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Forecasting the US housing market

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ABSTRACT

The recent housing market boom and bust in the United States illustrates that real estate returns are characterized by short-term positive serial correlation and long-term mean reversion to fundamental values. We develop an econometric model that includes these two components, but with weights that vary dynamically through time depending on recent forecasting performances. The smooth transition weighting mechanism can assign more weight to positive serial correlation in boom times, and more weight to reversal to fundamental values during downturns. We estimate the model with US national house price index data. In-sample, the switching mechanism significantly improves the fit of the model. In an out-of-sample forecasting assessment the model performs better than competing benchmark models.

1. Introduction

The bursting of the housing bubble in the US has often been mentioned as the factor triggering the financial crisis in 2007 and 2008. By lending to individuals with poor credit scores, the so called sub-prime market, financial institutions and investors in mortgage-backed securities were effectively speculating on ever-increasing house prices (Gorton, 2009).[1] The housing market may be more vulnerable than other markets to such inefficiencies and occasional crashes due to a lack of effective short selling mechanisms that prevent bearish investors from participating (Hong & Stein, 2003). Clearly, having an econometric model that can help to predict house price returns is of great importance.

The contribution of this paper is that we develop a smooth transition model for housing markets and estimate the model with data from the US national house price index (the Case–Shiller Index). Similar to a standard vector error correction model (VECM) model, the smooth transition model assumes that housing prices revert back to a fundamental value estimate in the long term. The fundamental value estimate is based on rental income. Further, the model has an autoregressive component for capturing the short-term positive serial correlation in real estate prices. The innovative part of the model is that we allow the weights assigned to the fundamental mean reversion and the autoregressive model part to vary dynamically, depending on the recent forecasting performance. This allows the model to give a higher weight to positive return autocorrelation during housing market booms, and to switch back to fundamental value based forecasts during the eventual bust.

We analyze both the in-sample and out-of-sample performances of the model for the US housing market over the period 1960–2012. In-sample, the smooth transition model has a significantly better fit than a static model with constant weights for the fundamental mean reversion and autoregressive model parts. Out-of-sample, we find that the smooth transition model has lower forecast errors than either a vector error correction model (VECM) or an ARIMA model. Additional tests show that the forecasts generated by the smooth transition model are more efficient and

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[1] Alternatively, it could have been based on expected increases in future labor income. For lenders in the sub-prime market, however, this is unlikely.

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contain more information than several benchmark models. Our findings illustrate that the model can be a useful forecasting tool for both housing market participants and policy makers. In addition to its relevance for understanding and predicting house price index returns, the model may also be of value for pricing futures written on the Case Shiller Index.[2]

Our work is related to several other empirical papers on house price dynamics. Case and Shiller (1989, 1990) provide evidence that the prices of single-family homes do not follow a random walk: year-to-year price changes are positively correlated, while the correlation is negative at higher lags. Case and Shiller (1990) also show that future house price changes can be predicted using rents and other lagged fundamental variables. This confirms the general mean reversion pattern of asset returns found by Cutler, Poterba, and Summers (1991) for stocks, bonds, exchange rates, and precious metals. Rapach and Strauss (2009) focus on the forecastability of house prices across US states, and find that autoregressive models perform relatively well for interior states but less so for coastal states. They interpret this as evidence of a disconnect between prices and fundamentals.

Capozza and Israelsen (2007) develop and estimate a model for the real estate market that captures both the short-term serial correlation and the long-term mean reversion property of housing markets. For a panel of real estate investment trusts (REIT), they estimate how the coefficients of serial correlation and mean reversion depend on REIT properties such as the size and leverage.[3] Our contribution is that we introduce the smooth transition dynamic weighting mechanism and show, both in-sample and out-of-sample, that this feature substantially improves the model's fit and its forecasting ability for the US housing market.

Our paper is also related to the recent literature on bubbles in real estate markets. Coleman, LaCour-Little, and Vandell (2008), Himmelberg, Mayer, and Sinai (2005), Mikhed and Zemčík (2009) and Nneji, Brooks, and Ward (2013a) test whether prices respond to changes in fundamentals and macroeconomic conditions. Nneji, Brooks, and Ward (2013b) and Roche (2001) estimate regime-switching models for the housing market using a bubble state and a crash state. Regime-switching can generate time-variation in the serial correlation and reversion to fundamental value, similar to our model. Nneji et al. (2013b) show that a regime switching model fits the US housing data used in this paper well. One main difference is that our model is not intended to test for bubbles in house prices, but rather to improve out-of-sample forecasts. Furthermore, the transitions between the two components in our model are smooth instead of discrete.

Our paper is also related to and inspired by the literature on heterogeneous agent models (Frankel & Froot, 1991). In recent years, Dieci and Westerhoff (2012), Malpezzi and Wachter (2005) and Sommervoll, Borgersen, and Wennemo (2010) have developed specialized heterogeneous agent models for the housing market. In these models, boundedly rational agents apply different rules for forming expectations about future housing returns. Typically, these rules are 'fundamentalist' and 'chartist', based on mean reversion and past price trends, respectively. Agents can switch between these rules depending on recent forecasting performances, similar to our smooth transition mechanism. However, these heterogeneous agent models have not been calibrated or estimated with housing market data, or used for out of sample forecasting.

2. A smooth transition model for the housing market

In this section we define our econometric model for explaining and predicting the price dynamics of the housing market. Our model exploits two well-known properties of real estate returns: short-term positive autocorrelation and long-term mean-reversion (see Capozza & Israelsen, 2007; and Case & Shiller, 1989, 1990). We assume that the log real house price P_t has a long-term equilibrium relationship with an estimate of the fundamental house value $F_t : P_t = \delta_0 + \delta_1 F_t$, where F_t is based on rental income. We can then explain short-term changes in the house price ($R_{t+1} = P_{t+1} - P_t$) using a standard vector error correction model (VECM):

$$R_{t+1} = c + \alpha(P_t - \delta_0 - \delta_1 F_t) + \sum_{l=1}^{L} \beta_l R_{t-l+1} + \varepsilon_{t+1}, \quad (1)$$

where P_t is the log of the real house price, the return R_{t+1} is defined as the log-price difference $P_{t+1} - P_t$, F_t is the log of the real fundamental value, $\alpha < 0$ is the mean reversion coefficient, and β_l are autoregressive coefficients (for $l = 1, 2, \ldots, L$). In Section 3, we describe in detail how we derive an estimate of the fundamental value based on rents, while in Section 4 we test for cointegration between P_t and F_t.

Inspired by empirical house price behaviors and the heterogeneous agent model literature (see Brock & Hommes, 1997, 1998), we now make several changes to the standard VECM model. Historically, housing markets appear to be prone to prolonged boom periods in which the prices of housing units rise far above fundamental value estimates based on rents, income, or other indicators. In these boom periods, markets appear to be driven mainly by price speculation based on the simple extrapolation rule that "house prices always go up". However, boom periods are inevitably followed by painful corrections, during which real house prices are pulled back down towards the fundamental value.

The boom-bust character of housing markets suggests that the weight of the autoregressive component in the VECM model, as well as the weight of the error correction component, may actually vary through time. A positive

[2] The standard no-arbitrage relationship to price futures does not hold in this case because the underlying house price index cannot be traded easily in the spot market, as it would involve buying and selling housing units in several regions of the US. Expectations of future house price returns therefore become paramount in valuing these futures.

[3] The effect on the model coefficients depends on the difference between a REIT's properties and the overall sample average. Capozza and Israelsen (2007) find that the serial correlation is stronger for larger, more focused and more levered REITs, while mean reversion is faster for more levered and more focused REITs.