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Housing Cycles and Consumption in Emerging-Market Economies*

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The estimation results of structural VARs show that, in comparison with dynamic responses of real consumption with respect to a stochastic trend shock, dynamic responses of real house prices in emerging-market countries are smaller than in advanced countries. For example, the ratio of the initial impulse response of the real estate price to that of consumption is lower in emerging countries than in advanced countries. A DSGE model is analyzed to account for the observed difference between advanced and emerging-market countries. The model's simulation results indicate that higher equity shares required for mortgage loans and higher fraction of financially-constrained households in emerging-market countries help explain the difference in the estimation results described above.

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1. INTRODUCTION

Academia and practical policy circles have emphasized the idea that aggregate business cycles are closely associated with housing cycles in advanced countries. For example, Leamer (2009) showed that eight of ten U.S. recessions since World War II were preceded by significant declines in residential investment. Iacoviello (2011) demonstrated that changes in housing wealth have a substantial effect on aggregate consumption.

One might wonder how the aggregate business cycles in emerging-market countries interact with housing cycles. Taylor and Lee (2014) show that the US financial crisis shock has a contractionary effect on the Korean economy. Ando (2010) said that the global financial crisis affected international production/distribution networks in East Asia. And Hwang (2012) indicated that development in housing sectors is closely interrelated to other macro variables. In this paper, a structural vector autoregression (SVAR) analysis is used to investigate the relation between aggregate business cycles and housing cycles in both advanced and emerging-market countries. The main finding of my analysis is that impulse responses of real house prices compared to the response of consumption are relatively smaller in emerging countries of Asia and Latin America than in advanced countries. The ratio of the initial impulse response of real house price to the initial impulse response of consumption is between –0.57 and 1.91 in emerging-market countries, whereas the ratio is between 2.07 and 5.21 in advanced countries.

It should be noted that the choice of a sample period critically determines whether real estate prices are more volatile in emerging-market countries than in advanced countries. For example, Minetti and Peng (2013) show that real estate prices have been more volatile and procyclical in emerging-market countries than in developed economies by using a data set that covers the period between 1994 and 2006. However, the data set used in this paper covers more recent observations of real house prices and consumption and also more emerging-market countries than their data set.

In order to account for the observed relation between housing cycles and aggregate business cycles described above, I analyze a dynamic stochastic general equilibrium model. The theoretical model in this paper draws on the work of Campbell and Hercowitz (2005), who analyze the relationship between the size of down payments for durable goods purchases and the volatility of aggregate fluctuations. My contribution is to allow for the possibility that a fraction of impatient households cannot borrow from patient households, so they should purchase their houses with their own funds. I do this to reflect the institutional difference of housing markets within advanced and emerging-market countries. I also include the role of real estate developers who construct new houses so that real house prices vary over time, which is absent in the model used by Campbell and Hercowitz (2005).

It is then shown in this paper that the model's impulse responses are similar to the estimated impulse response of real house price and consumption especially when both the required equity share and the fraction of financially-constrained households are lower in advanced countries than in emerging-market countries. The key reason behind his result is that housing prices should be less responsive to stochastic trend shocks when a lower fraction of households can borrow for their durable goods purchases. More precisely, responses of real house prices measured in units of consumption goods dampen when a lower fraction of households can borrow from mortgage loans.

The rest of this paper is organized as follows: In section 2, I discuss estimation results of the SVAR analysis. In sections 3 and 4, I describe a DSGE model and present its numerical solutions to show that the model can account for the estimation results of the SVAR anlaysis. Section 5 concludes.

2. EMPIRICAL ANALYSIS

2.1. Data

The data set used in the empirical analysis includes quarterly data on real GDP, real private consumption, and real house price indexes for 12 countries, where real house price indexes are computed by deflating nominal house price indexes with consumption price indexes. I should note that the sample period is not identical across countries because of limited data availability for emerging countries. In general, the sample periods of emerging-market countries are shorter than those of advanced countries. For example, the sample period of Malaysia and Thailand ranges from 2000 through 2011. The sample of the U.S. and the U.K. includes quarterly data for the period between 1989 and 2013. A detailed description of data sources is included in the Appendix.

2.2. Structural VAR Analysis

A structural vector autoregression (SVAR) analysis is used to investigate the relation between aggregate business cycles and housing cycles. A long-run restriction on the level of consumption is imposed to identify a stochastic trend shock from a bivariate vector autoregression of consumption growth and the growth rate of real house prices following Blanchard and Quah (1989).

I will describe how to identify a stochastic trend shock from a bivariate unrestricted vector autoregression of consumption growth with HP-filtered real house prices. Let X be the vector $(\Delta C, \Delta H)'$ where C and H denote logarithms of consumption and house price index, respectively. A structural model implies that X has a moving average representation: $X_t = \sum_{j=0}^{\infty} A_j e_{t-j}$ where e_t is a vector of structural shocks and the covariance matrix of this vector is an identity matrix. The long-run restriction is imposed on the sum of matrices in the moving average representation. For example, the restriction $\sum_{j=0}^{\infty} A_j(1, 2) = 0$ implies that e_{2t} also has no long-run effect on the level of *C*, where $A_j(1, 2)$ is an element of matrix A_j and e_{2t} is the second element of e_t. On the other hand, $\sum_{j=0}^{\infty} A_j(1, 1) > 0$ implies that the first shock has a long-run impact on the level of consumption. In this paper, the first shock is identified as a stochastic trend shock to the level of consumption. On the other hand, a bivariate vector autoregression produces a Wold-moving average representation: $X_t = \sum_{j=0}^{\infty} B_j v_{t-j}$ where v_t is a vector of residuals and the covariance matrix of this vector is Ω. This moving average representation can be obtained by first estimating and then inverting the vector autoregressive representation of *X*.

Comparing these two representations, we can find a relation between the residual vector and the vector of structural shocks: $v_t = A_0 e_t$ with $A_j = B_j A_0$ for all $j = 1, 2, \ldots$. Hence, these two relations imply that $\sum_{j=0}^{\infty} A_j = (\sum_{j=0}^{\infty} B_j) A_0$ and $A_0 A_0' = \Omega$. Meanwhile, the absence of a long-run effect of the second shock on consumption is $K(1, 2) = 0$ where $K = (\sum_{j=0}^{\infty} B_j) A_0$. By combining these relations described above, it is possible to identify elements of matrix A_0. This means it is possible to compute the moving average representation of structural shocks by using $A_j = B_j A_0$ for all $j = 1, 2, \ldots$. I note that the long-run level of consumption is normalized to be on in all countries.

Table 1 reports estimation results of SVARs for emerging-market and advanced countries. The ratios of the initial impulse responses of the real house price to consumption are estimated to be 5.21, 2.07 and 2.41 in the U.S., the U.K., and Hong Kong, respectively. The ratios of initial impulse responses of real house price to consumption are 1.07, 0.27, 0.41, and –0.57 in Indonesia, Korea, Malaysia and Thailand, respectively, while they are –0.55, 0.97, 0.07, and 0.28 in Chile, Colombia, Mexico and Peru, respectively. The dynamic responses at the initial period of real house prices with respect to a stochastic trend shock are smaller in emerging-market countries when compared with those of real consumption than those in advanced countries. The reason for this choice lies in the well-known result of the literature that long-run restrictions typically lead to much wider standard error bands for

Table 1 Ratio of Initial Impulse Responses of Real House Price and Consumption (Structural VAR)

Countries	Initial Impulse Response of Real House Price	Initial Impulse Response of Consumption	Initial Impulse Response of Real House Price / Initial Impulse Response of Consumption
U.S.	0.69	0.13	5.21
U.K.	0.61	0.30	2.07
Hong Kong	1.48	0.61	2.41
Brazil	0.57	0.30	1.91
Chile	–0.21	0.38	–0.55
Colombia	0.62	0.64	0.97
Mexico	0.05	0.71	0.07
Peru	0.14	0.51	0.28
Indonesia	0.87	0.81	1.07
Korea	0.17	0.65	0.27
Malaysia	0.24	0.58	0.41
Thailand	–0.26	0.45	–0.57

Note: Real house price means the nominal house price index deflated by consumption price index.

impulse responses in longer-term periods.[1)] As a result, relative responses of real house prices in initial periods are more accurate than those in longer-term periods.

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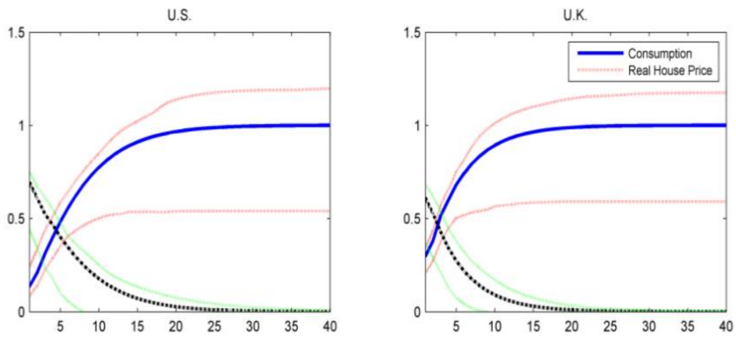
1) Christiano, Eichenbaum, and Vigfusson (2006) show that confidence intervals are wider in the case of long-run restrictions, while long-run identified VARs can be useful for discriminating between competing economic models.

Figure 1 Impulse Responses of Advanced Countries (Structural VAR)



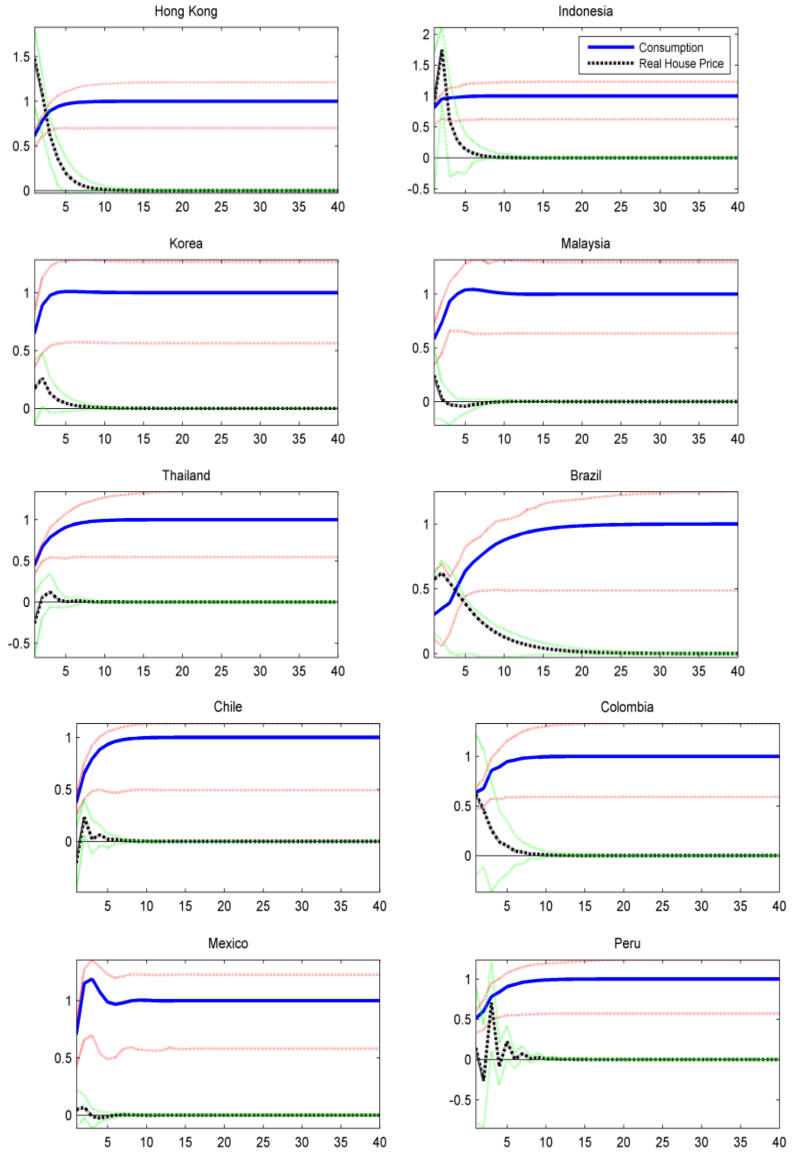
Notes: The red and green dotted lines are 80 percent bootstrap confidence bounds. The solid line represents responses of consumpiton and the dotted line corressponds to those of real house prices.

Figure 1 shows impulse responses of the aggregate consumption level and the growth rate of real house price indices with respect to stochastic trend shocks in the U.S. and the U.K. The solid line represents responses of consumption and the dotted line corressponds to those of real house prices. The aggregate consumption level rises gradually to its long-run level. The real house prices increase on the impact of stochastic trend shocks in both countries.

Figure 2 shows impulse responses of the aggregate consumption level and the growth rate of real house price indices with respect to stochastic trend shocks in emerging-market countries. The aggregate consumption level rises gradually to its long-run level in all emerging-market countries. The real house prices also trend to move up in the initial period except for in Thailand and Chile.

Comparing figure 1 and figure 2, the initial response of consumption tends to be larger in emerging-market countries than in advanced countries. In addition, the initial impulse response of real house prices tends to be smaller in emerging-market countries.

Figure 2 Impulse Responses of Emerging-Market Countries (Structural VAR)



Notes: The red and green dotted lines are 80 percent bootstrap confidenc bounds. The solid line represents responses of consumpiton and the dotted line corressponds to those of real house prices.

3. THE MODEL

Following the model of Campbell and Hercowitz (2005), there are two types of households: impatient and patient households. Impatient households are borrowers because their discount factors are smaller than those of patient households. In addition, patient households own and accumulate all productive capital stocks. The novel feature of their model is to allow for mortgage contracts between patient and impatient households. My contribution is to allow for the possibility that a fraction of impatient households cannot borrow from patient households, so that they should purchase their houses with their own funds. I also include the role of real estate developers who construct new housing stocks so that the real house prices vary over time, which is absent in the model of Campbell and Hercowitz (2005).

3.1. Households

As mentioned above, there are three types of households: patient households, the first group of impatient households, and the second group of impatient households. The first group of impatient households can make mortgage contracts with patient households, whereas the second group cannot.

3.1.1 Patient households

The life-time utility function at period t of patient households can be written as

$$E_t\left[\sum_{t=0}^{\infty}\tilde{\beta}^t(\theta\log\tilde{S}_t+(1-\theta)\log(\tilde{C}_t-\tau C_{t-1}))\right], \tag{1}$$

where $\tilde{S}_t$ and $\tilde{C}_t$ are the housing stock and non-durable consumption of patient households, $\tilde{\beta}$ is the time discount factor of patient households, and θ is the relative weight of the utility for housing services. In addition, I allow for the external habit persistence of consumption. So the current utility level of these households is affected by one-period lagged aggregate consumption (C_{t-1}), while parameter τ represents the degree of the habit persistence. The one-period flow budget constraint is given by

$$\tilde{C}_t + Q_t \tilde{X}_t + I_t + \tilde{B}_{t+1} = H_t K_t + R_{t-1} \tilde{B}_t, \tag{2}$$

where K_t and H_t are the capital stock at the beginning of period t and its rental rate, I_t is the investment at period t for the next-period' capital stock, Q_t is the price of new houses, $\tilde{X}_t$ is the amount at period t of new houses purchased by patient households, and $\tilde{B}_{t+1}$ represents the savings of patient households that is lent to impatient households at the end of period t with its corresponding gross rate R_t.

In particular, patient households do not sell their labor services to firms, so they specialize in providing mortgage loans to impatient households and accumulating capital stock according to a linear technology: $I_t = K_{t+1} - (1-\delta_K)K_t$ where δ_K is the depreciation rate of the capital stock. Patient households also accumulate their own housing stock according to a linear technology: $\tilde{X}_t = \tilde{S}_{t+1} - (1-\delta_S)\tilde{S}_t$ where δ_S is the depreciation rate of the housing stock. Households do not produce new houses. Real estate developers construct new houses. So, patient households purchase new houses at a price of Q_t in order to add them to their existing housing stock.

Given the initial capital K_0, housing stock $\tilde{S}_0$, and interest earnings $R_{-1}\tilde{B}_0$, the representative patient household chooses state-contingent sequences of $\tilde{C}_t$, $\tilde{X}_t$ and $\tilde{B}_{t+1}$ to maximize the utility function subject to the budget constraint. The optimization condition for the housing stock can be written as

$$Q_t = \tilde{\beta} E_t \left[\frac{\tilde{C}_t - \tau C_{t-1}}{\tilde{C}_{t+1} - \tau C_t} \left(\frac{\theta}{1-\theta} \frac{\tilde{C}_{t+1} - \tau C_t}{\tilde{S}_{t+1}} + (1-\delta_S Q_{t+1} \right) \right]. \tag{3}$$

The optimization condition for the capital stock is given by

$$1=\tilde{\beta}E_t\left[\frac{\tilde{C}_t-\tau C_{t-1}(1-\delta_K+H_{t+1})}{\tilde{C}_{t+1}-\tau C_t}\right]. \tag{4}$$

The optimization condition for the household's savings is also given by

$$1=\tilde{\beta}E_t\left[\frac{\tilde{C}_t-\tau C_{t-1}}{\tilde{C}_{t+1}-\tau C_t}R_K\right]. \tag{5}$$

3.1.2. Impatient households I

The first group of impatient households is defined as households that can borrow from patient households for their purchase of new houses. The fraction of these households out of all impatient households is denoted by $1-\lambda$. The utility function of the representative impatient household can be written as

$$E_t\left[\sum_{t=0}^{\infty}\hat{\beta}^t\left(\theta\log\hat{S}_t+(1-\theta)\log(\tilde{C}_t-\tau C_{t-1})+\omega\frac{(1-\hat{N}_t)^{1-\gamma}}{1-\gamma}\right)\right], \tag{6}$$

$$0<\theta<1,\ \omega>0,\ \gamma>0,$$

where $\hat{S}_t$, $\hat{C}_t$ and $\hat{N}_t$ are the housing stock, non-durable consumption, and labor supply of these impatient households, $\hat{\beta}(<\tilde{\beta})$ is the time discount factor of these households that is less than that of patient households, θ is the relative weight of the utility for housing services, ω is the weight of disutility of labor, and γ determines the labor elasticity of these households. The one-period flow budget constraint is

$$\hat{C}_t=Q_t\hat{X}_t=W_t\hat{N}_t+\hat{B}_{t+1}-R_{t-1}\hat{B}_t, \tag{7}$$

where $\hat{X}_t$ is the amount at period t of new houses purchased by these impatient households, and $\hat{B}_{t+1}$ represents the mortgage debt of impatient households with its corresponding gross rate R_t, and W_t is the real wage. In addition, impatient households accumulate their own housing stock according to a linear technology: $\hat{X}_t = \hat{S}_{t+1} - (1-\delta_S)\hat{S}_t$ where δ_S is the depreciation rate of the housing stock. However, real estate developers construct new houses. So, impatient households purchase new houses at a price of Q_t from real estate developers in order to add them to their existing housing stock.

I now describe the mortgage contract between patient and impatient households. In their mortgage contracts, impatient households are required to pay cash for a fraction of house price as equity for mortgage debt. Hence, this initial equity requirement constrains the size of mortgage debts between patient and impatient households. In addition, the debt amortization rate is an exogenously determined to be constant in this model, which governs the speed of equity accumulation in their mortgage contracts. Hence, the requirement for the equity share at period $t+j$ of a mortgage debt made at period t is given by

$$e_j = 1 - \left(\frac{1-\phi}{1-\delta_S}\right)^j (1-\pi). \tag{8}$$

In particular, this equity-share requirement gets closer to one because the debt amortization rate is larger than the depreciation rate $(\phi > \delta_S)$. In addition, a large value of π might reflect under-development of the housing financial market.

The requirement of equity share gives rise to a constraint of the amount of mortgage debt in each period. The market value of equity from impatient households' houses should be greater than the required value of equity imposed by mortgage contracts. If this does not hold, the collateral value of houses provided by impatient households is short of their debt. As a result, the requirement of equity share leads to the following constraint.

$$(1-\delta_S)Q_t\hat{S}_{t+1} - R_t\hat{B}_{t+1} \geq (1-\delta_S)\sum_{j=0}^{\infty}(1-\delta_S)^j Q_{t-j}\hat{X}_{t-j}e_j. \tag{9}$$

The left-hand side of this inequality is the market value of impatient households' houses and the right-hand side is the required equity value measured in its book value. When this borrowing contract shown in (9) binds, it is possible to have the following recursive representation.

$$\hat{B}_{t+1} = \frac{(1-\delta_S)(1-\pi)}{R_t}Q_t\hat{X}_t + \frac{(1-\phi)R_{t-1}}{R_t}B_t. \tag{10}$$

The expression of $(1-\delta_S)(1-\pi)/R_t$ can be interpreted as the loan-to-value ratio for new purchases, while $(1-\phi)R_{t-1}/R_t$ is equal to one minus the rate of amortization of the outstanding debt.

Given $R_{-1}\hat{B}_0$ and $\hat{S}_0$, these impatient households choose state-contingent sequences of $\hat{C}_t$, $\hat{X}_t$ and $\hat{B}_{t+1}$ to maximize the utility function subject to the budget constraint and the borrowing constraint. The optimization condition for the housing stock can be written as

$$\begin{aligned} &Q_t\left(1-\Xi_t\frac{(1-\delta_S)(1-\pi)}{R_t}\right) \\ &= \hat{\beta}E_t\left[\frac{\theta}{1-\theta}\frac{\hat{C}_t-\tau C_{t-1}}{\hat{S}_{t+1}} + (1-\delta_S)\frac{\hat{C}_t-\tau C_{t-1}}{\hat{C}_{t+1}-\tau C_t}Q_{t+1}\left(1-\Xi_{t+1}\frac{(1-\delta_S)(1-\pi)}{R_{t+1}}\right)\right], \end{aligned} \tag{11}$$

where Ξ_t is the Lagrange multiplier of the borrowing constraint deflated by the Lagrange multiplier of the budget constraint. The optimal condition for the total debt of these households is given by

$$\Xi_t = 1-\hat{\beta}E_t\left[\frac{\hat{C}_t-\tau C_{t-1}}{\hat{C}_{t+1}-\tau C_t}R_t\right] + (1-\phi)\hat{\beta}E_t\left[\frac{\hat{C}_t-\tau C_{t-1}}{\hat{C}_{t+1}-\tau C_t}\Xi_{t+1}\frac{R_t}{R_{t+1}}\right]. \tag{12}$$

The utility maximization condition for labor supply can be written as

$$W_t = \omega(1-\hat{N}_t)^{-\gamma}\,\frac{(\hat{C}_t - \tau C_{t-1})}{1-\theta}. \qquad (13)$$

3.1.3. Impatient households II

The second group of impatient households is defined as households that cannot borrow from patient households for their purchase of new houses. Since they are financially constrained, these households should pay in full when they purchase new houses. In this model, the size of new houses is divisible so that these households should purchase a relatively small amount of new houses without any access to mortgage loans. The fraction of these impatient households out of all impatient households is λ. The utility function of the representative impatient household can be written as

$$E_t\left[\sum_{t=0}^{\infty}\hat{\beta}_t\left(\theta\log\breve{S}_t + (1-\theta)\log(\breve{C}_t - \tau C_{t-1}) + \omega\frac{(1-\breve{N}_t)^{1-\gamma}}{1-\gamma}\right)\right], \qquad (14)$$

where $\breve{S}_t$, $\breve{C}_t$ and $\breve{N}_t$ are the housing stock, non-durable consumption, and labor supply of these impatient households, $\hat{\beta}(<\tilde{\beta})$ is the time discount factor of these households that is less than that of patient households, θ is the relative weight of the utility for housing services, ω is the weight of disutility of labor, and γ determines the labor elasticity of these households. The one-period flow budget constraint is

$$\breve{C}_t + Q_t\breve{X}_t = W_t\breve{N}_t, \qquad (15)$$

where $\breve{X}_t$ is the amount at period t of new houses purchased by these impatient households, and W_t is the real wage. In addition, although they cannot borrow from patient households, they accumulate their own housing stock according to a linear technology: $\breve{X}_t = \breve{S}_{t+1} - (1-\delta_S)\breve{S}_t$ where δ_S is the depreciation rate of the housing stock. As mentioned above, these impatient households use their labor incomes to purchase new houses at a price of Q_t from real estate developers in order to add them to their existing housing stock.

Given $\hat{S}_0$, these impatient households choose state-contingent sequences of $\breve{C}_t$ and $\breve{X}_t$ to maximize the utility function subject to the budget constraint. The optimization condition for the housing stock can be written as

$$Q_t = \hat{\beta} E_t \left[\frac{\breve{C}_t - \tau C_{t-1}}{\breve{C}_{t+1} - \tau C_t} \left(\frac{\theta}{1-\theta} \frac{\breve{C}_{t+1} - \tau C_t}{\breve{S}_{t+1}} + (1-\delta_S) Q_{t+1} \right) \right]. \qquad (16)$$

The utility maximization condition for labor supply can be written as

$$W_t = \omega (1 - \breve{N}_t)^{-\gamma} \frac{(\breve{C}_t - \tau C_{t-1})}{1-\theta}. \qquad (17)$$

3.2. Firms

3.2.1. Final-goods producers

There are many identical firms that produce final goods and sell them in a perfectly competitive market. Each firm has a Cobb-Douglas production function: $Y_t = K_t^{\alpha} (A_t N_t)^{1-\alpha}$, where Y_t is output, K_t is capital, N_t is labor input, A_t is the labor augmenting technology level and $0 \le \alpha < 1$. The labor augmenting technology follows a logarithmic random walk so that its growth rate is an identically and independently distributed random variable with zero mean and constant variance.

The markets for production inputs are perfectly competitive and their prices are fully flexible. So, the representative firm's profit maximization conditions can be written as

$$W_t = (1-\alpha)A_t^{1-\alpha}\left(\frac{K_t}{N_t}\right)^{\alpha}, \tag{18}$$

$$H_t = \alpha A_t^{1-\alpha}\left(\frac{K_t}{N_t}\right)^{\alpha-1}, \tag{19}$$

where W_t is the real wage and H_t is the real rental rate for capital stock.

3.2.2. Real estate developers

Real estate developers purchase X_t from final-goods producers to produce new houses by paying quadratic adjustment costs. Each household purchases new housing stock from real estate developers where its real price is Q_t. So their optimization problems can be written as

$$\prod_{X,t} = \max_{X_t}\left[Q_t X_t - C(X_t, S_t) - X_t\right]$$

$$\text{subject to } C(X_t, S_t) = \chi\frac{S_t}{2}\left(\frac{X_t}{S_t} - r\right)^2.$$

The adjustment costs denoted by $C(X_t, S_t)$ are quadratic in the ratio of the new housing stock to the existing housing stock, as used in the literature. Hence, the role of real estate developers is to construct new housing stock by converting their purchases of X_t from final-goods producers into new houses after paying quadratic adjustment costs. The optimization condition of real estate developers can be written as

$$Q_t = 1 + \chi\left(\frac{X_t}{S_t} - r\right).$$

The real house price is therefore proportional to the ratio of the new housing stock to the existing housing stock. It means that the real house price rises as the amount of new houses increases.

3.3. Aggregate Market Clearing Conditions

The market clearing condition for mortgage debt can be written as

$$\hat{B}_t = \breve{B}_t. \tag{20}$$

The market clearing condition for labor input is also given by

$$N_t = \hat{N}_t + \breve{N}_t. \tag{21}$$

The aggregate non-durable consumption and housing investment are defined as sums of demands of three types of households:

$$C_t = \tilde{C}_t + \hat{C}_t + \breve{C}_t, \tag{22}$$

$$X_t = \tilde{X}_t + \hat{X}_t + \breve{X}_t. \tag{23}$$

As a result, the aggregate market clearing condition is given by

$$Y_t = C_t + X_t + I_t + C(X_t,\ S_t). \tag{24}$$

4. RESULTS

4.1. Calibration

Numerical values of structural parameters for advanced countries are taken from Campbell and Hercowitz (2005). In order to assign numerical values to parameters π and λ for emerging-market countries, I use data on the ratio of collateralized debt in the period from 2010 to 2013 that can be obtained from the Survey of Household Finance and Living Conditions of Korea.

Table 2 Parameter Values

Parameters	Values		Definitions
	Advanced Countries	Emerging-market Countries	
π	0.2050	0.5214	Rate of down payment
λ	0	0.363	Fraction of financially-constrained households
τ	0.30	0.30	Intensity of habit formation
χ	52	52	Cost of changing housing stock
ϕ	0.0161	0.0161	Debt amortization rate
α	0.3	0.3	Capital share in production
δ_S	0.01	0.01	Depreciation rate for housing
δ_K	0.025	0.025	Depreciation rate for capital
$\tilde{\beta}$	1/1.01	1/1.01	Time discount of patient household
$\hat{\beta}$	1/1.015	1/1.015	Time discount of impatient household
ω	1.95	1.95	Preference of leisure
θ	0.37	0.37	Preference for housing
μ_g	0.0152	0.0152	Long-run mean growth rate of productivity
σ_ε	1	1	Standard deviation of permanent effect disturbance

According to Kim (2010), the average loan-to-value of the Korean domestic commercial bank was 46.2 percent at the end of 2009.[2)] The model's LTV for emerging-market countries is equal to $(1-\pi)(1-\delta_S)/R.$ So, the parameter π is set to be 0.52. The ratio of households that don't have financial access is calculated by using data on household assets and liabilities in the Survey of Household Finance and Living Conditions. According to this survey, 63.7 percent of households have debts. So, I set $\lambda = 0.36.$ The other parameter values are reported in table 2.

2) Unfortunately, this calibration is lacking in substance in the respect that sources and periods of data are not in accordance.

4.2. Simulation Result

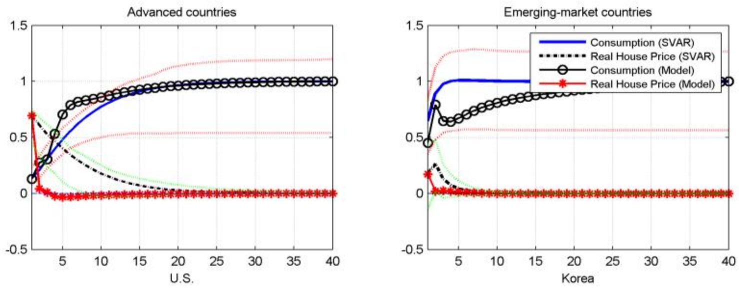
Numerical simulation results are presented to show that the theoretical model can explain the estimation results of the SVAR analysis described in section 2. Table 3 summarizes the simulation results from the theoretical models and compares them to corresponding estimates. On the impact of the trend shock, the initial impulse response of consumption is 0.128 in advanced countries and that of real house prices is 0.694. So, the ratio of real house prices to consumption is 5.430. For Korea, the impulse response of consumption is 0.450 and that of real house price is 0.173. The ratio of real house price to consumption is 0.385. As a result, these two models can explain the observed difference of the relative responses of real house prices between advanced and emerging-market countries.

Figure 3 reports impulse responses of consumption and real house prices with respect to stochastic trend shocks that are implied by theoretical models. The aggregate consumption rises gradually to its long-run level responding to a positive stochastic trend shock in two models for advanced and emerging-market countries. The growth rates of real house prices show positive initial responses and then decline gradually. In sum, initial responses of two

Table 3 Ratio of Initial Impulse Responses of Real House Price and Consumption (Model)

Countries	Initial Impulse Response of Real House Price	Initial Impulse Response of Consumption	Initial Impulse Response of Real House Price / Initial Impulse Response of Consumption
Advanced Countries			
U.S. (SVAR)	0.6942	0.1333	5.2062
U.S. (Model)	0.6942	0.1278	5.4303
Emerging-Market Countries			
Korea (SVAR)	0.1731	0.6487	0.2669
Korea (Model)	0.1731	0.4502	0.3846

Figure 3 Impulse Responses of Advanced and Emerging-Market Countries (Model)



Note: The red and green dotted lines are 80 percent bootstrap confidence bounds.

models for advanced and emerging-market countries are closely similar to estimated impulse responses.

5. CONCLUSION

It has been shown that the institutional differences in housing financial markets between advanced and emerging-market countries can account for the observed relation between aggregate business and housing cycles. The key mechanism behind my results is that the fraction of households that can smooth their consumption levels by using collateralized debts is higher and the initial down payment is lower in advanced countries. As a result, I can derive a relatively low increase in the impulse response of consumption and a high rise in that of house price for advanced countries.

The availability of data is limited for emerging-market countries. For this reason, my empirical analysis is focused on the cyclical behavior of real house prices. Minnetti and Peng's (2013) analysis also concentrates on the cyclical behavior of real house prices in emerging-market countries. In the model, the simulation results do not really represent emerging-market countries in the respect that they deal only with that Korean case and these cannot cover the variant dynamics of responses of consumption and house prices on changes in parameter values. It was difficult to verify the robustness of the model by analyzing changes in impulse responses to the variations of parameter values because of limitations of the data.

I leave a more rigorous analysis for future studies that cover more countries and include measures of housing investments for emerging-market countries.

APPENDIX

Table A1 Data Sources of House Price Index

Countries	House Price Index	Source
U.S.	S&P/Case-Shiller U.S. National Home Price Index (Q)	S&P Dow Jones Indices
U.K.	Halifax House Price Index: All Houses (All Buyers), NSA	Lloyds Banking Group
Hong Kong	RESIDENTIAL PROPERTY PR., ALL DWELLINGS, PER SQUARE M., M-ALL NSA	BIS Property Price Statistics
Indonesia	RESID. PROPERTY PRICES, NEW HOUSES (BIG CITIES), PER DWELLING, NSA	BIS Property Price Statistics
Malaysia	RESIDENTIAL PROP. PRICES, ALL DWELLINGS, PER SQ.M. Q-ALL Y-ALL NAS INDEX	BIS Property Price Statistics
Korea	Housing Purchase Price Index-Apartment	Bank of Korea
Thailand	House Price Index (The Government Housing Bank's Mortgage Loans)-Town House (including land) (Q)	Bank of Thailand
Brazil	RESID. PROPERTY PRICES, ALL DWEL. (METROPOL. AREA) PER DWEL., M-ALL NSA	BIS Property Price Statistics
Chile	Chile_ÍNDICE REAL DE PRECIOS DE VIVIENDAS (IRPV)	Cámara Chilena de la Construcción - CChC
Colombia	HPI - For Three Major Colombian Cities (Q)	Banco de la República

Mexico	RESIDENTIAL PROPERTY PRICES, ALL DWELLINGS, PER DWELLING, Q-ALL NSA	BIS Property Price Statistics
Peru	RESIDENTIAL PROPERTY PRICES, FLATS (LIMA), PER SQ.M., Q-ALL NSA	BIS Property Price Statistics

Table A2 Data Sources of Consumer Price Index

Countries	Consumer Price Index	Source
U.S.	Consumer Price Index for All Urban Consumers: All Items (CPIAUCSL), Index 1982-84=100, Monthly, (SA)	FRED
U.K.	Consumer Price Index of All Items in the United Kingdom (GBRCPIALLMINMEI), Index 2010=100, Monthly, (NSA)	OECD
Hong Kong	Consumer Price Indices (Oct 2009 - Sep 2010=100)	Hong Kong Monetary Authority
Indonesia	CPI:17 CAPITAL CITIES	IFS
Malaysia	Consumer Price Index (2000=100) All Groups	Bank of Malaysia
Korea	Consumer Price Indexes (2010=100) (All Cities)	Bank of Korea
Thailand	Consumer Price Index of the Northeastern Region	Bank of Thailand
Brazil	Consumer Price Index: All Items for Brazil (BRACPIALLMINMEI), Index 2010=100, Monthly (NSA)	OECD
Chile	ÍNDICE DE PRECIOS AL CONSUMIDOR – IPC (Base: diciembre 2008=100)	Central Bank of Chile
Colombia	- (Real House Price Index is used.)	-
Mexico	Consumer Price Index: All Items for Mexico (MEXCPIALLMINMEI), Index 2010=100, Monthly (NSA)	OECD
Peru	Consumer Price Index Índices (Dec. 2001=100) - Period Average	Central Bank of Peru

Table A3 Data Sources of GDP and Consumption

Countries	GDP and Consumption	Source
U.S.	GDP / Private Final Consumption	OECD
U.K.	GDP / Private Final Consumption	OECD
Hong Kong	GDP / Private Consumption Expenditure	Hong Kong Monetary Authority
Indonesia	GDP/ Private Final Consumption	OECD
Malaysia	GDP / Private Consumption	Bank of Malaysia
Korea	GDP / Private Final Consumption	OECD
Thailand	Expenditure on GDP / Private Consumption	Bank of Thailand
Brazil	GDP / Private Final Consumption	OECD
Chile	GDP / Private Final Consumption	OECD
Colombia	GDP / Consumo de Hogares	Banco de la República
Mexico	GDP / Private Final Consumption	OECD
Peru	GDP / Private Consumption	Bank of Peru

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