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Dynamic asymmetries in house price cycles: A generalized smooth transition model

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ABSTRACT

In this paper we propose a novel nonlinear model to capture asymmetries in real estate cycles. The approach involves a particular parametrization of the transition function used in the transition equation of a smooth transition autoregressive model which improves the fit in the non-central probability region. The dynamic symmetry in house price cycles is strongly rejected for the housing markets taken into consideration. Further, our results show that the proposed model performs well in a out of sample forecasting exercise.

1. Introduction

Modelling the behavior of housing markets has always been an important issue for academics due to spillover effects on the whole economy. Accurate modelling of house prices is also crucial for policy makers interested in preventing unsustainable swings in the housing markets. However, modeling house price appreciation proved to be a challenging task due to the strong vulnerability of the housing markets to finance systems and market fundamentals.

A large body of literature shows that real estate cycles are closely related to business cycles. From the theoretical point of view, in the literature models used to describe housing market cycles fall within the demand-supply framework, where supply is assumed to be rigid. For example, Abraham and Hendershott (1996) describe an equilibrium price level to which the housing market tends to adjust. The authors divide the determinants of house price appreciation in two groups: one that

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explains changes in the equilibrium price and another that accounts for the adjustment mechanism in the equilibrium process. Slow adjustment toward the equilibrium can be regarded as an indication of asymmetries in real estate cycles. Muellbauer and Murphy (1997) explore the behaviour of house prices in the UK. The authors suggest that the presence of transaction costs associated with the housing market cause important nonlinearity in house price dynamics. Further, Holly et al. (2010) (see also Holly et al., 2011) extend the analysis to the spatiotemporal diffusion of shocks in the housing market. Using a model that takes into account spatial and temporal interactions the authors are able to investigate to which extent real house prices are driven by common shocks.

Another strand of the literature has related asymmetric cyclical movements of housing markets to house price bubbles. In their seminal paper Case and Shiller (1989) find that house prices are correlated, which suggests that residential property markets are inefficient. In a more recent work Case and Shiller (2003) consider house prices in relation to the fundamentals. The authors make a compelling case that house prices exhibit statistically significant short-term momentum and do not incorporate information about changes in the fundamentals.

The purpose of this paper is to seek empirical evidence of asymmetric behaviour in house prices cycles. To this end a novel regime-switching model is proposed in order to capture dynamic asymmetries in the housing market. Although almost all previous empirical work relating to house price modelling is based on linear specifications (see for example Abraham and Hendershott, 1996) the well established literature on cyclical behavior of macroeconomic variables suggests that the nonlinearity of house prices should stem from the asymmetric properties of house price determinants like GDP, interest rate or bank lending. There are a few available empirical works which corroborate this hypothesis; for example, Kim and Bhattacharya (2009) use smooth a transition autoregressive model (STAR) to test for nonlinearity in the regional hosing market in the United States. Balcilar et al. (2015) use a STAR-type model to forecast house price distributions. Nonlinear models are also used in Crawford and Fratantoni (2003) to forecast house price changes.

Regime-swiching models such as STAR allow the dynamic of house price growth rates to evolve according to a smooth transition between regimes that depends on the sign and magnitude of past realization of house price growth rates (see Chan and Tong (1986)). The low speed of transition between different regimes in house price growth found in empirical studies validate the choice of smooth transition models. A possible shortcoming of this type of nonlinear models is that a symmetric transition function is used to capture oscillations from the conditional mean of the changes in the house price series. Although STAR-type models efficiently describe nonlinearity in house price growth rates, the most commonly used transition functions may not be suitable to capture dynamic asymmetries in real estate cycles.

In this paper we address the following questions: Are contractions in house prices steeper than expansions, or does the amplitude of troughs in house prices exceeds that of peaks? From the methodological point of view the question is as follows: Is the rate of change in the left tail of the transition function of the STAR-type model different with respect to that of the right tail? And if so, how much? We argue that being the transition function adopted in STAR-type models generally symmetric, by construction, the resulting model may not be suitable to address the issues above. We believe that what economic literature has called “asymmetry” may be better reflected by a statistical model that uses a more general parametrization of the transition function. Accordingly, in this work it is suggested that a class of models indexed by two shape parameters be used to model dynamic asymmetry in house price cycles. By using shape parameters that influence the symmetry and heaviness of the tails of the fitted transition equation the proposed model may be more suitable to fit the non-central probability regions and therefore be better able to capture the asymmetries that are often found in empirical research. The suggested transition function, which is in the spirit of Stukel (1988), has two parameters governing the two tails of the sigmoid function in the nonlinear component of the model. The advantage of the proposed parameterization is that the resulting model is able to preserve smoothness of the transition function without requiring any restriction in the parameters. This feature may be appealing in empirical applications. Below we refer to the proposed model as generalized smooth transition autoregressive model (GSTAR).

Asymmetric behaviour over the business cycle has long been the object of interest in applied and theoretical research. It is therefore not surprising that several variations of the STAR model have been suggested in the literature. For example, Sollis et al. (1999) suggest to raise the transition function of the STAR to an exponential. Alternatively, Sollis et al. (1999) propose to add a parameter inside the transition function in order to control the asymmetry of both tails of the transition function. The suggested procedures successfully address the issue of dynamic asymmetry in several classical macroeconomic series. A possible shortcoming, however, is that the transition function suggested by Sollis et al. (2002) may be non-smooth. Also, the effect of increasing the asymmetry of the parameter may resolve to a shift of the transition function (see Zanetti Chini (2014) and Lundbergh and Teräsvirta (2006)).

Our results reveal several insights into the patterns of the housing markets under consideration. In particular, it is found that during boom periods house prices deviate from their mean at an exponential rate, whereas they return to the equilibrium level at a logarithmic rate. This implies that when improving economic conditions boost housing demand above the potential stock, prices rise rapidly above their expected level. On the other hand, house prices fall slowly when economic conditions worsen and changes in house prices are below the expected values. We then consider the forecasting properties of the GSTAR model by comparing the out of sample performance of the GSTAR with an autoregressive linear model. Using several performance criteria it is found that, overall, the proposed nonlinear model performs better than its symmetric counterpart.

The reminder of this paper proceeds as follows. In Section 2 the specification, estimation and testing of the proposed nonlinear model is presented. In Section 3 the empirical results are described. Section 4 offers some concluding remarks. In the Appendix the derivations for the misspecification tests used in Section 3 are reported.