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Hedonic estimation of housing demand elasticity with a markup over marginal costs ☆

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ABSTRACT

We show that recent developments in hedonic pricing theory allow modeling of the equilibrium pricing function as the marginal cost of an additional housing unit plus a markup that varies inversely with the elasticity of demand. Useful information about demand elasticity at a given point on the envelope function can be recovered from the hedonic regression and limited information on marginal costs. In particular, the elasticity of the envelope with respect to any characteristic such as interior area provides information on the elasticity of demand. Relative price elasticities (i.e., elasticities that vary from a base value in a known way with interior area, unit type or neighborhood characteristics) can be computed from the elasticity of the hedonic envelope. Like Yinger (2010), our method is based on a single hedonic equation.

We test our method using sales of new high rise condominiums in two districts within Shenzhen, China: Futian and Longgang. The results strongly confirm the main hypothesis of this paper: price elasticity with respect to size is increasing for more complex types of units. Together with estimates of marginal costs of production, these results imply that relative demand elasticity is declining for larger, more complex units.

1. Introduction

It is well established that monopolistic competition implies that firms obtain a markup over the marginal cost of production and that the markup decreases with the absolute value of the price elasticity of demand (Henderson and Quandt, 1980).[1] Recent literature has extended this result to hedonic equilibrium (Pakes, 2003). Moreover, the hedonic model has been extended to allow different pairings between supply and demand at each of several discrete points along the hedonic function (Ekeland et al., 2004; Bajari and Benkard, 2005). These developments allow

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[1] Standard textbook treatments point out that this does not imply inefficiency: price (higher than marginal cost) equals average total cost. The gap between price and marginal cost provides payment to resources such as land (location) and scarce permissions to build that give rise to the monopolistic market structure. Note that the value of land is a residual in urban economic theory and that monopolistic competition for renters is assumed.

modeling of disparate demand and supply equilibria with a single hedonic function in a single submarket.[2]

This paper shows that these seemingly unrelated facts allow estimation of the *relative* price elasticity of demand for a unit of housing[3] from the hedonic function and limited information on the functional form of marginal cost. In other words, this paper develops the logical relation between the elasticity of the hedonic envelope and the price elasticity of demand. Relative price elasticities are calculated for each hedonic bundle relative to a numeraire bundle.

We show that high-rise condominium construction within a given neighborhood provides one case where our hedonic elasticity method can be applied without extensive knowledge about marginal costs. In this case, the land component of an additional square meter of interior area is approximately fixed for a unit of a given type, and construction cost is approximately linear in size, so the functional form of marginal costs is known with reasonable accuracy. The developer can be modeled as supplying units of various sizes and types on a given land area so as to maximize profit from the limited number of households in each demand segment. In our model, demand is segmented by size and type of unit. We show that relative demand elasticities for units of different types and sizes can be estimated from the hedonic function.

The intuition behind our analysis is that developers allocate limited floor area to large and small units depending on their expectations about the willingness and ability of each demand segment to pay. For example, the demand for large or luxurious units may be less elastic than that for small units. Our key insight is that the equilibrium hedonic envelope function – e.g., the elasticity of predicted hedonic price with respect to unit size – provides information about the price elasticity of demand for the hedonic bundle. Empirically, we derive a method for estimating the direction, degree, and statistical significance of changes in the price elasticity of demand as a function of hedonic characteristics.

We present a new database for Shenzhen China, part of the rapidly growing Guangzhou conurbation near Hong Kong.[4] Our data are a very rich and complete representation of free market transactions of ownership units in high-rise buildings (i.e., condominiums) between August 2004 and January 2006. Many of the sales are presales: i.e., sold before the buildings are completed. Thus, we take our results as an approximation to the market for new housing. These condominium sales and construction costs allow us to estimate relative price elasticities of demand for buyers in housing markets both inside and outside Shenzhen's special economic zone (SEZ). We find that relative demand elasticity is declining for the larger, more complex units.

Useful summaries of the American and European literatures are found in Zabel (2004), Ermisch et al. (1996), Mayo (1981), and Hanushek and Quigley (1980). One strand of the literature estimates price elasticity for housing services as a bundle, including structural, neighborhood and location attributes. Several papers have established the importance of allowing price elasticity parameters to differ across market segments, such as structure and land (Ioannides and Zabel, 2008; Zabel, 2004); income, tenure and location (Garcia and Hernandez, 2008); by demographic group (Ermisch et al., 1996); by degree of neighborhood choice (Ihlanfeldt, 2007); for movers (Bajari and Kahn, 2005); and stayers (Goodman, 2003).[5]

Our investigation of hedonic equilibrium pairings between demand and supply provides a new approach linking demand for a bundle of characteristics (units of housing or of housing services) to market segments associated with these bundles sold in each of two Shenzhen neighborhoods, and the marginal costs of these bundles. This context allows us to develop a model that associates market segments with price elasticity of demand. Like Yinger's (2010), ours is a single equation method; multiple market data are not required. Yinger's model is based on household types sorting by steepness of their bid functions. At each point along the hedonic envelope, willingness to pay is allowed to change. Our model is similar in that each point on the envelope is an equilibrium with a possibly different household type. We allow households to differ by elasticity of demand for units whereas Yinger estimates demand elasticities for separate services and amenities such as safety, school quality or distance from an environmental hazard. Our method is based on the assumption of monopolistic competition whereas Yinger's is based on constant elasticity of demand utility functions. We allow supply, as represented by marginal cost, to differ at each point on the envelope, as required by hedonic equilibrium.[6]

The next section discusses the relevance of Shenzhen in Chinese economic and housing development. Section 3 develops the role of equilibrium hedonic pricing theory in identifying the relative price elasticity of housing demand. Section 4 proposes a functional form for the hedonic regression. Section 5 presents the data and empirical results. Section 6 compares our estimates of demand elasticity to those contained in the previous literature. Section 7 concludes.

2. Housing in Shenzhen and China as a whole

Shenzhen is an important engine of Chinese economic development, with population growth of roughly 15% per

[2] Rosen's (1974) framework encourages thinking about a single utility function shifted continuously by a taste parameter or by income. Recent research points out that Rosen's model requires only that the demand and supply sides pair off along a non-decreasing pricing function for a desirable characteristic. Pairings can occur at discretely limited points, which pool disparate sources of demand.

[3] Zabel (2004) and Ioannides and Zabel (2008) distinguish between the price elasticity for structure and for land. They point out that these elasticity quantities may differ, depending on whether structure and neighborhood are complements or substitutes. Similarly, Brasington and Hite (2005) evaluate the relations between environmental quality and house size.

[4] Data source: *Shenzhen Land and Real Estate Exchange Centre*.

[5] These papers join a large strand of the literature estimating price elasticity for environmental quality and neighborhood amenities such as school quality. For recent examples, see Brasington and Hite (2005) and Yinger (2010).

[6] Basic hedonic theory requires that each point on the envelope represent an equilibrium pairing between supply and demand (See Rosen, 1974; Ekeland et al., 2004).