Regional Science and Urban Economics 54 (2015) 74–86

Contents lists available at ScienceDirect

Regional Science and Urban Economics

journal homepage: www.elsevier.com/locate/regec

The hedonic model and the housing cycle☆

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ARTICLE INFO

Article history:
Received 13 March 2015
Received in revised form 21 June 2015
Accepted 17 July 2015
Available online 1 August 2015

Keywords:
Hedonic model
Housing cycle
Hedonic coefficients

ABSTRACT

The hedonic house price model is a significant workhorse when it comes to estimating the value of local public goods such as school quality and crime, and locational amenities such as job accessibility. Given Rosen's (1974) result that hedonic coefficients can be interpreted as the marginal willingness to pay (MWTP) for the good, the hedonic model can be used to calculate the benefits of policies based on improving school performance or public safety. One of the key assumptions for this interpretation of the hedonic coefficients as MWTP is that the market is in equilibrium. The recent turbulence in the U.S. housing market has led many researchers to question the interpretation of the hedonic coefficients. Putting periods of significant market instability aside, housing markets go through cycles just as the economy does. One might expect, then, that hedonic coefficients will also vary over the housing cycle.

A house price hedonic for the Greater Boston Area is estimated using transactions data over a long time period, 1987–2012, that covers multiple cycles with peaks in 1988 and 2005. The impacts of standardized test scores, crime rates, and job accessibility on house prices are estimated on an annual basis. Surprisingly, there is evidence that these estimates exhibit a counter-cyclical variation with the largest impacts occurring during the recent downturn. This can be explained by changes in the composition of buyers over the housing cycle.

1. Introduction

The hedonic house price model has become a significant workhorse when it comes to estimating the coefficients for local amenities such as public goods (school quality and crime) and locational amenities such as job accessibility (collectively referred to as local public goods). When it comes to evaluating policies based on improving school performance or improving public safety, researchers have often relied on hedonic estimates to calculate the benefits of such policies.

An important motivation for using the hedonic model to evaluate policies that involve local public goods is Rosen's (1974) result that hedonic coefficients can be interpreted as the marginal willingness to pay (MWTP) for the good. This means that coefficient estimates for local public goods can be used to measure the benefits of these goods. One of the key assumptions underlying Rosen's result is that the market is in equilibrium. The recent turbulence in the U.S. housing market has led many researchers to question the interpretation of the hedonic coefficients.[1]

Putting periods of significant market instability aside, housing markets go through cycles just as the economy does. One might expect, then, that hedonic coefficients will also vary over the housing cycle, potentially being largest in magnitude at the peak when demand and hence willingness to pay (WTP) is high and smallest in magnitude at the trough when demand and hence WTP is low.

To get an idea of how much variation in hedonic coefficients one might expect over the housing cycle, a house price hedonic for the Greater Boston Area is estimated in this study using transactions data over a long time period: 1987–2012. This time period covers multiple cycles with peaks in 1988 and 2005 and troughs in 1991 and 2012.

The local public goods that are included in the model are state-administered standardized test scores, crime rates, and an index of job accessibility. The hedonic coefficients for these local amenities are estimated on an annual basis to investigate how they vary over the housing cycle. Contrary to the hypothesis that the hedonic coefficients will be

☆ The author would like to thank the MIT Center for Real Estate, the Warren Group, and CORELOGIC for providing the housing data and Kathy Kiel, two referees, and participants at the North American Regional Science Conference and the January meeting of the Weimer School of Advanced Studies in Real estate and Land Economics for their useful comments.

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[1] For example, this was the topic at a panel at the Association of Environmental and Resource Economists Summer Conference in 2012 entitled "Valuation in a Bubble: Hedonic Modeling Pre- and Post-Housing Market Collapse." There was a general belief that hedonic coefficients should be referred to as "implicit prices" rather than as MWTP, particularly when the market experiences significant instability (Boyle et al, 2012).

http://dx.doi.org/10.1016/j.regsciurbeco.2015.07.005
0166-0462/

largest in magnitude at the peak of the housing cycle, the results show that the coefficient estimates are largest during the recent downturn.

As a comparison, similar results for three structural characteristics are provided: lot size, living space, and bathrooms. The price impacts for these variables exhibit consistent trends and do not appear to be affected by the housing cycle.

The annual price impacts for the local public goods are significantly related to housing transaction volume. This is an indication that the number of buyers and hence the type of buyer in the market can change over the housing cycle. As such, the marginal buyer will vary and hence the hedonic coefficient estimates, which reflect MWTP, will also change over time. This can explain the counter-intuitive result that the hedonic coefficient estimates for the local public goods are actually largest during the recent recession.

One recommendation from this study is that results for the hedonic coefficients using data over a complete housing cycle are likely to give estimates of the MWTP for local public goods that are most representative of the population as a whole. This is particularly true for policymakers who are using the hedonic results to measure the benefits associated with policies related to local public goods. The evidence shows that using data from the recent housing market downturn can be problematic and the results from the 1987–2005 housing cycle are preferred (versus the 1996–2012 period). Furthermore, applying data over the housing cycle allows for the effective use of fixed effects that mitigate omitted variables bias due to unobserved neighborhood quality.

Section 2 surveys the relevant literature. Section 3 provides details about the data. Section 4 develops the standard hedonic model and discusses the use of fixed effects to control for unobserved neighborhood quality. The results are given in Section 5 and the results are discussed and conclusions are drawn in Section 6.

2. Literature survey

There is little prior evidence on the impact of the housing cycle on hedonic coefficients. One prominent study is conducted by Smith and Huang (1995) who carry out a meta-analysis of 86 hedonic estimates of implicit prices for reductions in total suspended particulates (TSP). They regress these estimates on a number of city, hedonic model, and data characteristics. They include as city indicators, TSP level, real income, and the housing vacancy rate. Real income has a positive effect and the vacancy rate has a negative impact. These results are consistent with the conjecture that MWTP is larger in magnitude when the market is booming and smaller in a down market (vacancies are higher when the market is down). Finally the TSP level has a negative coefficient estimate. While one would expect that the MWTP to reduce TSP would be higher at higher levels of TSP (lower levels of air quality), the negative coefficient could indicate that higher TSP levels are proxying for other city-wide factors that affect the demand for air quality (other than real income). It could also signify residential sorting whereby households with greater preferences for clean air sort into cities with lower air pollution levels.[2]

Another factor that can affect coefficient estimates is the composition of buyers/sellers in the market. Krainer (2001) develops a model to explain hot and cold markets where the former are characterized by high prices and volume and the latter are characterized by low prices and volume. Krainer shows that in a hot market, sellers are able to (and want to) sell houses quickly, thus prices and volume are high. Novy-Marx (2009) notes that buyer entry is induced when markets are hot because the value of entry increases. This raises prices and volume even more, exacerbating the values of these fundamentals. Of course, the opposite happens in cold markets. To the extent that hedonic coefficients depend on house prices, one would expect to see significant variation across hot and cold markets

Chernobai and Chernobai (2013) categorize buyers into long- and short-term buyers, and housing units into low- and high-quality units. They note that short-term buyers are more likely to buy low-quality units than long-term buyers because the costs of attaching themselves to the low quality unit are lower. This generates a form of selection bias in that lower quality units are more likely to transact since they are more likely to be sold and purchased by short-term buyers.

Combining the results from the Krainer (2001) and Novy-Marx (2009) papers on the one hand and those from Chernobai and Chernobai (2013) on the other hand allows for a conjecture about selection bias in hot and cold markets. First, one can think of high-/low-quality units as those with higher/lower levels of local public goods. Then it follows that since long-term buyers prefer high-quality units, they have a higher MWTP for local public goods. Second, it follows that hot markets, with higher levels of transactions, have a relatively higher proportion of short-term buyers as sellers are able to sell houses quickly which appeals to these buyers. Then cold markets, with lower levels of transactions, have a relatively higher proportion of long-term buyers as houses are sold at a slower pace. This reflects sellers' reluctance to lower prices in down markets (e.g. sellers are subject to "loss aversion" as they are not (psychologically) willing to sell their houses for less than they paid for them (Genesove and Mayer, 2001)). Then the hedonic coefficients can actually be larger (in magnitude) in cold markets (than in hot markets) since the marginal buyer is more reflective of long-term buyers with higher MWTP. The result is a counter-cyclical relationship between market conditions and the estimated MWTP for local public goods.

3. Data

The transaction data include single-family home sales in the Greater Boston Area for 1987–2012. The data are from the Warren Group for 1987–1994 and CoreLogic for 1995–2012 and cover towns in Bristol, Essex, Middlesex, Norfolk, Plymouth, and Suffolk Counties.[3]

Sales that were not standard market transactions such as foreclosures, bankruptcies, land court sales, and intra-family sales are excluded. Furthermore, for each year, the bottom and top 1% of sales prices are excluded to guard against non-arms-length sales and transcription errors. The data include typical house characteristics: age, living space, lot size, the number of bathrooms, bedrooms, and total rooms. The sample is limited to units with at least one bedroom and bathroom, 3 total rooms and 500 square feet of living space and no more than 10 bedrooms and 10 bathrooms, 25 total rooms, 8000 square feet of living space, and 10 acres.

The second transaction is excluded for properties that sold twice within 6 months (similar to Case/Shiller) and for properties with two sales in the same calendar year with the same transaction price (likely duplicate records). Properties for which consecutive transactions occurred in the same year or in consecutive years and where the transaction price changed (in absolute value) by more than 100% are excluded. Similarly, properties where consecutive transactions were in year t and $t + j$ and where the transaction price changed (in absolute value) by more than j00% were excluded for $j = 2,\ldots,12$.

32 towns with less than 100 total observations are dropped and 36 census tracts with less than 10 observations are excluded leaving a total of 145 towns, 630 census tracts, and 369,859 observations in the data set.

The test score data used for this analysis come from the Massachusetts Department of Education (MADOE). Starting in 1988, the Massachusetts Educational Assessment Program (MEAP) was administered every other year until 1996. Mathematics and reading exams were given

[2] See Chay and Greenstone (2005) for a test of residential sorting by preference for air quality.

[3] The city of Boston is not included since it is not in the data that was provided by the Warren Group.