

Hedonic Price Model-Based Real Estate Appraisal

Subjects: **Economics**

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Hedonic price model-based real estate appraisal is used for evaluating the value of real estate by using multiple regression function models based on the hedonic price theory.

real estate appraisal

hedonic price model

big data

machine learning

1. Introduction

The word "hedonic", which means pleasant, is derived from the Greek word "hedonikos". In economics, it refers to the utility or satisfaction brought by goods or services to consumers.

Residential products have the characteristics of durability and spatial fixation, and are heterogeneous commodities [1]. There are obvious differences among products in the characteristics that constitute the use value [1]. The hedonic price model (HPM) focuses on the impact of property characteristics on its price, including location, housing structure and neighborhood factors. Therefore, the HPM is well suitable for real estate appraisal.

2. Theoretical Framework

The HPM was first proposed by Court in 1939 [2]. Since being introduced by Rosen (1974) to the residential market, it has developed to one of the most widely used models in the real estate industry [3]. The theoretical foundation underpinning HPM predominantly comprises Lancaster's preference theory and Rosen's market supply and demand equilibrium model [4]. Lancaster (1966) argued that product demand is based on a product's characteristics rather than on itself, and that goods are sold as collections of intrinsic characteristics [5]. Therefore, products cannot only be represented by a total price, but a series of prices should be used to reflect the quality of the product or the features it contains, which we call hedonic price [1]. Rosen (1974) established the market supply and demand equilibrium model based on hedonic theory, a theory that helps to value the characteristics of differentiated products [6]. According to Rosen's theory, we can use econometric methods to separate the implied price of product features and analyze the demand for product features [6]. Since the characteristic price corresponding to residential characteristics cannot be obtained directly, it is necessary to collect information on residential characteristics and market transaction data to build a functional model [3]. Following an understanding of this, the regression relationship between price and asset-related attributes can successfully be established. Economic theory, however, does not clearly reveal how the functional form of such price regression should be

chosen [7]. Consequently, researchers have attempted to use various functional forms to explore optimal solutions. Several basic functional forms such as linear, semi-log and log-log forms have been applied to the HPM [8].

3. Recent Developments

The traditional HPM is based on the ordinary least squares (OLS) linear regression [9]. With advancements in computer technology and the increasing application of such advancements in the real estate industry, scholars are no longer satisfied with linear hedonic pricing models (which are neither stable or accurate) [9][10][11][12]. Additionally, the hedonic theory assumes all essential characteristics are considered in the hedonic equation, which is seldom fulfilled due to limited data availability. Therefore, in the new era, technical improvements include: (1) With the development of big data and related technology, scholars are able to obtain residential characteristics that are difficult to obtain, extract and accurately quantify in traditional valuation processes (e.g., the combination of point of interest (POI) data and geographic information system (GIS) analysis technology can accurately quantify the neighborhood characteristics of the properties [13]; some researchers have used deep neural network model to quantify the visual impression of properties [14]), which will undoubtedly make the results more convincing. (2) Multiple linear regression has disadvantages such as its inability to solve the collinearity of parameters, its insufficient consideration of the spatiality of housing price data, its sensitivity to noise, and it can also easily fall into over-fitting and have poor-fitting accuracy [15][16]. The HPM in the new era has attracted and integrated the advanced theoretical achievements of many disciplines and is continually improving and innovating based on actual demand. At present, researchers are predominantly adopting new algorithms to replace the kernel-least squares regression of the traditional HPM, and the new algorithm kernel can bring significant improvements to model stability and prediction accuracy. For example, specific improvements include: Long et al. (2009) used the spatial lag and spatial error model to examine the housing prices in Beijing, China, and obtained higher accuracy than the OLS model [17]. Ma et al. (2020) regarded house price prediction as a classification problem of interval prediction and used the deep forest (DF) model to predict housing rent and prices in the United States [18]. In recent years, extensive studies have shown that machine learning (ML) models based on hedonic price theory have higher accuracy than traditional models [9][19][20]. Although ML models are black box models and have the disadvantage of low interpretability, they are still the future of automated valuation models (AVMs). Because they can move AVMs from low-risk valuations with sufficient comparables towards more complex valuations for all property types [21]. Additionally, with rapid developments in related research, some researchers have begun to compare various advanced models toward determining the conditions for their optimal application [10].

4. The advantages of HPM in real estate appraisal

Compared with the three most widely used traditional methods in real estate appraisal (i.e., the cost, market and income methods), the HPM has the advantages of flexible modeling and it is intuitive in terms of the economic significance of variables. It also makes it easy to observe the impact of increasing and decreasing variables in the modeling process. In the era of big data, a large number of housing price transaction cases have consistently led to an urgent need for data processing and analysis capabilities. This makes the HPM, with its strong multi-parameter

processing capability more favorable among scholars [14][22][23][24]. Additionally, mass appraisal is based on real estate appraisal theory, relying on computer technology and using pre-established appraisal models to evaluate multiple real estates at one time, which is an important direction of the real estate appraisal industry. It is also a choice for many scholars to use hedonic price method to construct the model of mass appraisal, and has achieved good results [9][12][25].

5. Empirical Issues

On the other hand, the real estate appraisal based on HPM is most favored by scholars, but the complexity of use and some inherent defects limit its application in practice. Specific factors include: (1) As mentioned above, the theory of hedonic pricing does not clearly reveal how the proper functional form should be chosen; (2) hedonic price studies don't pay enough attention to market segmentation, but it is an important empirical issue; (3) the misspecification of variables will lead to inefficient or biased and inconsistent estimated coefficients [8].

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