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The house price determination process: Rational expectations with a spatial context

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ABSTRACT

Applying the rational expectations hypothesis, this essay models the current value of a house as the conditional expectation of the discounted stream of housing services accruing to the owner of the house. The value of housing services is determined by neighborhood effects as well as the physical attributes of the property itself. In the existing hedonic literature, future transactions have not been utilized to describe neighborhood effects. The rational expectations asset pricing model in this study accounts for expected future neighborhood effects as well as observed current neighborhood effects. The reduced form of the rational expectations model is a spatial autoregressive (SAR) model with two spatial lags. After employing the generalized method of moments (GMM) in estimating the spatial asset pricing model, I find that both expected future transactions and prior transactions in the neighborhood are significant. The inclusion of expected future transaction prices in the neighborhood takes into account the influence of expected changes in the community and factors these potential changes into the current house price. This is consistent with forward-looking households. The forward-looking model generates superior out-of-sample prediction performance relative to both the conventional hedonic model without considering neighborhood effects or the standard spatial hedonic model including only past transactions.

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1. Introduction

Location, location, location. This is a common realtor mantra, indicating the most important determinant of the values of housing assets. The fixed geographic position of housing fundamentally distinguishes it from other assets. Unlike assets such as stocks, houses are attached to their spatial locations. A household's utility derived from living within a residence (the dividend of this particular housing asset), is significantly influenced by the quality of the neighborhood, including the public schools, the socioeconomic characteristics of the neighbors, the public facilities, the natural environment, the accessibilities, etc., which are all indivisible from where the property is located. Dividends derived from housing assets are thus inseparable from their surroundings – the neighborhood, whose effects are usually capitalized into the values of houses in the vicinity. Accordingly, house prices within a common locality tend to present close correlations. The spatial interdependence of house prices in a neighborhood governs the house price determination process.

In the hedonic literature, there has been a marked increase in studies highlighting concerns about the spatial interdependence of residential prices. The spatial correlation of house prices has been addressed in the hedonic analysis through two approaches: the lattice model, and the geostatistical model.[1]

[1] The essential distinction between these two perspectives is that the lattice model explicitly expresses the neighborhood influence in the functional form using a predetermined spatial weight matrix, while the geostatistical model allows the spatial interdependence to reside in the residuals and it estimates the parameterized variance–covariance matrix together with other coefficients in the regression function to improve the efficiency of those estimates.

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Following the lattice modeling approach, Can (1992) appears to be the first to systematically test the spatial dependence of house prices in the context of the hedonic pricing models. She verified the existence of spatial correlation using Lagrange Multiplier (LM) tests and demonstrated that the spatial models are superior to the mainstream hedonic models in explaining residential prices. Can and Megbolugbe (1997) extended the spatial hedonic model in Can's previous study, and explicitly estimated the impact of prior sales on the transaction price of a house using a spatial lag functional form.[2] Along the same line, Pace and Gilley (1997), and Pace et al. (1998) adopted the lattice modeling methodology, but with a slightly different approach by ascribing the spatial correlation to the residuals of a hedonic function and estimating the spatial dependence existing between the disturbance terms.[3]

Dubin (1992 and 1998), Dubin et al. (1999), as well as Basu and Thibodeau (1998) adopted the geostatistical technique of Kriging that relies upon an estimated variance–covariance matrix to generate the coefficient estimates using estimated generalized least squares (EGLS) estimation method.[4]

Both of the geostatistical models and the lattice models are effective in handling the spatial correlations among observations, though, they have different focal points. The former mainly focuses on correlation in the disturbance terms; while the latter emphasizes directly estimating the extent of spatial dependence (i.e., the mean effect) as well as disturbance correlation. As the purpose of this research is to measure how the price of a residential unit depends on the neighborhood effects, the method applied here is more in line with lattice models.[5] Rather than adopting the hedonic framework, I approach the spatial dependence in housing market through the rational expectations hypothesis.[6]

In this study, housing units are treated as assets that generate dividends across time periods, and the dividend of a housing asset at a given time can be interpreted as the value of housing services that accrue to the owner of the house through that time period. Because houses do not exist in isolation, neighborhood effects should play an important role in determining the value of the housing services received by the owner. Hence, housing dividends present spatial dependence in a vicinty. The neighborhood effects addressed in this study refer to both types of neighborhood effects classified by Can (1992): (1) "absolute neighborhood effects", representing the impacts of the absolute location of the house associated with an array of community characteristics, such as public services provision, accessibility, and natural environment, and (2) "adjacency effects" or "neighborhood spillover effects", externalities spatially associated with the behavior of neighbors, such as maintenance/repair decisions made by neighbors, on a nearby household's total utility.[7] Compared with type (1) neighborhood effects, which are easily perceived and widely illustrated in the literature, type (2) neighborhood effects appear to be less obvious but still substaintial. For example, a household who lives next to a property that has an inviting appearance with a well manicured lawn, an attractive garden and tidy exterior tends to enjoy a higher utility than a household who lives next to a run-down property, ceteris paribus. In other words, a well maintained residence provides services not only to the owner but also to the neighbors nearby through a positive externality flow. Both types of neighborhood effects are not easy to be directly observed by econometricians,[8] whereas they should be capitalized into house values and reflected by the market prices of houses in the neighborhood. Spatially interdependent housing dividends therefore results in spatially dependent house values. The information conveyed by a price change in neighboring houses reveals a change in either neighborhood quality (i.e., absolute neighborhood effects), or add-on spillovers (i.e., the adjacency effects), which in turn changes the value of accrued housing services.[9] Because the value of a house, as an asset, is determined by not only the current dividend, but also the expected future dividends, a house's current price is thus governed by the expected future values of nearby houses as well as the contemporaneous values of nearby houses.

Although the concurrent neighborhood effects are well-recognized and factored into a house's price through the inclusion of prior sales in the neighborhood, the expected

[2] Can and Megbolugbe (1997) used a spatial autoregression (SAR) model as $Y = \lambda WY + X\beta + u$, where Y is the house price, WY denotes the weighted average of house prices in the neighborhood, X represents other exogenous variables explaining house prices, and u is assumed to be independent and identically distributed.

[3] Their models are also called spatial error (SER) model, which has a funcitonal form as $Y = X\beta + u, u = \rho\ Wu + \varepsilon$. In the SER model, the error term u is no longer i.i.d., but assumed to be spatially dependently on the weighted average of nearby us.

[4] The estimation of the variance–covariance matrix involves the computation of an empirical variogram/semivariogram. From the empirical variogram/semivariogram, the parameters of a fitted variogram/semivariogram function can be estimated. Kiefer (2007) applied a spherical semivariogram function to form school district price indices within Franklin County, OH.

[5] Ideally, the measure of "neighborhood effect" should reflect all houses in the given neighborhood. Due to the fact that not every house is on the market (the proxy used to quantify neighborhood effect) during a given time period, only houses with valid transaction prices are represented in terms of "neighbors".

[6] The assumption of rational expectations implies that households make optimal forecasts given the information and they know the true structure of economy and true behavioral relationships, i.e., they know how economy works. They make forecasts as statisticians do. This assumption provides the rules to households in forming forecasts. For the estimation purpose, the rational expectations hypothesis also allows a reduced functional form to be derived from the structural model.

[7] Can reserves the use of "neighborhood effects" for type (1) effects. This paper uses "neighborhood effects" as a more general term, which is interchangeable with "locational effects" including both type (1) effects and type (2) effects.

[8] Although the first type of absolute neighborhood effects can be captured by corresponding community variables measuring the quality of a neighborhood or community dummies, no agreement has been reached in the literature on the selection of appropriate variables. Moreover, even for a set of carefully selected community variables or community dummies, measure error is likely to occur.

[9] The model here assumes away the possibility that nearby homes may be over-priced or under-priced due to buyer's mistake or manipulating the transaction record. An increase in the price of a nearby house indicates a higher utility delivered to the given household.