국토연구 제82권(2014. 9): pp49~60 http://dx.doi.org/10.15793/kspr.2014.82..004

The Linked Movement of House Prices and GDP in the G7 Countries[1)]

G7 국가의 주택가격과 GDP 경기동행성 분석

윤재호 Yoon Jaeho[2)], 이주형 Lee Joohyung[3)]

Abstract

In order to determine exactly when the housing bubble burst and to examine the co-movement of housing price and the real growth of output for individual G7 countries (U.S., U.K., Canada, Germany, France, Italy, and Japan), this study adopted Hamilton's Markov-switching model (1989). This study found that the housing price for the individual countries showed procyclical movement with the real growth of output during the 1970s, 80s, and 90s and the financial shock in 2008. These findings suggest that the FIML Markov-switching model of Yoon (2006) is very useful for determining the common international business cycle between housing price and the real growth of output in the G7 countries. In addition, extremely large shocks, such as oil shocks, cause procyclical housing price movement with the real growth of output, including the burst housing bubble in 2008.

Keywords: Housing Bubble Burst, House Price, GDP, FIML, Hamilton's Markov-Switching Model, Common Business Cycle, G7, U.S., U.K., Canada, Germany, France, Italy, Japan

Ⅰ. Introduction

The relationship between housing prices and the real growth of output has been assumed to be positive and stable. This idea was formalized by a cointegrating relationship between housing price and income, and error-correction models such as those of Abraham and Hendershott (1996), Malpezzi (1999), Capozza et al. (2002), and Meen (2002) before the 2008 financial shock. Valadez (2010) also assumed a stable relationship between the price of houses and the United States gross domestic product (GDP) before, during, and after the period known as the "2008 global financial meltdown". However, Cooley and Ohanian (1991) argued that, with the exceptions of the two world wars, particularly during the period of the Great Depression (1928-1946) and part of the late

1) We are grateful to James D. Hamilton for helpful comments at the 33rd International Symposium on Forecasting (http://forecasters.org), June 23-26, 2013, KAIST, Seoul, Korea. This study was accepted to present at the 1st International Association for Applied Econometrics, (http://www.iaae2014.org) June 26-28, 2014, Queen Mary University Of London, London, U.K.

2) 포스코경영연구소 수석연구원(제1저자) | Senior Economist, POSCO Research Institute | Primary Author | jhyoon@posri.re.kr

3) 한양대학교 도시대학원 교수(교신저자) | Prof., Graduate School of Urban Studies, Hanyang Univ.| Corresponding Author | joo33@hanyang.ac.kr

19thcentury, there was relatively little evidence of procyclical prices over the last 150 years, including the post-WWII period. Poterba (1991) implicitly assumed that house prices and income are not cointegrated. Gallin (2006) found an unstable relationship between housing prices and the real growth of output.

Therefore, this Study examined whether there really is co-movement between housing prices and the real growth of output in the G7 countries (U.S., U.K., Canada, Germany, France, Italy, and Japan).

To establish a relationship between housing prices and the real growth of output in G7 countries, we adopted the Markov-switching model of Hamilton (1989, 1994) and the full information maximum likelihood (FIML) Markov-switching model of Yoon (2006).

This Study found that housing price showed procyclical movement with the real growth of output during the oil shock periods of the 1970s, 80s, and 90s, and when there are extremely large shocks, such as the burst housing bubble in 2008.

The Study has been divided in four sections. Section 2 presents the FIML Markov-switching model. Section 3 summarizes the empirical results. Section 4 concludes this study.

II. FIML Markov-switching model

In order to estimate the parameters of the Markov-switching model in the simultaneous equations consistently, we consider the following FIML Markov-switching model:

$$YB_{St} + Z\Gamma_{St} = U_{St}, \quad U_{St} \sim i.\,i.d,\, N(0, \Sigma_{St} \otimes I_T) \qquad \langle 1 \rangle$$

where

$$Y = \begin{bmatrix} Y_{11} & Y_{12} & \cdots & Y_{1M} \\ Y_{21} & Y_{22} & \cdots & Y_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ Y_{T1} & Y_{T2} & \cdots & Y_{TM} \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_T \end{bmatrix}, \; B_{St} = \begin{bmatrix} \beta_{11,S1t} & \beta_{12,S2t} & \cdots & \beta_{1M,SMt} \\ \beta_{21,S1t} & \beta_{22,S2t} & \cdots & \beta_{2M,SMt} \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{M1,S1t} & \beta_{M2,S2t} & \cdots & \beta_{MM,SMt} \end{bmatrix}$$

$$Z = \begin{bmatrix} Z_{11} & Z_{12} & \cdots & Z_{1K} \\ Z_{21} & Z_{22} & \cdots & Z_{2K} \\ \vdots & \vdots & \ddots & \vdots \\ Z_{T1} & Z_{T2} & \cdots & Z_{TK} \end{bmatrix} = \begin{bmatrix} z_1 \\ z_2 \\ \vdots \\ z_T \end{bmatrix}, \; \Gamma_{St} = \begin{bmatrix} \gamma_{11,S1t} & \gamma_{12,S2t} & \cdots & \gamma_{1M,SMt} \\ \gamma_{21,S1t} & \gamma_{22,S2t} & \cdots & \gamma_{2M,SMt} \\ \vdots & \vdots & \ddots & \vdots \\ \gamma_{K1,S1t} & \gamma_{K2,S2t} & \cdots & \gamma_{KM,SMt} \end{bmatrix}$$

$$U_{St} = \begin{bmatrix} u_{11,S1t} & u_{12,S2t} & \cdots & u_{1M,SMt} \\ u_{21,S1t} & u_{22,S2t} & \cdots & u_{2M,SMt} \\ \vdots & \vdots & \ddots & \vdots \\ u_{T1,S1t} & u_{T2,S2t} & \cdots & u_{TM,SMt} \end{bmatrix} = (u_{S1t}\, u_{S2t} \cdots\, u_{SMt})$$

$$E(U_{St}{}'\,U_{St}) = E\left[\begin{bmatrix} u_{S1t} \\ u_{S2t} \\ \vdots \\ u_{SMt} \end{bmatrix}(u_{S1t}\ u_{S2t} \cdots u_{SMt}\ )\right] = \begin{bmatrix} \sigma_{S1t,S1t}I_T & \sigma_{S1t,S2t}I_T & \cdots & \sigma_{S1t,SMt}I_T \\ \sigma_{S2t,S1t}I_T & \sigma_{S2t,S2t}I_T & \cdots & \sigma_{S2t,SMt}I_T \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{SMt,S1t}I_T & \sigma_{SMt,S2t}I_T & \cdots & \sigma_{SMt,SMt}I_T \end{bmatrix}$$

$$= \Sigma_{St} \otimes I_T$$

Y is the T × M matrix of jointly dependent variables; B_{St} is an M × M matrix and nonsingular; Z is the T × K matrix of predetermined variables; Γ_{St} is K × M matrix positive definite and rank(Z) = K; and U_{St} is T × M matrix of the structural disturbances of the system. Consequently, the model has M equations and T observations. The structural errors are assumed as a nonsingular M-variate normal (Gaussian) distribution. In addition, σ is variance and covariance of the error terms and Σ_{St} is an M×M matrix that is positive definite with no restrictions placed on it. It is assumed that all equations satisfy the rank condition for identification. Also if lagged endogenous variables are included as predetermined variables, the system is assumed to be stable. An orthogonality assumption, $E(Z'U_{St})=0$, is required between the predetermined variables and structural errors and we assume the presence of contemporaneous correlation but no intertemporal correlation in 〈1〉. If we assume that the single Markov-switching variable St has an N-state, first-order Markov process, then we can write the transition probability matrix in the following way:

$$p = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1N} \\ p_{21} & p_{22} & \cdots & p_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ p_{N1} & p_{N2} & \cdots & p_{NN} \end{bmatrix}$$

where $p_{ij}=\Pr(S_t=j\,|\,S_{t-1}=i)$ with $\sum_{j=1}^{N} p_{ij}=1$ for all i

If our model involves only two unobserved two-state first order Markov-switching variables, such as S_{1t} and S_{2t}, The dynamics of Markov-switching variables such as S_{1t}, S_{2t} can be represented by a single Markov-switching variable St in the following manner:

To derive the FIML Markov-Switching Model in the simultaneous equations, we can obtain $\Pr(S_t=j\,|\,\psi_t)$by applying a Hamilton filter (1989) as follows:

$S_t=1$ if $S_{1t}=0, S_{2t}=0$

$S_t=2$ if $S_{1t}=0, S_{2t}=1$

$S_t=3$ if $S_{1t}=1, S_{2t}=0$

$S_t=4$ if $S_{1t}=1, S_{2t}=1$

with $p_{ij}=\Pr(S_t=j\,|\,S_{t-1}=\mathrm{i})$, $\sum_{j=1}^{4} p_{ij}=1$

To derive the FIML Markov-Switching Model in the simultaneous equations, we can obtain $\Pr(S_t=j|\psi_t)$ by applying a Hamilton filter (1989) as follows:

Step 1 :

At the beginning of the tth iteration, $\Pr(S_{t-1}=i|\psi_{t-1})$, $i=0, 1, \cdots, N$ is given. And, we calculate

$$\Pr(S_t=j|\psi_{t-1})=\sum_{i=1}^{N}\Pr(S_{t-1}=i, S_t=j|\psi_{t-1})=\sum_{i=1}^{N}\Pr(S_t=j|S_{t-1}=i)\Pr(S_{t-1}=i|\psi_{t-1})$$

where $\Pr(S_t=j|S_{t-1}=i)$,

$i=0, 1, \cdots, N, j=0, 1, \cdots, N$ are the transition probabilities.

Step 2 :

Consider the joint conditional density of y_t and unobserved $S_t=j$ variable, which is the product of the conditional and marginal densities:

$$f(y_t, S_t=j|\psi_{t-1})=f(y_t|S_t=j, \psi_{t-1})\Pr(S_t=j|\psi_{t-1})$$

from which the marginal density of y_t is obtained by:

$$f(y_t|\psi_{t-1})=\sum_{j=1}^{N}f(y_t, S_t=j|\psi_{t-1})=\sum_{j=1}^{N}f(y_t|S_t=j, \psi_{t-1})\Pr(S_t=j|\psi_{t-1})$$

where the conditional density $f(y_t|S_t=j, \psi_{t-1})$ is obtained from equation 〈2〉 :

$$\begin{aligned} & f(y_t|S_t=j, \psi_{t-1}) \\ & =(2\pi)^{-M/2}\det(\Sigma_{St})^{-1/2}|\det(B_{St})|\cdot\exp[-\frac{1}{2}(y_tB_{St}+z_t\Gamma_{St})\Sigma_{St}^{-1}(y_tB_{St}+z_t\Gamma_{St})'] \end{aligned} \quad \langle 2\rangle$$

where $\Sigma_{St}=\frac{1}{T}(YB_{St}+Z\Gamma_{St})'(YB_{St}+Z\Gamma_{St})$, y_t is the t^{th} row of the Y matrix. z_t is the t^{th} row of the Z matrix, and B_{st} and Γ_{st} are obtained from equation 〈1〉.

Step 3 :

Once y_t is observed at the end of time t, we update the probability terms:

$$\Pr(S_t=j|\psi_t)=\Pr(S_t=j|\psi_{t-1}, y_t)=\frac{f(S_t=j, y_t|\psi_{t-1})}{f(y_t|\psi_{t-1})}=\frac{f(y_t|S_t=j, \psi_{t-1})\Pr(S_t=j|\psi_{t-1})}{f(y_t|\psi_{t-1})}$$

As a byproduct of the above filter in Step 2 we obtain the log likelihood function:

$$\ln L = \sum_{t=1}^{T} \ln f(y_t | \psi_{t-1})$$

which can be maximized in respect to the parameters of the model.

III. Empirical results using Hamilton's Markov-switching model

Let us consider the quarterly real GDP[4] and Housing Price Index[5] in the G7 countries (U.S., U.K., Canada, Germany, France, Italy, and Japan). The ordinary least squares (OLS) regression is given by equation[6]

$$\Delta Y_t = \alpha + \beta \Delta H_t + e_t \qquad \langle 3 \rangle$$

where ΔYt, is the log differenced real GDP and ΔHt is the log differenced housing price[7] in the G7 countries.

In equation ⟨3⟩, Valadez (2010) assumed a constant β. However, we examined whether β is really constant before and after the periods when the bubble burst in the G7 countries. To do this, we adopt Hamilton's (1989) simple two-state Markov-switching model.

$$\Delta Y_t = \alpha_{st} + \beta_{st} \Delta H_t + e_{st} \qquad \langle 4 \rangle$$

where

$$\alpha_{St} = \alpha_1 S_t + \alpha_0 (1 - S_t) \qquad \beta_{St} = \beta_1 S_t + \beta_0 (1 - S_t)$$

$$\Pr(S_t = 0 | S_{t-1} = 0) = q \qquad \Pr(S_t = 1 | S_{t-1} = 1) = p$$

$$p = \begin{bmatrix} p & 1-q \\ 1-p & q \end{bmatrix}$$

Table 1 and 2 give the estimation results for Hamilton's Markov-switching model. Coefficient β_1 is significant and showed an upward shift during the regime 1 period in the model, and the degree of the upward movements is obvious from β_0 to β_1 because $\beta_1 > \beta_0$ except Italy. From this result, we observe regime switching during the

4) We obtained the G6 quarterly real GDP from the OECD database and the Japan GDP from the cabinet office of Japan.

5) Source: National sources, BIS Residential Property Price database (http://www.bis.org/statistics/pp.htm).
Please refer to Appendix for the relationship between real GDP and Housing Price Index.

6) For Japan, we use the land price instead of the housing price index because the Japan land price consists at least two-thirds of the house price and we can get only land prices from the BIS Residential Property Price database.

7) It does not make much difference in summarizing the size of any given shock whether one uses the nominal price or the real price of Housing Price, since in most of these shocks the move in nominal prices is an order of magnitude larger than the change in overall prices during that quarter. Another practical reason is that we only get the G7 Housing Price Index not the real House Price for 44 years.

regime 1 period which is the inferred probabilities $\Pr(S_t=1 \mid Y_T)$. This finding offers evidence that coefficient β is not constant, which differs from Valadez's (2010) model, which assumed a constant β. Coefficient σ_1 is also significant and showed large volatility during the regime 1 period in the model because $\sigma_1 > \sigma_0$ including Italy.

Figure 1 depict the two-state Markov-switching smoothed probabilities. We find that the inferred probabilities $\Pr(S_t=1 \mid Y_T)$ are very similar to the U.S. recession dates, not only in the 1970s but also in the 1980s, 90s, and 2008. From Figure 1, we find that the inferred probabilities $\Pr(S_t=1 \mid Y_T)$ are very large in the 1970s and during the regime change in 2008.

These results are consistent with Hamilton (1989), who suggests that there was great uncertainty regarding GDP growth after the two major OPEC oil shocks in 1973–1974 and 1979–1980. In addition, the procyclical movement occurs in conjunction with the oil shock in 1990.

Table 1 _ Maximum–likelihood estimation with Hamilton's model (1970. II – 2013. IV)

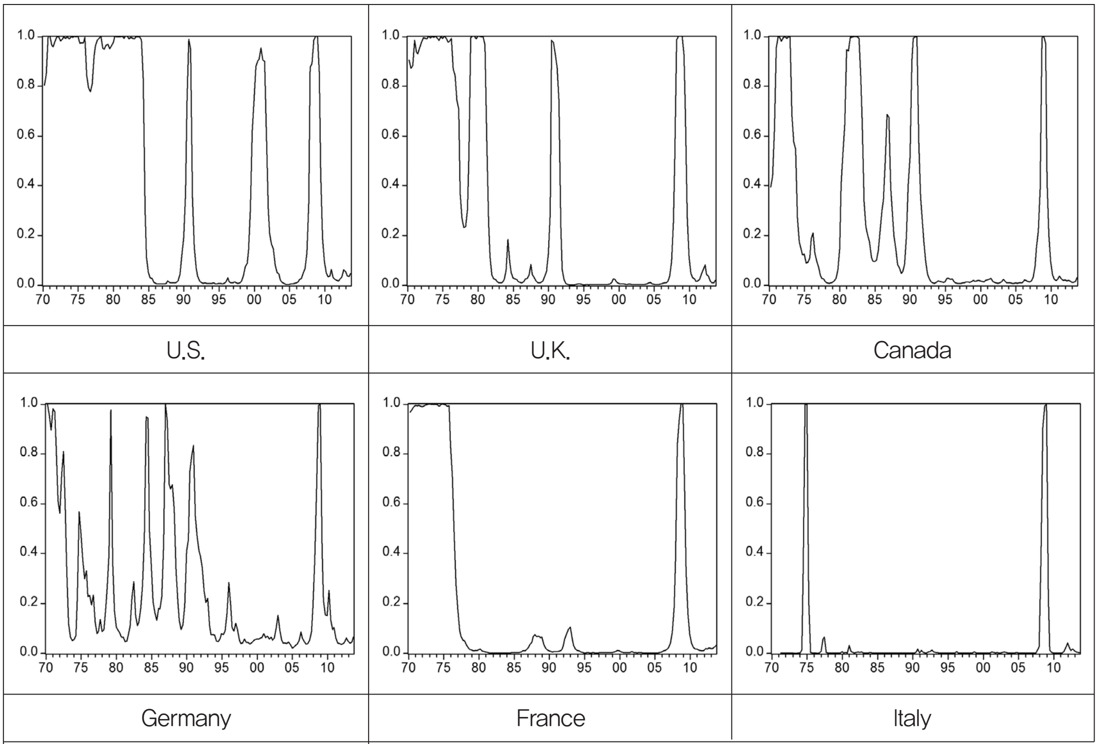
Parameters	U.S.	U.K.	Canada	Germany
β_0	0.059 (0.031)	0.060 (0.019)	0.004 (0.017)	–0.016 (0.083)
β_1	0.102 (0.052)	0.195 (0.053)	0.079 (0.055)	0.375 (0.259)
α_0	0.719 (0.061)	0.660 (0.064)	0.763 (0.058)	0.494 (0.132)
α_1	0.408 (0.155)	–0.350 (0.249)	0.318 (0.262)	0.302 (0.516)
σ_0	0.397 (0.036)	0.494 (0.037)	0.519 (0.042)	0.685 (0.102)
σ_1	1.125 (0.099)	1.340 (0.139)	1.296 (0.178)	1.488 (0.321)
q	0.954 (0.025)	0.964 (0.020)	0.957 (0.023)	0.915 (0.051)
p	0.941 (0.032)	0.923 (0.046)	0.866 (0.069)	0.751 (0.252)
Log likelihood	–184.43	– 196.02	–189.14	–232.01

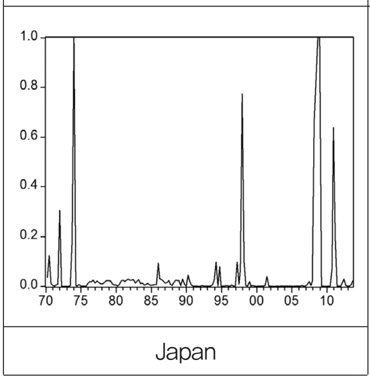
Table 2 _ Maximum–likelihood estimation with Hamilton's model (1970. II – 2013. IV)

Parameters	France	Italy (71.II-13.IV)	Japan
β_0	0.041 (0.019)	0.090 (0.024)	0.195 (0.031)
β_1	0.220 (0.069)	0.044 (0.136)	1.283 (0.486)
α_0	0.450 (0.047)	0.334 (0.076)	0.607 (0.067)
α_1	0.293 (0.203)	–1.730 (0.779)	–1.373 (0.626)
σ_0	0.409 (0.026)	0.724 (0.040)	0.744 (0.050)
σ_1	0.890 (0.123)	1.050 (0.359)	1.092 (0.377)
q	0.984 (0.012)	0.986 (0.011)	0.969 (0.022)
p	0.948 (0.044)	0.642 (0.208)	0.395 (0.229)
Log likelihood	–127.04	– 201.39	–216.57

Note: The standard errors of the parameter estimates are given in parentheses.

Figure 1 _ Smoothed probabilities of regime 1 Pr(S_t=1|Y_T) for the G7 countires





In addition, we can see evidence of a regime change in 2008 resulting from the burst housing bubble. Therefore, when there are extremely large shocks, such as oil shocks and burst housing bubbles, the house price movement is procyclical with the real growth of output.

Ⅳ. Derivation of a common business cycle using the FIML Markov-switching model

To derive a common international business cycle relating housing prices and the real growth of output in major countries, the FIML Markov-switching model was applied. This assumes common two-state Markov-switching probabilities in the simultaneous equations.

$$\Delta Y_{us} = \alpha_{S_t} + \beta_{St}\Delta H_{us} + e_{St,us} \tag{5}$$

$$\Delta Y_{uk} = \alpha_{S_t} + \beta_{St}\Delta H_{uk} + e_{St,uk} \tag{6}$$

$$\Delta Y_{canada} = \alpha_{S_t} + \beta_{St}\Delta H_{canada} + e_{St,canada} \tag{7}$$

$$\Delta Y_{germany} = \alpha_{S_t} + \beta_{St}\Delta H_{germany} + e_{St,germany} \tag{8}$$

$$\Delta Y_{france} = \alpha_{S_t} + \beta_{St}\Delta H_{france} + e_{St,france} \tag{9}$$

$$\Delta Y_{italy} = \alpha_{S_t} + \beta_{St}\Delta H_{italy} + e_{St,italy} \tag{10}$$

$$\Delta Y_{japan} = \alpha_{S_t} + \beta_{St}\Delta H_{japan} + e_{St,japan} \tag{11}$$

where $\alpha_{St} = \alpha_1 S_t + \alpha_0(1-S_t),\ \beta_{St} = \beta_1 S_t + \beta_0(1-S_t)$

$\Pr(S_t = 0|S_{t-1} = 0) = q,\ \Pr(S_t = 1|S_{t-1} = 1) = p$

$p = \begin{bmatrix} p & 1-q \\ 1-p & q \end{bmatrix}$

To solve the equations 〈5〉 - 〈11〉 together, we can rewrite them as follows:

$$\left[\Delta Y_{us}\right] \cdots \ \Delta Y_{japan} * \begin{bmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{bmatrix} - \left[\Delta H_{us} \ \cdots \ \Delta H_{japan}\right] * \begin{bmatrix} \beta_{St,us} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \beta_{St,japan} \end{bmatrix} - \left[\alpha_{St,us} \ \cdots \ \alpha_{St,japan}\right]$$

$$= (e_{St,us} \ \cdots \ e_{St,japan})$$

where $(e_{St,us} \ \cdots \ e_{St,japan}) \quad \sim i.i.d.N(0, \Sigma_{,St} \otimes I_T)$

$$\hat{\Sigma}_{St} = E\left[\begin{bmatrix} e_{St,us} \\ e_{St,uk} \\ \vdots \\ {}_{St,japan} \end{bmatrix} (e_{St,us} \quad e_{St,uk} \quad \cdots \quad e_{St,japan})\right] = \begin{bmatrix} \sigma_{St,us} & 0 & \cdots & 0 \\ 0 & \sigma_{St,uk} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_{St,japan} \end{bmatrix}$$

$\alpha_{St} = \alpha_1 S_t + \alpha_0(1-S_t)$, $\beta_{St} = \beta_1 S_t + \beta_0(1-S_t)$,

$\Pr(S_t = 0\,|\,S_{t-1} = 0) = q$, $\Pr(S_t = 1\,|\,S_{t-1} = 1) = p$, $p = \begin{bmatrix} p & 1-q \\ 1-p & q \end{bmatrix}$

Table 3 gives the estimates from the FIML Markov-switching Model using quarterly data for 1971:II to 2013:IV. Coefficient β_1, which is larger than β_0, is statistically significant, except for Canada and Italy. The variance σ_0 is significant and the variance σ_1 is also significant and showed large volatility during the regime 1 period in the model because $\sigma_1 > \sigma_0$.

Figure 2 shows that the international common smoothed probabilities $\Pr(S_t=1|Y_T)$ match the oilprice shock periods during 1970s, 80s and 90s well. In addition, there were other common business cycles during the savings and loan (S&L) crisis (1987:I to 1988:I) and burst housing bubble (2008:II to 2009:II). We cannot find the early 2000s recession from the common international inferred probabilities $\Pr(S_t=1|Y_T)$ Therefore, we can infer that the shock in the recession of the early 2000s occurred only in the U.S..

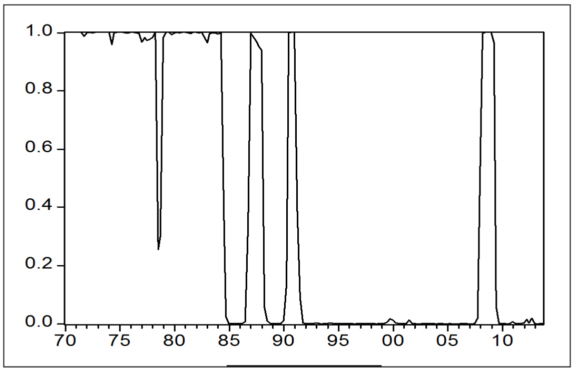
The results in Table 3 and Figure 2 give evidence of a common international business cycle between housing prices and the real growth of output with large shocks.

Table 3 _ MLE of the FIML Markov-switching model (1971. II – 2013. IV)

Parameters	France	Italy (71.II-13.IV)	Japan
β_{0US}	0.060 (0.031)	β_{1US}	0.132 (0.054)
β_{0UK}	0.047 (0.019)	β_{1UK}	0.205 (0.047)
$\beta_{0Canada}$	–0.007 (0.018)	$\beta_{1Canada}$	0.068 (0.040)
$\beta_{0Germany}$	–0.029 (0.086)	$\beta_{1Germany}$	0.223 (0.116)
$\beta_{0France}$	0.050 (0.020)	$\beta_{1France}$	0.140 (0.041)
β_{0Italy}	0.078 (0.033)	β_{1Italy}	0.065 (0.051)
β_{0Japan}	0.227 (0.068)	β_{1Japan}	0.273 (0.063)
α_{0US}	0.685 (0.061)	α_{1US}	0.378 (0.166)
α_{0UK}	0.648 (0.059)	α_{1UK}	–0.203 (0.204)
$\alpha_{0Canada}$	0.698 (0.054)	$\alpha_{1Canada}$	0.587 (0.164)
$\alpha_{0Germany}$	0.524 (0.074)	$\alpha_{1Germany}$	0.264 (0.187)
$\alpha_{0France}$	0.429 (0.046)	$\alpha_{1France}$	0.283 (0.127)
α_{0Italy}	0.261 (0.064)	α_{1Italy}	0.341 (0.237)
α_{0Japan}	0.522 (0.082)	α_{1Japan}	0.350 (0.177)
σ_{0US}	0.192 (0.028)	σ_{1US}	1.262 (0.222)
σ_{0UK}	0.222 (0.032)	σ_{1UK}	1.537 (0.270)
$\sigma_{0Canada}$	0.240 (0.035)	$\sigma_{1Canada}$	1.263 (0.223)
$\sigma_{0Germany}$	0.470 (0.070)	$\sigma_{1Germany}$	1.440 (0.256)
$\sigma_{0France}$	0.150 (0.021)	$\sigma_{1France}$	0.522 (0.092)
σ_{0Italy}	0.282 (0.040)	σ_{1Italy}	1.431 (0.251)
σ_{0Japan}	0.638 (0.089)	σ_{1Japan}	1.208 (0.212)
Q	0.956 (0.021)		
P	0.933 (0.033)		
Log likelihood	–1296.39		

Note: The standard errors of the parameter estimates are given in parentheses.

Figure 2 _ Common smoothed probabilities[8)] of regime1 $Pr(S_t=1|Y_T)$ in the G7 countries



Ⅴ. Conclusion

Applying a Markov-switching model to the G7 countries, we found that the housing price movement was procyclical with the real growth of output during the oil shock periods of the 1970s, 80s, and 90s, and when there are extremely large shocks, such as the burst housing bubble in 2008, the housing price shows procyclical movement with the real growth of output.

The results suggest that when there are extremely large shocks, such as oil shocks or the burst housing bubble in 2008, house prices show procyclical movement with the real growth of output.

References

Abraham, J. M. and P. H. Hendershott. 1996. Bubbles in metropolitan housing markets. *Journal of Housing Research* 7, no. 2: 191-207.

Capozza, D. R., P. H. Hendershott, C. Mack, and C. J. Mayer. 2002. Determinants of real house price dynamics. *NBER Working Paper* 9262.

Cooley, T . F. and L. E. Ohanian. 1991. The cyclical behavior of prices. *Journal of Monetary Economics* 28: 25-60.

Gallin, J. 2006. The long run relationship between house prices and income: evidence from local housing markets. *Real Estate Economics* 34, no.3: 417-438.

Hamilton, J. D. 1994. *Time Series Analysis*. Princeton: Princeton University Press.

_____. 1989. A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica* 57 no.2: 357-384.

Kim, C. J. and C. R. Nelson. 1999. *State-space models with regime switching: Classical and Gibbs sampling approaches with applications*. Cambridge, Massachusetts: MIT Press.

Kim, K. and B. Renaud. 2009. The global house price boom and its unwinding: an analysis and a commentary. *Housing Studies* 24, no.1: 7-24.

Malpezzi, S. 1999. A simple error correction model of house prices. *Journal of Housing Economics* 8: 27-62.

Meen, G. 2002. The time series behavior of house prices: a transatlantic divide?. *Journal of Housing Economics* 11: 1-23.

Poterba, J. 1991. House price dynamics: The role of tax policy and demography. *Brooking Paper on Economic Activity* 2: 143-183.

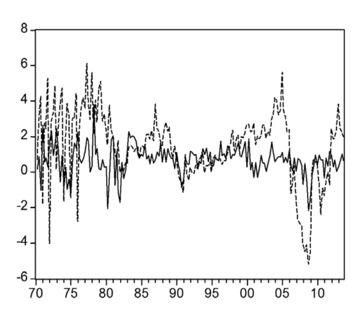
Valadez, R. M. 2010. The housing bubble and the GDP: real growth of output. *Journal of Case Research in Business and Economics* 3, no.1: 1-18.

Yoon, J. H. 2006. The co-movement of inflation and the real growth of output. *The Journal of the Korean Economy* 7, no.2: 213-229.

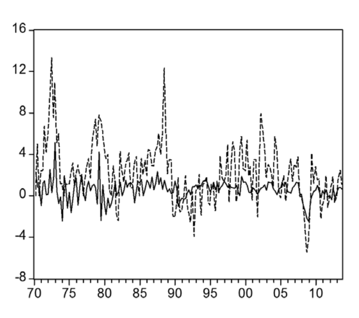
• 논문 접수일: 2014. 7. 28
• 심사 시작일: 2014. 8. 11
• 심사 완료일: 2014. 8. 25

8) For common smoothed probabilities, we followed Kim's algorithm from Kim and Nelson (1999).

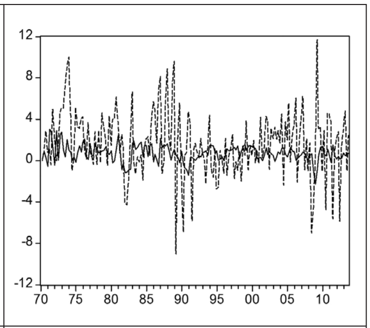
Figure 3 _ The relationship between GDP ΔY_t and housing price ΔH_t for the G7 countires



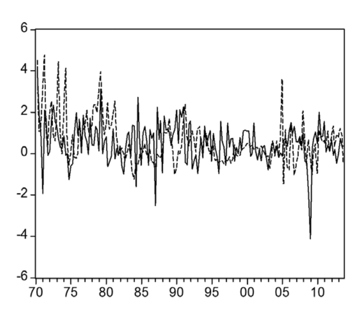
U.S.



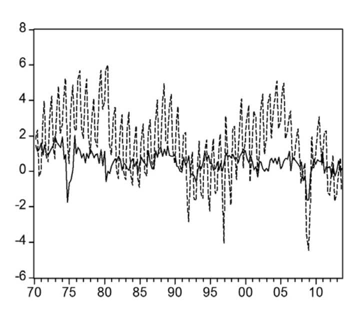
U.K.



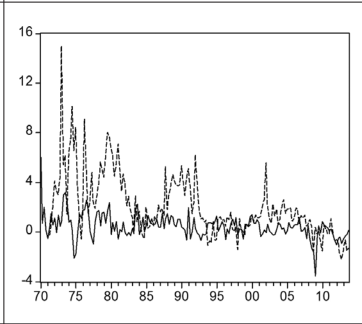
Canada



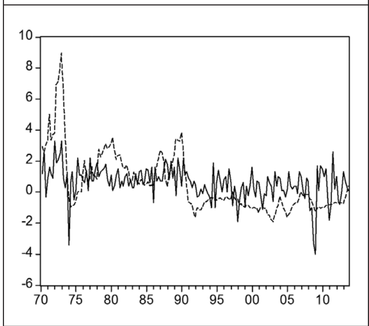
Germany



France



Italy



Japan

Notes:

1) —— GDP, ----- Housing price, land price.

2) For Japan only, we use the land price instead of the housing price index because the Japan land price consists at least two-thirds of the house price and we can get only land prices from the BIS Residential Property Price database.

요약

주제어: 주택가격 버블 붕괴, 주택가격, GDP, FIML, 마코프 스위칭, 공통 경기변동, 미국, 영국, 캐나다, 독일, 프랑스, 이탈리아, 일본

본 논문에서는 G7 국가의 주택가격 붕괴 시점 및 주택가격과 GDP 간의 경기동행성 여부를 파악하기 위해 Hamilton 교수의 마코프 스위칭 모형(1989)을 사용하였다. 실증분석 결과 G7 개별 국가의 주택가격 및 GDP는 1970년대, 1980년대, 1990년대, 그리고 2008년 금융위기 시점 등 경기 저점 시기에 경기동행성을 보였다. 이에 Yoon의 FIML 마코프 스위칭 모형(2006)을 이용하여 G7 국가들의 공통된 주택가격 및 GDP 간의 경기 사이클을 도출하여 보았다. 결론적으로 오일 쇼크뿐 아니라 2008년 주택가격 붕괴와 같은 큰 경기 쇼크가 발생하면 주택가격과 GDP 관계는 경기동행 모습을 보였다.