad (3)$$

In Equation (3), the subscript 2 denotes the impatient residents. These residents are subject to a budget constraint, which governs their financial decisions and consumption patterns. The budget constraint faced by impatient residents is presented as follows:

$$P_t C_t^2 + P_t^E E_t^2 + X_{t-1}^2(1 + r_t^x) + M_t^2 + B_t^2 + Q_t^2 = W_t L_t^2 + P_t^E E_{t-1}^2 + M_{t-1}^2 + B_{t-1}^2(1 + r_t^b) + X_t^2. \quad (4)$$

In Equation (4), X_t^2 represents the size of the loan obtained by impatient residents. $Q_t^2 = \frac{\chi(B_t^2 - B_{t-1}^3)}{2}$ denotes the bond adjustment cost of the impatient resident sector. r_t^b denotes the interest rate applicable to these loans for impatient residents.

3.2. Firm Sector

Building on the insights from Antosiewicz et al. [44] and Jandhana et al. [45], the Cobb–Douglas production function serves as a robust framework for analyzing the relationship between input factors and output. Furthermore, research by Acemoglu and Azar [46] and Oberfield and Raval [47] underscores that constant returns to scale imply that any proportional increase in input factors results in an equivalent proportional increase in output. Firms integrate technology, capital, land, and labor in their production processes, adjusting the proportions of these inputs to achieve cost minimization. Under the assumption of a Cobb–Douglas production function and constant returns to scale, firms optimize their input mix to minimize production costs while maintaining output levels. The resulting production function of the firm is represented as follows:

$$Y_t = (A_t E_t^c)^{\alpha_1^1 + \alpha_1^2} (\frac{K_t}{1 - \alpha_1^1 - \alpha_1^2})^{1 - \alpha_1^1 - \alpha_1^2} (\frac{L_t^1}{\alpha_1^1})^{\alpha_1^1} (\frac{L_t^2}{\alpha_1^2})^{\alpha_1^2}. \quad (5)$$

In Equation (5), Y_t denotes the firm's production scale, while A_t represents the level of technology employed. E_t^c denotes land used by firms. K_t signifies the amount of capital input utilized in the production process. α_1^1 indicates the contribution of patient residents' labor to the overall output, whereas α_1^2 reflects the contribution of impatient residents' labor. Accordingly, the firm's cost minimization utility function, which optimizes the allocation of these inputs to achieve the lowest possible production costs while maintaining output, is expressed as follows:

$$U = W_t(L_t^1 + L_t^2) + r_t^k K_t. \quad (6)$$

In Equation (6), r_t^k denotes the return rate on capital. Building on the insights from Carvalho et al. [48], Flamini and Hasan [49], and Jaccard [50], the assumption of price stickiness is essential for understanding firms' pricing behavior under market frictions. Typically, in the presence of such frictions, firms exhibit a certain degree of price stickiness when adjusting product prices. This paper assumes that firms have a probability of $1 - \psi$ of being able to reprice in each period, with the new price denoted as P_t^*. In setting these prices, firms adhere to the principle of profit maximization. The utility function representing the firm's optimization problem in setting prices is expressed as follows:

$$U = \sum_{j=0}^{\infty} \psi^j \beta_c^j E_t (\frac{C_t^c P_t}{C_{t+j}^c P_{t+j}}) [P_t^* Y_{t+j|t} - \psi Y_{t+j|t}]. \quad (7)$$

In Equation (7), $\beta_c^j E_t(\frac{C_t^c P_t}{C_{t+j}^c P_{t+j}})$ represents the intertemporal utility discount factor, which discounts future utilities to their present value. P_t^* denotes the optimal product price under the sticky pricing mechanism. This optimal price reflects the production cost ($\psi Y_{t+j|t}$) corresponding to the firm's production scale ($Y_{t+j|t}$) at that time. Of course, the budget constraint faced by the firm is presented as follows:

$$Y_{t+j|t} = (\frac{P_t^*}{P_{t+j}})^{-\epsilon} Y_{t+j} \tag{8}$$

In Equation (8), ϵ denotes the price elasticity of substitution. Assuming that the firm's objective is to maximize utility through its production and operations, and under the premise that the firm does not hold cash, its utility is primarily influenced by consumption and real estate holdings. The firm generates income through its production activities and secures additional funds by issuing bonds and applying for loans. Regarding the allocation of these funds, the firm utilizes them for consumption, purchasing real estate, paying wages to employees, and servicing interest on loans and bonds. When issuing bonds, the firm encounters certain constraints, and the bond yield is influenced by the total scale of bonds and loans in relation to the investment ratio. Generally, a higher reliance on bond issuance and loans for investment purposes results in higher bond yields due to increased risk. Thus, the firm's optimization problem utility function, which seeks to balance these financial decisions to maximize utility, can be expressed as follows:

$$U = \sum \beta_t^{1+2} [\ln(C_t^c) + \varphi \ln(E_t^c)]. \tag{9}$$

Similarly, firms are also subject to budget constraints. Their forms are as follows:

$$Y_t P_t^* + E_t^c + B_t + P_t^E E_{t-1}^c = P_t C_t^c + P_t^E E_t^c + (1 + r_{t-1}^{E,c}) E_{t-1}^c + (1 + r_{t-1}^b) B_{t-1} + W_t (L_t^1 + L_t^2). \tag{10}$$

$$\frac{1 + r_t^b}{1 + r_{t-1}^b} = \varsigma_t (\frac{I_{t-1}}{E_{t-1} + B_{t-1}} \frac{P_{t-1}}{\frac{P_t}{P_{t-1}}}). \tag{11}$$

In Equation (10), $r_t^{E,c}$ denotes the interest rate faced by firms applying for loans. I_t denotes the investment.

3.3. Trade Sector

Assume that total domestic consumption comprises two components: the consumption of domestically produced goods by domestic residents and the consumption of foreign-produced goods by domestic residents. Accordingly, the total domestic consumption can be expressed as follows:

$$C_t = \frac{C_{h,t}^{1-\varepsilon} C_{f,t}^{\varepsilon}}{\varepsilon^{\varepsilon} (1 - \varepsilon)^{1-\varepsilon}}. \tag{12}$$

In Equation (1), C_t represents the total domestic consumption. $C_{h,t}$ denotes the consumption of domestically produced goods by domestic residents, while $C_{f,t}$ signifies the consumption of foreign-produced goods by domestic residents. The parameter ε indicates the elasticity of substitution between the consumption of domestic goods and foreign goods (i.e., imported products). The domestic price level can be formulated as a function of the price level of domestically produced goods and the price level of foreign-produced goods, both denominated in the domestic currency. Consequently, the overall domestic price level can be expressed as follows:

$$P_t = P_{h,t}^{1-\varepsilon} P_{f,t}^{\varepsilon}. \tag{13}$$

In Equation (13), P_t denotes the domestic price level. $P_{h,t}$ represents the price level of domestically produced goods, while $P_{f,t}$ signifies the price level of foreign-produced goods, both denominated in the domestic currency. Additionally, if the foreign currency price of foreign products is $P_{f,t} = 1$, then $P_{f,t} = e_t P_t^*$, where e_t is the exchange rate. Assuming that the foreign exchange reserves of the country are primarily influenced by net exports and the returns on foreign exchange reserve investments, the following equation applies:

$$B_t^* + \frac{P_{f,t}C_{f,t}}{e_t} = (1 + r_t^*)B_{t-1}^* + \frac{P_{h,t}Ex_t}{e_t}. \quad (14)$$

In Equation (14), B_t^* represents the size of the country's foreign exchange reserves. r_t^* denotes the international market interest rate level. Ex_t indicates the scale of domestic exports, where $Ex_t = (\frac{e_t P_t^*}{P_{h,t}})\widetilde{Ex}_t$. Here, $\widetilde{Ex}_t$ refers to the foreign demand for domestic products, which is considered an exogenous variable.

3.4. Commercial Finance Sector

According to Hollander and Liu [51], Ashraf et al. [52], and Karmelavičius and Ramanauskas [53], the profit maximization of commercial banks involves balancing the cost of funds with the returns on investments while effectively managing operational and transactional expenses. Commercial banks achieve profit maximization through the strategic management of assets and liabilities. They issue loans to impatient residents and businesses and purchase corporate bonds to earn interest income. Additionally, they accept deposits from patient residents, paying interest on these deposits, and maintain deposit reserve requirements with the central bank, earning a certain interest income. Furthermore, they engage in short-term borrowing from the central bank, incurring interest expenses. To accurately reflect the costs associated with managing and operating deposits, loans, and bonds, transaction costs and operating costs are included in the bank's expenses. The operations of commercial banks must also satisfy balance sheet constraints. Consequently, the utility function for the profit maximization problem of commercial banks can be expressed as follows:

$$\begin{aligned} U = \sum \beta_t^v [& r_{t-1}^{E,c} E_{t-1}^c + r_t^{E,2} E_{t-1}^2 + r_t^b B_{t-1}^v + (r_t^r \alpha_t^v - r_t^h) S_{t-1} - r_t^1 ST_{t-1} - \\ & \frac{\varphi_h S_t^2 + \varphi_t^{E,c}(E_t^c)^2 + \varphi_v (B_t^v)^2 - r_f (S_t - S_{t-1})^2 + r_E^c (E_t^c - E_{t-1}^c)^2 + r_E^2 (E_t^2 - E_{t-1}^2)^2 + r^b (B_t^v - B_{t-1}^v)^2}{2}]. \end{aligned} \quad (15)$$

In Equation (15), B_t^v represents the corporate bonds purchased by commercial banks. ST_t denotes short-term borrowing from the central bank. r_t^r indicates the legal deposit reserve rate, and α_t^v signifies the legal deposit rate set by the central bank. Concurrently, commercial financial institutions are subject to a budgetary constraint, which is expressed as follows:

$$E_t^c + E_t^2 + B_t^v = ST_t + (1 - \alpha_t^v)S_t. \quad (16)$$

3.5. Bank of Korea

According to Klingelhöfer and Sun [54], Diluiso et al. [55], and Svartzman et al. [56], the central bank's role in maintaining economic stability involves meticulous balance sheet management to ensure that its policy actions do not result in imbalances or financial instability. As the supervisory and regulatory authority responsible for formulating and implementing the country's macroeconomic policies, the central bank aims to maintain financial and economic stability rather than pursue profit maximization. However, it is essential for the central bank to keep its balance sheet balanced. The central bank performs several critical functions, including issuing currency, accepting reserve deposits from commercial banks and paying interest on these reserves, managing foreign exchange reserves to earn returns, and lending short-term funds to commercial banks while charging interest. Consequently, the following constraint must be satisfied:

$$B_t^* e_t + ST_t = (1 + r_t^*)B_{t-1}^* e_t + (1 + r_t^1)ST_{t-1} + M_t - M_{t-1} + \alpha_t^v [S_t - (1 + r_t^r)S_{t-1}]. \quad (17)$$

Additionally, the central bank formulates monetary and macroprudential policies to regulate the entire economic system. The policy interest rate level is determined in accordance with the following equation:

$$r_t^1 = \frac{r_{t-1}^1 + \widetilde{r^1}}{2} + \mu_r^1. \tag{18}$$

3.6. Real Estate Sector

According to Kim et al. [57], the disparities in supply and demand dynamics within and outside the Seoul metropolitan area significantly influence the efficiency of real estate market models. Furthermore, Ciccarone et al. [58] and Bednarek et al. [59] emphasize that speculative capital flows contribute to the formation of real estate bubbles, which traditional models inadequately account for. In the real estate sector, housing products are ultimately produced and sold in the market through the input of labor, capital, and land. This methodology is commonly used by scholars to establish real estate market models. However, given the substantial differences in supply and demand between the real estate markets inside and outside the Seoul metropolitan area in South Korea, this approach often imposes excessive constraints, thereby affecting the overall efficiency of the model. Additionally, the current investment properties of housing cannot be overlooked. The influx of speculative capital has expanded the demand for funds in the real estate market beyond the construction needs of the sector. Consequently, traditional real estate market models fail to adequately reflect the bubbles caused by excessive capital inflows. Notably, unlike the land factor market, the supply and demand for capital and labor do not exhibit significant differences across various markets, including the real estate market. Therefore, it is practical to consider the land factor market separately. It is assumed that the demand in the land factor market is primarily driven by patient residents, impatient residents, and enterprises, while the supply of land is generally determined by the government and is subject to other external shocks.

$$E_t = E_t^1 + E_t^2 + E_t^c \tag{19}$$

3.7. Real Estate Bubbles

The presence of a real estate bubble significantly transforms the risk profile of both the financial markets and the real economy. The occurrence of such a bubble triggers shifts in asset prices within the financial market, alters interest rate levels, reconfigures the structure of the real economy, and modifies the relative prices of various production factors. This paper aims to comprehensively examine the impact of fluctuations in the real estate bubble on the entire economic and financial system. A critical aspect of this analysis is understanding how a real estate bubble influences the financing costs for the corporate sector. Typically, the more pronounced the real estate bubble, the greater the risk perceived by investors when purchasing bonds issued by corporations. This heightened risk perception leads investors to demand higher bond yields as compensation for the increased risk. Consequently, this study integrates the effect of the real estate bubble into the constraints of the corporate sector's intertemporal optimization problem, recognizing that severe real estate bubbles necessitate higher yields on corporate bonds to mitigate investor risk. By incorporating these dynamics, this research provides a detailed understanding of how real estate bubbles affect corporate financing conditions and investment decisions, thereby influencing overall economic stability and growth. The findings highlight the critical need for the careful monitoring and management of real estate bubbles to ensure the robustness of both financial markets and the broader economy.

$$\frac{1 + r_t^b}{1 + r_t^b} = \varsigma_t\left(\frac{I_{t-1}P_{t-1}}{E_{t-1} + B_{t-1}} \frac{P_{t-1}}{P_t}\right). \tag{20}$$

When the system reaches an equilibrium level, Equation (20) can be rewritten as:

$$\varsigma = \frac{E + B^b}{I * P}. \quad (21)$$

In equilibrium, the magnitude of the real estate bubble can be quantified as the ratio of the total stock of bonds and loans issued by enterprises to the present value of their investments. A higher total amount of corporate borrowing and bond issuance indicates a more severe real estate bubble. This paper delves into the ramifications of elevated real estate bubbles on financial and economic systems. It examines these impacts from multiple perspectives, including the asset structures within financial markets, prevailing interest rate levels, the configuration of the real economy, and the relative prices of various production factors. By exploring these dimensions, the study aims to provide a comprehensive analysis of how substantial real estate bubbles influence economic stability, investment decisions, and overall market dynamics, thereby offering valuable insights into the interconnectedness of real estate markets and broader economic health.

3.8. Market Clearing

The entire economic system must attain market equilibrium conditions, satisfying the following criteria to ensure stability and optimal functioning:

$$B_t = B_t^1 + B_t^2 + B_t^E. \quad (22)$$

$$M_t = M_t^1 + M_t^2. \quad (23)$$

$$C_t^h = C_t^1 + C_t^2 + C_t^E. \quad (24)$$

$$K_{t+1} = (1 - \delta)K_t + C_t^h + I_t + Ex_t - C_t. \quad (25)$$

3.9. Solution Process of Dynamic Optimization

The methodological approach to dynamic optimization for all sectors analyzed in this study is detailed comprehensively in Appendix A.

4. Results and Discussion

4.1. Structural Parameter Calibration and Estimation

The parameters utilized in this study are established through two primary approaches: calibration and estimation. First, parameter calibration is based on values derived from prior research, ensuring consistency with established findings in the literature. Second, parameter estimation is conducted using Bayesian methods, applied to quarterly data obtained from the Bank of Korea's economic statistics system. This approach allows for the derivation of parameters that are empirically grounded and specific to the context of the study. To be specific, the Bayesian estimation approach is particularly well-suited for this study for several reasons. First, it enables the incorporation of prior knowledge and empirical data in a unified framework, which is essential given the complexities of modeling the South Korean economy's unique dynamics. By leveraging both theoretical priors and real-time data, Bayesian estimation allows for a more robust calibration of the DSGE model, resulting in more precise and reliable parameter estimates. This is especially critical in the context of real estate-induced financial instability, where prior empirical research is often limited, and uncertainty surrounding the true values of key parameters is high. Second, Bayesian methods allow for the direct estimation of uncertainty through the posterior distributions of the model's parameters. In the context of this research, where the economic impacts of real estate bubbles are subject to significant variability, the ability to quantify and assess parameter uncertainty is a crucial advantage. This feature of Bayesian estimation strengthens the validity of the model's predictions, providing policymakers with a clearer understanding of the potential range of outcomes under different economic scenarios. Moreover, Bayesian estimation facilitates model comparison and validation, allowing for the incorporation of data-driven refinements that enhance the model's predictive accuracy. This is particularly relevant in the context of South Korea's real estate market, where evolving economic conditions require models that can adapt and remain robust across different time periods and shocks. The calibrated parameters are detailed in Table 1.

Table 1. Results of parameter calibration.

Parameter	Value	Definition	Source
β_1	0.9925	Discount factor (patient residents)	Suh [32]
β_2	0.98	Discount factor (impatient residents)	Suh [32]
Ω	0.1	Adjustment cost associated with real money holdings	Kim [60]
φ	0.1	Weight assigned to housing consumption for patient residents	Yu [61]
β_c	0.975	Discount factor (firm sector)	Ha and So [62]
χ	0.001	Bond adjustment costs of the resident sector	Jung and Lee [16]
α_1^1	0.35	Contribution of patient residents' labor to the overall output	Iacoviello and Neri [63]
α_1^2	0.1	Contribution of impatient residents' labor to the overall output	Iacoviello and Neri [63]
ψ	0.25	Probability of not being able to reprice in each period	He and Wang [64]
ε	0.25	Elasticity of substitution between the consumption of domestic goods and foreign goods	He [65]
δ	0.025	Depreciation rate	
ς	6.08	Ratio of total debt to investment in the firm sector (size of real estate bubbles)	This value is calculated by author based on the data of South Korea in 2023

This study proceeds with Bayesian estimation, utilizing quarterly data from the Economic Statistics System of the Bank of Korea, covering the period from Q1 2000 to Q4 2023. This analysis focuses on determining South Korea's GDP and the consumer price index, which are derived based on specific economic factors. Consistent with the methodology employed by He [65], both variables undergo logarithmic transformation to remove underlying trends. Subsequently, the first-order differences are calculated, and the resulting series is standardized by multiplying by 100. The dataset ultimately comprises 92 observations. In the formal application of the Bayesian method, the prior distribution of the parameter vector, denoted as $p(\theta_M|M)$, is established for the chosen model. The likelihood function, conditional on the model and its parameters, is represented as $L(\theta_M|Y_T, M)$, where $p(Y_T|\theta_M, M)$ signifies the probability density function value associated with the observed data. Here, Y_T denotes the observations up to period T. The probability density function $p(\cdot)$ may follow various distributions, such as gamma, beta, generalized beta, normal, inverse gamma, shifted gamma, or uniform distributions. The marginal density function of the data, given the model, is then expressed as indicated in Equation (26). This marginal density function integrates over all possible parameter values θ_M, providing a comprehensive measure of the model's fit to the observed data. This step is crucial in the Bayesian framework, as it allows for updating the prior distributions with the observed data, resulting in posterior distributions that offer the most probable estimates of the model parameters given the available information.

$$p(Y_T|\theta_M, M) = \int_{\theta_M}^{1} p(\theta_M, Y_T|M) d_{\theta_M} = \int_{\theta_M}^{1} p(Y_T|\theta_M, M) p(\theta_M|M) d_{\theta_M}. \tag{26}$$

Applying Bayes' theorem, the posterior density, denoted as $p(Y_T|\theta_M, M)$, is expressed as the product of the likelihood function and the prior density. This relationship is mathematically represented in Equations (27) and (28). The posterior density provides a probabilistic framework that incorporates both the prior beliefs about the parameter vector θ_M and the information obtained from the observed data Y_T. By combining the likelihood, which reflects the probability of the observed data given the parameters, with the prior distribution, the posterior distribution offers a refined estimate of the parameters, accounting for the observed evidence within the context of the specified model M.

$$p(\theta_M|Y_T, M) = \frac{p(Y_T|\theta_M, M)p(\theta_M|M)}{(Y_T|M)}. \quad (27)$$

$$p(\theta_M|Y_T, M) = \frac{L(\theta_M|Y_T, M)p(\theta_M|M)}{\int_{\theta_M}^{1} p(Y_T|\theta_M, M)p(\theta_M|M)d_{\theta_M}}. \quad (28)$$

The posterior kernel is defined as the numerator of the posterior density, denoted by $k(\theta_M|Y_T, M) \equiv L(Y_T|\theta_M, M)p(\theta_M|M)$. This kernel represents the product of the likelihood function and the prior distribution, encapsulating the combined influence of the observed data and prior beliefs on the parameter estimates. The posterior distribution of the parameter vector θ_M for the model M is directly proportional to the posterior density, reflecting the relationship between the model parameters and the observed data. This proportionality is formally expressed in Equation (29), illustrating the mathematical foundation of the posterior distribution within the Bayesian framework.

$$p(\theta_M|Y_T, M) \propto L(\theta_M|Y_T, M)p(\theta_M|M). \quad (29)$$

The distribution described above is characterized by standard central tendency metrics, including the mean, median, and mode, as well as dispersion measures such as the standard deviation and specific percentiles. Once the model is specified and the relevant data are available, the likelihood function can be estimated using techniques such as the Kalman filter for linear models or particle filters for nonlinear models. These methods allow for the efficient estimation of the likelihood function, even in complex modeling scenarios. The resulting statistical measures, which are essential for interpreting the model's outcomes, are presented in Table 2.

Table 2. Results of Bayesian estimation.

Parameter	Prior Distribution	Prior Mean	Standard Deviation	90% HPD Interval	Posterior Mean
Θ	Gamma	0.5	0.1	[0.54, 0.82]	0.68
ρ_t	Beta	0.8	0.1	[0.93, 0.99]	0.96
ϵ_t	Inverse Gamma	0.1	Inf	[0.12, 0.18]	0.15
ρ_r	Beta	0.8	0.15	[0.87, 0.98]	0.92
ϵ_t	Inverse Gamma	0.1	Inf	[0.06, 0.09]	0.08

4.2. Simulating the Financial Effects of Real Estate Bubbles

In the context of South Korea's economy, fluctuations in the real estate market have far-reaching implications, extending beyond domestic financial stability to influence capital markets, banking sectors, and foreign exchange reserves, thereby affecting the broader macroeconomic landscape. The bursting of a real estate bubble typically precipitates pronounced disruptions in financial markets, manifesting in shifts in deposit rates, bond yields, and corporate financing costs. Moreover, such shocks reverberate through international financial channels, impacting global market interest rates and returns on foreign exchange reserves. These dynamic responses underscore the vulnerability of South Korea's economy and its adjustment mechanisms when faced with both internal and external real estate disturbances. To rigorously examine these effects, we applied Bayesian estimation techniques to simulate the behavior of key financial variables and analyzed their responses to real estate bubble shocks through impulse response functions. Figure 1 presents these response trajectories over a 20-quarter period, accompanied by 90% confidence intervals, providing a detailed visualization of the economic adjustments following a real estate shock.

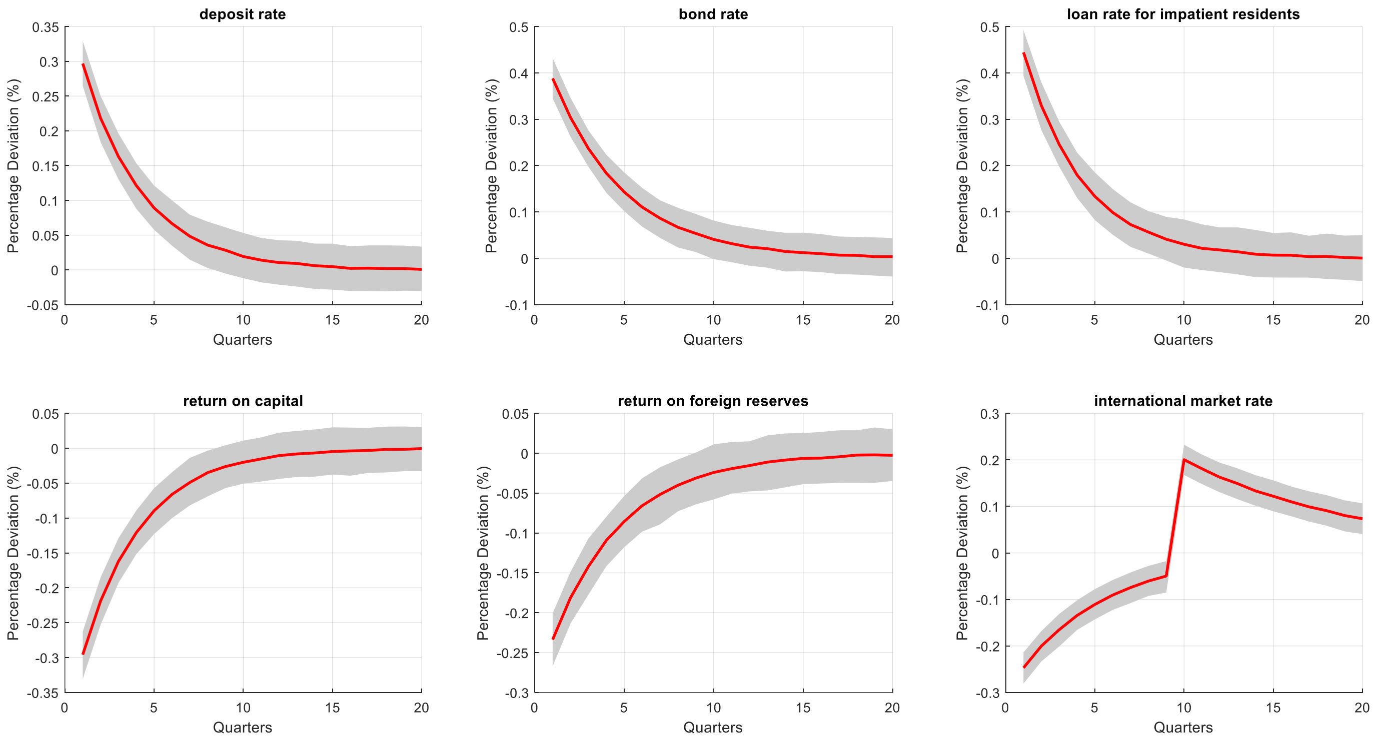

Figure 1. Results of simulating the financial effects of real estate bubbles.

As illustrated by the simulation results in Table 1, a real estate bubble burst in South Korea would substantially elevate risks within financial markets, thereby intensifying liquidity demands on the banking system. In response to potential withdrawal pressures and other funding needs, banks are likely to increase deposit rates to attract more savings—a measure that aligns with the findings of Suh [32] and Kim et al. [57], who underscore the critical importance of liquidity management during periods of financial distress. This adjustment in interest rates reflects the banking sector's urgent need to maintain safety and stability under heightened financial strain. The collapse of the real estate market is typically accompanied by increased economic uncertainty and elevated market risk, as noted by Dong et al. [66] and Ikeda [67]. The bond market is particularly sensitive to these developments, with investors demanding higher returns to compensate for their exposure to increased risk. This results in a significant rise in bond yields, particularly for corporate and government bonds, a phenomenon further explored by Zurek [68] and Taylor and Aalbers [69]. For impatient households that rely heavily on borrowing to sustain consumption, a real estate bubble burst would lead to higher loan risk premiums. Banks and other lending institutions, anticipating an increased risk of borrower default, are likely to raise loan interest rates, especially for these impatient borrowers, reflecting patterns observed by Lainà [70]. This escalation in borrowing costs would, in turn, dampen consumption, consistent with findings in similar economic contexts.

The return on corporate capital, defined as the profits generated from firms' capital investments, is also expected to decline in the short term following a real estate market collapse. This decline is driven by reduced market demand and rising financing costs, eroding corporate profitability—a situation documented by Kim and Ko [71]. Additionally, heightened market uncertainty and increased investment risk could exacerbate volatility in capital returns, as highlighted by Kim [72] and Chen and Tsang [73]. In the global capital markets, a real estate bubble burst typically prompts shifts in capital flows, particularly reallocations from high-risk assets to safer investments. These shifts can significantly impact the investment returns on foreign exchange reserves, consistent with global patterns observed by Duca et al. [74] and Bang and Kwon [75]. As investors withdraw from high-risk markets, yields on global safe assets, such as government bonds, tend to decrease, thereby affecting the overall return on foreign exchange reserves. The repercussions of a real estate market collapse extend far beyond the domestic economy, influencing international market interest rates through interconnected capital flows and financial market linkages. Specifically, an increase in global risk aversion could lead to lower interest rates in developed economies, particularly for safe assets. However, if the real estate bubble burst triggers a global financial crisis, interest rates in some countries may rise due to concerns over credit tightening and capital flight.

The impact of a real estate bubble burst on these interest rates and yields is both extensive and profound. It not only affects the financing costs for residents and businesses but also propagates through complex market linkages into the global financial system. Understanding these intricate dynamics is crucial for developing effective macroeconomic policies, particularly in mitigating potential financial crises. Through the application of impulse response analysis, as demonstrated in this study, the dynamic evolution of these variables under different scenarios can be more precisely predicted, offering robust support for policymakers. The findings of this study not only corroborate the existing literature but also provide new insights into the distinctive dynamics of the South Korean economy, particularly in the context of real estate-induced financial instability.

4.3. Simulating the Economics Effects of Real Estate Bubbles

Building on our detailed examination of the financial implications of a real estate bubble burst in South Korea, it is essential to broaden the scope of our analysis to encompass the wider economic impacts. The interconnections between real estate market fluctuations and key macroeconomic variables—such as output, investment, and consumption—underscore the inherent vulnerability of the South Korean economy to such disruptions. Utilizing impulse response function analysis, we can simulate the cascading effects across various economic sectors, thereby gaining a comprehensive understanding of how a real estate bubble burst may affect critical economic indicators. This section presents the findings from these simulations, offering a nuanced perspective on the short- and long-term repercussions for the overall economy, as illustrated in Figure 2.

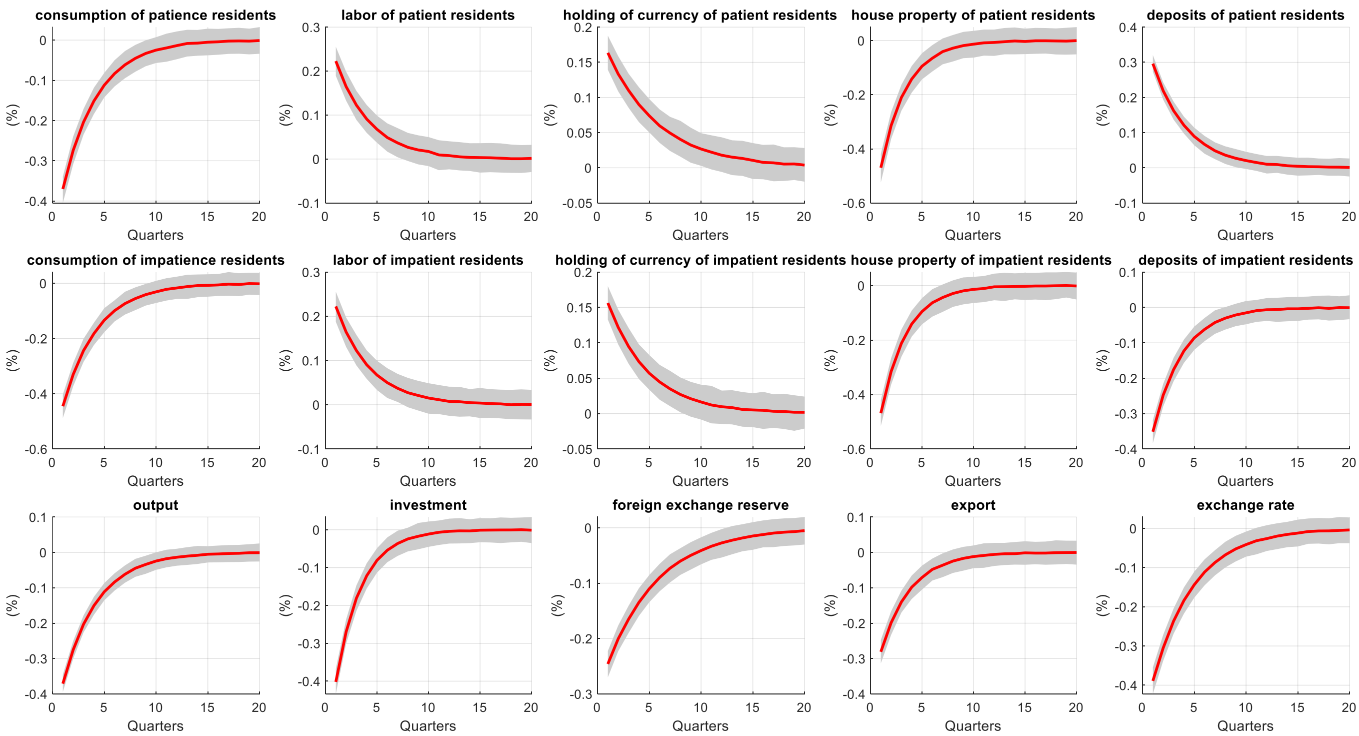

Figure 2. Results of simulating the economic effects of real estate bubbles.

As depicted in the simulation results of Figure 2, the bursting of a real estate bubble in South Korea is likely to exert a substantial negative impact on the consumption behavior of patient households. The precipitous decline in property values would significantly erode household wealth, thereby diminishing their capacity and willingness to consume. This finding is corroborated by recent studies, including Park [76], Jung and Kim [77], and Son and Park [78], which underscore the pronounced wealth effects of real estate market fluctuations on household consumption in South Korea. Given that real estate constitutes a significant portion of household assets, any volatility in the housing market directly influences the overall wealth status of South Korean residents. Additionally, as uncertainty in the real estate market intensifies, consumers may adopt a more pessimistic outlook on future income prospects, leading to further reductions in consumption expenditures. This pattern aligns with the findings of Nowzohour and Stracca [79], Ghosh [80], and Choudhry and Wohar [81], who documented a decline in consumer confidence and spending in response to heightened real estate market uncertainty. In response to asset depreciation and market volatility, patient households may opt to increase their labor supply in an effort to offset the wealth losses associated with declining property values. However, this decision is likely contingent upon labor market conditions and wage dynamics. In a saturated labor market or in the absence of wage increases, the additional labor input from these households may prove insufficient to fully compensate for their wealth losses. This observation contrasts with the conclusions of Park et al. [82], who suggest that while increased labor supply may partially mitigate wealth losses, its effectiveness is constrained in a stagnant labor market, thereby emphasizing the critical role of wage adjustments.

Moreover, the turmoil in the real estate market could prompt patient households to increase their cash holdings as a strategy to enhance liquidity and prepare for potential economic shocks. This behavior reflects a broader tendency among residents to reduce exposure to risky assets during periods of financial uncertainty, preferring instead to hold cash or cash equivalents. Such a shift toward conservative asset allocation, however, could have significant implications for the banking system. As financial risks escalate, patient households may be inclined to increase their bank deposits as a means of safeguarding their wealth, particularly when other investment channels appear increasingly risky. Nevertheless, this behavior is dependent on the interest rates offered by banks and the overall stability of financial institutions. Should the stability of the banking system be called into question, residents might seek out alternative, safer assets, a phenomenon also observed in Alhenawi and Yazdanparast [83] and Acharya et al.'s [84] analyses of flight-to-safety behavior amid rising financial uncertainty. For impatient households, whose consumption behavior is heavily reliant on borrowing, fluctuations in the real estate market could severely constrain their consumption capacity as borrowing costs escalate. The collapse of the real estate bubble not only leads to higher loan interest rates but also exacerbates the financial burden on these households. They may be compelled to increase their labor supply to cope with the heightened borrowing costs and growing repayment pressures. Similar to patient households, impatient households might also choose to increase their cash holdings in response to economic uncertainty, thereby bolstering their financial resilience. The impact of the real estate bubble burst on the property values of impatient households is similarly pronounced, resulting in a substantial decline in their net worth. This deterioration in their balance sheets further restricts their ability to consume and invest, echoing the findings of Gaffney [85] and Duffie [86], which highlight a marked decrease in the net worth of over-leveraged households following real estate market downturns.

Businesses are not immune to the shocks induced by real estate market fluctuations. As demand diminishes and financing costs rise, corporate output is likely to decrease significantly, particularly in sectors closely linked to real estate, such as construction and real estate development. Moreover, the uncertainty surrounding the real estate market could dampen corporate investment intentions and capabilities. The deterioration of financing conditions makes it increasingly difficult for firms to secure low-cost capital, thereby inhibiting their ability to expand production and engage in long-term investments.

This observation is consistent with the research of Deng et al. [87], Fougère et al. [88], and Qu and Md Kassim [89], who identified similar constraints on corporate investment and output during periods of real estate market volatility. At the international level, a real estate bubble burst could trigger shifts in international capital flows, particularly through the withdrawal of capital from high-risk markets. Such shifts could lead to fluctuations in South Korea's foreign exchange reserves. As global investors seek safer assets, capital inflows into South Korea may decrease, or even reverse into capital outflows, exerting pressure on the country's foreign exchange reserves. Furthermore, South Korea's exports may be adversely affected by changes in global demand and exchange rate fluctuations, especially as the spillover effects of the real estate market impact the broader economy. Finally, instability in the real estate market may prompt adjustments in exchange rates, reflecting the market's reassessment of risks associated with the South Korean economy, which could further influence international trade and capital flows. These complex chain reactions underscore the importance of systematic monitoring and policy intervention across various facets of the South Korean economy in the aftermath of a real estate bubble burst. The results of this analysis are consistent with the global financial spillover effects discussed by Igan et al. [90], Aizenman et al. [91], and Benigno et al. [92], who emphasize the interconnectedness of real estate markets and international capital flows.

4.4. Discussion

While this research is indeed tailored to the specific economic structure and unique characteristics of the South Korean market, the broader methodological framework and key insights have significant relevance for other economies with similar characteristics. First, the dynamic stochastic general equilibrium modeling framework employed in this study is not limited to South Korea alone but can be applied across different economies to analyze real estate market dynamics and financial instability. Researchers in other regions, particularly those with real estate-dependent economies, such as China, Singapore, or even parts of the United States, can adapt this model by calibrating the parameters to their local economic conditions. This allows for cross-country comparisons and deeper insights into how real estate bubbles and macroeconomic variables interact. Second, the differentiated impact on household segments, specifically patient and impatient households, offers a versatile lens through which to explore consumption and labor market responses to economic shocks. The behavioral patterns identified in this study—such as varying responses to wealth shocks and labor supply—are not unique to South Korea. They can serve as a valuable reference for other economies that exhibit high household debt or speculative real estate investments. By adjusting for local financial conditions, other researchers can apply these findings to better understand household-level dynamics in the wake of economic disturbances. Finally, the study's analysis of global financial spillovers resulting from real estate market disruptions has broad applicability. South Korea's position as a globally integrated economy makes the insights gained from this research relevant for other countries exposed to international capital flows and exchange rate fluctuations. Policymakers and researchers outside of South Korea can utilize the findings to inform strategies for mitigating risks associated with capital flight, exchange rate volatility, and financial contagion. In conclusion, while this study is firmly grounded in the context of South Korea, its methodological contributions and empirical insights are broadly applicable to other economies, particularly those facing similar financial vulnerabilities. Furthermore, economically, the study's findings provide critical insights for policymakers, particularly in South Korea, where real estate constitutes a significant portion of household wealth and plays a central role in financial markets. By identifying how real estate shocks propagate through the economy, this research helps inform more effective regulatory frameworks aimed at stabilizing the real estate market and preventing the escalation of systemic risks. Moreover, understanding the differentiated impacts on patient and impatient households offers a valuable lens for designing targeted fiscal policies to mitigate wealth loss and consumption declines, thereby promoting more equitable economic stability. Socially, the implications of real estate-induced financial instability are profound, particularly regarding wealth inequality. This research highlights the disproportionate effects of real estate bubbles on different household segments, with low-income and impatient households bearing the brunt of economic downturns due to higher borrowing costs and limited access to capital. By shedding light on these dynamics, the study emphasizes the need for inclusive policy measures that protect vulnerable populations from the adverse effects of real estate volatility. Furthermore, the analysis of labor supply responses to wealth shocks underscores the potential social consequences of economic disruptions, such as increased unemployment and shifts in labor market participation.

Regarding the angles of consumers and firms, in the period leading up to a real estate bubble burst, consumer and corporate behavior typically reflects heightened risk-taking, with households increasing their investments in real estate and companies expanding operations tied to property markets. This speculative behavior, often fueled by easy access to credit and rising property values, can contribute to unsustainable levels of debt. For consumers, particularly impatient households, this leads to over-leveraging, which significantly increases their financial vulnerability. As a result, in the event of a market correction, these households may drastically cut consumption as their wealth diminishes and borrowing costs rise, which would intensify the negative economic impacts. Similarly, companies in sectors linked to real estate, such as construction and real estate development, may face sharp declines in demand and increased financing costs, leading to reduced output and investment. During the burst of a real estate bubble, the behavioral responses of both consumers and companies play a pivotal role in the propagation of shocks throughout the economy. Consumers, especially those with high debt levels, tend to shift toward more conservative spending patterns, prioritizing debt repayment over consumption. This reduction in consumption can create a feedback loop, further depressing demand across multiple sectors, exacerbating the downturn. For companies, liquidity constraints become more pronounced, particularly for firms heavily reliant on real estate assets as collateral. The tightening of credit conditions leads to reduced investment, layoffs, and in extreme cases, insolvencies, further deepening the recessionary effects. In the aftermath of the bubble burst, consumer and corporate behavior generally shifts towards greater caution. Consumers are likely to increase savings rates and reduce leverage, which could result in a slower recovery in consumption. Companies, on the other hand, may become more risk-averse, delaying investment decisions and reducing their reliance on debt financing. These behavioral adjustments, while stabilizing in the long term, could contribute to a prolonged recovery phase, as reduced spending and investment slow the return to pre-crisis levels of economic activity. Incorporating these behavioral changes into the model's framework would not only deepen our understanding of the real estate market's role in financial instability but also provide more nuanced insights for policymakers. By anticipating the shifts in consumer and corporate behavior at various stages of the bubble cycle, policymakers can design more effective interventions to mitigate both the immediate and long-term effects of a bubble burst.

5. Conclusions

This study provides a thorough examination of the multifaceted impacts of real estate bubbles on the South Korean economy. By applying Bayesian estimation and impulse response function analysis specifically tailored to the unique characteristics of South Korea, the research simulates both the short- and long-term effects of real estate market disruptions on financial and macroeconomic variables. The findings underscore the economy's vulnerability to real estate shocks, particularly highlighting the substantial adverse effects on household consumption, corporate investment, and overall economic stability. A key insight from this analysis is the differentiated impact on patient and impatient households. Patient households experience significant declines in consumption and wealth, while impatient households face increased financial strain due to rising borrowing costs. Additionally, the study elucidates how these domestic shocks propagate through the global financial system, affecting international capital flows, exchange rates, and foreign reserves. These results align with the existing literature while offering novel perspectives on the interconnectedness of real estate markets and broader economic dynamics in South Korea. In conclusion, this study not only contributes to the academic discourse on real estate-induced financial instability but also offers practical recommendations for safeguarding the South Korean economy. As the global economic environment continues to evolve, the insights gained from this research will be instrumental in guiding future policy decisions, ensuring sustained economic growth and stability in South Korea.

To reinforce the resilience of South Korea's economy against potential real estate bubbles, several crucial policy recommendations emerge from this study. First, it is essential to implement stricter macroprudential regulations aimed at mitigating the risks of asset price bubbles. This includes enforcing tighter loan-to-value and debt-to-income ratios, specifically targeting speculative real estate investments. These measures will curb excessive borrowing and reduce the financial system's vulnerability to sharp corrections in asset prices, which is critical in preventing systemic risks that could destabilize both the real estate and financial sectors. Second, the research highlights the need for a comprehensive financial stability framework that integrates regular stress testing of financial institutions. Policymakers should focus on evaluating banks' exposure to real estate-related risks and ensure that contingency plans are in place to address potential liquidity shortfalls. This proactive approach will help safeguard the financial sector from the cascading effects of real estate market disruptions, thereby promoting overall economic stability. Third, to reduce South Korea's dependence on the real estate sector, economic diversification is paramount. Policymakers should encourage investment in alternative industries, such as technology, manufacturing, and green industries, to buffer the economy against the inherent volatility of the real estate market. Diversification will foster more balanced, sustainable long-term growth and reduce the economy's reliance on a single sector, thereby enhancing its resilience to sector-specific shocks. Finally, given the global interconnectedness of financial markets, it is critical to monitor and manage capital flows effectively. Policymakers should implement strategies to maintain balanced capital flows and stabilize foreign exchange reserves, especially during periods of excessive capital inflows or outflows. In some cases, capital controls may be necessary to prevent destabilizing impacts on the exchange rate and the broader economy. By managing capital flows, policymakers can mitigate external shocks and maintain financial stability in an increasingly volatile global environment.

In concluding this study, it is essential to acknowledge its limitations and propose avenues for future research that could enhance the understanding of real estate-induced economic dynamics in South Korea. First, although the model employed is specifically calibrated to the South Korean economy, it may not fully capture the complexity of macroeconomic interactions, particularly those involving international spillovers. Future research should integrate more sophisticated global economic variables and cross-border financial linkages to provide a more comprehensive analysis of the international implications of real estate bubbles. Second, the reliance on historical data for Bayesian estimation, while robust, may limit the model's predictive accuracy in the context of rapidly evolving economic conditions. Future studies could benefit from incorporating real-time data analytics and machine learning methodologies to improve the model's adaptability and predictive power in dynamic market environments. Third, the model's focus on aggregate macroeconomic indicators might overlook the differentiated impacts of real estate shocks across various socioeconomic groups and regions within South Korea. Subsequent research could develop more granular models to better account for regional disparities and the distributional effects of real estate market fluctuations. Third, in the context of a real estate bubble, consumers and firms might exhibit overconfidence, herd behavior, or delayed reactions to market signals, leading to outcomes that deviate from the predictions of a purely rational model. These behavioral aspects are particularly relevant in periods of economic uncertainty or market volatility, such as during a bubble burst or its aftermath. To address this limitation, future research could explore models that incorporate bounded rationality or adaptive expectations, which allow for more realistic decision-making processes. By relaxing the rational expectations assumption, future studies could better capture the potential overreactions or underreactions of agents to economic shocks, providing a more nuanced understanding of real estate-induced financial instability. Additionally, agent-based models or behavioral DSGE frameworks could offer valuable insights into how deviations from rationality impact both short- and long-term economic outcomes. Fourth, low interest rates may fuel speculative investments in real estate, while strong economic growth can inflate asset prices beyond sustainable levels. Ignoring these feedback loops could overlook important mechanisms that amplify or dampen the effects of real estate market fluctuations. In future research, addressing this limitation by developing a model that captures these bidirectional effects would provide a more comprehensive understanding of the complex interactions between real estate markets and the broader economy. Specifically, incorporating endogenous macroeconomic variables that influence real estate dynamics—such as monetary policy, labor market conditions, and credit availability—could offer deeper insights into how cyclical interactions shape financial stability and economic performance. Lastly, while this study offers significant insights into the financial and economic consequences of real estate bubbles, it does not fully address the potential trade-offs associated with policy interventions designed to mitigate these risks. Future research should strive to quantify the costs and benefits of different policy measures, thereby providing a more nuanced framework for policymakers to balance economic stability with growth objectives. Addressing these limitations and exploring these future research directions will not only enhance the robustness of the current findings but also ensure that the discourse on real estate-induced financial instability remains both rigorous and relevant.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Household sector for patient residents:

The Lagrangian function, formulated to encapsulate the intertemporal utility maximization problem and its associated constraints for the patient resident sector, is presented as follows:

$$\mathcal{L} = \sum \beta_1^t \{\ln[C_t^1 + \Omega \ln(\frac{M_t^1}{P_t}) + \varphi \ln(E_t^1) + \Theta(1 - L_t^1)] + \lambda_t[W_t L_t^1 + P_t^E E_{t-1}^1 + M_{t-1}^1 + B_{t-1}^1(1 + r_t^b) + S_{t-1}(1 + r_t^s) - P_t C_t^1 - P_t^E E_t^1 - S_t - M_t^1 - B_t^1 - \frac{\chi(B_t^1 - B_{t-1}^1)}{2}]\}. \tag{A1}$$

The first-order condition is as follows:

$$\frac{C_{t+1}^1}{C_t^1} = \beta_1(\frac{1 + r_{t+1}^s}{\pi_t}). \tag{A2}$$

$$\frac{W_t}{P_t C_t^1} = \Theta. \tag{A3}$$

$$\frac{M_t^1}{P_t} = \Omega C_t^1(\frac{r_{t+1}^s}{1 + r_{t+1}^s}). \tag{A4}$$

$$(1 + r_{t+1}^s)[B_t^1 + \chi(B_t^1 - B_{t-1}^1)] = \chi(B_t^1 - B_{t-1}^1) + (1 + r_t^b). \tag{A5}$$

$$\frac{\varphi}{E_t^1} = \frac{\beta_1[P_t^E(1+r_{t+1}^s) - P_{t+1}^E]}{P_{t+1}C_{t+1}^1}. \tag{A6}$$

The household sector for impatient residents:

The Lagrangian function, formulated to encapsulate the intertemporal utility maximization problem and its associated constraints for the impatient resident sector, is presented as follows:

$$\mathcal{L} = \sum \beta_2^t\{\ln[C_t^2 + \Omega\ln(\frac{M_t^2}{P_t}) + \varphi\ln(E_t^2) + \Theta(1-L_t^2)] + \lambda_t[W_tL_t^2 + P_t^E E_{t-1}^2 + M_{t-1}^2 + B_{t-1}^2(1+r_t^b) + X_t^2 - P_tC_t^2 - P_t^E E_t^2 - X_{t-1}^2(1+r_t^x) - M_t^2 - B_t^2 - Q_t^2]\}. \tag{A7}$$

The first-order condition is as follows:

$$\frac{P_tC_t^2}{P_{t-2}C_{t-2}^2} = \beta_2\frac{\chi(B_t^2 - B_{t-1}^3) + (1+r_t^b)}{B_t^2 + \chi(B_t^2 - B_{t-1}^3)}. \tag{A8}$$

$$\frac{W_t}{P_tC_t^2} = \Theta. \tag{A9}$$

$$\frac{\Omega}{M_t^2} + \frac{\beta_2}{P_{t+1}C_{t+1}^2} = \frac{1}{P_tC_t^2}. \tag{A10}$$

$$\frac{\varphi}{E_t^2} + \frac{P_t^E}{P_tC_t^2} = \frac{P_t^E\beta_2}{P_{t+1}C_{t+1}^2}. \tag{A11}$$

$$\beta_2(1+r_t^x) = \frac{P_tC_t^2}{P_{t+1}C_{t+1}^2}. \tag{A12}$$

The firm sector for production costs' minimization:

The Lagrangian function, formulated to address the minimization problem of the firm's production costs, is presented as follows:

$$\mathcal{L} = W_t(L_t^1 + L_t^2) + r_t^k K_t + \lambda_t(Y_t - (A_tE_t^c)^{\alpha_1^1+\alpha_1^2}(\frac{K_t}{1-\alpha_1^1-\alpha_1^2})^{1-\alpha_1^1-\alpha_1^2}(\frac{L_t^1}{\alpha_1^1})^{\alpha_1^1}(\frac{L_t^2}{\alpha_1^2})^{\alpha_1^2}). \tag{A13}$$

The first-order condition is as follows:

$$W_tL_t^1 = \alpha_1^1 MC_tY_t. \tag{A14}$$

$$W_tL_t^2 = \alpha_1^2 MC_tY_t. \tag{A15}$$

$$r_t^k K_t = MC_tY_t(1-\alpha_1^1-\alpha_1^2). \tag{A16}$$

$$MC_t = (\frac{W_t}{A_tE_t^c})^{\alpha_1^1+\alpha_1^2} r_t^{k,(1-\alpha_1^1-\alpha_1^2)}. \tag{A17}$$

The firm sector for the optimal product price under the sticky pricing mechanism:

The Lagrangian function, formulated to address the maximization of firms' profits, is presented as follows:

$$\mathcal{L} = \sum_{j=0}^{\infty} \psi^j\beta_c^j E_t(\frac{C_t^c P_t}{C_{t+j}^c P_{t+j}})[P_t^*(\frac{P_t^*}{P_{t+j}})^{-\epsilon}Y_{t+j} - \psi(\frac{P_t^*}{P_{t+j}})^{-\epsilon}Y_{t+j}]. \tag{A18}$$

The first-order condition for the firm's sticky pricing mechanism problem can be equivalently expressed as solving the following system of recursive equations:

$$h_t = \beta_c[\frac{\frac{P_t}{P_{t-1}}}{(\frac{P_t}{P_{t-1}})^{\zeta}}]^{\epsilon}h_{t+1} - \frac{MC_t}{C_{t-1}^{1+2}P_{t-1}}Y_t. \tag{A19}$$

$$f_t = \beta_c \psi [\frac{\frac{P_{t+1}}{P_t}}{\frac{P_t}{P_{t-1}})^{\zeta}}]^{\epsilon - 1} (\frac{\frac{P_t^*}{P_{t-1}^*}}{\frac{P_{t+1}^*}{P_t^*}}) f_{t+1} - \frac{\frac{P_t^*}{P_{t-1}^*}}{C_{t-1}^c P_{t-1}} Y_t. \tag{A20}$$

$$h_t = \frac{\epsilon - 1}{\epsilon} f_t. \tag{A21}$$

The firm sector for the maximization of the firm's own utility:

The Lagrangian function, formulated to address the maximization of the firm's own utility, is presented as follows:

$$\begin{aligned} \mathcal{L} = \sum \beta_t^c [\ln(C_t^c) + \varphi \ln(E_t^c)] + \lambda_{1,t}[P_t C_t^c + P_t^E E_t^c + (1 + r_{t-1}^{E,c}) E_{t-1}^c + (1 + r_{t-1}^b) B_{t-1} + \\ W_t(L_t^1 + L_t^2) - Y_t P_t^* - E_t^c - B_t - P_t^E E_{t-1}^c] + \lambda_{2,t}[\varsigma_t(\frac{I_{t-1}}{E_{t-1}+B_{t-1}} \frac{P_{t-1}}{\frac{P_t}{P_{t-1}}}) - \frac{1+r_t^b}{1+r_{t-1}^b}]. \end{aligned} \tag{A22}$$

The first-order condition is as follows:

$$\beta^{1+2} \frac{P_t C_t^c}{P_{t+1} C_{t+1}^c} (1 + r_{t+1}^{E,c}) = \frac{E_t^c + B_t - I_t}{E_t^c + B_t}. \tag{A23}$$

$$\beta^c \frac{P_t C_t^c}{P_t C_{t+1}^c} (1 + r_{t+1}^b) = \frac{E_t^c + B_t - I_t}{E_t^{1+2} + B_t}. \tag{A24}$$

$$\frac{\varphi}{E_t^c} + \beta^c \frac{P_t^E}{P_{t+1} C_{t+1}^c} = \frac{P_t^E}{P_t C_t^c}. \tag{A25}$$

$$\begin{aligned} (r_t + \delta)[\psi P_{h,t-1}^{1-\epsilon} + (1-\psi) P_t^{1-\epsilon}]^{\frac{\epsilon}{1-\epsilon}} = \frac{E_t^c}{K_t[\psi P_{h,t-1}^{1-\epsilon} + (1-\psi) P_t^{1-\epsilon}]^{\frac{\epsilon}{1-\epsilon}}} r_t^{E,c} + \\ \frac{B_t}{K_t[\psi P_{h,t-1}^{1-\epsilon} + (1-\psi) P_t^{1-\epsilon}]^{\frac{\epsilon}{1-\epsilon}}} r_t^b. \end{aligned} \tag{A26}$$

$$\frac{E(1 + r_{t+1}^b)}{1 + r_t^b} = \varsigma_t E(\frac{I_t}{E_t^c + B_t} \cdot \frac{P_t}{P_{t+1}}). \tag{A27}$$

The commercial finance sector for the profit maximization problem of commercial banks:

The Lagrangian function, formulated to address the profit maximization problem of commercial banks, is presented as follows:

$$\begin{aligned} \mathcal{L} = \sum \beta_t^v [r_{t-1}^{E,c} E_{t-1}^c + r_t^{E,2} E_{t-1}^2 + r_t^b B_{t-1}^v + (r_t^r \alpha_t^v - r_t^h) S_{t-1} - r_t^1 ST_{t-1} - \\ \frac{\varphi_h S_t^2 + \varphi_t^{E,c} (E_t^c)^2 + \varphi_v (B_t^v)^2 - r_f (S_t - S_{t-1})^2 + r_E^c (E_t^c - E_{t-1}^c)^2 + r_E^2 (E_t^2 - E_{t-1}^2)^2 + r^b (B_t^v - B_{t-1}^v)^2}{2} - \lambda_t (ST_t + (1 - \\ \alpha_t^v) S_t - E_t^c - E_t^2 - B_t^v)]. \end{aligned} \tag{A28}$$

The first-order condition is as follows:

$$\varphi^{E,c} E_t^c + r_E^c (E_t^c - E_{t-1}^c) = \beta^v [(r_{t+1}^{E,c} - r_{t+1}^1) + r_E^c (E_{t+1}^c - E_t^c)]. \tag{A29}$$

$$\varphi^{E,2} E_t^2 + r_E^2 (E_t^2 - E_{t-1}^2) = \beta^v [(r_{t+1}^{E,2} - r_{t+1}^1) + r_E^2 (E_{t+1}^2 - E_t^2)]. \tag{A30}$$

$$\varphi^b B_t^v + r^b (B_t^v - B_{t-1}^v) = \beta^v [(r_{t+1}^b - r_{t+1}^1) + r^b (B_{t+1}^v - B_t^v)]. \tag{A31}$$

$$\varphi_h S_t^1 + r^h (S_t^1 - S_{t-1}^1) = \beta^v \{ r^h (S_{t+1}^1 - S_t^1) + (1 - \alpha_t^v) r_{t+1}^1 + r_{t+1}^r \alpha_{t+1}^v - r_{t+1}^h. \tag{A32}$$

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