Housing and the Business Cycle: Evidence from the UK Housing Price and Quantity

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This paper investigates the importance of housing price and quantity variables in the UK business cycle since the mid 1950s. We start with a baseline Markov-switching common factor model for the UK economy into which we incorporate a house price variable (nationwide house price index) and a quantity variable (new housing starts) into the baseline model. Then, we evaluate the importance of the two housing market variables in the fluctuations of the overall economic activities. When house variables are allowed to directly affect the evolution of key macro indicators, the results are similar to those for the US in the previous studies: although the year-on-year housing quantity changes have significant effects on the UK business cycle beyond the three macro indicators, the usual year-on-year house price changes do not. However, asymmetric decreases in house price significantly affect the UK business cycle more than the asymmetric decreases in house quantity. When house variables are accommodated to influence the probabilities of transitions between expansions and contractions, we find strong evidence that changes in both house price and quantity variables significantly affect the switching of the UK economy between the two phases, although house quantity variables predict the upcoming business cycle phases better than house price. Moreover, for both house price and quantity variables, most useful information is contained in their asymmetric decreases.

Keywords: Housing, Price, Quantity, UK, Business cycle, Markov-switching

JEL Classification: E21, E44, D41

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I. Introduction

The extended period of sharp and continued house price increases, coupled with the booming investment in residential construction since the mid 90s has engendered a plethora of studies on the link between the housing market and the macroeconomy. As summarized in the satisfactory survey by Muellbauer and Murphy (2008), housing markets and the rest of the economy interact in multiple ways. However, if we concentrate on the effects of housing price on macroeconomic activities, we seem to have reached a wide consensus on the theoretical front. The "wealth effects" channel emphasizes price appreciation, which causes subsequent increases in the wealth of homeowners, a direct extension of the permanent income hypothesis. More recent research, such as those by Aoki *et al.* (2004) and Iacoviello (2005), suggest that innovations in housing finance allow homeowners to use their homes as collateral to loosen their borrowing constraints.

Unlike the general agreements revolving around the presence of the house price-macroeconomy relation in the theoretical front, the empirical evidence on the role of house prices over the business cycle remains mixed. For example, Davis and Heathcote (2005) find a contemporaneous correlation between the nationwide house prices in the US and output as high as 65% over the 1971-2001 period. However, Kan *et al.* (2004) find that the contemporaneous correlation between house prices and output growth is merely 15% or smaller on average in about 50 major US cities. Recently, Leamer (2007) challenged the traditional view on the role of house prices, arguing that housing markets are grossly understudied by macroeconomists interested only in understanding business cycles. He reported several stylized facts about the behavior of the US housing market over the business cycle, claiming that i) housing investment leads the business cycle, and a fall in residential investment is a reliable harbinger of a recession, and ii) volumes, rather than prices, in the housing sector are what matter for business cycles. Supporting the second stylized fact, he pointed out that eight out of ten US postwar recessions have been preceded by substantial problems in quantity variables such as housing investment and consumer durables. Alvarez *et al.* (2009) (for the Eurozone) and Alvarez and Cabrero (2010) (for Spain) provided similar evidence highlighting the leading nature of housing market cycles with respect to business cycles, which reflects the cyclical features of a variety of housing market indicators such as housing starts, housing permits, and the amount of residential investment.

The aim of this paper is to further our understanding of the relation between housing and overall economic activities. Using the UK quarterly data over the 1956-2011 period, we revisit the issue raised by Leamer (2007) regarding the importance of housing market variables for overall economic activities. More specifically, by investigating how housing price and quantity compare in terms of their effect on the overall UK business cycle, we attempt to study whether the decline in house prices plays a key role in driving the business cycle, or whether the fluctuations in housing quantities serve as the main driving force behind the UK business cycle.

We start with a baseline Markov-switching common factor model for the UK economy that captures two main features of business cycles, *i.e.*, the co-movements of key macro indicators and their asymmetric development between expansions and recessions. The baseline model is then estimated using the key macro variables such as real output, consumption, and investment. We then augment the baseline model in two ways. First, we allow housing variables to directly influence the individual macro variables in the mean equations. In the second extension, house market variables are allowed to affect the probabilities of switching between expansion and recession phases. Next, we compare the results from the two extended models with those of the baseline model. If the extended models yield significantly different results from those of the baseline model, we can conclude that the house market contains additional information for describing the UK business cycles beyond those stated by individual indicators. By comparing the relative importance of housing price and quantity variables, we can also check the validity or Leamer's claim (2007) regarding the UK economy.

The results for the first strand of extended models corroborate the claim of Leamer (2007), who stressed the importance of the housing quantity variable. In particular, although the growth in housing price does not provide additional information about the business cycle, the housing quantity variable can explain the business cycle beyond the three macro indicators. If measured in terms of asymmetric decreases, similar to Mork (1989) and Hamilton (2003), both housing price and quantity variables significantly affect the evolution of the UK business cycle, with housing price having a greater effect than house quantity. For the second extension, the results support the relevance of both house price and quantity growth in governing the transition of the economy from the recession to the expansion phases. An interesting finding is that while the movement in house price affects the probabilities of both phases in the next period, only when the current phase of the economy is in expansion, the movement in housing quantities provides useful signals for the upcoming business cycle phases regardless of the current phase of the economy. These two features turn out to be preserved even when the asymmetric decreases in the housing sector variables are employed.

The remainder of the paper proceeds as follows: Section II presents the structure of the baseline model and the extended models, Section III discusses the estimation results for the extended models and evaluates the importance of house price and quantity variables, and Section IV concludes.

II. The Models

A. Baseline Model

As the baseline model for the UK economy, we employ a Markov-switching common factor model similar to those used by Kim and Piger (2002) and Senyuz (2011). We assume that two unobserved components drive the logarithms of real output (y_t), consumption (c_t), and investment (i_t) up to their idiosyncratic disturbances given as follows:

$$y_t = \gamma_y x_t + \lambda_y z_t + e_{y,t}, \tag{1}$$

$$c_t = \gamma_c x_t + e_{c,t}, \tag{2}$$

$$i_t = \gamma_i x_t + \lambda_i z_t + e_{i,t}, \tag{3}$$

where x_t is the trend or the permanent component of the business, and z_t denotes its transitory component. Similar to previous studies (Kim and Piger 2002; Senyuz 2011), we specify consumption in equation (2) as a proxy for the common stochastic trend among the three variables. The specifications for the permanent component, output, and consumption are motivated by the permanent income hypothesis and empirical findings in Fama (1992) and Cochrane (1994), which show that consumption represents the trend in output well. The factor loading coefficients (γ_j, λ_j) for $j=y$, c, i measure the sensitivity of the three macroeconomic variables to the two unobserved components. To allow consumption for its own short-run dynamics as found in earlier literature (*e.g.*, Fama 1992), we separately model its transitory variation via the idiosyncratic error term $e_{c,t}$.

The two unobserved components and idiosyncratic disturbances are specified as follows:

$$x_t=\mu(S_t)+x_{t-1}+v_t, \quad v_t\sim iiN\ (0,\ \sigma_v^2), \tag{4}$$

$$\mu(S_t)=\mu_0\cdot(1-S_t)+\mu_1\cdot S_t, \quad \mu_1<\mu_0, \tag{5}$$

$$\phi(L)z_t=\tau\cdot S_t+u_t, \quad \tau<0, \quad u_t\sim iiN\ (0,\ \sigma_u^2), \tag{6}$$

$$\psi_j(L)e_{j,t}=\varepsilon_{j,t}, \quad \varepsilon_{j,t}\sim iiN\ (0,\ \sigma_j^2), \quad j=y,\ c,\ i, \tag{7}$$

where the permanent component x_t is assumed to be a random walk with drift. The lag polynomials in equations (6) and (7) are assumed to imply stationary AR processes, and the idiosyncratic disturbance terms $\varepsilon_{j,t}$ are correlated neither with one another nor with $(v_t,\ u_t)$ at any leads and lags. We allow for the interdependence between the two unobserved components via contemporaneous correlation coefficient $\rho=\text{corr}(v_t,\ u_t)$, similar to Morley *et al.* (2003).

To incorporate the inherently different dynamics of the business cycle across the expansion and recession phases, we assume that the hidden state variable S_t characterizes the phases of the two components x_t and z_t in Equations (5) and (6), respectively. More specifically, $S_t=1$ indicates low growth or a recession. Thus, μ_1 is interpreted as the trend growth rate during recessions, similar to Hamilton (1989), and $\tau<0$ measures the size of temporary pluck during recession, similar to Friedman (1993). We close the baseline model by specifying the evolution of St as a first order two-state Markov process with the following transition probabilities:

$$\Pr[S_t=0\mid S_{t-1}=0]=\frac{\exp(q_0)}{1+\exp(q_0)}=q, \tag{8}$$

$$\Pr[S_t=1\mid S_{t-1}=1]=\frac{\exp(p_0)}{1+\exp(p_0)}=p. \tag{9}$$

B. Extended Models

We extend the baseline model in two ways to allow for the role of housing sector variables. In the first strand of extended models, the mean equations (1) to (3) for the individual series are modified as follows:

$$y_t = \gamma_y x_t + \lambda_y z_t + \beta_y H_{t-1} + e_{y,t}, \tag{10}$$

$$c_t = \gamma_c x_t + \beta_c H_{t-1} + e_{c,t}, \tag{11}$$

$$i_t = \gamma_i x_t + \lambda_i z_t + \beta_i H_{t-1} + e_{i,t}, \tag{12}$$

where H_t denotes the control variable that captures the influence of the housing market variables in the business cycle. Equations (10)-(12), (4)-(7), and (8)-(9) constitute the first strand of the extended models.

We consider two specifications in the construction of the control variable H_t in equations (10) to (12). First, we use the usual year-on-year growth rates of the house price variable (P_t^H) or the quantity variable (Q_t^H), which are constructed as $HP_t^0 = \sum_{i=0}^{4} \Delta \log(P_{t-i}^H)$ and $HQ_t^0 = \sum_{i=0}^{4} \Delta \log(Q_{t-i}^H)$, respectively. We label the corresponding extended models HP-M[1] and HQ-M[1], depending on whether house price or quantity variable is incorporated in the mean equation. Moreover, H_t allows for the asymmetry in the effects of the house variables on the business cycle, similar to Mork (1989) and Hamilton (2003), where the relation of the business cycle with the increases in house price or quantity can be inherently different from that with their decreases.[1] Therefore, we employ $HP_t^- = -\max(HP_t^0, 0)$ and $HQ_t^- = -\max(HQ_t^0, 0)$, as measures of the *asymmetric decreases* (in absolute values) in house price and quantity variables, respectively. The extended models of this kind are called HP-M[2] and HQ-M[2].

The second strand of extended models is motivated by a limitation in the first strand: the housing market movements are prevented from directly affecting the business cycle phases because the transition probabilities are still assumed to be fixed. Therefore, in our second extension, we follow Filardo (1994) and relax the time-invariant transition probabilities assumption of the Markov state variable as follows:

$$\Pr[S_t = 0 \mid S_{t-1} = 0, H_{t-1}] = \frac{\exp(q_0 + q_1 H_{t-1})}{1 + \exp(q_0 + q_1 H_{t-1})} = q(t), \tag{13}$$

[1] Hori and Satosh (2004) argue that that the marginal propensity to consume out of stock price and real estate price since the "lost decade of 1990s" are slightly higher than previous estimates, suggesting asymmetry in the wealth effects.

TABLE 1
SUMMARY OF MODELS

H_{t-1} in the mean equations				
Model	HP-M[1]	HQ-M[1]	HP-M[2]	HQ-M[2]
H_t is⋯	$HP_t^0 = \sum_{t=1}^{4} \Delta \log(P_{t-i}^H)$	$HQ_t^0 = \sum_{t=1}^{4} \Delta \log(Q_{t-i}^H)$	$HP_t^- = -\max(HP_t^0, 0)$	$HQ_t^- = -\max(HQ_t^0, 0)$
H_{t-1} in the transition probabilities				
Model	HP-TP[1]	HQ-TP[1]	HP-TP[2]	HQ-TP[2]
H_t is⋯	$HP_t^0 = \sum_{t=1}^{4} \Delta \log(P_{t-i}^H)$	$HQ_t^0 = \sum_{t=1}^{4} \Delta \log(Q_{t-i}^H)$	$HP_t^- = -\max(HP_t^0, 0)$	$HQ_t^- = -\max(HQ_t^0, 0)$

$$\Pr[S_t = 1 \mid S_{t-1} = 1, H_{t-1}] = \frac{\exp(p_0 + p_1 H_{t-1})}{1 + \exp(p_0 + p_1 H_{t-1})} = p(t). \tag{14}$$

where the significant estimates for (q_1, p_1) imply the importance of house market variables in governing the switching between the two business cycle regimes. Equations (1)-(3), (4)-(7), and (13)-(14) constitute the second strand of extended models. For the specifications of H_t in modified equations (13)-(14), we follow the same approach as in the first strand. The resulting four extended model versions are labeled HP-TP[1], HQ-TP[1], HP-TP[2] and HQ-TP[2], respectively, depending on whether the housing price or quantity variables is employed in forming the variations. Table 1 below summarizes the specifications of all of the extended models considered.

To estimate the parameters of the baseline and the extended models, we cast them into appropriate state space forms and apply the method of Kim (1994). Based on the estimation results, inferences can be drawn regarding the unobserved common factor and its latent phases. Intuitively, if the housing variables do not contribute a better explanation of the business cycle on top of those by the macro indicators, the estimated coefficients of β_j or (q_1, p_1) become insignificant, and the difference between the overall fits of the extended models and the baseline model will be trivial.

III. Empirical Results

A. Data

To estimate the baseline model, we use the following three macro series of the UK: real GDP, real private consumption expenditures, and gross fixed capital formation spanning from 1956:Q2 to 2011:Q4. All these are available as seasonally adjusted volume indices from the OECD statistical warehouse. The raw series are transformed into logs, and used as y_{it}s. We run the ADF and Phillip-Perron tests for unit roots and the Johansen test for the co-integration. The results support the presence of a common stochastic trend among the three series, which justifies the specification of the mean equations (1) to (3). As the housing quantity variable, the volume of new housing construction output in both the public and private sectors is used. This series is available from the Office for National Statistics in seasonally adjusted form.[2] The house price we use is the nominal Nationwide House Price Index available from 1952:Q2 on.[3] The CPI deflates the nominal index into real terms. We opt to use the year-on-year growth in the two housing sector variables[4] due to the seasonality of the real housing price series, which appears to remain even after seasonal adjustment.

Figure 1 plots the real house price and the new housing construction, along with the UK recession periods identified by the Economic Cycle Research Institute. Overall, the two series exhibit considerable declines prior to historical recessions, up until the two exceptions where the new housing construction and the real house price series fail to give early warning signals for the 1973:Q4-1975:3 and the 1979:Q3-1981:Q2 recessions, respectively. At any rate, the historical relation between the housing sector variables and the business cycle chronology provides us with enough motivation to delve into their roles in the housing-business cycle relations.

[2] The link is http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-283308.

[3] The link is http://www.nationwide.co.uk/hpi/datadownload/data_download.htm.

[4] We use the X-11 routine in Eviews 5.0 to remove the seasonality in the new housing construction, but the resulting series still shows a considerable degree of seasonality.

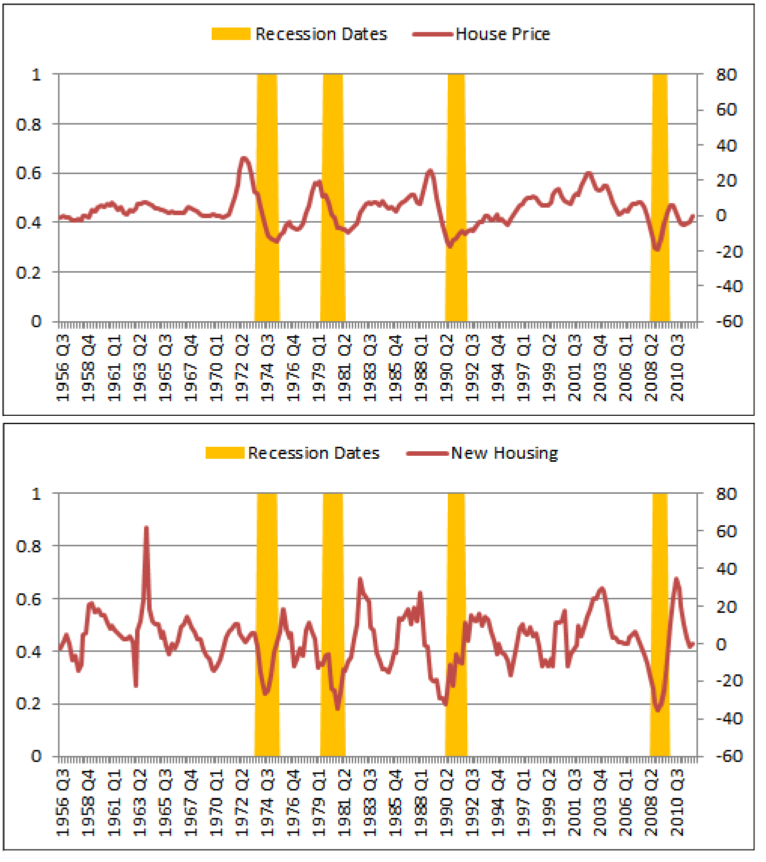


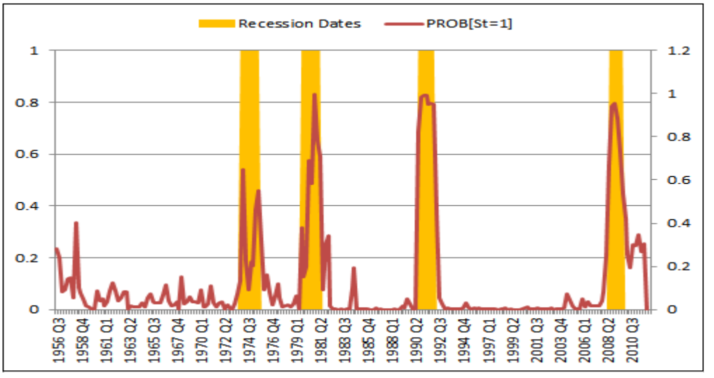
FIGURE 1
HOUSING VARIABLES AND THE RECESSION PERIODS[5]

B. Estimation Results: Baseline Model

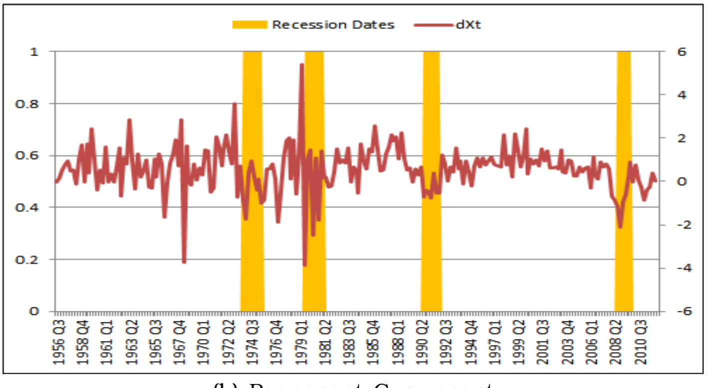
The baseline model has a decent fit to the data in terms of overall economic activity and support the presence of two distinctive phases in the UK business cycle. We only provide a graphical summary of the estimation results because our detailed results for the baseline model are not our main interest at this juncture.[6] In Panel (a) of Figure 2, the

[5] The two housing market series are the one-quarter lags of their year-on-year growth rates.

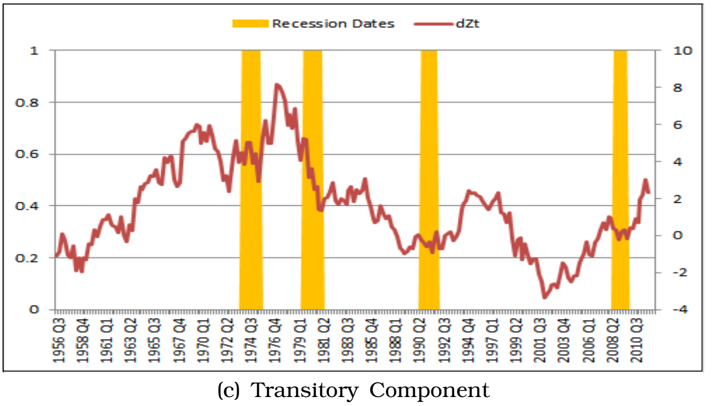
[6] The full estimation results for the baseline model are available from the authors upon request.



(a) Recession Probabilities



(b) Permanent Component



(c) Transitory Component

FIGURE 2

ESTIMATION RESULTS FOR THE BASELINE MODEL filtered estimates of the recession probabilities (solid line) are plotted against the recession periods (shaded). As can be seen, the recession probabilities increase substantially around the onset of recessions and decreases toward the end of recessions. Moreover, Panels (b) and (c) show that the recession periods are marked with or are proceeded by the declines in either of the two common components, except for the "false alarm" signaled by the permanent component in 1966:Q3. Hence, Figure 2 provides a reasonable description of the actual UK business cycle and exhibit sensible benchmark results for further analyzing the role of housing sector variables.

C. Estimation Results: Housing Variables in the Mean Equations

Having confirmed the decent fit of the baseline model, we examine the effects of the housing sector variables on the business cycle. Table 2 shows the key estimates of the baseline model and the four models of the first extension, which incorporate the housing market variables in the modified mean equations (10) to (12). The third and fourth columns of Table 2 report the estimates of the HP-M[1] and HQ-M[1] models, respectively, which employ the usual year-on-year growth in the housing sector variables. For the HP-M[1] model, we fail to find strong evidence in support of the importance of the past house price growth on the UK business cycle: although the estimated values of β on the house price growth are statistically significant for consumption and marginally so for output, the other estimates are very similar to those of the baseline model. These results imply that the role of house price growth on the business cycle is limited. The maximized likelihood values convey the same picture: the likelihood test statistic for the null of the baseline model is $2 \times (433.84 - 431.46) = 4.76$ with a p-value of 19 %, thus failing to support the HP-M[1] model as a better alternative to the baseline model. However, turning to the HQ-M[1] model reported in the fourth column, we note that the new housing constructions have significant effects on the business cycle, that is, the β coefficients are sharply estimated for output and consumption. The likelihood ratio statistics for the HQ-M[1] model have a p-value of 1.3, which rejects the baseline model at the 5% significance level and lower. Notably, unlike house price in the HP-M[1] model, the higher growth in housing starts yields a significantly lower estimate of p. As a result, the expected duration of the recession phase in the HQ-M[1] model is $1/(1\text{-}0.774) = 4.42$ quarters, in comparison to $1/(1\text{-}0.850) = 6.67$ quarters in the baseline model. This

TABLE 2
KEY ESTIMATES FOR THE EXTENDED MODELS (1)

Para-meters	Model				
	Baseline	Year-on-year growth		Asymmetric decrease	
		HP-M[1]	HQ-M[1]	HP-M[2]	HQ-M[2]
q	0.972 (0.015)*	0.967 (0.017)*	0.973 (0.008)*	0.983 (0.009)*	0.970 (0.005)*
p	0.850 (0.090)*	0.861 (0.071)*	0.774 (0.045)*	0.785 (0.016)*	0.802 (0.026)*
μ_0	0.835 (0.053)*	0.766 (0.060)*	0.817 (0.041)*	0.870 (0.054)*	0.873 (0.034)*
μ_1	-0.256 (0.234)	-0.071 (0.116)	-0.296 (0.172)	-0.265 (0.485)	-0.223 (0.149)
τ	-0.184 (0.263)	-0.241 (0.146)	-0.241 (0.146)	-0.581 (0.177)*	-0.105 (0.032)*
γ_2	1.053 (0.037)*	1.058 (0.040)*	1.046 (0.026)*	1.108 (0.041)*	1.054 (0.023)*
γ_3	1.143 (0.059)*	1.087 (0.106)*	1.098 (0.061)*	1.376 (0.066)*	1.454 (0.059)*
λ_2	1.035 (0.186)*	1.021 (0.222)*	0.946 (0.176)*	1.159 (0.219)*	1.158 (0.116)*
β_y	N/A	0.012 (0.005)*	0.009 (0.004)*	-0.065 (0.013)*	-0.009 (0.004)*
β_c	N/A	0.014 (0.005)*	0.004 (0.004)	-0.086 (0.014)*	-0.011 (0.005)*
β_i	N/A	0.025 (0.017)	0.037 (0.012)	-0.168 (0.027)*	-0.056 (0.010)*
Log-LKHD	-433.84	-431.46 [0.190]	-428.43 [0.013]	-420.79 [0.000]	-427.21 [0.004]

Note: Standard errors are in parentheses, and p-values are in square brackets. Here, "*" denotes significance at the 5% level.

result, in turn, implies that, the span of the recession phase would have been shorter by half a year on average had it not been for the historical fluctuations in the new housing starts. All in all, the results in Table 1 corroborate the claim of Leamer (2007), which highlights the importance of housing quantity variables but not house price.

For the results of the HP-M[2] and HQ-M[2] models, which employ the asymmetric decreases in the housing sector variables, the most conspicuous finding is that the asymmetric house price decreases in the HP-M[2] model have very significant effects on the business cycle. This means that all values of β are significantly estimated with correct ($-$) signs and considerable magnitudes, thus implying that the large asymmetric decreases in house price lead to slower subsequent growth in all three individual indicators. In particular, the largest effect of the house price decrease is on investment, followed by consumption and then output. The decreases in asymmetric house price also affect the transitory component of the business cycle. Once we account for the negative effects of asymmetric decreases in house prices on the macro indicators, the temporary pluck in the business cycle is now sharply estimated, unlike in the baseline and the HP-M[1] models. Reflecting all these results, the likelihood ratio statistic for the HP-M[2] model has a p-value of virtually 0, which clearly rejects the baseline model at any practical level of significance.

Meanwhile, for the HQ-M[2] model, we find that its likelihood value is far smaller than that of the HP-M[2] model, but the estimation results are qualitatively similar, that is, once the asymmetric decreases in new housing starts are accounted for, the growth rates of three macro indicators are lower than the opposite, and the temporary pluck in the business cycle is again sharply estimated. Although the formal comparison of the two models is more complicated and requires a Bayesian model selection approach, we can make a firsthand argument for the HP-M[2] model over the HQ-M[2] based on the large difference in their likelihood values and the corresponding p-values of the likelihood ratio statistics.

Thus, from the results in Table 2, we can draw the following interim conclusions on the role of the housing sector variables: i) the usual year-on-year growth in the housing price variable does not contain useful information regarding the UK business cycle; ii) in contrast, the growth in the housing quantity variable helps explain the business cycle beyond the three macro indicators; and iii) measured in terms of asymmetric decreases, house price significantly affects the evolution of the UK business cycle, probably more than the house quantity does in view of the maximized likelihood values.

D. Estimation Results: Housing Variables in the Transition Probabilities

Table 3 reports the key results for the second strand of extended models, in which the transition probabilities are dependent upon the housing sector variables. The performances of the HP-TP[1] and HQ-TP[1] models, which employ the usual year-on-year growth in the housing price and quantities, respectively, are shown in the third and fourth columns. For the HP-TP[1] model, we find some evidence that house price growth over the previous year affected the transition of the UK business cycle between the two phases. This means that, according to the significant estimate of 0.365 for q_1, if the economy is currently in expansion, higher house price growth in the previous period significantly raises the probability of a continued expansion (or equivalently, significantly lowers that of switching to a recession) in the next period. The importance of house price growth is also reflected in the likelihood ratio test statistic with a p-value of 0.034, which rejects the null of the baseline mode in favor of the HP-TP[1] model as an alternative. Thus, looking at the results for the HQ-TP[1] model, we obtain stronger support for the importance of housing quantity variables for the transitions between the business cycle phases. Specifically, the estimated coefficients q_1 and p_1 show that a higher growth in the new housing starts significantly raises the probability of back-to-back expansions and lowers the probability of back-to-back recessions. Furthermore, the likelihood ratio statistic rejects the null of the baseline in favor of the HQ-TP[1] model virtually at any level of significance. Therefore, the results for the HP-TP[1] and the HQ-TP[1] models support the notion that the housing quantity variable can serve as a better signal for the evolution of the business cycle: those in new housing starts affect which phases will prevail in the next period whether the economy is in expansion or recession, whereas the movements in housing price are useful mainly when the economy is currently in expansion.

We then move on to the results for the HP-TP[2] and HQ-TP[2] models, which employ the asymmetric decreases in the housing sector variables. The most conspicuous finding is that the fits of the two models are comparable to those of their counterparts estimated with the usual year-on-year growth in housing variables. For example, the HP-TP[1] and the HP-TP[2] models yield the estimates of q_1 with similar magnitudes (but with opposite signs) and virtually identical goodness-of-fit values (measured by the likelihood values). Likewise, the HQ-TP[1] and HQ-TP[2]

TABLE 3

KEY ESTIMATES FOR THE EXTENDED MODELS (2)

Para-meters	Model				
	Baseline	Year-on-year growth		Asymmetric decrease	
		HP-TP[1]	HQ-TP[1]	HP-TP[2]	HQ-TP[2]
q_0	3.562 (0.556)*	3.898 (0.202)*	4.351 (0.202)*	4.511 (0.322)*	5.461 (0.322)*
p_0	1.741 (0.705)*	-1.165 (1.206)	-0.933 (1.206)	1.302 (1.220)	-2.980 (1.220)
q_1	NA	0.365 (0.092)*	0.134 (0.092)*	-0.380 (0.112)*	-0.185 (0.112)*
p_1	NA	-0.194 (0.112)	-1.657 (0.112)	0.013 (0.089)	1.855 (0.089)
μ_0	0.835 (0.053)*	0.810 (0.042)*	0.839 (0.054)*	0.833 (0.049)*	0.836 (0.049)*
μ_1	-0.256 (0.234)	-0.355 (0.171)*	-0.165 (0.105)	-0.304 (0.195)	-0.1724 (0.195)
τ	-0.184 (0.263)	-0.002 (0.061)	-0.001 (0.023)	-0.023 (0.072)	-0.001 (0.072)
γ_2	1.053 (0.037)*	1.083 (0.057)*	1.081 (0.050)*	1.063 (0.046)*	1.082 (0.046)*
γ_3	1.143 (0.059)*	1.139 (0.065)*	1.137 (0.076)*	1.137 (0.065)*	1.139 (0.065)*
λ_3	1.035 (0.186)*	1.035 (0.174)*	1.039 (0.101)*	1.029 (0.174)*	1.041 (0.174)*
Log-LKHD	-433.84	-430.46 [0.034]	425.12 [0.000]	430.07 [0.032]	425.63 [0.000]

Note: Standard errors are in parentheses, and p-values are in square brackets. Here, "*" denotes significance at the 5% level.

models also yield qualitatively and quantitatively similar estimates of (q_1, p_1), and indistinguishable goodness-of-fit values. These results, in turn, imply that most of the useful information the housing sector variables provide for the upcoming business cycle phases are contained in their decreases rather than their increases. Another finding to note is that the goodness of fit of the HQ-TP[1] and HQ-TP[2] models, which employ the housing quantity variable, is better than those of their counterparts (*i.e.*, the HP-TP[1] and HP-TP[2] models), which employ the housing price variable in terms of maximized likelihood values and the additional significance of the estimated p_1 coefficients.

From the discussion of the results in Table 3, another set of interim conclusions can be drawn about the role of the housing sector variables: i) UK housing sector variables contain useful information regarding the switching in the business cycle phases; ii) housing quantity helps predict the upcoming business cycle phases better than housing price; and iii) for the price and the quantity variables alike, useful information is contained in their decreases not increases.

IV. Conclusion

This paper investigates the importance of the housing-business cycle relation in the UK. We address this issue by examining whether housing market variables contain additional information that can better explain the overall business cycles beyond what is done by a set of macro indicators. Our point of departure is to construct and estimate a baseline Markov-switching common factor model, which we extend by incorporating housing price and quantity variables. In the first extension, the growth rate of housing variables directly enters the mean equations of individual macro indicators. The second extension allows the housing variables to affect the transition probabilities between expansions and recessions.

The results for the first strand of extended models provide mixed support for the claim of Leamer (2007) who reported that although the usual hosing price growth does not contain useful information regarding the UK business cycle, that in the housing quantity variable helps explain the business cycle beyond the three macro indicators. However, if measured in terms of asymmetric decreases, the house price variable significantly affects the evolution of the UK business cycle, probably more than house quantity. For the second extension, the results provide stronger support for the role of housing quantity in governing the transitions between recession and expansion phases: the movements in the new housing starts provides useful information regarding the phase that will prevail in the next period regardless of the current phase, but those in housing quantity turn out to be useful in this regard only when the economy is currently in the expansion phase.

Strictly speaking, we do not aim to establish the causal relations between housing sector and economic activities. Nevertheless, we believe that our results are substantial, especially with regard to the significant role of asymmetric house price decreases are mainly associated with housing collateral or credit channels, as argued by Muellbauer and Murphy (2008). Furthermore, in view of the span of the data used, this asymmetric effect may well be observed when the housing price drops significantly, *i.e.*, a period of severe recession accompanied by a huge price drop similar to the recent Great Recession. We plan to extend the present paper towards identifying such causal relations in subsequent research.

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