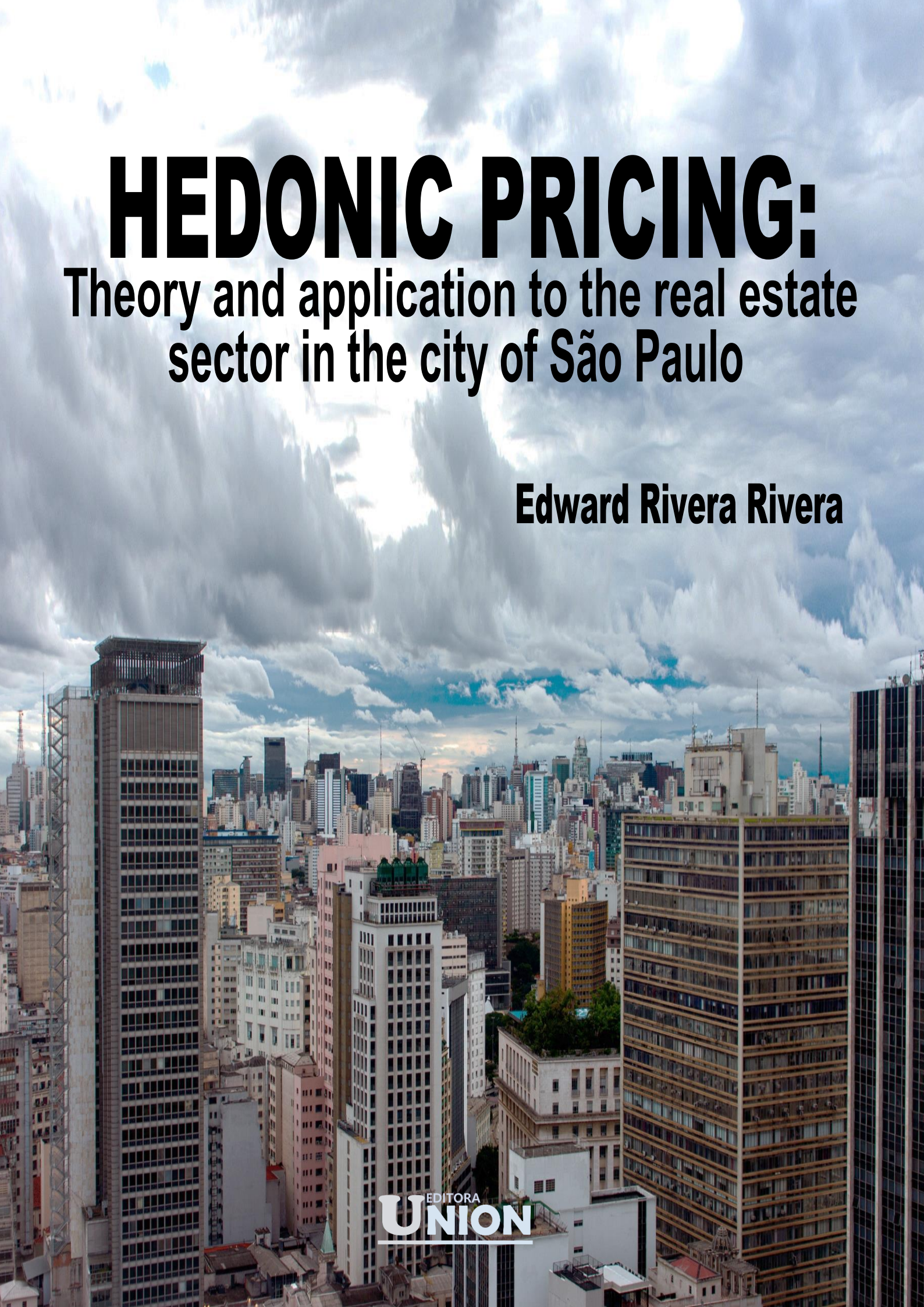
HEDONIC PRICING:

Theory and application to the real estate sector in the city of São Paulo

Edward Rivera Rivera



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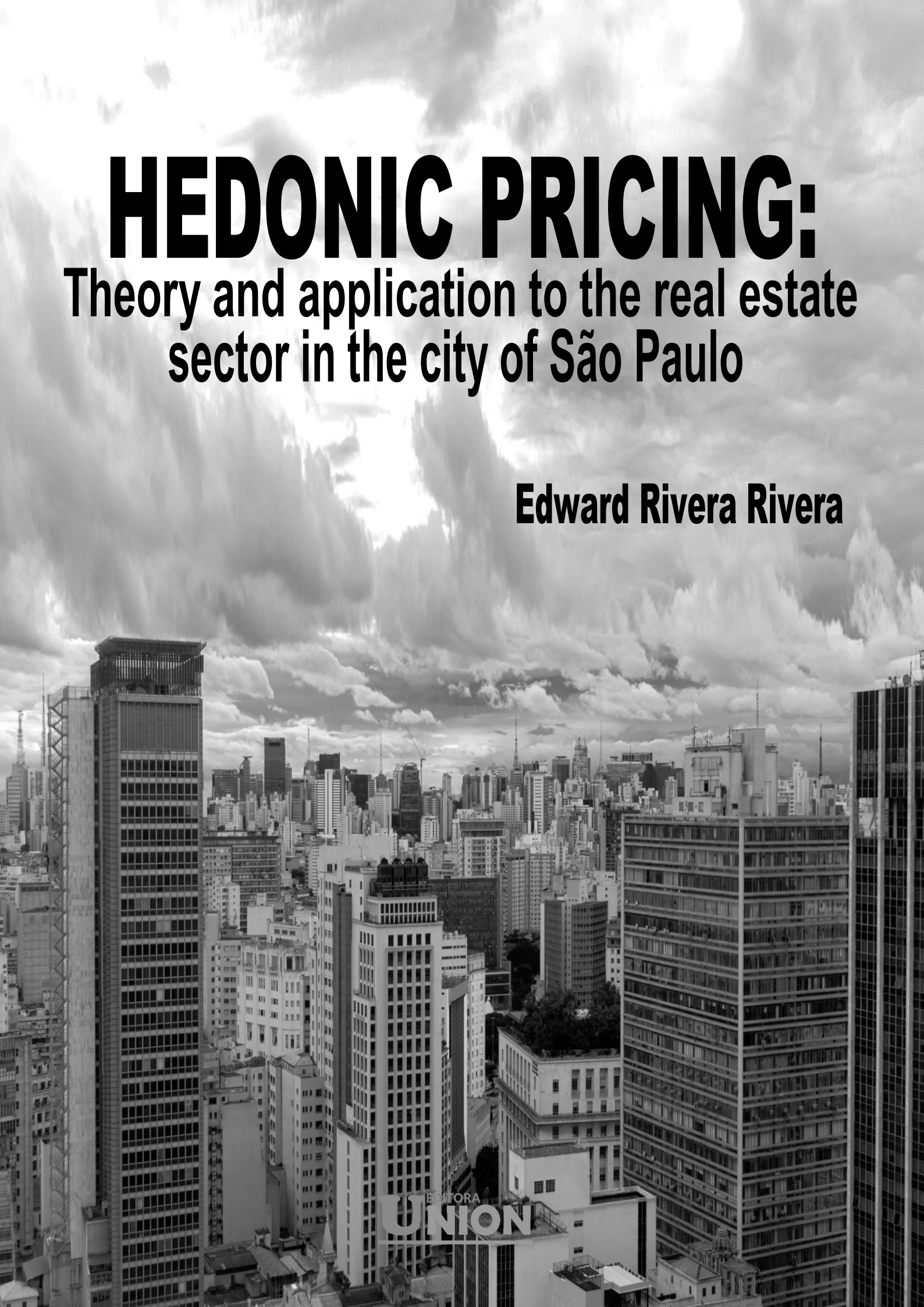

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HEDONIC PRICING: THEORY AND APPLICATION TO THE REAL ESTATE SECTOR IN THE CITY OF SAO PAULO

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This book is based on my Monograph developed for the Bachelor's Degree in Economic Sciences with the objective of systematizing the initial study of Hedonic Prices. To carry out this project, I took into consideration the theme for further studies both at undergraduate and graduate levels.

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To my mother, for her patience, incentive, trust and affection along my path. For teaching me to walk with confidence and dedication.

ABSTRACT

One of the existing problems concerning the traditional economic theory is explaining price behavior without considering quality differences among the same type of goods. Among the various recent technical contributions underlying this issue is the hedonic price theory. The purpose of this work is threefold. Firstly, to present the hedonic price theory intuitively through classical empirical works. Secondly, to discuss the hedonic method usefulness as well as its limitations. Finally, to estimate a hedonic price econometric model for the real state sector of the economy in the Great São Paulo Metropolitan Area (RMSP) in order to identify intrinsic characteristics that value and devalue residential buildings in the RMSP as well as the possible reasons and explanations for verified tendencies. The results bring useful information about marginal prices that can be useful for both the private and public sectors in Brazil.

Keywords: hedonic prices; marginal prices; real estate economics.
JEL Classification: C31**;** C33; R21.

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CHAPTER I

INTRODUCTION

One of the problems of traditional economic theory is that it explains the behavior of prices without considering possible differences in quality within a set of goods. Thus, the theory of relative prices is based on the signaling of relative scarcity of homogeneous (identical) goods in the market without considering the basket of characteristics of a set of goods as proposed and conducted in this book.

Quality differences within a group of goods are understood as specific attributes of a good that differentiate it from its close substitutes. The idea of close substitute comes in opposition to the definition of homogeneous goods, which are perfect substitute goods, adopted as a basic assumption, for example, in perfect competition models. However, this supposition is simplistic for empirical analysis.

Among the many recent theoretical contributions dealing with the problem of quality differences between substitute goods, one of them is the theory of hedonic pricing that contrasts differences in characteristics affecting the prices of goods.

Hedonic pricing models are those in which the characteristics of goods are considered to explain their prices. They date back in the 20th century, precisely in the late 1930s. Before the development of specific theories related to the subject, Andrew T. Court (1939) was the pioneer in this type of analysis, when GM financed his work aiming to prevent the U.S. government from controlling the prices charged by the company supposedly to stabilize production and unemployment levels.

Contrary to the U.S. Bureau of Labor Statistics (BLS), according to which the GM brand price index had risen 45% in the period 1925-1935, Court (1939) used a single equation procedure – corresponding to the first stage of the model proposed by Rosen (1974) – that allows the more precise analysis that considers how much each underlying characteristic influences the final price of the vehicle, concluding that, in fact, the prices of GM brand cars had decreased 55% throughout that period.

Court's (1939) procedure to assess implicit prices of goods was called the Hedonic Price Method, inspired by utilitarian philosophers who promoted hedonistic thinking based on the pursuit of pleasure, defining hedonic price comparisons as "those which recognizes the potential contribution of any good – from a car engine, for example – to the welfare and happiness they can provide for their customers".

Hedonic pricing theory, attributed to authors Lancaster (1966) and Rosen (1974), considers different attributes or basket of characteristics of a good in its price formation process. Although empirical application of hedonic pricing models had occurred before, the models were devoid of well-defined theoretical support. According to Sartoris (1996), the empirical applications became popular after the works of Griliches (1961), which inspired many other empirical works in different markets, both for durable and non-durable goods, such as automobiles and breakfast cereals.

In the real estate sector of the economy, the technique is used to solve problems associated with searching for a heterogeneous good such as housing or office prices. Thus, a hedonic price regression equation deals with each attribute separately, estimating monetary values for each assessed characteristic.

In addition to estimating the representativity that each characteristic of a good exerts on the final price of the product, the hedonic method can be used to compare the prices of real estate (or any other product) in different locations, or to perform time series analysis. Thus, the hedonic technique is also used in the calculation of consumer price indexes (such as the Consumer Price Index - CPI) to correct for price changes that occur exclusively due to quality changes.

The initial objective of this paper is to study hedonic pricing theory in a systematic way and its limitations on empirical work. As a specific objective, the hedonic price assessment is conducted in the real estate sector of the economy of Great São Paulo Metropolitan Area (RMSP) in order to investigate the effects of different underlying characteristics in the price formation of residential buildings.

This paper will be divided into four sections in addition to this introduction. First, the theoretical framework of hedonic prices is presented, based on classic works such as Rosen (1974), Murray and Sarantis (1999), and Stanley and Tschirhart (1991), as well as national empirical works, explaining the utilities and limitations inherent in the application of the hedonic pricing technique. Next, sample data are presented for residential real estate of RMSP and the econometric model with analyses of coefficients related to attributes. Finally, the last section is reserved for conclusions.

CHAPTER II

1. THEORETICAL FRAMEWORK

1.1 GENERAL APPROACH TO THE HEDONIC METHOD

One of the authors of the works that eliminated the lapse of the absence of a theory behind the empirical application of Hedonic Pricing was Rosen (1974). This author defines hedonic prices as implicit prices of utility-bearing attributes that are revealed to economic agents through the observed prices of differentiated products and the specific quantities of characteristics associated with them.

Rosen's (1974) theory of hedonic prices consists of a spatial equilibrium economics problem, $p(x) = p(x_1, x_2, x_n)$ which is derived from jointly observing the variation in prices of products and their various baskets of characteristics. Applied hedonic prices are found in different industries, such as real estate and automobiles.

The proposal of hedonic price indexes is to model the demand for a good in terms of a small number of intrinsic characteristics to assess the value of each attribute, rather than a large number of similar goods. Therefore, it becomes possible to identify key determinants in consumer behavior through the hedonic price index.

According to Rosen (1974), in traditional economic theory, the utility function has goods as arguments, which is equivalent to saying that the consumer derives utility directly from these. In the hedonic pricing approach, the consumer acquires the goods seeking utility through the characteristics of which these goods are composed.

Rosen (1974) applies the hedonic pricing method in a market context, being the most important connection between theory and empirical method in pricing goods according to their different attributes. Hedonic pricing theory is developed as a problem in spatial equilibrium economics in which the set of implicit prices guides the locational decisions of both consumers and producers in the space of characteristics.

1.2 Technical Literature Review

Following Rosen (1974), in hedonic price theory, any location in the plane is represented by a vector of coordinates $z = (z_1, z_2, \dots, z_k)$, where z represents the good in question and k, the different characteristics contained in this good.

The function that relates the price of the purchased good to its characteristics is expressed by $p = f(z_1, z_2, \dots, z_k)$. Therefore, $p(z)$ is the set of hedonic prices that guide the locational decisions of consumers and producers with respect to the different baskets of product characteristics bought and sold.

A linear model of hedonic prices can be expressed as follows:

(1) $$p = \beta_0 + \sum_{k=1}^{K} \beta_k z_k$$

where $$\frac{\partial p}{\partial z_k} = \beta_k$$

Thus, p represents the price of the good; z_k represents the basket of characteristics of this good x; and β_k, the marginal or implicit value of the *k*-th characteristic of the good z in analysis, indicating how much of the price p of a given good varies if it is, *ceteris paribus*, endowed with an additional quantity of z_k attributes.

One paper in which hedonic price theory is applied is that of Murray and Sarantis (1999). The authors analyze the price-quality relationship for cars in the United Kingdom, where the main objective is to employ a more complete data set compared to Griliches' (1961) work on the characteristics of cars in the UK to examine changes in market prices of different models during the first four months of 1977 through the last four months of 1991 in a series of cross-sectional regressions using the least squares method. A second objective is to use the estimates from the hedonic pricing model to construct hedonic price indices for cars, which allows the investigation of car price increases due to quality or non-quality related factors.

Murray and Sarantis (1999) assume the existence of an implicit market for each car feature Q_j and that each of these implicit markets tends to an equilibrium price. Thus, each feature of cars will have a price equal to the marginal value of this feature to consumers. Consequently, the price of a new car (P_i), whereby i represents the *i*-th car registered in a given period, can be considered the sum of the expenditure on the features contained in such a vehicle. The expenditure on the *i*-th feature is the product of the quantity of that feature ($Q_{j,i}$) by the marginal value or implicit price of such a characteristic (α). Thus, the price of the car is given by the equation:

(2) $$P_i = \alpha_0 + \alpha_1 Q_{1,i} + \alpha_2 Q_{2,i} + \cdots + \alpha_j Q_{j,i}$$

The characteristics used by Murray and Sarantis (1999) are: comfort, durability, economy, maneuverability, performance, safety, and luxury.

Comparing estimated coefficients of each variable with expectations, Murray and Sarantis (1999) identify some surprising results. The estimated coefficient of comfort was significant at a 5% level in all periods, having a positive sign as expected. Although the size of the coefficient varied considerably throughout the observed period, it is shown to be on an upward trend, reflecting efforts of manufacturers to increase interior space of vehicles for drivers and passengers.

However, Murray and Sarantis (1999) note that the durability coefficients produced mixed results. For the authors, this must be the result of the changing relationship between each variable and durability, or possibly the influence of some other factor. To achieve greater fuel efficiency, manufacturers have invested heavily in engine engineering to reduce engine wear. According to the authors, this should reflect in the durability coefficient representing rpm (revolutions per minute), making an engine that produces maximum power at a higher rpm desirable today.

Murray and Sarantis (1999) analyze that implicit prices for fuel economy indicate the British public placed less value on such economy during the periods from the third quarter of 1980 to the last quarter of 1981, and during the second quarter of 1986 to the first quarter of 1988, while peaks in implicit prices were in the second quarter of 1979, the last quarter of 1984, and the first quarter of 1990.

Murray and Sarantis (1999) observe that the coefficient representing maneuverability is significant in 80% of the periods and shows the expected positive effect on car prices but exhibits considerable variability over time. The value of maneuverability during the late 1970s is lower, while a higher value was assigned to this characteristic during the 1980s and 1990s. The reasoning is that this coincided with the introduction of mini cars in the late 1970s and early 1980s. Once small, one of their main design goals is for them to be easy to handle in congested urban areas.

The performance of the car was represented by the force-weight ratio of the vehicle. The coefficient is positive and significant as expected by Murray and Sarantis (1999). It is found that the implied value of performance had consistently dropped since the early 1980s, which is possibly due to the drop in oil prices from this date.

Murray and Sarantis (1999) analyze that the estimated coefficient of safety does not behave as expected. It has the opposite sign in all cases and is insignificant in 35 out of 60 periods, with the value below unity in 30% of the periods. This

unexpected and insignificant performance of the variable may be due to the fact that the form of measurement (braking distance) is not satisfactory for measuring safety. Impact bars and the hardness of the vehicle's roof could be better parameters to measure it. However, data for such measurements were not available.

According to Murray and Sarantis (1999), the variable luxury was a count of luxury attributes that were fitted as standard to the vehicles. As expected, the variable had a positive effect in all periods. The implicit price of luxury is shown to be fairly stable over the periods studied, except for a small decline in the period 1986-88.

In their conclusion, Murray and Sarantis (1999) observe that the use of price indexes that do not consider changes in quality can produce misleading information about the movement in the price level of goods that are not homogeneous across time and differ in their characteristics. In the case of cars, the inaccuracy from the traditional price index is clearly significant, since considerable price increases in the car market are caused almost entirely by changes in the qualities of the cars purchased.

Murray and Sarantis (1999) state that price differences among car models can be explained by variations in individual car characteristics, with comfort, luxury items, handling, economy, and performance having the greatest influence. On the other hand, durability and safety tended to show negative signs and are insignificant in most periods. Murray and Sarantis (1999) point out that implicit prices of car features vary considerably over time, probably reflecting changes in consumer preferences.

Since the work of Griliches (1961) on changes in automobile quality using hedonic price indices, several other studies have been developed that estimate hedonic prices for characteristics of durable goods. However, non-durable goods can also be defined by their inherent characteristics and assessed by a hedonic model. Depending on the good, the estimation of implicit prices provides useful information about consumer preferences, the structure of the market in which the product is sold, pricing policies, and the use of information by agents in the industry.

Stanley and Tschirhart (1991) also apply the hedonic technique to estimate implicit prices for breakfast cereal characteristics. The authors chose cereals as it is relatively easy to gather information on their characteristics in the market, either through experience, advertising, or labels. The results provide information about manufacturer and marketer pricing policies, additional values consumers pay for the convenience of cereals, and consumer reaction to nutritional information on the package – the latter being particularly important to the issue of disclosure policies.

To motivate empirical work, Stanley and Tschirhart (1991) modified Rosen's (1974) original theory by assuming that consumers derive utility from the "services" breakfast cereal characteristics provide (*s*) and from a composite good X. Then, the utility is represented by the function $U(s_1, \dots, s_m, X)$. Examples of services cited by the authors include the taste and nutrition of cereals. The authors consider $z = (z_1, \dots, z_n)$ to be the vector of characteristics and $s_h(z_1, \dots, z_n)$ the service $h,\ h = 1, \dots, m$.

An important feature is that a characteristic can enter positively into one service and negatively into another. For example, the sugar characteristic can increase the taste service and decrease the nutrition service. Utility maximization shows that the marginal implicit price of a characteristic measures the value of an additional unit of the characteristic relative to the dollar addition of other goods. Since there are characteristics, z_k, that enter positively into one service function and negatively into another, the implicit marginal price of z_k can be positive during an interval of z_k and negative in another. As in classical hedonic theory, the implied marginal prices represent an envelope of consumers' utility functions and firms' supply functions.

Stanley and Tschirhart (1991) collected data from four large supermarkets to observe differences in the hedonic price function, suggesting that stores set prices based on the preferences of the consumers they serve. For example, marginal willingness to pay for an attribute should vary across different income levels.

Prices and information on product characteristics were collected by Stanley and Tschirhart (1991) for all cereals found in each store. For a cereal found in different sizes, then each size would represent a different observation. The dependent variable is price per serving (PPS). The characteristics comprising the set of independent variables were chosen based on the information presented on each package. Each characteristic contributes to one or more of the three services considered positively related to the utility of consumers: nutrition, taste, and convenience.

Stanley and Tschirhart (1991) note that the coefficient relating to vitamin is positive and highly significant across all the stores surveyed and that consumers pay more for cereals made from oats as well as for more "puffy" cereals. It is also noted that the coefficients on preservatives and sodium are insignificant across all the stores surveyed, and that the coefficient on sucrose is positive and significant – which is in contrast to research indicating that many consumers consider salt, sugar and preservatives unhealthy. However, the significant and positive coefficients confirm data

from the 1990 U.S.D.A. Food Consumption Survey that indicated that Americans were consuming sweets at higher levels than at any time during that century.

According to Stanley and Tschirhart (1991), a generally accepted idea is that providing consumers with information about the products they buy increases market efficiency. However, providing information is not cheap, which prevents an optimal quantity or quality of the information disclosed for decision making.

Information, whether mandatory or voluntary, is useful only if consumers collect and actually use such information that is made available. However, consumers' reaction to information is often misinterpreted. The results of this work can be used to better observe whether consumers read information printed on cereal boxes.

Stanley and Tschirhart (1991) conclude that hedonic techniques are a practical method of measuring consumer reaction to revealed information when researchers collect market price information along with the characteristics of the good over various time periods to assess the implicit prices of the characteristics about which information is revealed. Combining this information with knowledge of consumer preferences reveals whether or not the information is actually being used.

1.3 Other Applications of the Hedonic Method

In the field of public goods, Brookshire et al. (1982) empirically measure the demand value of public goods, presenting a literature review on the use of this technique in public goods. Brookshire et al. (1982) conclude that the hedonic technique is the best known and most accepted method when it is assumed that either wages or property values reflect spatial variations in the characteristics of public goods in different communities. Among public goods and externalities assessed using the hedonic pricing technique are climate, air pollution, social infrastructure, and other community characteristics such as noise level and ethnic composition.

However, Brookshire et al. (1982) propose a technique of obtaining information directly from households or individuals about their willingness to pay for public goods for cases where statistical information limitations exist.

An example would be the situation of a beautiful landscape, valued by a group of agents that is threatened by air pollution from a possible coal plant installation. As much as it is possible to impute the value of clean air and visibility of the landscape that might follow the plant installation, information about the value of visibility is needed

prior to construction in order to execute a socially optimal decision about the location of this plant and pollution control equipment. Thus, the hedonic method is not available in such case, because the scarcity of local population prior to the installation of the company makes the use of data on wage or property value impossible.

In international literature, the hedonic technique is also applied in health goods market. As an example, Cutler et al. (1999) estimated price indexes for the treatment of heart attacks. This article presents two alternative price indexes: the Service Price Index (SIP), which prices the specific treatments offered, and a Cost-of-Living Index (COL), which prices the health outcomes of patients, to determine how much of the improvement in health results from medical treatments in comparison with other factors. The paper concludes that a quality-corrected service price index showed a smaller increase than traditional indices. Thus, according to Cutler et al. (1999), detailed illustrations of medical price indexes suggest that, at least for the case of heart attacks, medical prices are not increasing much, and might even be declining.

Cutler et al. (1999) note that the U.S. Bureau of Labor Statistics (BLS) had recently been improving its measure of quality in health care prices. Recently revised methods attempted to include quality adjustments by asking hospitals to report major changes in indicated conditions of care. According to these authors, the rapid technological advance and the spread of health care require the development of cost-of-living indices considering quality changes, as was done in this work.

In the computer field, Berndt and Rappaport (2001) examine the stability of hedonic price parameters for desktop and mobile personal computers over the years 1976-1999, as well as the equity of hedonic price parameters between desktops and cell phones. The three characteristics on which the authors focus are hard disk, processor speed, and the amount of RAM. Other variables were also added, such as the existence or not of a CD-ROM drive, as well as the brand. Among results obtained, it can be seen that from the year 1987 onwards the coefficient estimates differ significantly between desktop and cell phone models. Adjusted for changes in quality, PC prices declined dramatically, and these declines accelerated in the 1990s.

1.4 Empirical Studies in Brazil

Among the empirical works in Brazil, there is the study by Oliveira (1997) that sought to specifically measure the value of atmospheric air quality related to

housing activity. It is explained that the market price of a property should depend on its qualities, since these attributes affect both its production cost and the price that consumers are willing to pay for it. If the value of real estate is affected by its qualities, whether inherent or external, it can then be said that people are willing to pay for them, and it is possible to estimate the price of these attributes through statistical techniques.

Oliveira (1997) then sought to present a theoretical model that provides the basis for the application of the hedonic pricing method that does not differ from that of Rosen (1974). Thus, the theoretical model of hedonic prices was employed in the evaluation of the benefits caused by an eventual reduction in air pollution in the region of the city of São Paulo. This empirical study sought to estimate the hedonic function for residential properties in São Paulo; to estimate the demand functions compensated by the characteristic "air pollution"; and to perform simulations of consumer surplus gains in case of improved weather conditions in different regions of the city.

The residential property was considered as a package of characteristics, which were divided into three groups: intrinsic, environmental and locational characteristics. The intrinsic characteristics are those that can be effectively produced by the supplier, such as the built area and the number of rooms and parking spaces. The environmental characteristics are those that depend on the conditions of the region where the property is located, such as access to transportation, green areas, and crime. Finally, the locational characteristics are not directly related to the region where the property is located but to the way this region is related to other regions in the city, such as distance and access time to work and leisure centers.

To estimate the hedonic function for the value of residential real estate launched in the city of São Paulo, Oliveira (1997) employed the ordinary least squares method and considered the real estate price in US dollars as the dependent variable. Initially, four functional forms were considered: linear, logarithmic, semi logarithmic, and exponential. It was then justified by a possible bias that the average property in the sample studied did not seem to be effectively the representative property. Although it was not possible to precisely determine the consumer surplus function regarding air pollution, there is strong evidence that it is affected and that the benefits of an improvement in air quality on the housing activity would not be negligible.

Pereira (2004) also applies the hedonic price index developed by Lancaster to the restaurant market in São Paulo, whose innovation consisted in using the clientele that frequents the restaurant as an attribute of the restaurant itself. The main objective

of Pereira (2004) was to measure the interpersonal influence among college students who are consumers at restaurants in the city of São Paulo, applying the hedonic price index method. His secondary objective was to contribute to the development of a marketing theory that explains how interpersonal influence occurs among consumers. The sample universe used was the population of college students from the main Administration and Marketing courses in the city of São Paulo.

For the first research hypothesis, Pereira (2004) concluded that there are ways to measure interpersonal influence in the sample. The application of this statistical technique enabled the recognition of three distinct conglomerates. In all these consumer segments, the importance of some characteristic of the public that frequents the restaurant was detected. This conclusion is based on the composition of the calculated factors. Three factors have been detected in which the importance of the public is made explicit: "Frequenters", "Social Group"; and "Entertainment".

From these factors, the three conglomerates used in the analysis were calculated: "Pecuniary Emulators", "Good Gourmets", and "Aristocrats". The first conglomerate apparently indicates a group of people who intend to go to places different from those where people of their social group normally go; the second represents individuals who wish to enjoy a good meal, regardless of the appearance of the place, the existence of famous people in the restaurant, location or price; the third, are those whose main purpose is to meet people with whom they share some familiarity and, therefore, are probably part of the same social class. Thus, in each of these segments, the importance of each factor is distinct. That is, each type of consumer evaluates in a different way the public that goes to a restaurant.

In the sample surveyed, people from the Emulators conglomerate try to go to places where consumers from the Aristocrats conglomerate are, but the latter prefer to go to places where they find people who belong to the same social group. Due to informational asymmetry, it becomes a cycle. People from the Good Gourmets conglomerate are only interested in knowing how crowded the restaurant is, but without being overly concerned about the type of audience, although they give preference to people from the same social group. Thus, as different niches affect one another, it is possible to include clients that go to the restaurants as attributes themselves.

However, in relation to the second hypothesis formulated stating that the approach of attributes presented by Lancaster assists in the further development of marketing theory, the answer of Pereira's (2004) thesis is inconclusive despite the possibility of assisting in the explanation of the phenomenon of fashion cycles.

Applied to the real estate industry, there is the study by Sartoris (1996) whose objective was to estimate a market model for residential real estate for the city of São Paulo. In particular, the model to be estimated referred to the launching market, that is, real estate launched between 1994 and 1995 in the city of São Paulo, where the inherent characteristics of the same were considered for price formation, such as the number of bedrooms, bathrooms, garages, floor area, and total area.

The model built by Sartoris (1996) was set within a context of market equilibrium, involving the estimation of the supply and demand equation and focusing on the supply and demand of two characteristics: floor area and total property area. The characteristics included were mostly given by common sense, considering, among other attributes, the area of the property itself and the area actually built; the quality of the construction; intrinsic characteristics such as the number of bedrooms, bathrooms and garages; in addition to income, location and availability of public services.

Regarding the estimation of the hedonic equation – Rosen's first stage – the results were as expected with a high explanatory power. In the inclusion of the price function as a function of attributes within a market context – Rosen's second stage – variables that influence consumers' decision have been included (such as income and variables related to availability of public services) as well as a variable that influences supply – population density – taken as a measure of difficulty to build, since, supposedly, densely populated regions have fewer spaces available.

Thus, in the work of Sartoris (1996), the supply and demand equations for floor area proved to be infinitely elastic; the demand equation for total area presented the expected signs, while the respective supply equation showed greater influence of the floor area than on total area itself. In relation to services, only the variables related to security and health presented significant coefficients, but the coefficient related to public health presented the opposite sign to the expected one, raising the suspicion that it is actually measuring some other aspect, such as the standard of living, which, when high, would be associated with a greater presence of private health.

Income and population density had significant coefficients with the expected sign, positive in both cases, and the other component variables of the vector of

characteristics, that is, number of bedrooms, bathrooms, garages, elevators, floors and total land area were also significant. On the other hand, the sewage and slum variables proved to be insignificant. According to Sartoris (1999), no significance is due to the fact that most properties in the sample were located in districts with an incidence of slums and tenements, as well as residences with precarious access to sewage.

1.5 Utilities and Limitations of the Hedonic Method

Once analyzed the theory of hedonic pricing and its application in international and Brazilian empirical works, it is cited that the estimated coefficients can bring enlightening information about marginal prices, being useful for analysis of price policy, consumer preferences, use of information, and labeling.

It has been noted the analysis of the UK car market by Murray and Sarantis (1999), whose conclusion from the analysis of the hedonic pricing model was that price variation was due primarily to differences in quality related to comfort, luxury items, handling, economy, and performance. Also cited is the work on cereals by Stanley and Tschirhart (1991), where there was a positive and significant result of the coefficient of sucrose, indicating that consumers might not be reading the information printed on cereal boxes, since, according to the research, consumers considered salt, sugar, and preservatives harmful to health. A negative coefficient was therefore expected.

Thus, hedonic techniques prove to be a practical method of measuring consumer reaction to published information, provided that researchers combine information about market prices and the characteristics of the good over several time periods in order to analyze the implicit prices of the characteristics whose information is relevant. The combination of this information, along with knowledge about consumer preferences, can reveal whether or not the available information is used.

However, the coefficients can also assume inconsistent signs due to the fact that the form of measurement is not satisfactory to measure what is desired, as in the case of the braking distance as a measure of safety in cars in the work of Murray and Sarantis (1999) and in the case of the thesis of Sartoris (1996) whose coefficient on public health presented a sign opposite to that expected, raising the suspicion that it was actually measuring some other aspect such as the standard of living which, when high, would be associated with a greater presence of private health.

Inconsistencies may occur due to changes in the relationship of the analyzed variable and the other exogenous variables in the model, as observed in the analysis of marginal prices related to the durability of cars by Murray and Sarantis (1999). There is also the possibility of the influence of other factors that are not captured by the model, such as changes in consumption habits and peculiarities inherent to each type of good within a basket of similar goods, besides the possible unavailability of information to develop a consistent hedonic pricing model.

Besides data availability and market limitations, there are also the implications inherent to econometric models in general related to heteroscedasticity that can occur when the implicit prices of characteristics vary considerably over time, reflecting changes in consumer preferences; the autocorrelation of errors correlated with previous periods; non-normality, i.e., observations not normally distributed around the mean; besides the functional form proving to be inadequate or the omission of relevant variables in the model (such as locational aspects, in the case of real estate), thus compromising the consistency and efficiency of hedonic price regressions.

Furthermore, the application of the hedonic pricing technique for the development of other theories can generate inconclusive results as the estimated equation has the potential to present mixed coefficients and signs, as observed in the thesis of Pereira (2004) in which, although it was possible to include the public that consumes a good as an attribute of the same – in the sample researched, people from the Emulators conglomerate seek to go to places where consumers from the Aristocrats conglomerate are, but the latter prefer to go to places where they find people who belong to the same social group – the application of this statistical technique did not generate results consistent enough for the development of marketing theory that would systematically explain interpersonal influence among consumers.

Finally, according to M. Dickie et al. (1997), under the purely hedonic hypothesis, preferences are defined only with respect to characteristics. Thus, the equilibrium determines a common hedonic price function that applies to each good within a given product class. However, if consumers have preferences for specific car models as well as for certain features, then a common set of implicit prices estimated for a sample of cars might not provide, for instance, an appropriate basis for estimating the demand for safety or in developing quality-adjusted price indexes.

CHAPTER III

2. METHODOLOGICAL PROCEDURES

2.1 Research Problem

According to Marconi and Lakatos (2022), the formulation of the research problem aims to clarify the specific difficulty one encounters and, by sticking to the proposed theme, clarifies the specific difficulty one faces and intends to solve. In this way, the research problem has been formulated. What are the attributes, both intrinsic and locational, that actually value and devalue residential properties in the RMSP?

2.2 Working Hypothesis

According to Richardson (2019), not every type of research requires hypotheses. For example, Malhotra (2019) states that due to his type of research no hypothesis was proposed, because one of the objectives of his type of research is to generate hypotheses. In this research, the hypothesis is that traditional regions of the Municipality of São Paulo (West and Center-South zones), including the Alphaville region, are among the most valued regions according to the hedonic pricing approach. Additionally, although the Central Zone is expected to be among the most valued, the statistical insignificance of the results is expected given the heterogeneity of this region. Regarding intrinsic attributes, no specific hypothesis has been proposed.

2.3 Type of Research

This is a quantitative and descriptive research of an economic nature.

2.4 Objectives

2.4.1 General Objective

According to Marconi and Lakatos (2022), the general objective is associated with a global and comprehensive view of the theme, relating to the intrinsic content of the phenomena and events, as well as the ideas studied. Thus, the general objective

of this study was to develop a hedonic pricing model, in order to verify which attributes value (or devalue) residential real estate in RMSP.

2.4.2 Specific Objectives

According to Marconi and Lakatos (2022), the specific objectives must contribute objectively to answer the research problem, and the specific objective presents a more concrete character in relation to the general objective. It has an intermediary and instrumental function, allowing, on one hand, the achievement of the general objective and, on the other, to apply it to particular situations.

Thus, the specific objectives of this research are to:

1. Present the Theory of Hedonic Pricing
2. Execute a technical literature review
3. Look at other applications of the Hedonic Method
4. Analyze Brazilian empirical works in which the Hedonic Method is used
5. Discuss the utilities and limitations of the Hedonic Pricing Method
6. Apply the Hedonic Pricing model for residential real estate in RMSP
7. Perform a critical appraisal in relation to the effects of each attribute under study on the residential real estate prices in RMSP

2.5 Method

According to Richardson (2019), method in research means the choice of systematic procedures for describing and explaining a phenomenon. In principle, the difference between the qualitative and quantitative method is that the former does not employ a statistical instrument as the basis of the process of analyzing a problem and does not intend to number or measure homogeneous units or categories.

According to Flick (2008) qualitative research consists of the correct choice of appropriate methods and theories to be applied, the recognition and analysis of different perspectives, the researchers' reflections about their research as part of the knowledge production process, and the variety of approaches and methods.

On the other hand, Gressler (2004) and Creswell and Creswell (2018) state that quantitative research is characterized by the formulation of operational definitions

of variables, quantification in data and information collection modalities, use of statistical treatment and hypotheses that generally require a relationship between cause and effect, and supports its conclusions in statistical data, proofs and tests.

Thus, the method is statistical as it investigates the quantitative relationship, admitting margin of error, of the effects of variations in the attributes of residential properties in RMSP on their prices, based on databases and econometric tools.

2.6 Data Collection Instruments

To apply the statistical method and hedonic pricing econometric techniques to the real estate sector of the economy, data have been collected from EMBRAESP (Brazilian Company for Property Studies) regarding residential launches in the RMSP (São Paulo Metropolitan Region) for the period of July 1995 to May 2004.

The prices in R$ of the properties were updated based on the INCC (National Index of Construction Cost) of February 2007. This is a continuous, monthly statistic for 18 cities in the following state capitals of the country: Aracaju, Belém, Belo Horizonte, Brasília, Campo Grande, Curitiba, Florianópolis, Fortaleza, Goiânia, João Pessoa, Maceió, Manaus, Porto Alegre, Recife, Rio de Janeiro, Salvador, São Paulo and Vitória. The national index has been surveyed by FGV since January 1944.

In this way, values of properties launched in different periods are in the same pattern of analysis, making it possible to apply the Hedonic Pricing Method and conduct adequate interpretation regarding the effects of each available attribute on the price per square meter of floor area in residential properties of the RMSP.

2.7 Technique of Analysis

To assess the different attributes in residential buildings through hedonic pricing techniques, the available variables are presented on Chart 1 as follows:

Chart 1 – Definition of Hedonic Variables of Intrinsic Attributes

VARIABLE	VARIABLE DEFINITION
ANDARES	number of floors
AREAUTIL	floor area in m^2
BANH	number of bathrooms
BLOCOS	number of blocks
COBER	number of top-floor units
DORM	number of bedrooms
ELEV	number of elevators
GAR	number of garages
UNIDAND	number of units per floor

Source: Prepared by the author based on data collected from EMBRAESP.

Then, to analyze both types of available developments (horizontal and vertical), dummies have been created for this attribute, according to Chart 2 below:

Chart 2 – Definition of Real Estate Development Dummy Variable

VARIABLE	VARIABLE DEFINITION
DUMMY_VERTICAL	Vertical Launches = 1 Horizontal Launches = 0

Source: Prepared by the author based on data collected from EMBRAESP.

The Sub-Municipalities Map (Appendix) have been used to classify the real estate launchings by regions according to official norms, so as to adequately interpret the dummies in the model concerning the attribute "location". Aiming to avoid excess dummies and make the analysis more efficient, the Northwest and Northeast Zones have been added up into a single variable, as with the East 1 and East 2 Zones (denominated "NORTE" and "LESTE", respectively). Thus, dummies created relative to the regions of the Municipality of São Paulo are shown on Chart 3 below.

Chart 3 – Definition of Location Dummies in the Municipality of São Paulo

VARIABLE	VARIABLE DEFINITION
CENTRO	Central Area of São Paulo
CENTROSUL	South-Central Zone
LESTE	East Zone
NORTE	North Zone
SUDESTE	Southeast Zone
SUL	South Zone

Source: Prepared by the author based on the Sub-Municipalities Map and data collected from EMBRAESP.

Regarding the metropolitan regions not located in the Municipality of São Paulo, those with fewer than 20 observations were grouped in a separate dummy, named RMSPR (Other Regions of RMSP), so as not to have an excessive number of dummies, seeking the interpretative power of the model, as shown on Chart 4.

Chart 4 – Definition of Location Dummies in the RMSP

VARIABLE	VARIABLE DEFINITION
RMSP1	Alphaville
RMSP2	Cotia
RMSP3	Diadema
RMSP4	Guarulhos
RMSP5	Mauá
RMSP6	Mogi das Cruzes
RMSP7	Osasco
RMSP8	Santo André
RMSP9	São Bernardo do Campo
RMSP10	São Caetano do Sul
RMSP11	Taboão da Serra
RMSPR	Other Regions of RMSP

Source: Prepared by the author based on the Sub-Municipalities Map and data collected from EMBRAESP.
Note: Regions comprising RMSPR are Arujá, Caieiras, Cajamar, Carapicuíba, Embu, Ferraz de Vasconcelos, Guararema, Itapevi, Itaquaquecetuba, Jandira, Mairiporã, Santana do Parnaíba, Suzano e Vargem Grande Paulista.

Next, based on the cross-sectional database, a multiple ordinary least squares (OLS) regression has been performed in which the price (in R$) per m^2 of area of the real estate launches is the dependent variable and the respective attributes of the residential buildings are the exogenous variables. Based on results obtained, it has been identified which attributes either add or detract value from residential properties in RMSP and what the possible reasons are for the trends observed.

In the concluding chapter, a critical appreciation is made in relation to the results produced by the hedonic pricing method considering attributes that, based on the sample data, value and devalue residential real estate in the RMSP. The insights can contribute to more effective measures for the construction of real estate that can

be applied both to the RMSP and Brazil if certain tendencies verified are assumed to be national. Thus, the results obtained can provide enlightening information on marginal prices that is useful for both private and public valuations in Brazil.

CHAPTER IV

3. RESULTS AND DISCUSSION

3.1 Data Presentation

Initially, multiple scatter plots have been prepared to observe how each exogenous variable behaves in relation to the dependent variable price per square meter (m^2) of floor area, called $PRECOUTIL\_INCC$. In an initial analysis, it can be seen from Figure 1 that the intrinsic attributes with the greatest apparent potential to increase the value of a property are the number of bedrooms, bathrooms and garages. On the other hand, those with less apparent potential are the number of elevators, top-floor units, blocks, and floor area. Meanwhile, the seemingly ambiguous relationship has been found in the variables regarding the number of units per floor and floors.

In addition, the average prices per m^2 of residential properties for each region of the RMSP are presented. From Figure 2, it can be seen that the regions with the most valued m^2 are the South-Central Zone, the West Zone and the Central Area of São Paulo. On the other hand, the least valued regions are Taboão da Serra, Other Regions of RMSP, Diadema, and Mauá. However, the estimated econometric model results will enable a more precise conclusion using the data under study.

The statistics for each attribute component of the model are as Appendices.

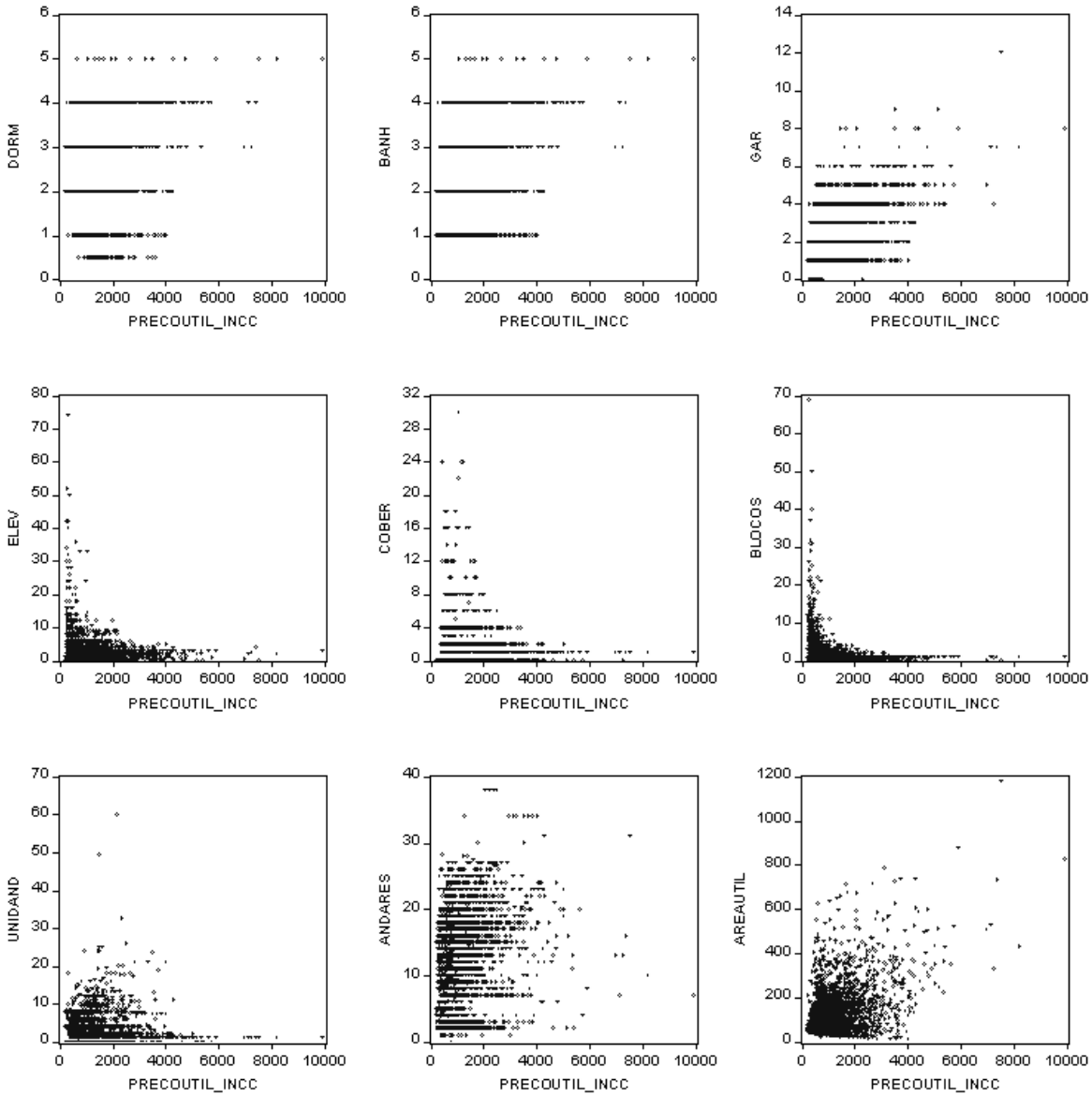

Figure 1 – Scatterplot of Exogenous Variables Against Dependent Variable.

Source: Prepared by the author based on data collected from EMBRAESP.

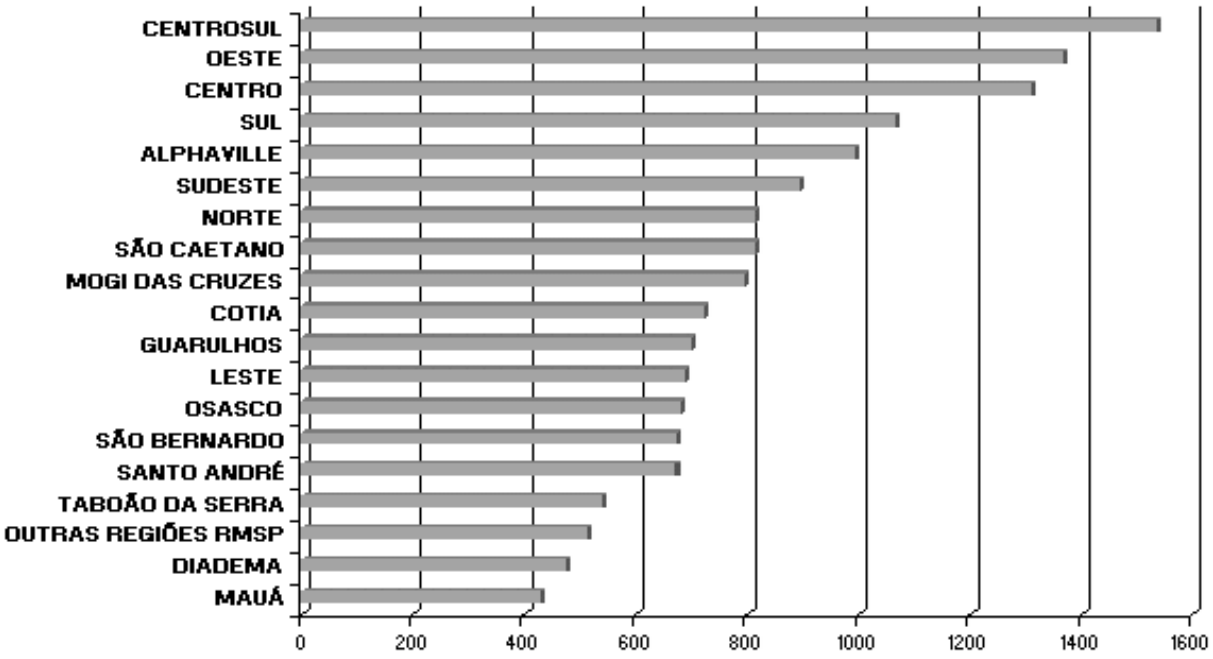

Figure 2 – Bar Graph of RMSP Zones and Respective Average m² Prices
Source: Prepared by the author based on data collected from EMBRAESP.

3.2 The Hedonic Pricing Econometric Model

To analyze more precisely the relationships between the price of M for each property and the respective attributes under study, we proceed with the econometric analysis of the data, elaborating the hedonic price model as shown on Table 1.

According to the F-test of the multiple regression, there are no multicollinearity problems in the model, with the R^2 component indicating that 44.02% of the model can be explained by its included independent variables referring to the various attributes of residential real estate. This result is expected and represents an expected level of explanatory power. As the model indicates, about 56% of the price of real estate is not explained by its intrinsic attributes or location, but by external factors such as services related to health, safety and education (Sartoris, 1996).

For the statistical diagnoses of normality and heteroscedasticity of the residuals, given that the sample size under study is extensive (4774 observations), the asymptotic properties of the estimators are used, ensuring unbiased estimators.

Table 1 – Hedonic Pricing Econometric Model Results

Number of Obs =	4774			
F(27, 4746)	133.26			
Prob > F	***			
R^2	0.4402			
PRECOUTIL_INCC	Coef.	Standard Error	t	
DORM	-222.5311	16.9251	-13.15	***
BANH	24.9053	20.7801	1.20	
GAR	275.7579	16.9686	16.25	***
ELEV	-11.2394	3.3783	-3.33	***
COBER	5.8201	4.4305	1.31	
BLOCOS	-5.1197	4.4216	-1.16	
UNIDAND	37.4958	3.8982	9.62	***
ANDARES	22.6262	1.8743	12.07	***
AREAUTIL	2.3721	0.1976	12.01	***
DUMMY_VERTICAL	-182.3353	34.3407	-5.31	***
CENTRO	17.6033	52.7878	0.33	
CENTROSUL	85.7666	29.6448	2.89	***
LESTE	-226.5347	35.2059	-6.43	***
NORTE	-245.7703	31.9589	-7.69	***
SUDESTE	-246.2641	31.2450	-7.88	***
SUL	-103.5005	29.5527	-3.50	***
RMSP1	-188.2597	84.6863	-2.22	**
RMSP2	-230.6257	73.3884	-3.14	***
RMSP3	-371.6676	114.1364	-3.26	***
RMSP4	-309.6650	56.2521	-5.50	***
RMSP5	-344.3036	123.5856	-2.79	***
RMSP6	-175.7825	123.4955	-1.42	
RMSP7	-287.1017	82.3753	-3.49	***
RMSP8	-406.8666	45.9239	-8.86	***
RMSP9	-249.8104	43.4431	-5.75	***
RMSP10	-258.2940	61.2746	-4.22	***
RMSP11	-341.8258	114.0198	-3.00	***
RMSPR	-285.0274	80.1404	-3.56	***
C	735.4887	43.9744	16.73	***

Source: Research results obtained from EMBRAESP data for the proposed hedonic prices model.
Note: *** significant at 1%; ** significant at 5%; * significant at 10%.

3.2.1 Analysis of Hedonic Variables of Intrinsic Attributes

In relation to the variable related to the number of bedrooms, it is observed that its coefficient is negative and highly significant to the model, indicating that additional bedrooms can negatively affect the price of a property. At first glance, the sign this coefficient assumes may seem counter intuitive. Of course, the number of bedrooms is a variable that defines the target audience to be reached. Despite the fact that properties with a different number of bedrooms have the most potential for market appreciation (see Figure 1), it can be seen that, *ceteris paribus*, additional bedrooms depreciate the price of a property, since space per capita becomes more important than the number of bedrooms itself. Thus, a property with only one bedroom may have as much or more value than a 3-bedroom property that does not offer the same comfort in terms of space and luxury attributes (such as a suite) as the first.

Analyzing the variable related to the number of bathrooms, it is observed that it has a positive coefficient, not reaching the significance of 10% in the model. It is interpreted that, within the same property, individuals or groups of individuals value having their own bathroom/suites. Thus, one has distinct bathrooms for different family members, as well as for guests and employees. On the other hand, due to the statistical insignificance of the parameter, the number of bathrooms in itself is not a decisive variable for adding value to the property, suggesting the existence of even more relevant variables. The characteristics of the bathroom itself – its size and the presence of certain features such as bathtub and whirlpool – are potentially more important than the number of bathrooms itself to add value to the property.

The parameter related to the number of parking spaces is the highest among the attributes under analysis, being highly significant as expected. It is empirically verified this is a characteristic of high perceived value and, given the increasing number of vehicles per inhabitant both in the RMSP and in large Brazilian cities, it is an attribute whose quantity itself is directly related to real estate appreciation.

By the negative and highly significant coefficient of the variable related to the number of elevators, it is interpreted that additional elevators do not appreciate the value of the property. Thus, adding elevators to the building is not an effective way to increase the value of a property. Similarly, observing the variable related to the number of top-floor units, despite its coefficient assuming a positive value, it is not significant

at the 10% level. This way, it is not possible to verify with satisfactory reliability that the number of top-floor units in a condominium adds value to its respective properties.

Analyzing the variable that represents the number of blocks, its coefficient is negative, but it is not statistically significant at 10%. This way, additional blocks in a condominium may have a depreciating effect on the value of the property, possibly related to the loss of privacy and exclusivity perceived, considering that consumers do not perceive added value in condominiums with several blocks. However, one cannot state with satisfactory reliability that additional blocks in a condominium depreciate the value of a property. In fact, several real estate offerings are composed by blocks, having as attributes a differentiated structure both in terms of leisure and security.

In relation to the parameter that relates to the units per floor, it is observed that its coefficient assumes a positive sign, being highly significant to the hedonic pricing model. Units per floor is a valued attribute since it represents the possibility of apportioning condominium fees. Additionally, a structure with courts, swimming pool, and gym, is usually associated with a larger supply of properties within the same real estate development, so that the number of properties sold will cover the construction costs of such structure as soon as possible. Thus, the logic of apportionment of condominium fees is valid to interpret this attribute and its respective coefficient.

The coefficient of the variable related to the number of floors is positive and highly significant to the model, being an attribute that appreciates the value of a property. This phenomenon may be related to the fact that properties on higher floors are less affected by negative externalities such as noise coming from the street and sometimes enjoy a more privileged view. Additionally, properties with a higher-than-average number of floors are also related to a differentiated structure, offering attributes such as greater security, positively affecting even the lower floors.

Analyzing the parameter related to the floor area, the coefficient is positive and highly significant as expected. This is considered the "attribute of attributes" for the valuation of a residential property. *A priori*, spacious rooms are valued, because it is an attribute more directly related to comfort than the number of rooms itself. However, given the increasing cost of the square meter in the RMSP as well as in other large cities around the world, the smaller floor area of a property is compensated with common areas generally endowed with design and luxury, as well as more technology in security, in the expectation of adding value to the property, which makes it possible to understand a coefficient that is positive but of significantly lower value in relation to other coefficients of intrinsic attributes that add value to the residential real estate.

3.2.2 Analysis of Real Estate Development Dummy Variable

Analyzing the dummy variable related to the type of development, it can be observed that horizontalization is more valued than verticalization in residential real estate. Given that the decision to buy a property is based on the analysis of several attributes that make up the property, even with the growing concern of the inhabitants of the RMSP in relation to safety, the "horizontal" attribute remains valued despite being countered by other negative attributes (such as the safety implicit in the attributes related to the location), which makes it worthwhile to choose a horizontal property.

3.2.3 Analysis of Location Dummies

To analyze the dummies related to the attribute "location", it should be noted that the analyzed coefficient parameters have the West Zone as reference, because it is the zone with the highest number of observations in the database. Thus, unlike the variables of intrinsic attributes, the dummies are not analyzed according to the sign of their coefficients, but rather by their assumed values relative to the other regions.

From the regression results it can be seen that the Central Zone is the second most valued region in the RMSP, but its coefficient is not statistically significant at 10%, which represents the intrinsic heterogeneity of this region. This result was expected, since, although there are both valued, restored buildings and decadent neighborhoods, the proximity of multiple commercial establishments, as well as health,

educational and cultural infrastructure and centers of excellence, makes this region among the most valued ones to live in due to its high relative convenience.

Observing the dummy variable referring to the South-Central Zone and its highly significant coefficient, one can see that this region is the most valued in the RMSP. It is a zone that benefits from the conveniences of a central region, sheltering the initial stretch of Paulista Avenue – the most important city thoroughfare and financial center of the state and of the country – the Ibirapuera Park and the Botanical Gardens, without suffering the negative externalities that come from the agglomeration and saturation of the Central Zone. There are neighborhoods such as Moema, with great real estate speculation; Vila Nova Conceição, with the most expensive square meter in the municipality according to real estate agency Coelho da Fonseca; and traditional neighborhoods such as Vila Mariana and Higienópolis.

Regarding the dummy variable for the West Zone, it is among the most valued regions in RMSP, only behind the Center and South-Central regions. Along with the South-Central Zone, it forms the "southwest vector", which is the main development axis in the city. After the Central Zone, it is the region with the largest quantity of buildings listed by Condephaat (Council for the Defense of Historical, Archeological, Artistic and Tourist Heritage), some even forming entire neighborhoods such as City Lapa. It is also the place where the city's cultural life is concentrated, with numerous cultural establishments and also two of the main universities in the Municipality: University of São Paulo (USP) and Pontificial Catholic University of São Paulo (PUC-SP). This is also the region of high speculation in high-end residential real estate, although much of the region has been consolidated since the mid-twentieth century.

In relation to the dummy related to the East Zone, it is verified that it is not among the most valued zones of the Municipality of São Paulo, being behind the Central, South-Central, West and South Zones of the Capital, placing it second to last under the aspect of valuation. It is the most populated region of São Paulo, being essentially formed by commercial establishments and popular housing and usually considered as a "sleeping region" of the city. The average income of the population is below the city's average, and the unemployment and crime rates are high. Thus, results obtained are consistent with those expected for residential launches.

As for the dummy variable reflecting the North Zone, it can be seen that it is not among the most valued areas in the Municipality of São Paulo, ranked right before the least valued zone. As it was the last region of the city to be colonized, its

development is very recent. Its history of colonization started with the exploration of the regions of Campinas and Jundiaí, and the exit to these cities is located in this region, through the Anhangüera Highway. The Northeast region is the only one in the city not served by CPTM (São Paulo Metropolitan Trains Company); and the Northwest region is crossed by Line A of CPTM and not served by the subway. It is formed by a population in general of low purchasing power, although there are some high standard residential areas in the districts of Pirituba and São Domingos. Thus, the results effectively obtained are consistent with the results expected for this region.

The dummy for Southeast Zone points out, through its coefficient, it is in last place under the aspect of valuation in the Municipality of São Paulo. Although a large part of its population belongs to the middle class, it is one of the most heterogeneous zones of the city, housing at the same time the Heliópolis neighborhood (previously considered the largest favela in Brazil) and some of the richest neighborhoods of São Paulo such as Tatuapé and Jardim Anália Franco. Furthermore, given the average of the sample data concerning the price per square meter (see Figure 2), which pointed to the Southeast Zone as one of the two least valued regions in the Municipality, it could not be expected that this region would reach a high relative coefficient.

Observing the coefficient of the dummy variable related to the South Zone, it is in an intermediate position among the regions of the Municipality of São Paulo, behind the South-Central, Central and West Zones. Being the region with the largest area in the city, despite being characterized as a deprived area and with a high relative crime rate per inhabitant of the city of São Paulo, there are "islands" of wealth in the region, especially in the district of Capela do Socorro, close to the district of Santo Amaro, located in the South-Central region. Thus, the coefficient captures such valuation for residential launches initially observed in the study of average prices per square meter (see Figure 2), in which the region is also in an intermediate position.

Regarding the dummies related to the metropolitan regions of Greater São Paulo, the most valued regions according to the data analyzed by the hedonic price method are, in descending order, Mogi das Cruzes (statistically insignificant at 10%), Alphaville, Cotia, São Bernardo do Campo, São Caetano do Sul, Outras Regiões da RMSP, Osasco, Guarulhos, Taboão da Serra, Mauá, Diadema, and Santo André.

Thus, the results from the hedonic pricing model are consistent when valuing the Alphaville region, region of residence of a significant portion of the city's elite, São Bernardo do Campo, with its economy originally based on the automobile

industry that undergoes a great diversification in economic activities with the growing importance of the service sector in the city, and São Caetano do Sul, which presents the best social indicators in the whole country, being considered an exemplary city in several aspects of HDI (Human Development Index) used by the United Nations.

CHAPTER V

4. CONCLUSION

The theory of hedonic pricing was presented based on classical works such as those of Rosen (1974), Murray and Sarantis (1999), and Stanley and Tschirhart (1991), as well as on national empirical works, exposing the utilities and limitations found inherent in the application of the hedonic pricing technique.

To apply the econometric method and hedonic pricing assessment to the real estate sector of the economy, data have been collected from EMBRAESP (Brazilian Company for Property Studies) regarding residential launches in the RMSP (São Paulo Metropolitan Region) for the period of July 1995 to May 2004.

In relation to the intrinsic variables, *ceteris paribus*, additional bedrooms depreciate the price of a property, since space per capita becomes more important than the number of bedrooms themselves. It can also be seen that the number of bathrooms itself is not a decisive variable for adding value to a property.

On the other hand, the number of parking spaces in the garage is a characteristic of high perceived value and, given the increasing number of vehicles per inhabitant both in RMSP and in large Brazilian cities, it is an attribute whose quantity in itself has a direct relationship with residential real estate appreciation.

It has also been observed that additional elevators do not appreciate property value. At the same time, it was not possible to state with satisfactory reliability that the number of penthouses in a condominium adds value to real estate, or that additional blocks in a condominium depreciate the value of a property.

It was found that units per floor is a valued attribute, representing the possibility of apportioning of costs at the condominium, as well as the number of floors, as it relates to a condominium with differentiated structure and less negative externalities, positively affecting the property. Additionally, it was observed that floor area is a valued attribute, because, *a priori*, spacious rooms are valuable, being an attribute more directly related to comfort than the number of rooms.

Analyzing the types of real estate development, it has been observed that horizontalization is more valued than verticalization in residential properties, even if this specific attribute is counterbalanced by negative attributes and externalities.

In relation to the regions that comprise the Municipality of São Paulo, the South-Central Zone is the most valued in the RMSP because it is a region that benefits

from conveniences in the dense urban area but does not suffer from the negative externalities resulting from agglomeration and saturation of the Central Zone.

The Central Zone is the second most valued region in RMSP according to the hedonic assessment, although there is no satisfactory statistical significance. Even though there are both upscale and downscale neighborhoods, the region is among the most valued regions in the RMSP due to its high relative desirability.

The West Zone is among the most valued regions in RMSP, second only to the Center and Center-South regions, with numerous educational and cultural establishments, and a region of high speculation in high-end residential real estate.

The South Zone is in an intermediate position among the regions of the Municipality of São Paulo. Even though it is characterized as a relatively poor area, there are "islands" of wealth in the region, especially in the district of Capela do Socorro, close to the district of Santo Amaro, located in the South-Central region.

It can be seen that the East Zone is not among the most valued areas in the Municipality of São Paulo, placed second to last in terms of valuation from the hedonic pricing technique. It is the most populated region of the Municipality of São Paulo, being essentially formed by commercial establishments and popular housing.

As for the North Zone, it is placed next to last in the assessment, being characterized by a population of low purchasing power in general, although there are some high standard residential areas in the districts of Pirituba and São Domingos.

The Southeast Zone is in last place in terms of valuation in the hedonic pricing econometric technique for the Municipality of São Paulo. Although at first glance this is not an expected result, given that a large part of its population belongs to the middle class, it is one of the most heterogeneous zones in the city.

In relation to the metropolitan regions of Greater São Paulo, the results are consistent when valuing the Alphaville region, São Bernardo do Campo, and São Caetano do Sul, being the most valued regions according to the hedonic model.

Fulfilling the objective of this work, the attributes that value and devalue residential real estate in RMSP have been analyzed, whose information and assessment derived from the econometric model can contribute to more effective measures for real estate construction that can be applied to both RMSP and Brazil.

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APPENDICES

Table A.1 – Dependent Variable's Frequencies and Percentages

PRECOUTIL_INCC (R$/m^2)	Freq.	%	Cumulative Rel. Freq.
Up to 500	665	13.93	13.93
]500, 1000]	2383	49.92	63.85
]1000, 2000]	1304	37.31	91.16
]2000, 3000]	279	5.84	97.00
Above 3000	143	3.00	100.00
TOTAL	4774	100	

Source: Prepared by the author based on data collected from EMBRAESP.

Table A.2 – Frequencies and Percentages by Type of Real Estate Development

Type of Development	Freq.	%	Cumulative Rel. Freq.
Horizontal	856	17.93	17.93
Vertical	3918	82.07	100
TOTAL	4774	100	

Source: Prepared by the author based on data collected from EMBRAESP.

Table A.3 – Frequencies and Percentages per Zone

Zone	Freq.	%	Cumulative Rel. Freq.
CENTRO	139	2.91	2.91
CENTROSUL	554	11.6	14.51
LESTE	399	8.36	22.87
NORTE	474	9.93	32.80
OESTE	1188	24.88	57.68
SUDESTE	501	10.49	68.17
SUL	577	12.09	80.26
XRMSP1	48	1.03	81.29
XRMSP2	68	1.42	82.71
XRMSP3	26	0.54	83.25
XRMSP4	118	2.47	85.72
XRMSP5	23	0.48	86.20
XRMSP6	22	0.46	86.66
XRMSP7	52	1.09	87.75
XRMSP8	183	3.83	91.58
XRMSP9	220	4.61	96.19
XRMSP10	97	2.03	98.22
XRMSP11	26	0.54	98.76
XRMSPR	59	1.24	100.00
TOTAL	4774	100	

Source: Prepared by the author based on data collected from EMBRAESP.

Table A.4 – Frequencies and Percentages by Intrinsic Characteristics

DORM	Freq.	%	Cumulative Rel. Freq.
0.5	95	1.99	1.99
1	233	4.88	6.87
2	1771	37.10	43.97
3	1747	36.59	80.56
4	910	19.06	99.62
5 and above	18	0.38	100
TOTAL	4774	100	

BANH	Freq.	%	Cumulative Rel. Freq.
1	1836	38.46	38.46
2	1893	39.65	78.11
3	669	14.01	92.12
4	359	7.52	99.64
5 and above	17	0.36	100
TOTAL	4774	100	

GAR	Freq.	%	Cumulative Rel. Freq.
0	16	0.34	0.34
1	2,142	44.87	45.2
2	1,531	32.07	77.27
3	588	12.32	89.59
4	335	7.02	96.61
5 and above	162	3.38	100
TOTAL	4774	100	

ELEV	Freq.	%	Cumulative Rel. Freq.
0	1080	22.62	22.62
1	876	18.35	40.97
2	1479	30.98	71.95
3	612	12.82	84.77
4	298	6.24	91.01
5 and above	429	8.99	100
TOTAL	4774	100	

COBER	Freq.	%	Cumulative Rel. Freq.
0	3663	76.73	76.73
1	284	5.95	82.68
2	391	8.19	90.87
3	16	0.34	91.2
4	305	6.39	97.59
5 and above	115	2.41	100
TOTAL	4774	100	

BLOCOS	Freq.	%	Cumulative Rel. Freq.
0	1197	25.07	25.07
1	2746	57.52	82.59
2	330	6.91	89.51
3	169	3.54	93.05
4	113	2.37	95.41
5 and above	219	4.59	100
TOTAL	4774	100	

Table A.4 (cont.) – Frequencies and Percentages of Intrinsic Characteristics

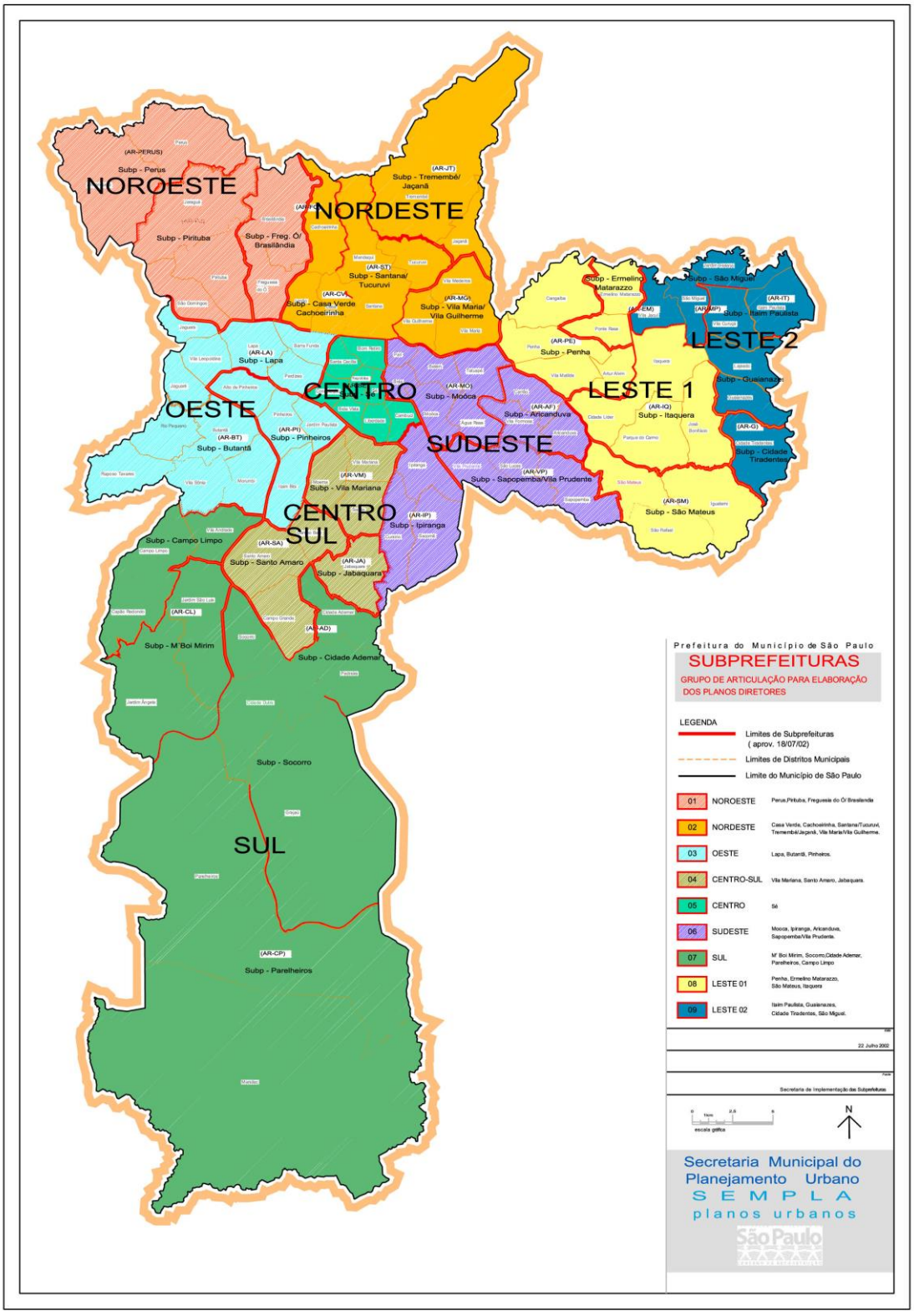
UNIDAND	Freq.	%	Cumulative Rel. Freq.
0	852	17.85	17.85
1	354	7.42	25.26
2	626	13.11	38.37
3	355	7.44	45.81
4	1859	38.94	84.75
5 and above	728	15.25	100
TOTAL	4774	100	

ANDARES	Freq.	%	Cumulative Rel. Freq.
1	16	0.34	0.34
2	704	14.75	15.08
3	182	3.81	18.89
4	179	3.75	22.64
5 and above	3,693	77.36	100
TOTAL	4774	100	

AREAUTIL (m^2)	Freq.	%	Cumulative Rel. Freq.
Up to 50	600	12.57	12.57
]50,100]	2609	54.65	67.22
]100,200]	1082	22.66	89.88
]200,300]	278	5.82	95.71
Above 300	205	4.29	100
TOTAL	4774	100	

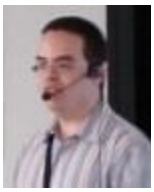
Source: Prepared by the author based on data collected from EMBRAESP.

Figure A.1 – Map of Sub-Districts in the City of São Paulo



Source: São Paulo City Hall.

About the Author



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