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Housing dynamics: An urban approach

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ABSTRACT

A dynamic linear rational equilibrium model in the tradition of Alonso, Rosen and Roback is consistent with many outstanding stylized facts of housing markets. These include: (a) that the markets are local in nature; (b) that construction persistence is fully compatible with mean reversion in prices; and (c) that price changes are predictable. Calibration exercises to match moments of the real data have notable successes and failures. The volatility in local income processes as reflected in HMDA mortgage applicant data can account for much of the observed price and construction volatility, except for the most inelastically supplied local markets. The model's biggest failure lies in its inability to match the strong persistence in high frequency price changes from year to year.

1. Introduction

Can the dynamics of housing markets be explained by a dynamic, rational expectations version of the standard urban real estate models of Alonso (1964), Rosen (1979) and Roback (1982)? In this tradition, housing prices reflect a spatial equilibrium, where prices are determined by local wages and amenities so that local heterogeneity is natural. Our model extends the Alonso–Rosen–Roback framework by focusing on high frequency price dynamics and by incorporating endogenous housing supply.

An urban approach can potentially help address the fact that most variation in housing price changes is local, not national. Less than 8% of the variation in price levels and barely more than one-quarter of the variation in price changes across cities can be accounted for by national, year-specific fixed effects. Clearly, there is much local variation that cannot be accounted for by common macroeconomic variables such as interest rates or national income.

We focus not on the most recent boom and bust, which was extraordinary in many dimensions, but rather on long-term stylized facts about housing markets. One such fact is that price changes are predictable (Case and Shiller, 1989; Cutler et al., 1991). Depending upon the market and specific time period being examined, a \$1 increase in real constant quality house prices in one year is associated with a 60–80 cent increase the next year. However, a \$1 increase in local market prices over the past five years is associated with strong mean reversion over the next five year period. This raises the question of whether the high frequency momentum and low frequency mean reversion of price changes can be reconciled with a rational market.

Another outstanding feature of housing markets is that the strong mean reversion in price appreciation and strong persistence in housing unit growth across decades shown in Figs. 1 and 2 is at odds with simple demand-driven models in which prices and quantities move symmetrically. This raises the question of what else is needed to generate this pattern.

Third, price changes and construction levels are quite volatile in many markets. The range of standard deviations of three-year real changes in our sample of metropolitan area average house prices runs from about \$6500 in sunbelt markets to over \$30,000 in coastal markets. New construction within markets also can be volatile, with its standard deviation much higher in the sunbelt region. Can this volatility be the result of real shocks to housing markets or must it reflect bubbles or animal spirits?

Section 2 presents our model and its implications. Naturally, the urban approach predicts that housing markets are local, not national, in nature. Predictable housing price changes also are shown to be compatible with a no-arbitrage rational expectations equilibrium. Mean reversion over the medium and longer term results if construction does not respond immediately to shocks and if local income shocks themselves mean revert. High frequency positive serial correlation of housing prices results if there is enough positive serial correlation of labor demand or amenity shocks. Conceptually, a dynamic rational expectations urban model is at least

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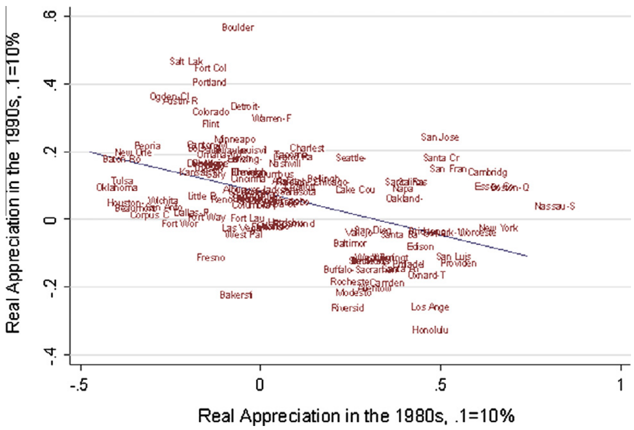

Fig. 1. Real house price appreciation in the 1980s and 1990s.

consistent with the outstanding features of housing markets, at least as they existed prior to the financial crisis.

However, our calibration exercises yield both successes and failures in trying to match key moments of the data. We are able to capture the extensive heterogeneity across different types of markets, especially in our contrast of coastal markets with high inelastic supply sides with interior markets with very elastic supplies of homes. Different shocks to the varying local income processes interact with very different supply side conditions to generate materially different housing market dynamics.

The model also does a reasonably good job of generating high variation in house price changes based on innovations in our proxy for local incomes, although we cannot match the extremely high volatility in house prices in the most variable coastal markets. The model also does a tolerably good job of matching the volatility of new construction, generating wide divergences across markets based on underlying supply elasticities. However, the model again cannot match the most volatile construction markets which are off the coasts.

With respect to the serial correlations of quantities and prices, the model gets the pattern, but not the magnitude, of the strong high-frequency persistence in construction. Our model correctly captures the weakening of that persistence over longer horizons, but still cannot replicate the mean reversion that is evident in the data over five-year periods. The model fails utterly at explaining the very strong, high frequency positive serial correlation in price changes. It does a better job at predicting mean reversion over longer five-year horizons, but still cannot precisely match the magnitude of that pattern, especially in coastal markets.

This suggests that the most important puzzle for housing economists to explain, apart from the most recent cycle, is the strong persistence in high frequency price changes from one year to the next. Persistence itself is not enough to reject a rational expectations model, but the mismatch between the data and model at annual frequencies indicates that Case and Shiller's (1989) conclusion regarding inefficiency could be right. Other issues deserving closer examination include whether there really is excess volatility in coastal markets and the nature of serial correlation in construction over longer time horizons.

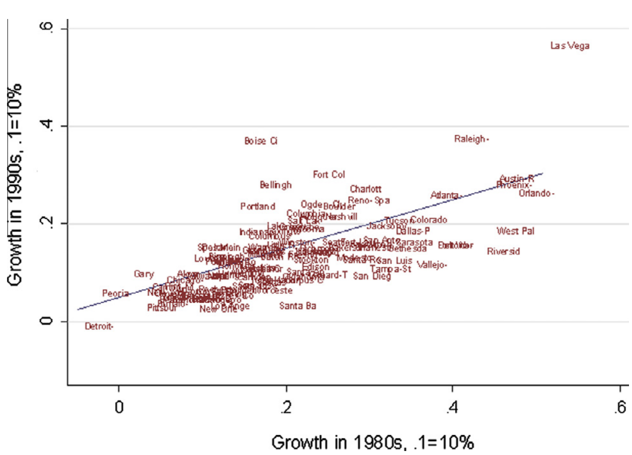

Fig. 2. Housing unit growth in the 1980s and 1990s.

2. A dynamic model of housing prices

2.1. Housing supply

Homebuilders are risk neutral firms that operate in a competitive market. Suppressing a subscript for individual markets for ease of exposition, the marginal cost to this industry of constructing a house at time t is given by

$$C + c_0 t + c_1 I_t + c_2 N_t,$$

where I_t is the amount of construction and N_t is the housing stock at time t. The c_0 term allows unit costs to trend over time. When $c_1 > 0$, the supply curve at time t is upward-sloping. The coefficient c_2 allows unit costs to depend on the city size, reflecting community opposition to development as density levels increase. We assume that $c_1 > c_2$ so that present construction has a larger effect on costs through the first effect. The supply parameters c_0, c_1, and c_2 can vary across metropolitan areas.

Housing is completely durable, and new supply is constrained to be non- negative:

$$I_t \geqslant 0.$$

Homebuilders also face a time to build. Housing constructed at time t cannot be sold until time $t+1$. Homebuilders also bear the costs of time t construction at time $t+1$. Perfect competition and risk-neutrality deliver the following supply condition:

$$E(H_{t+1}) = C + c_0 t + c_1 I_t + c_2 N_t \quad (1)$$

when $I_t > 0$, where H_{t+1} is the house price at time $t+1$. In equilibrium, the expected sales price of a house equals the marginal cost when homebuilders construct new houses.

2.2. Housing demand

Each person consumes exactly one unit of housing, so that N_t equals both the housing stock and the population. Consumer utility depends linearly on consumption and city-specific amenities:

$$U(\text{Consumption}_t, \text{Amenities}_t) = \text{Consumption}_t + \text{Amenities}_t.$$

Consumers are identical and face a city-specific labor demand curve of

$$\text{Wages}_t = W_t - \alpha_W N_t$$

at time t. Amenities also depend linearly on the population:

$$\text{Amenities}_t = A_t - \alpha_A N_t.$$

Consumers must own a house to access the city's labor market and amenities. We exclude rental contracts from the model to focus on the owner-occupancy market. Consumers are risk-neutral and can borrow and lend at an interest rate r. Their indirect utility is therefore