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## Dynamic analysis of the effects of mortgage-lending policies in a real estate market



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### ABSTRACT

The Korean government announced new policies to regulate mortgage lending that aim to decrease both the loan-to-value ratio and the debt-to-income ratio, in 2008. These policies were implemented on the expectation that they will control housing demand and stabilize house prices, focusing only on the current market status. However, it is difficult to analyze the effectiveness of these kinds of policies using an empirical approach. Consequently, a comprehensive and dynamic method is necessary for analyzing the effects of policies. This paper, therefore, develops an integrated and dynamic model for analyzing policy impacts. Using this model, the validity of mortgage-lending policies is assessed, and the interplay between various factors (including mortgage loans, housing prices, and demand) is examined. The model is also used to analyze unnoticed side effects in the real estate and financial markets. The dynamic analysis in this research can be applied not only to policy implication, but also to other dynamic fields such as project management, financial planning and demand analysis.

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### 1. Introduction

In the second half of 2008, the Korean government adopted policies aimed at invigorating mortgage lending and housing demand. The policies involved an increase in the maximum allowable loan-to-value ratio (LTV: amount borrowed as a percentage of the total appraised value of the property) and the maximum allowable debt-to-income ratio (DTI: the percentage of borrower's monthly gross income used to repay debt). The result of these policies is a steady increase in the number of mortgage loans, as well as increased demand for housing and upward pressure on housing prices. In response to increases in housing prices, the government announced a comprehensive real estate program in 2008 to regulate mortgage lending by commercial banks. One policy included in the plan was to decrease the maximum allowable LTV and DTI in order to control housing demand and stabilize house prices with a short-term perspective, focusing only on immediate market impacts. However, housing market forecasting and its link to mortgage lending are difficult to assess empirically. Intuitive and empirical approaches can overlook the side effects of mortgage-lending policies on housing and real estate financial markets. Specifically, it is likely that house prices and demand are impacted by the policy to a lesser degree than expected. Mortgage loans from secondary lending agencies (e.g., nonmonetary institutions such as mutual savings banks and credit unions) become attractive because they are not restricted by the policies, and potential mortgage borrowers move to secondary lending agencies, reducing the impact of the policy. Furthermore, mortgage loans are an essential element of the real estate financial market, and for this reason, any policy that alters the mortgage market would induce a behavioral response from financial institutions. This change in behavior and its impact on the secondary financial market should also be considered.

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**Table 1**  
Notation for the causal loop diagrams [9].

Legends	Explanation
	When other conditions are the same
	When other conditions are the same
	Including weighted delayed time between two factors
	Positive feedback or self-reinforcing loop
	Negative feedback or self-balancing loop

Many studies have addressed housing price market models and real estate policy analysis with a focus on several factors in the real estate market. Such studies have analyzed mortgage lender behaviors [1], bank lending restrictions [2], and existing futures contracts [3]. However, this research is limited by its empirical approach and in that it encompasses only a small number of potential factors. There is therefore a need for research that considers various perspectives as regards the real-world markets and systems at hand, and their interdependencies. To this end, many academics have attempted to develop integrated econometric models such as a dividend–price ratio model using time-series analysis [4], a rent–supply–demand model [5], impulse response functions for housing stocks derived from the VAR model [6], and a real house price growth model [7]. Although these econometric models are useful for point estimation, there are some limitations of such models in terms of separating the impact of correlated dependent variables, as well as difficulties in analyzing dynamic cause-and-effect relationships between model parameters. Therefore, as [8] demonstrated, in order to gain a comprehensive understanding of the real estate financial market and related policies, a comprehensive and dynamic approach is required. In this way, it is possible to forecast the sensitivity of the market to various policies, as well as the direction of the policy's impact on various outcome parameters.

In an effort to address this issue, this study outlines the development of system dynamics models replicating the Korean real estate and mortgage markets. These models are based on the fundamental principles and causal loops found in housing markets, and are set in motion by the economic activities of both consumers and financial agencies. Dynamics models represent numerous simultaneous interactions through a comprehensive and systematic approach elucidated by diagrams representing feedback loops. In addition, this research conducts a sensitivity analysis to validate, and estimate the impact of, the current and proposed policies of the Korean government as regards LTV and DTI ratios.

The policy models are based on the price expectations of consumers as well as the law of supply and demand. Simulation models in this research are focused on the housing market and mortgage-lending agencies and their profit-seeking behavior. The secondary financial market for mortgage securitizations is not well established in Korea, and therefore it is difficult to gather data regarding its influence factors. For this reason the secondary market is not considered in this study.

## 2. System dynamics modelling

System dynamics (SD) is a modeling tool used to analyze industrial, economic, social and environmental systems of all kinds [9]. An SD model can provide an analytic solution for representation of complex and dynamic systems by focusing on the interactions among variables and simulating model structures [10,11]. Table 1 shows the notation used in SD models. A causal loop diagram is a qualitative SD model consisting of feedback loops and variables. The feedback loop component can be divided into two categories: (1) a balancing loop, which is a goal-seeking structure bringing balance and stability to the system; and (2) a reinforcing loop, which generates a growth process (i.e., an action induces a result that generates still greater action) [12]. Using these loops, causal loop analysis can find links that have been missed in empirical study. In addition, SD models help connect factors using established knowledge, previous research and expert opinion. The analysis of policies can be validated through running simulations, based on the SD model, and by testing the model through sensitivity analysis. Sensitivity analysis is the process of repeatedly altering model parameters and running simulations, to gauge the sensitivity of outcomes to each model parameter. Sensitivity simulations can be very helpful in understanding the boundaries of a model and testing the robustness of model-based policies. With all these capabilities, SD has been successfully applied to solve complex project management problems in the construction industry [13,10,14] and to analyze the housing market [15,16]. Therefore, SD modeling can provide a comprehensive solution for analyzing the impact of Korean real estate policies.

## 3. Characteristics of the real estate market

### 3.1. Real estate policy trends in Korea

In the second half of 2008, the Korean economy suffered from a business recession resulting from the global financial crisis. In particular, Korea's real estate market was negatively impacted by a decline in housing transactions, a fall in house prices, and increased occurrence of apartments being unsold for extended periods of time. In an attempt to revitalize the real estate market, the Korean government adopted boosting policies aimed at deregulating real estate speculation.

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