HEDONIC PRICE ANALYSIS OF OFFICE RENTS:
A CASE STUDY OF THE OFFICE MARKET IN ANKARA

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EDA USTAOĞLU

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Prof. Dr. Sencer Ayata
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Erol Çakmak
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Prof. Dr. Ali Türel
Co-Supervisor

Assoc. Prof. Dr. Alper Güzel
Supervisor

Examining Committee Members

Assoc. Prof. Dr. Alper Güzel

Prof. Dr. Ali Türel

Assoc. Prof. Dr. Gülden Berkman

Asst. Prof. Dr. Meltem Dayıoğlu Tayfur

Prof. Dr. Erol Taymaz

ABSTRACT

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Ustaoğlu, Eda
M. S., Department of Economics
Supervisor: Assoc. Prof. Dr. Alper Güzel
Co-Supervisor: Prof. Dr. Ali Türel

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This thesis analyzes variations in office rents in Ankara. The theoretical background of this study is related to the hedonic methodology, which is extensively applied for explaining price or rental price variations of the real property. Given this theoretical framework, hedonic regression model is utilized for the estimation of hedonic price indices by using the cross sectional data of the office market in Ankara for the year 2002. Hedonic price function is specified in the log linear functional form and is estimated with the Ordinary Least Squares technique for two models. The models include the same variables; however, Model 1 differs from Model 2 in including the location variables. The estimation results obtained from the models suggest that height and construction quality of the building act as proxies for the locational characteristics. Also, it is found from Model 1 that locational characteristics have the greatest effect on the rental prices of the office units. In order to verify this fact, Model 1 is tested against Model 2 and vice versa based on alternative tests for non-nested models. The results of non-nested tests indicate that Model 1 is preferred to Model 2. This result is important in the sense that locational characteristics are found to be significant in explaining the rental price variations. Besides location variables, the other variables related to physical attributes and lease characteristics of the office property are also evaluated from the estimation results of Model 1. From the empirical results, it is finally concluded that locational characteristics explain the spatial rent variations of the office property in Ankara to a large extent.

Key words: Rental Price Variations, Hedonic Price Function, Hedonic Price Index

ÖZ

İŞYERİ KİRALARININ HEDONİK FİYAT ANALİZİ: ANKARA'DA İŞYERİ PAZARI ÜZERİNE BİR DEĞERLENDİRME

Ustaoğlu, Eda
Yüksek Lisans, İktisat Bölümü
Tez Yöneticisi: Doç. Dr. Alper Güzel
Ortak Tez Yöneticisi: Prof. Dr. Ali Türel

Eylül 2003, 107 sayfa

Bu çalışma Ankara'daki işyeri kiralarındaki farklılaşmayı analiz etmektedir. Çalışmanın ardında yatan teorik dayanağı hedonik metodoloji ile ilişkilidir. Bu yöntem taşınmazların fiyat veya kira fiyatlarındaki farklılaşmayı açıklamak üzere yaygın olarak kullanılmaktadır. Bu teorik çerçeve veri iken, Ankara'daki işyeri pazarı için 2002 yılına ait yatay-kesit verileri kullanılarak hedonik regresyon modeli oluşturulmuş ve hedonik fiyat endeksleri tahmin edilmiştir. Hedonik fiyat fonksiyonu doğrusal logaritmik bir fonksiyon olarak belirlenmiş ve en küçük kareler yöntemi kullanılarak iki farklı model için tahmin edilmiştir. Model 1 ve Model 2 deki değişkenlerin tümü aynı olmakla beraber; Model 1, Model 2 den farklı olarak binanın konumuna ait özelliklerini temsil eden değişkenleri de içermektedir. Modeller için elde edilen tahmin sonuçları, binanın toplam kat sayısının ve yapım kalitesinin binanın konumuna ait özellikleri temsil ettiğini göstermektedir. Ayrıca, Model 1 için elde edilen tahmin sonuçları, Ankara'da işyeri kiralarının farklılaşmasına çoğunlukla işyerinin konumuna ait özelliklerinin neden olduğunu göstermektedir. Bunu doğrulamak için, farklı non-nested hipotez testleri kullanılarak, Model 1 Model 2 ye ve Model 2 de Model 1 e karşı test edilmiştir. Test sonuçlarına göre Model 1, Model 2 ye tercih edilmektedir. Bu sonuç, binanın konumuna ait özelliklerin, kira farklılaşmalarını açıklaması bakımından önemli olduğunu göstermektedir. Binanın konumunu temsil eden değişkenlerle birlikte, önemli olduğu saptanan, işyerinin fiziksel ve kira sözleşmesine ait özelliklerini temsil eden değişkenlerin tahmin sonuçları da Model 1 için değerlendirilmiştir. Ampirik sonuçlar, binanın konumuna ait özelliklerinin Ankara'daki işyeri kiralarındaki farklılaşmayı büyük ölçüde açıklandığını göstermektedir.

Anahtar Kelimeler: Kira Fiyatındaki Farklılaşmalar, Hedonik Fiyat Fonksiyonu, Hedonik Fiyat Endeksi

To My Family

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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CHAPTER1

INTRODUCTION

Triggered by a growing interest for urban affairs, real estate has become an important field of study with the integration of many specializations. Real estate is defined as the interrelation of sociology, finance, economics and politics with the use of land and built environment. The interaction of these factors drives new forces for the new building, re-development and provision of new services. Therefore, real estate has dynamic, multi-functional, and multi-disciplinary characteristics which strengthen its importance on the substantial part of the economy.

Commercial property has an important role in real estate markets. It can be stated that commercial property as a property-related issue affects everyone in the sense that it shapes the built environment. Furthermore, the importance can be related to three different factors: First, as a factor of production, commercial property provides the space to house the activities of business and industry. Second, as a financial asset, commercial property constitutes a significant part within asset markets. Third, as an investment medium, it provides revenues to its holders on the basis of value.

These characteristics which make commercial property attractive are common in both housing and commercial property markets. However, less attention was paid on commercial property compared with residential real estate. The main reason is related to the general absence of information on commercial rental rates. The availability of price and rental price data is limited since there are fewer commercial buildings than residences, and holding periods are longer (Mills, 1992: 273). Nevertheless, real estate organizations and real estate brokers obtain data on asking rental rates and building characteristics, and such data are used to inform prospective tenants and investors; as well as to perform research on commercial real estate.

The availability of commercial rent and price data has extended the literature on commercial property markets. There are analyses of valuation and rate of return in commercial property investments, studies on commercial property development cycles, estimates of office rent indices, and examinations of the relationship between rent levels and office vacancy rates. Despite the fact that there is an expanding literature on the economics of commercial property markets, there is almost no study concerning the commercial property in Turkey. Previous research has been addressed to the issues in housing markets and the number of studies related to commercial property markets is limited due to the difficulties in the availability of information on commercial real estate.

Considering the growing need for a research on the economics of commercial property markets in Turkey, this study is aimed at analyzing the office market in Ankara by examining significant determinants of the value of office property.

There are two main objectives of this study: First one is to utilize the information on office property to construct hedonic price indices for the office market in Ankara, and the other one is to analyze the hedonic price indices in order to identify the relationship between the rental value and the specific attributes of the office property.

This study is organized in five parts: In Chapter 2, a theoretical framework is constructed for the hedonic analysis of office rents. This chapter is divided into two sections: In the first section, primary determinants of the rental value are examined, and in the next section, hedonic theory and significant contributions to the theory are discussed.

Chapter 3 includes the empirical studies on hedonic price models both in the World and in Turkish literature. Hedonic price analysis of commercial-office rents are discussed on the basis of their estimation methodology, data structures and estimation results. Then, two studies on housing market which were performed for the Turkish case are analyzed. This part is followed by a conclusion.

Chapter 4 presents the hedonic price analysis of office rents in Ankara. First, the source and the structure of the data are explained. Then, the specification of the model and the explanation of the variables are given. Following the specification of the model and the variables, hypothetical assumptions are developed. At last, hedonic price function is estimated by using the OLS (Ordinary Least Squares) estimation technique. The office property data referring to the period July 2002 to October 2002 is utilized.

Chapter 5 is the conclusion and in this chapter, estimation results obtained from the hedonic regression analysis are evaluated.

CHAPTER 2

THEORETICAL FRAMEWORK

2.1. Principal Determinants of Rental Value of the Office Property

The concept of ‘value’ has attracted the attention of researchers for many years. One of the basic problems that they focused on was the problem of determining ‘value’. The concept is rather complicated to explain and it is not possible to define ‘value’ from one point of view. There are different definitions and one of them is related to the economic concept of value. From this perspective, “value is the power of commanding commodities in exchange” (Karvel and Unger, 1991: 419).

Regarding this definition, the concepts of ‘value’ and ‘market value’ must be distinguished. Market value expresses “an estimate of value in terms of accepted medium of exchange” (Karvel and Unger, 1991: 420). In other words, market value is the price of a good and it is determined in line with the market conditions.

It can be seen from the definitions that the knowledge of ‘value’ and ‘market value’ is of great significance in all markets. In the real property market, the problem of determining value is more complex. The reason is related to the heterogeneity of the market: Each property possesses specific characteristics or attributes such as location and physical characteristics of the property. The value of each property varies widely and systematically with these characteristics.

In the property market, each property is either freehold or leasehold. Considering the leasehold property, both landlords and tenants are interested in the 'rental price' and the 'rental value' of the property. Rent has been defined as a "definite periodic return, in terms of money or other provisions, for the use of property" (Ring, 1972: 161). Based on this definition, it can be stated that rental price of the property is important as it indicates the amount of rental payment that must be paid by tenants and the amount of rental income that will be received by landlords. Rental price is primarily determined in the market due to the supply and demand relationship.

Greer and Farrell (1993) stated that a property's rental value is related to "its capacity to satisfy the needs of prospective tenants and its locational advantages relative to those of competing rental properties" (Greer and Farrell, 1993: 89). In other words, the ability of a property to satisfy a tenant need is generally reflected by the level of rental income that the property is capable of generating. This ability is referred to as property's 'functional utility' and is related to the measure of its productivity.[1] In Greer and Farrell's explanation, "both natural and man-made features contribute to productivity, as does location" (Greer and Farrell, 1993: 89). Hence, property's ability to command rents is basically related to its *physical and locational characteristics*.

Different from these two characteristics, there is another characteristic attributed to a leasehold property. It is the *transfer (lease) characteristics*. Transfer characteristics refer to the specific conditions identified in a lease.[2] These conditions have effect on the determination of the market rent and therefore, must be considered in analyzing the rental price of the property.

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[1] See Fisher and Robert, 1994: 208; Greer and Farrell, 1993: 89.

[2] Lease is a written contract between landlord and tenant. "It conveys the right of possession of the leased premises to the tenant in return for which the tenant pays the landlord rent" (Karvel and Unger, 1991: 237). In addition to this, the agreement contains numerous other covenants defining and limiting the right of the parties in the leased premises.

These three characteristics attributed to a rental property provide a base for the analyses of the rental value. Given this background, main determinants of the rental value of the offices are related to their 'physical characteristics', 'locational characteristics' and 'transfer (lease) characteristics'.

2.1.1. Physical Characteristics

Physical characteristics relate to natural endowments and man-made structures. Within the context of this study, physical attributes of the office property will be examined. These attributes include:

Size: Each structure has gross building area and some structures contain common areas that serve all tenants. Deducting the common area from gross building area will give the 'net usable area' (Fisher and Robert, 1994: 204). It is the floor area of offices, typically occupied by tenants. It is influenced by design and layout structure of the building and is the most important factor which affects productivity.[3]

Functional efficiency: It measures how well the structure is designed to accomplish its intended function. Decline in efficiency indicates the deviation from ideal design, layout and amenities. It is resulted in diminished productive capacity and decreases the property's ability to command rents (Greer and Farrell, 1993: 90).

Vertical location and internal accessibility: Vertical location of the office unit within the building is important in the sense that it is related to the unit's prestige and accessibility (Brennan, Cannaday and Colwell, 1984: 250). Existence of natural lighting and desirable view will affect unit's prestige while unit's vertical location, availability and quality of a lift will affect its accessibility.

[3] See Karvel and Unger, 1991: 421; Fisher and Robert, 1994: 204.

Construction components and internal services: The quality of construction components and the existence of specific internal services add value to the office building (Fisher and Robert, 1994: 206). The main construction components and internal services included in this study are air-conditioning, generator, security systems, parking areas, shopping facilities and interior construction elements (floor covering and wall covering).

Physical structure of the building: Construction type, construction quality, architectural style and other structural elements are directly related to physical structure and image of the building. They influence the property's value due to the fact that they are related to the prestige of the building. The prestigious buildings will attract the prospective tenants. Furthermore, quality of the elements of physical structure and the additional elements affect construction costs which give rise to both price and rental price of the property (Fisher and Robert, 1994: 204-205).

Physical Depreciation: Physical structure of the building is affected by physical depreciation due to aging as well as wear and tear. "Older or worn out properties, even if they have locational advantages and are designed efficiently, generally do not generate incomes equal to those of new buildings" (Fisher and Robert, 1994: 209). These drawbacks can be eliminated by repair and maintenance. Hence, it is resulted in high repair and maintenance expenditures. These additional expenditures have a negative impact on the rental income of the property.[4]

2.1.2. Locational Characteristics

Locational advantages are of great importance in determining the values of both urban land and built structure. Locational attributes will be examined under three specifications:

[4] See Fisher and Robert, 1994: 208-209; Karvel and Unger, 1991: 430.

Linkages: "Locational benefits are influenced by the network of relationships among locations referred to as *linkages*" (Greer and Farrell, 1993: 90).

> Workers who commute between home and employment, supporting services-the transmission of documents, the use of specialized telephone communication, face-to-face contracts are examples of linkages (Archer, 1981: 285).

Despite the growth in information technologies, it has been common to emphasize the need for face-to-face interaction among offices. As a result, CBD (Central Business District) continues to provide agglomeration economies[5] and most offices tend to be located within CBD to benefit from the linkage advantages it provides (Ball, Lizieri and Mac Gregor, 1998: 98-99).

Site access and transportation patterns: Physical access is a significant attribute of all income-producing property and quality of access has a significant effect on the property values.[6] According to Greer and Farrell (1993);

> Linkages may affect transfer and commuting costs, which are the explicit and implicit costs of moving things and commuting people between linked sites. The optimal location would be the one that minimizes total transfer and commuting costs (Greer and Farrell, 1993: 90).

CBD continues to be the most attractive site considering that it is close to the important transportation networks, bus and subway stations and to the main shopping center.

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[5] Alfred Marshall (1893) suggested three principal reasons for clustering which is referred to as agglomeration economies:

> 1.Clustering creates a pooled market for workers with specialised skills (who can move between firms) and the firm (which can draw on the labor pool to expand operations),
> 2. A greater variety of inputs exist at lower cost as subsidary trades grow up to supply input and services, while economies of scale mean that the suppliers can invest capital, even though each firm consuming the inputs provides only a small share of that investment, due to greater turnover and reduction in risk,
> 3.Information flows between firms create technology spillovers to the benefit of each firm (Ball, Lizieri and MacGregor, 1998: 53).

[6] See Greer and Farrell, 1993: 90; Fisher and Robert, 1994: 199.

Neighborhood influences: The environmental characteristics of the built area which influence the site value are called *neighborhood influences* (Greer and Farrell, 1993: 91). The general state of the built environment determines the reputation for the area through visual impressions. Moreover, "the neighboring property uses together with its favorable influences create an environment that enhances profit potentials" (Fisher and Robert, 1994: 200). Consequently, the prior decision to select location is important in order to capture the desirable external factors. It is difficult to escape from undesirable ones since real estate has long life and is physically immobile.

2.1.3. Transfer (Lease) Characteristics

It represents characteristics and terms of a lease. It can be seen from Karvel and Unger (1991) that a written lease[7] usually contains:

> Designation of the term for which the tenancy is to exist, a statement of the amount of rent to be paid by the tenant, amount and time of rent escalations, division of expenses, type of services included in rent and any other obligations of the parties (Karvel and Unger, 1991: 243).

Any variation in these conditions will result in the re-determination of market rent and therefore need careful examination.

As the office property embodies varying amount of each of a characteristic described above, it is considered as a heterogeneous good. In that sense, 'hedonic theory' which deals with the quality variations of a heterogeneous good will be the focus of interest.

[7] See also Ring, 1972: 169-176; Beaton and Bond, 1976: 230; Milgrim, 1987: 432.

2.2. Hedonic Price Analyses

Hedonic methodology is mainly used for market valuation of goods for their utility-bearing characteristics. The goods under consideration embody varying amounts of attributes and are differentiated by the particular attribute composition that they possess. In most cases, the attributes themselves are not explicitly traded, so that one can not observe the prices of these attributes directly. In such a case, hedonic pricing models are very essential in order to determine how the price of a unit of commodity varies with the set of attributes it possesses. If the prices of these attributes are known, or can be estimated, and the attribute composition of a particular differentiated good is also known, hedonic methodology will provide a framework for value estimation.

Invention of hedonic price analysis dates back to a 1939 research by Andrew Court. He was concerned with constructing price indices for automobiles with distinct characteristics. The term hedonic was used to describe "the weighting of the relative importance of various components among others in constructing an index of usefulness and desirability" (Goodman, 1998: 292). Another author, Rosen (1974), defined hedonic prices as "the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them" (Rosen, 1974: 34). It can be seen from the definitions that hedonic analysis has drawn attention to the importance of quality variations, especially for the differentiated products. The earlier contributions to the problem of quality variations were made by Court, L. (1941), Houthekker (1952), Muth (1966) and Lancaster (1966).

Court, L. (1941) was interested in the consumer demand theory and introduced the 'entrepreneurial and consumer demand theories for commodity spectra'. He derived the inverse utility function and via the inverse utility function, he defined the counterparts of the Hicks-Allen elasticity of (quantity) substitution which measure the substitutability of changes in pairs of commodity prices. His analysis is based on the linear continuum of commodities called ‘commodity spectrum’. By commodity spectrum, he meant that infinite number of commodities is taken into account. “The points of the spectrum represent point-goods and the totality of point-goods within a certain subinterval of the commodity spectrum can be regarded as composing a particular grossly *differentiated* class of commodities” (Court, L., 1941: 137). Housing is considered as a good item to be used in the commodity-spectrum concept, even though the number of types of buildings is finite. However, he claimed that “the number is large enough to construct a continuous distribution or spectrum of such types to facilitate the treatment of any economic study of housing” (Court, L., 1941: 138).

Houthekker’s (1952) research was about the ‘compensated changes in quantities and qualities consumed’. He pointed out that in recent research, quality variations of a commodity are ignored and the varieties (if any) of an item are evaluated as different commodities. To correct this, he introduced qualities as separate variables in the utility function, in addition to quantities. He examined compensated changes both in qualities and quantities via the Slutsky equation. His consumer theory was restricted in the sense that the quality of a commodity was described by one variable. However, he claimed that the methods he proposed could be easily extended to the multi-quality case.

Muth (1966) introduced the ‘household production and consumer demand functions’. His research is based on the hypothesis that “commodities purchased on the market by consumers are inputs into the production of goods within the household” (Muth, 1966: 699). This means that commodities purchased on the market do not possess final consumption attributes and consumers use these commodities as inputs into the self-production process for the ultimate services that the good provides. He gave examples for such process: Housing is considered to be an input and homeowners, as landlords, produce and sell housing services to themselves as tenants (Muth, 1966: 699). By including various goods as an input (for the production of an ultimate service) into the household production function, he derived the consumer demand function whose arguments are real income, relative prices of other goods and the ratios of relative prices of all commodities used to produce the final good to the price of the final good. He finally examined differences in commodity demand elasticities and suggested remarks on how his findings could be utilized in empirical work.

Lancaster (1966) brought a new dimension to the traditional consumer theory- according to which goods are the direct objects of utility- by proposing that consumers derive utility from properties or characteristics of the goods, not directly from the goods itself. In line with this proposal, he also assumed that "consumption is an activity in which goods, singly or in combination, are inputs and in which the output is a collection of characteristics" (Lancaster, 1966: 133). His model consists of three parts:

1) Utility function, U, is defined on K-dimensional vector of characteristics, Z;
2) Each household maximizes utility subject to the budget constraint: $Y = X'P$; X is the vector of quantities of goods and P is the vector of per unit prices of goods;
3) A linear technology relates the consumption of characteristics with that of goods: $Z = BX$.

Given the Lancaster's (1966) model,

> The consumer maximizes a utility function defined on characteristics space subject to a budget constraint defined in higher dimensional goods' price quantity space, given a linear technology function relating the quantities of characteristics with the quantities of goods (Radcliffe, 1984: 74).

The solution, for each household, h, is: $P^*_h = B^*_h{}' \Pi^*_h$ (where Π is the vector of characteristics' shadow prices) and multiplying it by $X^*_h{}'$ gives the equation: $X^*_h{}' P^*_h = Z^*_h{}' \Pi^*_h$.[8] It is the linear 'hedonic price' function which identifies the

[8] See Radcliffe, 1984: 73-76 for the derivation of the hedonic price function from Lancaster's (1966) model.

relationship between the product price of a differentiated good and the shadow prices associated with each characteristic of the differentiated good.

The studies of these authors did not take into account the producer behavior and the properties of market equilibrium. An important contribution to the theory of equilibrium in markets for differentiated products was provided by Rosen (1974). He developed an empirical methodology in order to estimate the structural demand and supply functions for the characteristics of differentiated products. The hedonic theory developed by Rosen (1974) will be explained briefly.

Rosen's model assumes competitive equilibrium in a plane of several dimensions on which both buyers and sellers locate. On the plane a vector of coordinates $Z = (Z_1, Z_2, \ldots\ldots, Z_n)$ is defined with Z_i representing the amount of i^{th} characteristic contained in each good.[9] A price function $P(Z) = (Z_1, Z_2, \ldots\ldots, Z_n)$ is also defined at each point on the plane where P(Z) specifies how the market price of the product varies as the characteristics vary. Producers and consumers are assumed to base their location and quantity decisions on maximizing behavior. Equilibrium prices are determined in terms of the equality in the quantities of commodities offered by sellers and demanded by consumers. Rosen (1974) indicated that equilibrium of all consumers is characterized by a family of value functions and producer equilibrium is characterized by a family of offer functions. In equilibrium, buyer's value function and seller's offer function are perfectly matched having a common gradient given by the gradient of the implicit price function, $P(Z) = (Z_1, Z_2, \ldots\ldots, Z_n)$.[10] Therefore, "implicit prices are determined on a joint envelope where the family of value functions on the demand side collides with another family of offer functions on the supply side" (Rosen, 1974: 44).

Rosen (1974) showed that hedonic theory is applied for the market valuation of differentiated products for their utility-bearing characteristics. Based on the theory constructed by Rosen, hedonic price function can be specified for the property

[9] Each product has a market price and obtains a set of characteristics.
[10] See Rosen, 1974: 38-44.

market which is considered to be a differentiated product market. General form of the hedonic price function can be written as:

$$P(Z) = f(Z_1, Z_2, \ldots, Z_n), \qquad (2.1)$$

Where P(Z) is the price of a given property and $Z = (Z_1, Z_2, \ldots, Z_n)$ is the vector of n intrinsic and extrinsic characteristics which the price depends. The coefficient of each characteristic will yield hedonic or implicit prices. Econometrically, implicit prices are estimated by regressing price on characteristics in order to construct hedonic price indexes. More specifically, hedonic equation can be written as:

$$P(Z) = \alpha_0 + \sum_{i=1}^{n} \alpha_i Z_i + \varepsilon \ , \qquad (2.2)$$

Where α 's are the regression coefficients, ε is the error term and P(Z) and Z are as defined above. Equation (2.2) is the general structure for both linear and nonlinear forms of equation (2.1).

By looking at the specifications of different functional forms, Hough and Kratz (1983) stated that the implicit (hedonic) price functions vary or stay constant depending on the functional form of P(Z).[11] Therefore, the implicit price function, $p_i(Z) = \partial P(Z)/\partial Z_i = \hat{\alpha}_i$, is constant if P(Z) is linear. In this case, the regression coefficient, $\hat{\alpha}_i$, is the hedonic price of the ith attribute and shows the contribution of additional attribute to the value of the property. The contribution of the additional attribute is constant and does not depend on how much of each attribute the property has. On the other hand, if the functional form is logarithmic i.e. $P(Z) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Z_i + \varepsilon$, the value of the additional attribute, $p_i(Z) = \hat{\alpha}_i / Z_i$, declines as more are added to a property. The coefficients of the logarithmic

[11] See Hough and Kratz,, 1983: 44.

function measure the absolute change in the value of the price for a relative change in Z_i i.e. $\hat{\alpha}_i = \frac{\partial P(Z)}{\partial Z_i / Z_i}$. If the functional form is log-linear i.e. $\ln P(Z) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Z_i + \varepsilon$, the implicit price function, $p_i(Z) = \hat{\alpha}_i (P/Z_i)$, varies with the ratio (P/Z_i). In this case, the regression coefficients, $\hat{\alpha}_i$, represent the elasticity of price with respect to the increase in the attribute i.e. $\hat{\alpha}_i = \frac{\partial P(Z) / P(Z)}{\partial Z_i / Z_i}$.

Considering the general form of the hedonic price function and the specifications on different functional forms, there has been a large number of hedonic price studies which utilized different functional forms and different estimation techniques for the estimation of hedonic prices for differentiated goods. Given that real estate is a good example of a differentiated product, it became the subject of substantial number of studies on hedonic price models.

CHAPTER 3

LITERATURE REVIEW: EMPIRICAL STUDIES

3.1. Empirical Studies on Hedonic Price Models of Office Rents

Recent research has mostly focused on the hedonic price analyses of the residential property. The difficulties in obtaining the data on commercial property restricted the number of studies related to commercial real estate. Despite the difficulties in the availability of data, there has been an extending literature on the hedonic price analysis of commercial/office rents.

In the literature, there are two sets of research papers focusing on hedonic analysis of office rents: The first group focused on the effects of intrinsic and extrinsic characteristics of offices on asking rents and the second group was concerned with the hedonic rent analysis by employing the actual rental data.

Firstly, the study made by **Clapp (1980)**, which is included in the first group, will be examined. His main purpose is to investigate the effects of intrametropolitan office locations on office rents throughout the Los Angles metropolitan area. He constructed a model by utilizing Cobb-Douglas function both for the production of office services and the production of office space. The production of office services which follows a Cobb-Douglas function is given in equation (3.1) together with the profit function in equation (3.2):

$$Q = A_1 L^{Z_1} S^{Z_2} F_C^{Z_3} F_S^{Z_4} \qquad (3.1)$$

$$\pi = pQ - (w - t_n u)L - R(u,x)S - tuF_c \qquad (3.2)$$
$$- t(u_s - u)F_s \quad \text{if u < u}_s$$
$$+ t(u_s - u)F_s \quad \text{if u > u}_s$$

Where

Q, L, S, F_c, F_s = output of office services and inputs of labor, office space, and face-to-face contracts,

R(0,X), p, w = market prices at the CBD[12] for output, labor, office space,

A_1, Z_i = parameters of the production function such that $\sum_i Z_i = 1$,

x = neighborhood and building characteristics which are not a function of distance from CBD,

u,u_s = distance of the office activity in miles from the CBD and distance of the suburban node from the CBD,

t_n ,t = cost per mile of a round-trip commute (t_n), travel costs for face-to-face contracts are represented by t.

After differentiating equation (3.2) with respect to each input and substituting the factor demand equations into equation (3.1), he took logarithms and introduced the x variable additively, and finally obtained the equilibrium bid-rent function (Clapp, 1980: 390):

$$\log R(U,x) = \log A - (Z_1/Z_2)\log(w - t_n u) - (Z_3/Z_2)\log(tu) + b\log x \qquad (3.3)$$
$$-0 \qquad \text{if u = u}_s$$
$$-(Z_4/Z_2)\log\left[t(u_s - u)\right] \quad \text{if u < u}_s$$
$$-(Z_4/Z_2)\log\left[t(u - u_s)\right] \quad \text{if u > u}_s$$

Where $A = (A_1 p \sum Z_i^{\;Z_i})^{1/Z_2}$.

[12] Central Business District-from here on referred as CBD.

The production of office space follows a Cobb-Douglas function under the assumption of non-constant returns to scale:

$$R = A_1 n^{Z_1/m} r^{Z_2/m} S^{(1-m)/m} \tag{3.4}$$

Where

m = Z_1+Z_2 ,

n = square footage of floor space,

r = prices per unit of non-land and land inputs,

S = output quantity.

He also claimed that if the property taxes are based on construction costs, tax rate enters into equation (3.4) as a multiplicative factor with a unitary coefficient (Clapp, 1980: 390). By taking logarithms of equation (3.5), he finally obtained the equation:

$$\log(R) = \log(A) + (Z_1/m)\log n + (Z_2/m)\log r + \log(1+TX) + \left[(1-m)/m\right]\log S \tag{3.5}$$

Where TX = tax rate applied to construction costs.

The data of this study covers 105 high rise office buildings in Los Angles metropolitan area. He used the entire office building as the unit of observation and took the average of 1974 asking rent for the building in order to construct the dependent variable. His independent variables include:

1)- Building characteristics (building's age, number of floors, net rentable area, internal amenities such as lobby, elevators, etc., internal parking),

2)- Locational characteristics (distance by road to the nearest freeway, straight line distance to the CBD), 3)- Value assessments (assessed land value per square foot, 1974 property tax rate of assessed property value, annual property tax bill),

4)-Accessibility (average commuting time by auto from home to building, percentage of employees who commute by bus).

He had two regressions one of which is the regression of equation (3.3) and the other one is the regression of equation (3.5). From equation (3.5), he found that (1+TX) is insignificant reflecting that assessments are not closely related to the cost of construction. On the other hand, the estimated coefficients of assessed land value, net rentable area and parking variables are significant with positive signs implying a direct relationship between rental price and the subject variables.

The significant negative sign on auto commuting time reveals that more accessible locations have higher rent premiums. Moreover, he found that more central locations are less accessible to employees which will cause a subsequent decentralization of the office activities toward the periphery. Therefore, the negative sign on the auto commuting time variable also indicates that locations which are farther from the residences of employees has lower rents comparing with the more accessible (peripheral) locations. Distance from the CBD is a significant variable which affects rent in negative direction, as expected. The other significant variables including number of floors and building's age affect rent in positive direction, which indicates that tenants will pay more for higher floors and new buildings will command higher rents. On the other hand, variables including commuters using buses and internal building amenities were found statistically insignificant.

His model is successful in explaining the supply and demand influences in the determination of market rents on office space. Furthermore, he searched the reasons for decentralization of office activities and examined the competing bids for a suburban location. He also examined the locational effects on the rental prices of offices in detail; however he pointed out that further research must be done in order to understand whether the locational principles developed in his study are consistent with a general equilibrium model.

Hough and Kratz (1983) developed a hedonic rent model in which demand side attributes of office property were used. They questioned whether the value of 'good' architecture is reflected in the rental prices of office space. Besides the quality of architecture, they specified three factors which determine the office rent. The first factor is the desire to be close to the center of the city. The second is the distance from the building to the commuter transportation and the third is the intrinsic and the extrinsic characteristics of an office building. They constructed the hedonic model with the data (collected in 1978) including 139 office buildings in the Chicago CBD. Their model can be written as:

$$R = R(Z_1, Z_2, \ldots\ldots\ldots, Zn) \qquad (3.6)$$

The dependent variable R is the rental price for the office space in the building and the independent variables Z_i consist of:

1)- Locational characteristics (distance from the building to the CBD, distance from the building to the nearest railroad station),
2)- Building characteristics (building's age, total gross floor area in the building, average rentable area per floor, number of floors in the building, number of public parking spaces, whether or not the building contains a restaurant, a conference room and a snack shop),
3)- Design quality (whether or not the building has been designated a national or Chicago landmark, whether or not it has received an award for aesthetic architectural excellence).

They investigated four functional forms but based on a Box-Cox test statistic, linear and logarithmic models were chosen. They reached these conclusions: Distance from the center of CBD is inversely related with rent implying a substantial benefit of being located near the center of CBD. On the other hand, distance to the nearest railroad station is insignificant, though its coefficient is negative. The age variable was found to be highly significant with an expected negative sign i.e. age factor lowers office rents. The variables including number of parking spaces, rentable area per floor, number of floors in the building and existence of a conference room are also significant with positive signs. Existence of a restaurant and a snack shop were found statistically insignificant because most of the buildings have these facilities.

These results are consistent with their hypothetical assumptions. However, the variables measuring for architectural quality are insignificant. The coefficient of the landmark variable is negative while the reward for architectural excellence is positive. Consequently, the authors stated that the market for office space will respond favorably to ‘good’ new architecture but not to ‘good’ old architecture.

Frew and Jud (1988), made a contribution to the traditional hedonic rent equation by introducing the vacancy rate variable. They made this study in Greensboro, North Carolina with the 1984 survey data collected by Greensboro Planning Department from 66 commercial buildings. They measured excess demand or supply by vacancy level, VL, and vacancy rate, V, is obtained by dividing the vacancy level, VL, by available supply, S:

$$VL = S - D \tag{3.7}$$

$$\mathrm{V} = \frac{S-D}{S} = 1 - \frac{D}{S} = 1 - (1/\mathrm{S})\mathrm{d}(\mathrm{R},\mathrm{X},\mathrm{Z}) \tag{3.8}$$

Where S is the supply of office services and is fixed in the short run, D is the demand for office space and is assumed to be a function of rent per unit of office services, R; building characteristics, X; and other economic factors, Z. Since demand is a function of rent and vacancy rate is related to demand; it can be seen from equation (3.8) that vacancy rate and rent are also related. Therefore, rent function can be written as an inverse demand function:

$$R = r(V,X,Z) \tag{3.9}$$

By definition, vacancy rate, V, is inversely related to the quantity demanded through equation (3.8). Despite the fact that there is an inverse relationship between rents and vacancy rates, they stated that

> Landlords who are willing to accept higher average vacancy rates will tend to have higher average rents at any point in time. Thus, vacancies are the result of an 'experiment' by the landlord designed to yield market information. Through this assumption, it is expected that level of vacancy rate is positively related with the office rent (Frew and Jud, 1988: 3).

They used 2SLS[13] estimation method in order to estimate:

$$R_i = f(V_i, D_i, A_i, F_i, C_i, H_i) \tag{3.10}$$

Where

R_i = office rent per square foot in the i^{th} building,

V_i = vacancy rate,

D_i = distance from the CBD,

A_i = building's age,

F_i = number of floors in the building,

C_i = % of total space devoted to common area,

H_i = location adjacent to major highways.

Only the percentage of building space devoted to common areas and distance from the CBD variables were found statistically insignificant. The coefficients of vacancy rate and floor variables were found to be positive while the age variable and the location adjacent to a major highway were negative. The positive sign on the coefficient of vacancy rate variable supports their assumption that vacancy rate and rent are positively related. The signs of the other coefficients are consistent with their expectations.

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[13] 2 Stage Least Square-from here on referred as 2SLS.

At last, they estimated elasticity of demand for rental office space and found that price elasticity of demand is very high due to the existence of close substitutes. Consequently, they stated that landlords must be careful when setting higher rent levels because they may experience an increase in vacancies when they raise rent and others do not.

A similar study by **Vandell and Lane (1989)** examined office rents and vacancy rates by including design amenities in both rent and vacancy rate equations. In their explanation, user derives pleasure from the 'aesthetic' utility that the design amenity provides. "This pleasure may come from the outside looking at the exterior of the structure (architecture), from the inside looking out (view) or from the inside looking in (exterior design)" (Vandell and Lane, 1989: 239). Therefore, design amenity affects rent from the users' point of view and must be included in the rent function:

$$R = \left[A_1, D_1', X_1, (D'_1\, A_1, D'_1\, X_1), V\right] \qquad (3.11)$$

Where
R = rent per unit of office service,
A_1 = vector of functional structural amenities,
D_1' = vector of design preference ratings,
X_1 = vector of location and site amenities,
V = vacancy rate.

The data consists of a sample of 102 office buildings in Boston and Cambridge with the following information:

1)- Quoted rent and vacancy information,
2)- Descriptive attributes of sites and structures (distance to the CBD, availability of parking on-site, number of parking places, age of the building, total size of

the building, number of floors, whether or not the building has been rehabilitated, date of rehabilitation),

3)- Ratings of design quality

The cross sectional data for the period 1986:4 was estimated using both OLS and 2SLS models. Some of the variables were found statistically insignificant. In the model estimated by OLS method, ratings of design variable was insignificant. However, in most equations estimated by 2SLS method, design variable was significant at least at the 10% level with a positive sign indicating that rents will increase with the increase in design ratings.

The coefficient on the age variable was found to be significantly negative. This result implies that rent will be lower if the building is old reflecting the effect of economic depreciation. The relationship with floor height was significantly positive, as expected, indicating that higher floors will offer higher rent premiums due to their desired views. Another variable, distance to the CBD, was found to be significantly negative enhancing the inverse relationship between rent and distance to the city center.

In contrast to the expectations, they found that existence of on-sight parking had an insignificant negative effect on rents. They thought that this variable could be evaluated as a proxy for the non-included location characteristics. They also found an unexpected result for the relation between rent and distance to a transit stop: Increased distance to a transit stop would increase rents. Their explanation for this situation was that positive sign on this coefficient represents a negative congestion externality effect. Lastly, they found that gross floor area of the building tended to affect rents in a positive direction (with a small effect) although they expected this relationship to be negative to the extent that economies of scale in production are present.

After all, they re-constructed the model for the significant variables and reached the conclusion that number of floors and age variables were responsible for most of the variation in rents but the design quality variable was not as influential as these variables.

Another study concerning the Greensboro, North Carolina office market came from **Glascock, Jahanian and Sirmans (1990)**. They investigated not only the variations in rent levels but also the rent adjustment mechanism by using a sample of 675 asking rents in Baton Rouge, Louisiana. The data for the model were collected from various buildings each year from 1984 to 1988. In their first model, rent is related to four set of variables:

$$R_{jt} = f\,(LOC_j, PHYCHAR_j, MKT_j, SERVE_{jt}) \qquad (3.12)$$

Where

R_{jt} = average real rent per square foot for the j^{th} building in the t^{th} year,

LOC = vector of location characteristics,

PHYCHAR = physical characteristics of the building,

MKT = reflects changes in overall market conditions,

SERVE = kinds of contracted services included in the rent.

Physical characteristics were represented by the size and the class (class A being the best and class D the worst) of the building. The contracted services include open parking, covered parking, utilities (gas and electric), janitorial, water, lighting, expense stop accounting, security, maintenance, and on site management. They based their analysis on the variations between 'full service' versus 'partial service' versus 'no service'. "Full service is defined as either the provision of one-half or more of the potential services or full service by the building manager, verified by the leasing agent" (Glascock, Jahanian and Sirmans, 1990: 108).

Rent adjustment model was obtained by taking the time derivative of equation (3.12) and allowing for lagged responses:

$$\dot{R}_{jt} = g\,(MKT_{jt}, SERVE_{jt}) \tag{3.13}$$

Where $\dot{R}_{jt}$ is the percentage change in rents on each building between time periods. For the changing market conditions, current and lagged values of the vacancy rate and the rate of growth in employment were used as an approximation.

Firstly, equation (3.12) was estimated both in linear and semi-logarithmic forms. All coefficients were found to be significant and had expected signs. Rents differ across all geographic areas and rents also differ across different classes of buildings, as expected. Rents tend to be higher in areas which are highly concentrated with medical office buildings rather than the offices in the downtown area. The reason is that operating costs are higher for these types of office buildings. The high quality buildings rent for more than the low quality buildings i.e. class A buildings rent for more than the other classes. Besides, the level of amenities will affect rent in positive direction indicating that 'full' service buildings rent for more than buildings with 'partial' or 'no' service. Building size was found to be directly related with rent: Large buildings command higher rents than medium-size buildings. In order to capture the interaction effects of geographical location and class of building, subsequent equations were estimated and the results indicated that class A and B buildings have the same rent premiums across all locations while the rents of class C buildings are differentiated across locations.

After estimating the model in equation (3.13), they reached these conclusions: Rate of increase in employment growth affects the level of rents in positive direction. The change in the direction of service variables was as expected and significant: Greater increase in the level of services will result in higher rents.

Their results were consistent with their expectations to a large extent. Finally, they emphasized the importance of researches related to office market by stating that further research must be done toward similar analysis for the other office markets.

Mills (1992) approached the problem in a different way by using the PV (present value) of asking rents as the dependent variable. He presumed that both landlords and tenants are interested in the PV of cash flows and more importantly, he claimed that tenants discount all the future rental payments instead of looking at first year asking rents to decide whether to occupy the office unit or not. He used 1990 office rents in the Chicago metropolitan area. His sample data contained 543 offices which constituted 80% of the office space. Mills specified the dependent variable as the PV of the anticipated costs of the lease:

$$R = R_1 \sum_{t=0}^{T-1} c_1^t + R_2 \sum_{t=0}^{T-1} c_2^t - R_3 \sum_{t=0}^{T-1} c_3^t \qquad (3.14)$$

Where

R = PV of the lease at time 0,

R_1 = base rent,

$C_1 = \dfrac{1+e}{1+r}$,

r = discount factor,

e = escalation factor[14],

R_2 = base year tax and operating costs that are paid by the tenant if the lease is net[15],

$C_2 = \dfrac{1+CPI}{1+r}$; CPI = Consumer Price Index[16],

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[14] Rent escalations may be proxied by CPI-Consumer Price Index escalations or specified percentage changes during each period.

[15] Net lease is defined as the one under which the tenant is responsible for some costs that are paid by the landlord under a gross lease, generally real estate taxes, insurance and operating costs. Heating, ventilation, air conditioning, lighting and janitorial costs are the examples of other costs that may be paid by the tenant under a net lease.

[16] Tax and operating costs are expected to rise as rapidly as CPI.

R_3 = tax and operating costs that are paid by the landlord if the lease has a stop provision[17],

C_3 = discount factor $= \frac{1}{1+r}$.

The model can be written as:

$$R_i = f(X_i) \quad (3.15)$$

Where R is the PV of rent per square foot for a fifteen-year lease and X_i are the independent variables which include the location dummies, the year building was built, total square feet, minimum and maximum square feet per floor, whether the building has parking space, whether the building contains a bank, a restaurant, shops, health club or a day care center.

Two regressions were applied: In the first regression, R was used as the dependent variable and in the second regression R_1, the first-year asking rent, was used for the same purpose. In the second regression, three dummies were included into the model: The first dummy, D_1, equals one if there is an escalation factor in the lease; otherwise equals zero. The second dummy, D_2, equals one if the offered lease is net and does not contain a stop clause; otherwise equals zero and the last dummy, D_3, is one if the offered lease is net and does contain a stop clause and zero if it is not.

After regressing rent in the two specifications, some coefficients were found to be statistically insignificant. These were the dummy variables of parking, age, shops, day care center and health club. The parking dummy has a small and negative coefficient. He suggested that parking dummy is insignificant because most of the buildings have parking spaces as the local government required it. Existence of

[17] Tax and expense stops indicate that any increases in taxes or operating expenses over a specified level be passed on to the tenant, or landlord according to the agreement in the lease.

restaurants and banks within the building tended to affect rents in a positive direction. The size variable was also significant with a positive sign. However, the coefficient on squared size was negative. This implies that the increase in the size of the building increases rent with a decreasing rate. The coefficients of the location dummies explained rental variations through the geographic location. Their signs and magnitudes are plausible and consistent with the expectations.

Related to the additional dummies, D_1, D_2 and D_3, he reached these conclusions: D_1 is insignificant due to the fact that most leases have escalation factors. The coefficient of D_2 is significantly negative indicating that first-year asking rents are lower if they are net and does not contain a stop clause. On the other hand, D_3 is significantly positive, indicating that first-year asking rents are higher if they are net and does contain a stop clause. The results concerning these additional dummies are also consistent with the expectations.

He finally concluded that using R and R_1 as the dependent variables produce similar coefficients. In fact, use of R_1 produces larger adjusted squared correlation coefficient. Therefore, he claimed that "earlier papers which used regressions with the base year asking rent being the dependent variable had not gone far astray" (Mills, 1992: 285).

Sivitanidou (1995) introduced a different dimension to the traditional bid-rent modeling by using supply side variables to explain the variations in office rents. He was concerned with Greater Los Angles on 1462 office-commercial properties. The data on commercial properties was obtained from the 1990 database. He grouped properties across 36 nodes, 10 of which belong to the city of Los Angles. He obtained the model:

$$R_{ij} = R(M_{ij}, D_i, X_i, A_i, Z_i, h_i, I_i) \quad (3.16)$$

Where

R_{ij} = rental price of the office-commercial properties (i=1,......,36; j=1,......, 1462),

M_{ij} = non-location attributes (i.e., age, size, etc.),

D_i = commercial node specialization dummies,

X_i = firm amenities (i.e., distance from the CBD, number of freeways passing through each commercial district, etc.),

A_i = worker amenities (i.e., levels of crime, education quality, etc.),

Z = percent of land zoned for office-commercial development,

H_i = density constraints,

I_i = constraints on the supply of commercial space.

Non-location property attributes, firm and worker amenities reflected the demand side attributes while density constraints, land area constraints and constraints on the supply of commercial space reflected the supply side attributes.

Two sets of models were estimated: Set A and set B. Set B models differed from set A models as they included node specialization variables. Logarithmic form was used as an approximation to the nonlinearities in the OLS regression. In the set B model, which included all variables, coefficients of property characteristics appeared to be significant with expected signs. Rentable area and age have positive and negative effects on rents, respectively. Firm and worker amenities were statistically significant at high levels of confidence. The negative sign on the distance from the downtown variable enhances the continuing attraction power of downtown Los Angles. Number of freeways is directly related with rent and the distance from the airport has an inverse relationship with rent suggesting that better access generates production cost savings which are capitalized into higher rents. Education quality and retail employment have positive rent effects while crime has negative effect, as expected.

Supply side attributes had also important effects on office-commercial rents and all the coefficients were found to be significant. Percentage of land zoned for office-commercial development has the expected negative sign indicating that city districts with a smaller percentage of land zoned do command higher rents. The density constraints reflected by height or floor area ratio limits have positive rent effect i.e. the stricter the density constraints, the stronger the effect on rents. Growth moratoria variable which denote cities with long term moratoria on their commercial development is significantly positive. Therefore, commercial-office properties subject to growth moratoria will command higher rents compared with the properties which do not have such a restriction.

By comparing the two sets of models, he claimed that including the jointly spatial amenities and development restrictions into the model will lead to better results in order to explain the intra-urban rent variations. He ended up his study by suggesting that "future studies should focus on the models through which both demand-and supply-side influences shape spatial *sectoral* variations in office-commercial rents" (Sivitanidou, 1995: 48).

The last study which is included in the first group is the **Dunse and Jones' (1998)** study. They chose Glasgow, Scotland's largest city, as their study area. Their data include 477 office units let during 1994 and 1995. Their contribution to the similar studies done previously is that they enlarged the sample size and added more explanatory variables to the model.

The details of their independent variables are as follows: They defined internal accessibility by three variables-existence of a private entrance, reception area provided and floor level. Area of the office unit and cellular layout were related to the capacity of the office and age displayed a good proxy for the physical structure. A set of internal characteristics of the building was represented by dummy variables. These were air conditioning, raised floors, security system, fluorescent light fittings, carpeting and tea preparation room. Dummies of internal parking, double glazing, location and date of lease execution were also added to the model. Their model can be written in general terms as:

$$R_i = r(X_{1i}, X_{2i}, \ldots\ldots\ldots\ldots, X_{ni}) \qquad (3.17)$$

Where R_i is the rent per square foot of the i^{th} office unit and X_i are the independent variables described above.

After testing the model for an appropriate functional form, linear form was chosen. Some of the correlated variables were deleted from the model by using stepwise regression method and final model was constructed having an explanatory power of 61.3 percent.

Dummy variable for the year in which property was let and dummies of fluorescent lighting, a private entrance, reception area, security system and floor level area were found to be insignificant. Physical attributes of air-conditioning, carpeting, double glazing, parking, raised floors and tea preparation area were positively related with rent. Age, size and location had expected effects in explaining the rent variations: Age is inversely related with the office rent. The coefficient of size variable is positive, though it was small and the location dummies explain the spatial rent variations to a large extent. Their results indicated that age and location can be considered as the main determinants of rents.

Lastly, they mentioned that "there is still an intention to occupy modern buildings within the traditional city centre locations, despite the impact of information technologies on office practices" (Dunse and Jones; 1998: 311).

In the second group, **Brennan, Cannaday and Colwell's (1984)** study will be examined first. They investigated office rent determinants in the Chicago CBD by using the lease data ranging from 1980 to 1983. Their model diverges from the models examined in the first group in terms of the data source and type of key explanatory variables. Their sample included 29 transactions where the office unit in the building was used as the unit of observation. The information collected on each transaction is as follows:

1)- Lease features (date of lease execution, rent per square foot per year, the term of the lease in years, the 'workletter' cost[18] per square foot, number of months of rental abatement[19], whether or not the lease includes CPI escalation, whether there is a 'stop' or a 'base year escalation'[20], the amount of 'stop' per square foot per year (if it exists),

2)- The occupancy rate of the building at the time the lease was executed,

3)- Physical characteristics of the building (total square feet, total number of floors, age),

4)- Physical characteristics of the unit (square feet in the transaction, loss factor[21], vertical location in the building, whether or not the unit is a preferential location within the building, whether or not there is any identification of the tenant on the exterior of the building),

5)- Location of the building.

In general terms, their model can be written as;

$$RENT/SF = f(X_1, X_2, ..., X_m) \quad (3.18)$$

Where RENT/SF is the rental rate per square foot per year and $X_1,....., X_m$ are the explanatory variables described above.

Log-linear model was chosen as the best model due to the Box-Cox/Box-Tidwell and likelihood ratio test statistics. Some variables were excluded from the model as they were insignificant or highly collinear with the other included variables. After constructing the final model, it was seen that most of the coefficients were as expected. The coefficients of the variables stop, base year escalation, vertical

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[18] The 'workletter' is a written commitment by the landlord to make certain improvements.

[19] Rental abatement states the period that tenant can occupy the unit before he starts paying rent.

[20] Base year escalation is the amount above which tenant pays increases in the base year costs.

[21] Loss factor is the proportion of the area paid but not usable.

location and total size were positive while the coefficients of square feet in the transaction, loss factor and location from CBD were negative. The coefficient on CPI is positive in contrast with their hypothetical assumptions. Their explanation was that CPI is a proxy for some characteristics of the building that are omitted from the model. The location variables included in the model have expected magnitudes with expected signs.

Finally, they concluded that their study diverges from the others in two ways: First, they utilized office unit rents instead of average building rents. Second, they employed the lease data to construct new variables which represent the transfer characteristics of the property.

Wheaton and Torto (1994) were interested in the concept of lease valuation. They stated that value of lease terms may change due to the changes in lease terms rather than the changes in 'market rent' for those terms. Therefore, a hedonic equation which captures the value of lease terms must be constructed. In their model, they used 'consideration rent'[22] as the dependent variable. They had a large data set which covers 60.000 leases over the period 1979-1991 in 5 metropolitan areas. Their hedonic model is in semi-logarithmic form and is written as:

$$\log(R) = \alpha_0 + \alpha_1 SQFT + \alpha_2 GROSS1 + \alpha_3 GROSS2 + \alpha_4 TERM + \alpha_5 HIGH + \alpha_6 NEW1 + \alpha_7 NEW2 + \sum_{i=1979}^{1991} \beta_i D_i + \sum_{j=1}^{n} \delta_j S_j \quad (3.19)$$

Where

R = total consideration/square feet/year,

SQFT = square feet of lease,

TERM = length of lease (years),

[22] 'Consideration rent' is the average (undiscounted) gross payment per square foot to be paid over the full term of the lease.

HIGH = (=1 if 5+stories, =0 otherwise),

NEW1 = (=1 if new building, =0 if existing),

NEW2 = (=1 if building built for tenant, =0 if not),

GROSS1 = (=1 if the lease in gross rent, =0 if not),

GROSS2 = (=1 if the lease gross with taxes passed through, =0 if not),

D_i = dummy variable for each year,

S_j = dummy variable for each submarket code (j=1,......,n),

α, β, δ = estimated statistical parameters.

Regression results were as expected except that HIGH and NEW variables were found to be imperfect measures of the related building characteristics. HIGH is an imperfect measure since it affects rents related to the buildings up to five stories. HIGH generates a rent premium between 3-15% considering all markets. NEW variable is again an imperfect measure. The reason is that its effect on the rental price depends on whether the unit is being leased for the first time or not. The coefficient of NEW is positive indicating that new buildings generate higher rents over the average age of older buildings. All the other variables, including SQFT, GROSS, TERM, D_i, S_j were significant with consistent signs. However, SQFT variable has negative sign in the equations estimated for three cities. With regard to supply and demand conditions, large blocks of space commands higher rent premiums. Large blocks are short in supply and often available only when new space is being constructed. As a result, they suggested that the inverse relationship between SQFT and rent is a representative of the market conditions analyzed.

The coefficients on GROSS variables were significantly positive. Another variable, TERM, has an expected positive coefficient implying that each year of a lease raises the average rent over the term of the lease. The location dummy, namely S_j, represents the rental variations across location within different markets. They indicated that locational rent variations in each market showed parallelism with their expectations. Finally, they depicted the relationship between time dummies and consideration rent, with the default year being the first year for which leases were recorded in that market. These were also statistically significant and consistent with the expectations.

As a final remark, they stated that consideration rent represents an improvement over either asking rents or initial year rental data. However, it is less satisfactory than 'net effective rent'. Therefore, inclusion of net effective rent into the hedonic analysis must be the focus of future studies.

Inclusion of net effective rent in the hedonic equation was realized by **Webb and Fisher (1996)**. They defined 'effective rents' as "the annual equivalent (over the term of the lease) of the present value of all explicit net cash flows from market-negotiated leases" (Webb and Fisher, 1996: 2). Explicit cash flows consist of base year escalations, free rent periods, tenant improvements, moving allowances, buyout allowances, and expense stops. They viewed cash flows from the landlords' point of view by claiming that the landlords make the investment decisions which may lead to oversupply (or undersupply) of office space. They suggested that effective rent indices can reflect the changes in real estate market conditions, so they estimated an effective rent index[23] by using the lease data over 1985-91 periods for the Chicago metropolitan area. They constructed the model:

$$EffRent_{i,t} = f(Building_i, Tenant_i, Space_i, Terms_i, Time_{i,t}) \quad (3.20)$$

Where

$EffRent_{i,t}$ = effective rent for lease i written at time t,

$Building_i$ = vector of dummy variables for each of the building,

[23] Their method for the calculation of effective rents can be summarized in three steps: In the first step, contract rent is identified for each month the lease is in effect. Then, tenant improvements, moving allowances, buyout allowances, and initial brokerage fees are deducted from the contract rent for each year. In the second step, present value of all the cash flows described in the first step is calculated. The treasury-bond rate that has the same maturity as the lease is used as the discount factor. In the last step, a level of annual rental payment which has the same present value as the actual cash flows from the lease is calculated. The same treasury-bond rate is used as the discount factor (Webb and Fisher, 1996: 7-8).

$Tenant_i$ = vector of (hedonic) characteristics to control for whether the space is being leased to a new tenant, is an expansion of space by an existing tenant, or is a renewal of an existing lease,

$Space_i$ = vector of characteristics to control for differences in the quality and location of the space within the buildings,

$Terms_i$ = variables to control for characteristics of the leases that do not involve explicit cash flows but may affect the level of the contractual cash flows to be received (i.e., term of the lease, whether the rent escalation is due to the changes in CPI-Consumer Price Index, whether the tenant was represented by a broker, number of free parking spaces, etc.),

$Time_{i,t}$ = vector of dummy variables to identify the year when each of the lease is negotiated.

Their data included 395 leases from 9 buildings. Data attributed to building characteristics include: age, last date remodeled, number of floors, square footage, current occupancy rate, parking availability, presence of retail space in the building, quality of its location within the submarket, functionality, prestige and building expenses. From these characteristics, a quality index which represents the quality of the space within the building is calculated.

Regression results were as expected. The coefficients of all the variables were consistent and 13 of 19 were significant. They found that effective rents are higher for new tenants and lower when the tenant was represented by a broker. Effective rents are lower for leases which include escalations related to CPI as the CPI adjustment lowered the risk of unexpected inflation to the tenant. Although CPI escalation has the expected negative sign, it is insignificant. The term TERMCPI, which is an interaction variable, indicates the relationship between term of the lease and CPI adjustment. Its coefficient has the expected negative sign, however it was insignificant. The variation of rents across buildings was represented by the building dummies and only one of them had a negative sign. Another variable QUALITY has the positive sign indicating that quality of the space adds value to the building. Time-series dummy variables indicated changes in effective rents relative to the initial year-1985. These were also significant and the resultant effective rent movements showed that effective rents declined almost 50% from 1985 to 1988 and increased slowly since.

They also noted that the level of concession increases with vacancy rates such as concessions increase from 1988 to 1989, a year before vacancy rates increase. Therefore, they came to a conclusion that effective rents are forward-looking indicators of market conditions.

3.2. Review of Literature on the Determinants of Housing Prices in Turkey

The studies examined under the previous section were the examples of empirical studies related to commercial-office property from the World. There is no such a study concerning the office property in Turkey. The previous studies mostly interested in residential property rather than office property due to the reasons of data accessibility problems. Therefore, housing price analyses in Turkey will be examined under this section. Two studies which are related to the determinants of housing prices will be examined: The first study-Türel's (1981) study- examined the housing price determinants at the microeconomic level while the second study-came from Hasekioğlu (1997)- focused on the factors which affect the asset prices of housing at the macroeconomic level.

Türel's (1981) study will be examined first. He was concerned with the analysis of non-squatter housing market in Ankara. By employing the cross section data collected in 1969-70, he estimated a hedonic rent model which can be specified as;

$$R_i = R(X_{1i}, X_{2i}, \ldots, X_{ni}), \qquad (3.21)$$

The dependent variable R_i is the annual rent of the i^{th} housing unit and the independent variables X_i consist of:

1)- Physical characteristics of the building (gross floor area, land area, existence of central heating system, hot running water and elevator, building's age, whether the building is new, whether the building is one or two storey),
2)- Physical characteristics of the housing unit (number of rooms, unit's vertical location within the building-whether it is a basement floor or a ground floor),
3)- Lease characteristics (whether the lease is with a new tenant or a renewal of an existing lease),
4)- Locational characteristics (straight line distance to the CBD, straight line distance to the employment nodes, dummies representing the sub-areas[24]),
5)- Characteristics of the sub-areas (air pollution[25], education quality[26], total public services (in m^2) per person, percentage of people in managerial-professional occupation residing in the sub-area).

Equation (3.21) was estimated in four stages by using linear functional form. In the first stage, four sets of equations were estimated. The variables representing the characteristics of the sub-areas and the dummies representing the sub-areas were excluded from these equations. Some variables including gross floor area, building's age and straight line distance to the employment nodes were dropped from the model since they were correlated with the other included variables.

In the second stage, characteristics of the sub-areas were included in the model and three sets of equations were estimated. From the first two equations, variables

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[24] The metropolitan area is divided into two areas with reference to the railway which has already divided the city into two parts-south and north. Each part is also divided into four sub-areas. In other words, the whole area is divided into eight sub-areas in order to capture the rental price variations, which is assumed to perform a spatial variation in the housing market in Ankara.

[25] Air pollution variable represents the percentage of families who complain about air pollution in the sub-area.

[26] Percentage of families who satisfy with the education provided by schools situated in the sub-area is used as a measure of the education quality.

of education quality and total public services per person were found to be statistically insignificant. The air pollution variable is significant, though it has a positive sign. The positive sign on air pollution indicates a direct relationship between rental prices and air pollution levels. However, this is an inconsistent result and he brought an explanation by claiming that air pollution level is higher in the centrally located neighborhoods because of high building densities in those neighborhoods. Therefore, high air pollution level represents central locations where building rents are also high. Furthermore, he stated that higher rents which stem from externalities-locational advantages to the CBD and competitiveness of residential uses with the other land uses- are not affected from air pollution.

The other variables were found to be significant with expected signs: The variables including central heating system, hot running water, land area, number of rooms, new building and percentage of managerial-professional groups residing in the sub-area have positive signs. The positive sign on the coefficient of the percentage of managerial-professional groups residing in the sub-area indicates that housing areas which are densely populated by high income groups command high rents. On the other hand, variables including basement floor, one or two storey buildings, existing tenant and distance to the CBD have negative signs.

Rental price variations across different sub-areas were observed from the equation which includes the sub-area dummies. From this equation, the variables representing the three sub-areas located in the northern region were found to be insignificant indicating that rental prices of the houses located in the northern region do not vary compared with the houses located in Ulus.[27] On the other hand, the variables representing the four sub-areas located in the southern region were significant. Therefore, he concluded that houses located in the southern region are heterogeneously distributed compared with the houses located in northern region.

[27] The dummy representing the sub-area in Ulus was chosen as the base category.

In order to observe the hedonic price variations between northern and southern regions, he estimated two further equations, one of which is for the northern region and the other one is for the southern region. The variables of elevator and hot running water were excluded from the equation estimated for the northern region due to the reason that they were small in number (and therefore insignificant). One or two storey buildings have an insignificant coefficient in the equation estimated for southern region. The coefficients of the other variables confirmed that there are significant differences in the hedonic prices estimated for the two regions of the city. However, in both equations, distance to the CBD has an insignificant coefficient, although its coefficient is significant in the equations estimated for the whole city. In his explanation, there may be two possible reasons for this situation: The first one is that housing stock located in each region is homogeneous compared with the housing stock in the whole area. The other reason is that distance to the CBD variable acts as a proxy for the non-included variables in the model estimated for the whole city.

In the final stage, equation (3.21) was estimated for each of the eight sub-areas. Only the physical characteristics of the building and the unit, and the lease characteristics were included in the model. The estimation results confirmed the fact that hedonic prices of the housing characteristics perform a spatial variation. He pointed out that central heating system and unit housing prices are the factors which are responsible for most of the variation in rental prices.

He finally ended up his study by stating that rental prices of the housing stock vary in location verifying the housing market segmentation hypothesis for Ankara. In his explanation, this variation is related to the high income groups' location preferences and the externalities came from locational advantages and environmental conditions.

The second study concerning the housing price analysis came from **Hasekioğlu (1997)**. She constructed a model with a theoretical framework which is different from the previous models considering the Turkish housing market. The goal of the study is to examine asset price of housing in terms of the determinants such as income, housing demand, housing credits and real interest rates. The model is based on the equilibrium which is determined by the equality of demand and supply prices of the housing. The demand and supply functions for the housing stock are specified as;

H_d = [PH(rm), P, Y_p, hh]; PH(rm) = R/rm, (3.22)

Phs =r(hs, c), (3.23)

Where

PH = asset price of housing,

R = price of services (rent),

rm = real interest rates of deposits having one year maturity,

P = price index (consumption),

Y_p = disposable income,

hh = vector of household characteristics,

Phs = supply price of housing,

hs = flow of housing investment,

c = vector of costs faced by the residential construction industry.

Equilibrium is determined by the equality of demand and supply prices of the housing i.e. PH = Phs. Hence, the implicit form of the model is derived from the equilibrium condition and stated below,

PH/P = f(K, rm, KH_{-1}/hh, Y_p), (3.24)

Where K = housing credits, and KH_{-1}/hh = housing of the previous year per household.

The estimation of the model is realized in two stages: In the first stage, the dependent variable is derived from the rent index of Turkey and in the second stage, an asset price index statistic is derived from the formula:

$$PA = R/(i-h), \quad (3.25)$$

Where
PA = real asset price index of housing,
R = rent,
i = interest rate,
h = rate of change in rent.

Her two stage model can be written as;

$$\Delta LPAR = \alpha_0 \Delta LX + \alpha_1 \Delta LOCCP + \alpha_2 \Delta LRKREDI + \alpha_3 LRR + u, \quad (3.26)$$

$$\Delta LRPAY = \beta_0 \Delta LX + \beta_1 \Delta LOCCP + \beta_2 \Delta LRKREDI + \beta_3 LRR + v, \quad (3.27)$$

Where
ΔLPAR = difference of the logarithm of the real asset price referring to rent index data,
ΔLRPAY = difference of the logarithm of the real asset price referring to derived asset price index data,
ΔLX = difference of the logarithm of GNP per capita,
ΔLOCCP = difference of the logarithm of the total area of housing according to occupancy permits,
ΔLRKREDI = difference of the logarithm of cumulative annual real estate credits,
LRR = logarithm of the real interest rate,
u, v = disturbance terms.

The model depends on the time series data collected between 1968-1994 periods. For the estimation of the model, co-integration technique is used. The coefficients of the variables, except the coefficient of interest rate variable (α_3 and β_3), give the growth of the percentage change in the dependent variable with respect to the growth of the percentage change in the independent variables.

The estimated values of α_0 and β_0 were positive; indicating that real asset price of housing is sensitive to changes in income. The positive sign of the coefficients indicates a direct relationship between real asset price of housing and income, as expected.

The estimated values of α_1 and β_1 were found to be negative. The negative sign reflects the inverse relationship between the real asset price of housing and the housing stock at the previous period per household. This result is consistent with the hypothetical assumption:

> A population increase will cause an increase in the housing need which is assumed to be in line with housing demand and therefore, the asset price of housing will increase. However, the housing stock at the previous period per household is low comparing with the increase in the number of households. In other words, housing stock at the previous period per household decreases while the asset price of housing increases, supporting the inverse relationship (Hasekioğlu, 1996: 73).

The estimation result for the coefficients of the cumulative annual real estate credits i.e., α_2 and β_2 shows that real asset price of housing and housing credits are positively related, as expected. The real interest rate variable was found to be negatively related with the real asset price of housing, as expected. This result confirms the hypothesis that increase in real interest rates causes an increase in the demand for alternative assets rather than housing, which results in lower asset price of housing.

She finally stated that the estimated values and the signs of the coefficients in equation (3.26) and (3.27) are similar and these results are consistent with the hypothetical assumptions.

3.3. Conclusion

The first five studies of Clapp, Hough and Cratz, Frew and Jud, Vandell and Lane and Glascock, Jahanian and Sirmans used the entire office building as their unit of observation in order to explain the rental variations. They calculated the average rent for the building as the dependent variable. By doing this, they lost the chance to analyze the variation of rents within the building and also they could not capture the true rent effects by using average rent. Another deficiency in their models is that their sample sizes were small (except Glascock, Jahanian and Sirmans' study) due to the constraints in the number of buildings. Therefore, they could not explain most of the variations in their selected study areas.

Despite these negative outlooks, the studies of the subject authors had important contributions to the literature. Clapp examined both the supply and demand side of the office property and his model is a good source for the effects of the locational characteristics on the rental prices.

Hough and Cratz were interested in the demand side of office services by including the architectural quality variable into their model. According to economists, architectural quality has the characteristic of a public good as it is visible from outside the building. Therefore, it is assumed that high architectural quality has no effect on rents. However, Hough and Cratz's results showed that the reverse is true and architectural quality is as influential as the other rent determinants.

Frew and Jud introduced vacancy rate variable into the hedonic model. In contrast with the proposal that rents and vacancy rates are negatively related, they claimed that "landlords who are willing to accept higher average vacancy rates will tend to have higher average rents at any point in time" (Frew and Jud, 1988: 3). The coefficient on vacancy rate was positive verifying their assumption.

Vandell and Lane combined the two studies made by Hough and Cratz, and Frew and Jud. In their model, both design quality and vacancy rate variables were used, though design quality variable was not found to be as influential as expected.

Glascock, Jahanian and Sirmans estimated both a rent level and a rent adjustment model. Through the rent adjustment model, they could examine variations in rent between time periods. So they could explain the rent changes with the changing market conditions. They improved Frew and Jud's model by including the vacancy rate into the rent adjustment process. They stated that the level of vacancy is strongly related with rent changes. Indeed, their results confirmed that there is an inverse relationship between vacancy rate and rent changes. Their sample size was larger compared with the previous ones but unfortunately they analyzed rents and rent adjustment at the building level.

Mills' study is interesting as he was concerned with the present value of cash flows. In his explanation, tenants are not interested in first year asking rents but discount all the future rental payments in order to decide whether to occupy the office unit or not. Therefore, he included the PV of all future payments as the dependent variable in his model. Compared with the previous five studies, he improved his model in three ways: First, he introduced PV of future payments in his model. Second, he used larger sample size and third, he examined the rental prices of individual office units, not the entire building itself.

Sivitanidou's model is similar with the Clapp's model as both of them were concerned with supply and demand side effects. However, Sivitanidou extended the sample size and worked with a sample of 1462 office units. He also added new variables such as worker amenities in the demand equation. His supply function differs from Clapp's function as he focused on the scarcity effects of supply restrictions on commercial real estate properties. He noted that not only demand but also supply side variables must be included in the hedonic models.

Dunse and Jones' study is the last one included in the first group. They improved similar models constructed previously by enlarging the sample size and by adding more explanatory variables. When the number of explanatory variables increases, there may be collinearity problem among some variables. They came across this problem and eliminated some of the correlated variables (through stepwise regression method) from the model. Their final model showed that age, location and size are the main determinants of rent as they explained the rental variations to a high degree.

The main characteristic of the models examined in the first group is that they based on asking rental data. Although actual rent would be a better measure for explaining the variations, asking rent is extensively used in the previous models. The reason is that there are some difficulties in the accessibility of actual rental data. First of all, both leasing agents and landlords may not want to report all the actual payments due to commercial confidentiality. Even if they provided the actual data, there may be concessions such as unexpected increases in the operating costs. It is difficult to capture all the concessions attributed to each transaction. Therefore, asking rental data is preferred in order to get rid of these problems. Despite the difficulties in the accessibility of actual transacted rents, researchers in the second group dealt with the lease data in detail.

Brennan, Cannaday and Colwell's study is the first one which follows this procedure. Their study improved earlier models by including the actual transacted rental values of individual office units. They also extended the number of key explanatory variables by employing the lease data. However, an important criticism for their study became a current issue: Although they used a large number of independent variables, their sample size of 29 is too small.

Wheaton and Torto were concerned with the lease data in detail. They extended the sample size to 60.000 leases by applying a large project. Their dependent variable was 'consideration rent' which is defined as the undiscounted gross payment to be paid over the full term of the lease. So they developed a method to value lease terms in order to capture the changes in these lease terms over time. Their approach corrected for biases that may result from the use of quoted rents. Despite the use of detailed lease data, their model could not gain priority over the models which include the effective rent as the dependent variable.

Finally, Webb and Fisher were successful in calculating the effective rents from 228 leases. Their sample size was smaller (compared with Wheaton and Torto) due to the difficulties in examining changes in lease terms in a specified period. However, they were successful in explaining the trends in office markets with the formulation of effective rent index. They emphasized that effective rents are much better than asking rents in order to explain the effects of rent determinants on commercial-office rents.

The models provided by Türel and Hasekioğlu were successful in explaining the factors which affect the housing prices in Turkey. Türel was interested in the relationship between housing characteristics and rental price. Moreover, he examined the spatial variation of the hedonic prices of the housing property in Ankara. On the other hand, Hasekioğlu focused on the determinants of asset price of housing. Her study diverges from the previous ones due to the fact that she used asset price of housing, instead of housing price, in the model derived from the supply-demand relationship.

The studies examined above more or less investigated the rent variations in the commercial-office market (housing market in the Turkish case) by using the 'hedonic price models'. Hedonic models have some drawbacks despite its contributions to the real estate analyses. The model assumed a general equilibrium throughout the entire property market. So it is not possible to observe the implicit price variations across different properties in different areas. This may put a restriction on the model's effectiveness but despite its failings, it has been widely used in the real estate analyses.

CHAPTER 4

HEDONIC PRICE ANALYSIS OF OFFICE RENTS IN ANKARA

Research on the economics of the office property markets in Turkey has not been undertaken previously. As highlighted before, the main reason is related to the general absence of information on commercial rental rates. The growing need for a research on the economics of the office property markets provided a base for the present study. Within this framework, variations in the rental prices of the offices are analyzed in this study.

By utilizing the hedonic price model, hedonic prices are estimated in order to identify the significant determinants of value of the office property in Ankara. The sample data including 244 office units was selected from the areas which serve as important centers for the office activities. Therefore, rental variations of the office property in Ankara could be explained to a large extent through this study.

This chapter analyzes the hedonic prices of the office property in Ankara. The analysis starts with the description of the data and the variables: The source of the data and the descriptive statistics computed for the data are explained, which is followed by a detailed description of the variables. Then, hypotheses and comments on the expected signs of the coefficients are given. Given the detailed data set and the hypothetical assumptions, hedonic price model is constructed based on the hedonic theory specified by Rosen (1974). In the last part of the study, estimation results are presented. The estimated coefficients of the variables in the final equation are also evaluated considering the hypothetical assumptions developed for the estimated signs of the explanatory variables.

4.1. The Data

The cross-sectional data of this study is based on a questionnaire conducted in Ankara from July 2002 to October 2002. The data was obtained by carrying out a survey among the current users of the rental office space.[28] The questionnaire[29] consisting of 32 questions was conducted in 16 neighborhoods which are densely populated by office buildings.[30] These neighborhoods and the number of offices which were taken as a sample from each neighborhood are given in Table B.1 in Appendix B.

The sample includes 244 transactions involving the office areas of 10 to 2420 square meters and monthly rental rates of approximately 967.000TL to 32.000.000TL per square meter. Figure 1 and Figure 2 show the variations of average gross[31] and net unit rents across location. The descriptive statistics for the quantitative data were also calculated for the five sub-areas and the results are given in Table 1.

As it can be seen from Figure 1 and Figure 2, both gross and net average unit rents in Gaziosmanpaşa have the highest value among all sub-areas. On the other hand, office buildings in Ulus generate the lowest gross and net average unit rents. Gross and net average unit rents in Yıldız and Ayrancı are higher than those of in the central core. Although Yıldız and Ayrancı are two distinct sub-areas, average gross unit rents in these sub-areas are very similar. However, they differ in the

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[28] As the real estate brokers do not want to provide the recently negotiated lease data due to commercial confidentiality, information on actual transacted rental data is not available generally.
[29] See Appendix A for the format of the questionnaire.
[30] Samples were chosen among the offices that provide professional, financial and business services. Other commercial properties were excluded from the analysis.
[31] Gross rents were calculated by adding property taxes and unit charges (include electricity, water, heating and other charges) to the net unit rents.

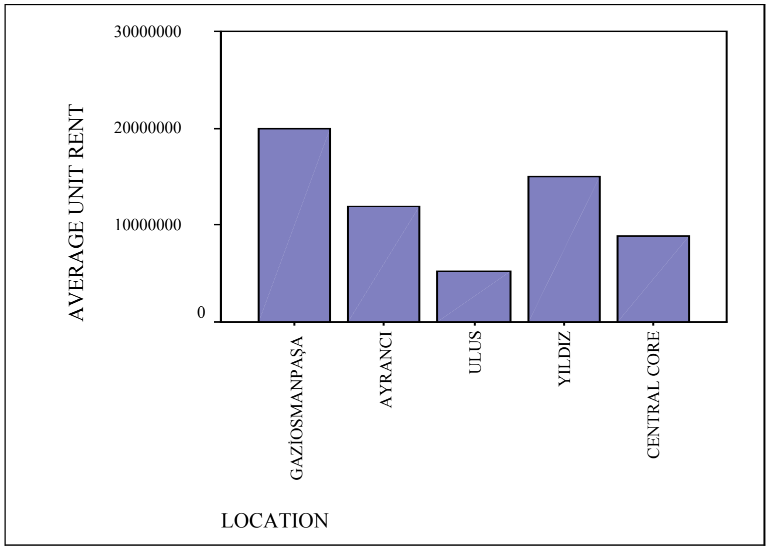

Figure 1 Variation of Average Monthly Gross Unit Rent Across Location

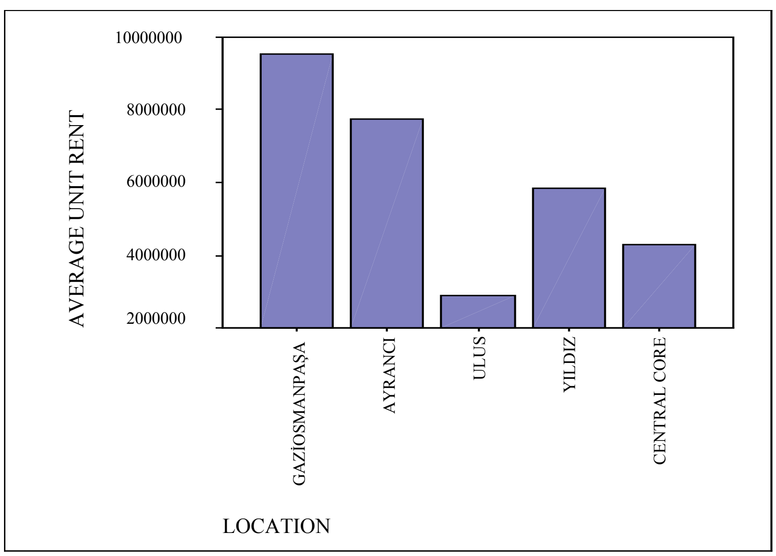

Figure 2 Variation of Average Monthly Net Unit Rent Across Location

amount of average net unit rents that they generate: Offices in Ayrancı District generate higher average net unit rents.

Table 1 specifies the summary statistics for the quantitative variables such as RENT, TOTFLOOR, OFAREA and AGE for the five sub-areas. Among all the 244 actual transacted rents, the minimum amount of net unit rent is 966.942 TL observed in the office market in the central core and the maximum net unit rent is 31.886.000 TL observed in Gaziosmanpaşa District. As stated before, the sample includes office units whose areas vary from 10 to 2420 square meters. The minimum and maximum office areas i.e. 10 m^2 and 2420 m^2 are observed in the central core.

Descriptive statistics for the variable TOTFLOOR show that the office buildings in Gaziosmanpaşa vary from one-storey to four-storey buildings and those are the lowest buildings of all. In contrast, office buildings in the central core include a wide range of multi-storey buildings varying from three-storey to twenty-storey buildings and those are the highest buildings on average. Considering the average values reported for the variable TOTFLOOR in the 5 sub-areas, it is important to note that office buildings included in the sample ranges from three-storey to six-storey buildings, on average.

Finally, it can be observed from Table 1 that office buildings in the sub-area, Yıldız, are newly constructed compared with the buildings located in the other sub-areas. The average age of the buildings located in one of the five sub-areas vary from 13 to 26 years. By looking at the average ages, Yıldız can be considered as a newly constructed sub-area. In contrast, Ulus and the central core include older buildings; the former being the old city center and the latter being the existing city center. The buildings in Ayrancı have the highest value of average age. It is observed that there is no such a building which is totally constructed as an office space in Ayrancı District. The buildings are partly transferred from residence to office use and for that reason; the area is an existing

Table 1. Descriptive Statistics for the Quantitative Data with Their Descriptions

VARIABLES:

RENT: Monthly net actual rent of the office unit per square meter

TOTFLOOR: Total number of floors in the building

OFAREA: Area of the office unit in square meter

AGE: Age of the building

	Sample Size	Minimum	Maximum	Mean	Standard Deviation
SUBAREA1-GAZİOSMANPAŞA					
RENT	17	2857143	31886737	9543302	7735002.074
TOTFLOOR	17	1.00	4.00	2.941	.747
OFAREA	17	50.00	450.00	177.352	106.552
AGE	17	5.00	52.00	17.705	11.504
SUBAREA2-AYRANCI					
RENT	18	3529412	15000000	7730290	3822602.759
TOTFLOOR	18	2.00	7.00	4.333	1.028
OFAREA	18	12.00	90.00	42.888	23.516
AGE	18	7.00	40.00	26.333	8.950
SUBAREA3-ULUS					
RENT	16	1857143	4000000	2888707	545135.258
TOTFLOOR	16	3.00	9.00	4.562	1.711
OFAREA	16	14.00	280.00	75.687	76.984
AGE	16	3.00	79.00	22.187	19.027
SUBAREA4-YILDIZ					
RENT	8	4166667	9461090	5849303	1740732.583
TOTFLOOR	8	2.00	7.00	4.00	1.511
OFAREA	8	12.00	680.00	124.375	225.939
AGE	8	5.00	28.00	12.500	8.071
SUBAREA5-CENTRAL CORE					
RENT	185	966942	15700000	4290311	2285808.598
TOTFLOOR	185	3.00	20.00	5.940	2.184
OFAREA	185	10.00	2420.00	166.805	233.229
AGE	185	1.00	56.00	24.524	10.472

sub-area rather than a newly constructed sub-area including old office buildings some part of which is used as a residence.

4.2. Specification of the Model

As discussed in Chapter 2, Rosen (1974) pointed out that "observed product prices of differentiated goods define a set of implicit or hedonic prices associated with each characteristic of the differentiated goods" (Rosen, 1974: 34). According to the Rosen's hedonic theory, implicit prices are estimated by the first-step regression analysis (regressing product price on characteristics) in order to construct hedonic price indexes. Hedonic equation which is subject to the regression analysis is written as:

$$P(Z) = \alpha_0 + \sum_{i=1}^{n} \alpha_i Z_i + \varepsilon \ , \qquad \text{(see equation 2.2)}$$

Based on the hedonic theory constructed by Rosen (1974), present study concerns with the estimation of hedonic price function in order to identify and quantify the significant determinants of value in the form of implicit or hedonic prices. The present study is similar with the model constructed by Brennan, Cannaday and Colwell (1984) (see Chapter 3). Demand side attributes are used to construct rental price indices and net *actual* transacted rents are used as the dependent variable. Individual office space is the unit of observation and in addition to physical and locational characteristics; lease characteristics of the office property are included in the data set. In this case, equation (2.2) can be written as;

$$R(Z) = \alpha_0 + \sum_{i=1}^{n} \alpha_i Z_i + \varepsilon \ , \qquad (4.1)$$

Where R(Z) is the net actual monthly rent per square meter, α 's are the regression coefficients, ε is the error term and Z_i's are the independent variables constructed under three categories: Location, physical characteristics and lease characteristics (see Chapter 2 section 2.1 for the determinants of rental value). The details of these characteristics will be explained under the next section.

4.3. Variable Definitions

Three main types of data such as location, physical characteristics and lease (transfer) characteristics of the office units were collected through the questionnaire. The data collected on each rental office space can be summarized as follows:

1)- Physical Characteristics

-Functional efficiency (whether the building was designed as an office space or transformed from residence to office use),

-Size-capacity (size of the office unit, size of the building-if the tenant uses the entire building),

-Occupancy (occupancy rate of a particular building),

-Internal accessibility (unit's vertical location in the building, existence of a lift, quality of the staircase),

-Internal services (air conditioning, heating, security system, parking facilities, shopping center, generator, fire escape/fire extinguishing system, kitchen and/or lavatory, floor/wall covering),

-Physical structure (total number of floors in the building, construction quality, image of the entrance),

-Physical depreciation (age of the building),

2)- Lease (Transfer) Characteristics

- Net actual rent in TLs per square meter per month,
- Term of the lease,
- Percentage of rent escalation,
- Whether the tenant paid a deposit or not,

3)- Location of the building.

Among the variables listed above, some of them were not included in the analysis. These are occupancy rate, lift, fire escape, heating, kitchen-lavatory, and quality of the entrance and the staircase. Occupancy rate variable is excluded because there are missing values for this variable in the model specified for the 244 offices. The existence of a lift and a fire escape are positively correlated with the total number of floors and the attributes related to the quality of the building, respectively. On the other hand, the quality of the entrance and the staircase are positively correlated with the construction quality of the building. Therefore, these variables are excluded from the analysis as they are also represented by the other variables included in the model. Finally, it is important to mention that almost all the offices have the services, heating and kitchen-lavatory either provided by the building or the office unit. Therefore, the existence of these services are considered to be insignificant and excluded from the analysis.

The details of the remaining variables are shown in Table B.2 in Appendix B. As it can be seen from Table B.2, most of the explanatory variables are expressed as dummy variables and some variables related to location, building design, and unit's vertical location need further clarification.

The variables representing the location will be explained first. In order to construct location variables, the whole area including 15 neighborhoods[32] is divided into 5 sub-areas.[33] Distance from the central core is an important factor which determines the boundaries of these sub-areas. Furthermore, these sub-areas differ from each other in the sense that offices in the same sub-area have similar

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[32] At first, 16 neighborhoods were specified to be included in the analysis (see Table B.1 in Appendix B). Because the number of offices which were taken as a sample from Balgat was small, Balgat is excluded from the analysis and the remaining 15 neighborhoods are used in the study.

[33] As explained in Chapter 3, Türel (1981) assumed that there is spatial variation in the rental prices of housing market in Ankara. Consequently, the metropolitan area is divided into 8 sub-areas to capture the rental price variations. His results confirmed that there is a rental price variation across location in the southern region of the city. Similarly, rental price variations across location are assumed to hold in the office market in Ankara and for that reason, the whole area-including 15 neighborhoods is divided into 5 sub-areas to capture the locational rent variations.

characteristics and similar rental prices. The sub-areas and the neighborhoods in each sub-area are given in Table B.2 (in Appendix B).[34] The central core is chosen as the base category[35] and the dummies, SUBAREA1, SUBAREA2, SUBAREA3, and SUBAREA4 are specified for the remaining 4 sub-areas.

The office buildings in Ankara differ in their architectural design. There are three types of buildings which house the office activities: Buildings in the first category were designed as an office space, buildings in the second category were transformed from residence to office use, and buildings in the third category are used for both housing and office activities. Two dummies, DESIGN1 and DESIGN2, are specified. The former represents the buildings designed as an office space, and the latter is for the buildings transformed from residence to office use. The buildings used for both housing and office activities are chosen as the base category.

Lastly, variables related to the unit's vertical location will be explained. Unit's location in the building is confined to three cases: Unit might be in the basement floor, in the ground floor, or it might be in the upper floors. Basement floors are represented by the variable OFFLOOR1 and ground floors are represented by OFFLOOR2. The offices in the upper floors are taken as the base category.

4.4. Hypotheses and Comments on the Expected Signs of the Coefficients

Before estimating the hedonic price model, several hypotheses were developed about the expected signs of the coefficients. The first set of hypothesis is related to the physical characteristics of the building which include functional efficiency, internal accessibility, internal services, physical structure, and physical depreciation.

[34] See map of Ankara in Appendix E for the illustration of the 5 sub-areas.
[35] The category that is assigned the value of 0 is called the base category.

For the functional efficiency, the variables DESIGN1 and DESIGN2 are specified. The design of the building is important as it indicates how well the structure accomplishes its intended function.[36] Deviation from ideal design is resulted in decline in functional efficiency and a consequent decline in productivity. Hence, it can be concluded that offices with low productive capacities would generate lower rents compared with those with high productive capacities. Because tenants may prefer the buildings which were designed as an office space to benefit from functional efficiency, the coefficient of DESIGN1 is assumed to be positively related to the rental price. The variable DESIGN2 is also expected to be directly related to rent. It is assumed that the buildings totally transferred from residence to office use will generate higher rents compared with the buildings used for both housing and office activities. The mixed usage will cause a loss of prestige and will decrease the property's ability to command higher rents.

The variables included in the internal accessibility category, OFFLOOR1 and OFFLOOR2, relate to the accessibility of the office unit. OFFLOOR2 represents the offices in the ground floor. Due to their easy accessibility, it is expected that the offices in the ground floor generate higher rents compared with those in the upper floors. On the other hand, the variable OFFLOOR1 indicates whether the unit is in the basement floor or not. The prestige of the unit is negatively affected by being in the basement floor and therefore, the coefficient of OFFLOOR1 is expected to be negative.

The existence of internal services is also assumed to be directly related to the office rent as the existence of such services adds value to either office building or office unit. The variables which represent the internal services are AIRCOND, SECUR, PARK, SHOPP, GENER, and INTDESIGN (see Table B.2 in Appendix B).

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[36] See the explanation on functional efficiency in Chapter 2.

Physical structure of the building is represented by the variables QCONST and TOTFLOOR. The coefficients of these variables are expected to be positive. The reason is that the quality of the construction elements and the additional elements affect construction costs and consequently, they give rise to both price and rental price. The rationale for TOTFLOOR needs further explanation: TOTFLOOR represents the total number of floors in a building and its coefficient shows the relationship between the height of the building and the rental price. The rationale is that higher buildings tend to be built where land is more expensive. Therefore, not only construction costs but also high land prices affect the cost of high buildings which is resulted in high prices and rental prices. By looking from the demand side, it can be stated that the two physical characteristics of the building, denoted by QCONST and TOTFLOOR, affect the prestige of the building and therefore, are highly valued by the users of the office space.

Age of the building is a measure for the physical depreciation. Older buildings do not generate incomes equal to those of new buildings because of the high repair and maintenance expenditures. These additional expenditures have a negative impact on the rental income of the property. As a result, the coefficient of AGE is assumed to be inversely related to the rental price.

Another set of hypotheses is developed concerning the lease characteristics of the office property which include LEASE, CPI and DEPOSIT. LEASE measures the effect of the length of a lease on rental prices. It is assumed that rent is higher if the lease is with a new tenant and is lower if it is a renewal of an existing lease. The rationale is that both landlords and tenants prefer longer to shorter leases in order to escape from transaction costs. “Besides transaction costs, landlords will try to escape from vacancy costs while tenants will try to avoid moving costs” (Brennan, Cannaday and Colwell, 1984: 253). In the present model, the tenancies up to 3 years[37] are evaluated as new tenancies and are compared with the

[37] In Türel’s model (see Chapter 3), new tenancies are represented by the dummy which takes one if the tenancy is more than three years. His results confirmed that this dummy is significant with an expected negative sign.

tenancies more than 3 years. Based on these assumptions, the coefficient of LEASE is expected to be positive implying that rent is higher for new tenants compared with old tenants.

Specification of the amount of rent escalation is an important feature of a lease. It is important in the sense that it determines the amount of rental payment that must be paid by the tenant to the landlord. In the present model, the nature of the rent escalation is represented by the dummy CPI. CPI shows whether the rent is subject to a Consumer/Wholesale Price Index escalation or not[38]. It is expected that the initial rents that will be subject to Consumer/Wholesale Price Index escalation will be low. The reason is that

> Landlords feel themselves protected against unexpected fluctuations in inflation and the risk of unexpected changes in inflation will pass on to the tenant; therefore, the tenant must be compensated for tolerating this risk by charging a lower initial rent.[39]

DEPOSIT is the last variable included in the lease characteristics of the office property. It indicates whether the tenant paid a security deposit[40] to the landlord or not. The reason for demanding a security deposit is that

> Landlords often cannot predict a tenant's future behavior and they will be willing to protect themselves against damages to the premise or damages brought about by wrongful abandonment (Benjamin, Shilling and Sirmans, 1992: 261).

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[38] In Turkey, issues on tenants and tenancy are regulated by Law No. 6570. The articles regulating the rent escalation through rent control policy were cancelled in 1963. To date the issues on rent escalations have been regulated by the Court of Cassation. According to the decree of the Court of Cassation, in the last years, the legal rent escalation rate in Turkey is decided to be 70 percent of the WPI (Wholesale Price Index). Given this information, it is clear that the variable CPI also represents the rental escalations that were decided to be 70 percent of the WPI. Therefore, it can be stated that the initial rents that will be subject to 70 percent of WPI escalation will be low. The reason is the same as the one explained for the initial rents that will be subject to CPI or WPI escalation.

[39] See Brennan, Cannaday and Colwell, 1984; Webb and Fisher, 1996.

[40] Security deposit is "a fixed amount of money given by a tenant to the landlord to insure performance of the covenants of the lease" (Karvel and Unger, 1991: 256).

By looking from the tenant's side, it can be stated that "they give up the yield that they can gain if they invest the money instead of giving it as a security deposit" (Benjamin, Shilling and Sirmans, 1992: 261). Therefore, tenants face up with the opportunity cost of the foregone interest on security deposits. It is hypothesized that low rents are charged from the tenants having rental contracts with security deposits to compensate them for the foregone interest on security deposits. Besides, security deposit reduces the risk of uncertainty in the tenant behavior and consequently, landlords will require lower rents from the tenants having contracts with security deposits compared with those having contracts without security deposits. Based on these assumptions, in the present model, the coefficient of DEPOSIT is expected to be negatively related to rent.

Finally, hypotheses about the locational characteristics will be explained. The four location dummies which are associated with the four sub-areas act as proxies for the three locational characteristics specified as; linkages, site access and transportation patterns and neighborhood influences (see locational characteristics in Chapter 2). The coefficients of these dummies show the contribution of locational advantages or disadvantages to the property value in comparison with the sub-area chosen as the base category. In our case, central core is chosen as the base category and therefore, comparisons will be made according to the central core. In other words, by utilizing the location variables, locational rent variations of the offices situated in one of the four sub-areas will be identified in comparison with those located in the central core.

4.5. Estimation Results

The equation which is subject to the hedonic regression analysis is of the log-linear form;

$$\ln RENT_i (Z, D) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln Z_{ki} + \sum_{j=1}^{m} \beta_j D_{ji} + \varepsilon_i, \ i = 1, \ldots, N \qquad (4.2)$$

Where $\ln RENT_i$ is the natural log of net actual monthly rent (in TLs) per square meter of the i^{th} office unit, α_0 is the constant, α_k and β_j are the regression coefficients, $\ln Z_{ki}$ is the natural log of the quantitative explanatory variables, D_{ji}'s are the qualitative explanatory variables specified as 0-1 dummies, ε_i is the error term and N is the sample size.

Given the hedonic model specified in equation (4.2), two models were estimated by using the OLS estimation technique.[41] The models have in common a set of physical characteristics and a set of lease (transfer) characteristics. However, the first model differs from the second model in including the locational characteristics. Excluding the locational characteristics from the second model provides means for identifying the effect of the use of non-locational attributes as proxies for the locational characteristics. On the other hand, including the locational characteristics in the first model is useful in identifying the effect of locational characteristics on the rental value of the office property. In other words, the two models namely, Model 1 and Model 2 are constructed in order to compare the effect of the use of locational characteristics with the use of their proxies. The two models are specified in general terms and are given below:

MODEL 1: R = f (Locational Characteristics, Lease Characteristics, Physical Characteristics) (4.3)

MODEL 2: R = f (Lease Characteristics, Physical Characteristics) (4.4)

Where R is the rental price of the office unit per square meter and the independent variables are as described before (see section 4.3). The estimation results of these two models will be examined in the following sub-sections.

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[41] The estimation process is carried out by using SPSS 11.0 and Microfit 4.0 softwares.

4.5.1. Estimation Results of Model 1 and Model 2

Hedonic equation-equation (4.2)- was estimated with the OLS estimation method for each of the two models by employing the data obtained from 244 office units. Estimation results of Model 1 and Model 2 are presented in Table 2 and Table 3, respectively.

Estimation results show that almost all the variables in each model have the expected signs as hypothesized in section 4.4. However, there are some variables which are insignificant in both models. These are the variables related to the lease characteristics of the property (DEPOSIT, CPI, and LEASE) and the physical characteristics related to internal services (SHOPP, PARK, and AIRCOND), internal accessibility (OFFLOOR1) and physical depreciation (lnAGE). Although they are insignificant, LEASE and CPI have the expected positive and negative coefficients, respectively. In contrast, DEPOSIT has an unexpected positive coefficient. Among the physical characteristics of the office property, OFFLOOR1 and AIRCOND have the hypothesized negative and positive effects on the rental prices in both models. The variable lnAGE has the correct negative sign in Model 2 but has an unexpected positive sign in Model 1. The reverse is true for the variable PARK considering its expected coefficient: PARK is positively related to rent in Model 1 while it has an unexpected negative effect on rent in Model 2. Finally, it can be seen from the estimation results that the variable SHOPP is negative in both models reflecting the effect of the existence of worn out shopping centers in the buildings. This variable probably acts as a proxy for the age of the building; however it is insignificant in both models.

It is important to mention that the two variables, lnTOTFLOOR and QCONST, are not significant in Model 1 but they are significant at either 0.05 or 0.10 significance level in Model 2. Because locational characteristics were not included in Model 2, this result implies that total number of floors in the building

Table 2. Estimation Results of Model 1

Model*	R	R Square	Adjusted R Square	Standard Error of the Estimate
1	.674	.454	.402	.40080

Variables**	Unstandardized Coefficients		t	Significance Level	Collinearity Statistics***	
	B	Standard Error			Tolerance	VIF
(Constant)	15.753	.301	52.325	.000		
SUBAREA1	.588	.134	4.378	.000	.563	1.776
SUBAREA2	.456	.134	3.395	.001	.534	1.872
SUBAREA3	-.451	.121	-3.728	.000	.735	1.361
SUBAREA4	.507	.170	2.977	.003	.715	1.398
DEPOSIT	.021	.055	.390	.697	.881	1.136
CPı	-.020	.065	-.311	.756	.866	1.154
LEASE	.081	.058	1.408	.161	.796	1.256
lnTOTFLOOR	-.081	.088	-.915	.361	.573	1.745
DESIGN1	.280	.073	3.830	.000	.514	1.944
DESİGN2	.346	.079	4.372	.000	.646	1.547
SHOPP	-.117	.078	-1.492	.137	.741	1.350
QCONST	.090	.058	1.545	.124	.786	1.272
lnOFAREA	-.196	.036	-5.507	.000	.712	1.404
OFFLOOR1	-.356	.225	-1.579	.116	.805	1.242
OFFLOOR2	.218	.097	2.257	.025	.504	1.984
lnAGE	.023	.049	.461	.645	.705	1.418
PARK	.023	.056	.415	.679	.852	1.174
AIRCOND	.089	.078	1.135	.258	.896	1.116
GENER	.249	.120	2.067	.040	.787	1.271
SECUR	.255	.070	3.620	.000	.760	1.315
INTDESGN	.224	.094	2.370	.019	.865	1.156

* Dependent Variable: lnRENT; see Table B.2 in Appendix B for the explanation of independent variables.

** If the coefficient is for the natural log of an independent variable, the variable is indicated by [ln *Variable Code*].

*** The collinearity statistics showed that there is no multicollinearity problem at a significant level in Model 1. The explanation of the multicollinearity problem and the collinearity statistics are given in section D.1 in Appendix D.

Table 3. Estimation Results of Model 2

Model*	R	R Square	Adjusted R Square	Standard Error of the Estimate
2	.570	.325	.275	.44156

Variables**	Unstandardized Coefficients		t	Significance Level	Collinearity Statistics***	
	B	Standard Error			Tolerance	VIF
(Constant)	16.133	.281	57.452	.000		
DEPOSIT	.068	.059	1.154	.250	.930	1.075
CPı	-.062	.070	-.876	.382	.888	1.127
LEASE	.058	.062	.933	.352	.829	1.206
lnTOTFLOOR	-.189	.086	-2.208	.028	.741	1.349
DESIGN1	.156	.078	1.995	.047	.549	1.822
DESİGN2	.262	.086	3.047	.003	.661	1.512
SHOPP	-.107	.083	-1.288	.199	.800	1.251
QCONST	.106	.063	1.688	.093	.805	1.242
lnOFAREA	-.194	.037	-5.270	.000	.812	1.231
OFFLOOR1	.002	.233	.007	.995	.910	1.099
OFFLOOR2	.445	.090	4.975	.000	.714	1.402
lnAGE	-.023	.052	-.447	.655	.784	1.276
PARK	-.004	.061	-.062	.951	.880	1.136
AIRCOND	.095	.085	1.117	.265	.912	1.096
GENER	.348	.131	2.651	.009	.805	1.243
SECUR	.250	.077	3.233	.001	.763	1.311
INTDESGN	.236	.100	2.352	.020	.930	1.075

* Dependent Variable: lnRENT; see Table B.2 in Appendix B for the explanation of independent variables.

** If the coefficient is for the natural log of an independent variable, the variable is indicated by [ln *Variable Code*].

*** The collinearity statistics showed that there is no multicollinearity problem at a significant level in Model2. See section D.1 in Appendix D for the collinearity statistics.

and construction quality of the building act as proxies for the locational characteristics of the building. This is not an unexpected result considering the fact that height and construction quality of the building are closely related to the locational characteristics. The rationale for the height of the building can be related to the density constraints: At different sites, the density of an area is controlled by the density constraints reflected by height or floor area ratio limits. For instance, the density constraints determined for the site may permit investors to construct higher buildings in one site and lower buildings in other locations. This implies that the height of the buildings in the same location do not vary widely because the density constraints determined for that location is nearly the same. As the height of the buildings in the same site show similar characteristics, building height is a good representative of the location.

Coming to the construction quality of the building, it can be claimed that both architectural design and construction quality of the building are the prior factors in determining the reputation of an area. Because of the locational preference of more affluent firms, prestigious buildings are constructed in certain locations adding value to the selected sites. On the other hand, in less preferable sites, the buildings are in low quality compared with the buildings that are preferred by more affluent firms. This indicates that construction quality and locational characteristics of a building are correlated in some degree. Therefore, construction quality of the building may act as a proxy for the locational characteristics.

In order to identify the significant determinants of the rental value and compare the effect of the use of locational characteristics with the use of their proxies, the two models were re-estimated for the significant variables again by using the OLS estimation method. The estimation results are given in Table 4 and Table 5.

As it can be seen from Table 4, the variables, LEASE and OFFLOOR1, became significant after excluding the insignificant variables from Model 1. It can be suggested that these two variables might be correlated with the variables which were initially included in the model and excluded from the model according to their significance levels. These excluded variables can be seen from Table 2.

The results obtained for Model 1 and Model 2 again verify that height and construction quality of the building act as proxies for the locational characteristics. Considering the expected signs of their coefficients, it can be observed from Table 5 that quality of the construction elements are directly related to the rental price as indicated by the positive sign on the coefficient of QCONST. In contrast, total number of floors in the building has a negative instead of a positive effect on the rental prices. Because height of the building is a

Table 4. Estimation Results of the Model 1 for the Variables with the Significance Level of 10 % or Less

Model*	R	R Square	Adjusted R Square	Standard Error of the Estimate
1	.662	.438	.406	.39963

Variables	Unstandardized Coefficients		t	Significance Level	Collinearity Statistics	
	B	Standard Error			Tolerance	VIF
(Constant)	15.686	.178	88.308	.000		
SUBAREA1	.636	.120	5.311	.000	.704	1.420
SUBAREA2	.451	.130	3.469	.001	.567	1.764
SUBAREA3	-.484	.111	-4.381	.000	.874	1.144
SUBAREA4	.475	.156	3.041	.003	.848	1.180
LEASE	.089	.053	1.667	.097	.927	1.078
DESIGN1	.255	.069	3.695	.000	.574	1.742
DESİGN2	.336	.078	4.305	.000	.659	1.518
lnOFAREA	-.183	.034	-5.322	.000	.760	1.316
OFFLOOR1	-.363	.218	-1.666	.097	.853	1.172
OFFLOOR2	.228	.095	2.383	.018	.514	1.947
GENER	.259	.117	2.209	.028	.826	1.211
SECUR	.269	.068	3.963	.000	.811	1.233
INTDESGN	.226	.094	2.416	.016	.876	1.142

* Dependent Variable: lnRENT

proxy for the locational characteristics, the unexpected sign on TOTFLOOR can be related to the existence of high buildings in less preferable locations. The reason for the existence of high buildings in less preferable sites can be related to the density constraints. In less preferable sites, the density constraints determined for the site may permit investors to construct higher buildings compared with the buildings in most preferable locations. In such a case, we expect higher unit rents in lower buildings since the locational advantages and the stricter density constraints will have stronger effect on rents. As a result, the total number of floors and the unit rents are expected to be inversely related. The negative sign on TOTFLOOR confirms this assumption.

From Model 1 which incorporates the location variables, it can be seen that the location dummies have the greatest effect on the rental prices of the office units.

Table 5. Estimation Results of the Model 2 for the Variables with the Significance Level of 10 % or Less

Model*	R	R Square	Adjusted R Square	Standard Error of the Estimate
2	.553	.306	.279	.44021

Variables	Unstandardized Coefficients		t	Significance Level	Collinearity Statistics	
	B	Standard Error			Tolerance	VIF
(Constant)	16.128	.212	75.987	.000		
lnTOTFLOOR	-.201	.079	-2.544	.012	.866	1.155
DESIGN1	.134	.075	1.790	.075	.590	1.694
DESİGN2	.231	.083	2.771	.006	.702	1.424
QCONST	.097	.061	1.599	.111	.858	1.165
lnOFAREA	-.193	.035	-5.445	.000	.874	1.145
OFFLOOR2	.443	.088	5.025	.000	.732	1.366
GENER	.352	.129	2.731	.007	.831	1.204
SECUR	.265	.076	3.492	.001	.792	1.262
INTDESGN	.243	.099	2.448	.015	.947	1.055

* Dependent Variable: lnRENT

Considering the magnitudes of the four location variables in Model 1 (see Table 4), it can be stated that locational characteristics are important in explaining the rental price variations. In order to verify this fact, Model 1, which differs from Model 2 in including the location variables, is tested against Model 2 and vice versa based on alternative tests for non-nested models. The results of non-nested tests and their details are given below.

4.5.2. Non-Nested Tests for Model 1 and Model 2

Non-nested hypothesis testing applied to Model 1 and Model 2 provides means for selecting the best model. Model 1 and Model 2 are non-nested because the explanatory variables under one model are not a subset of the other model even though they share some common explanatory variables. In order to apply the non-nested tests, the following hypotheses are formulated:

H_0: R = $\beta_1 + X\beta_2 + Z\beta_3 + u$

H_1: R = $\alpha_1 + X\alpha_2 + W\alpha_3 + v$

Where R is the $T \times 1$ vector of observations on the dependent variable, lnRENT, X's are the $T \times k$ observation matrices for the common[42] regressors of Model 1 and Model 2, Z and W are $T \times k_1$ and $T \times k_2$ observation matrices for the different[43] regressors of Model 1 and Model 2, $\alpha's$ and $\beta's$ are unknown regression coefficient vectors, and u and v are the $T \times 1$ disturbance vectors. Null hypothesis, H_0, is initially formulated for Model 1 against the alternative hypothesis, H_1, which is formulated for Model 2 and vice versa. In the hypothesis testing process, it is examined "whether there is any statistical significant evidence of departure

[42] The regressors including DESIGN1, DESIGN2, lnOFAREA, GENER, SECUR, INTDESIGN, and OFFLOOR2 are common in both models.

[43] Different from Model 2, Model 1 incorporates the variables, SUBAREA1, SUBAREA2, SUBAREA3, SUBAREA4, OFFLOOR1, LEASE and different from Model 1, Model 2 includes lnTOTFLOOR and QCONST.

Table 6. Non-Nested Tests for Model 1 and Model 2

Sample Size: 244

Dependent Variable: lnRENT

Regressors for Model 1 (M1):

Constant	GENER	SUBAREA1	OFFLOOR1
DESIGN1	SECUR	SUBAREA2	LEASE
DESIGN2	INTDESIGN	SUBAREA3	
lnOFAREA	OFFLOOR2	SUBAREA4	

Regressors for Model 2 (M2):

Constant	GENER	lnTOTFLOOR
DESIGN1	SECUR	QCONST
DESIGN2	INTDESIGN	
lnOFAREA	OFFLOOR2	

Test Statistic[a]	**M1 against M2**	**M2 against M1**
NT-Test	-1.4927 [.136]	-12.2501 [.000]
W-Test	-1.4784 [.139]	-11.0238 [.000]
J Test	1.6791 [.093]	7.5863 [.000]
Encompassing Test	1.4566 [.235] F (2, 228)	9.4596 [.000] F (6, 228)

Model 1 (M1): R-Bar-Squared .40526; Log-likelihood -115.2571

Model 2 (M2): R-Bar-Squared .27912; Log-likelihood -140.8277

Model M1+M2: R-Bar-Squared .40762; Log-likelihood -113.7081

AIC[b] **of M1 versus M2 =** 21.5707 favors M1

SBC[c] **of M1 versus M2 =** 14.5763 favors M1

[a] The detailed explanation of the test statistics are given in section D.3 in Appendix D.
[b] Akaike Information Criterion
[c] Schwarz Bayesian Criterion

from the null hypothesis in the direction of the alternative hypothesis" (Pesaran and Weeks, 2001: 287).

The results of non-nested tests performed under four different approaches are summarized in Table 6. The results based on the choice criteria, AIC (Akaike Information Criterion) and SBC (Schwarz Bayesian Criterion), are also presented at the bottom of the table. The first column in the table, displays the results of the statistics for the test of Model 1 against Model 2 with the significance levels in parentheses. Similarly, the results for the test of Model 2 against Model 1 are given in the second column (See section D.3 in Appendix D for the explanation of the test statistics).

The results of non-nested tests displayed in the first column show that null hypothesis formulated for Model 1 can not be rejected as Model 1 is found to be significant. On the other hand, the results presented in the second column indicate that the null hypothesis specified for Model 2 is rejected against the alternative specified for Model 1. It can be also seen from Table 6 that the choice criteria, AIC and SBC, support Model 1 in favor of Model 2.

Based on these results, it can be finally stated that Model 1 which incorporates the location variables is preferred to Model 2. This result is important in the sense that the model which includes the locational characteristics is found to be significant and is chosen to be the best model. Therefore, further attention will be on Model 1 and the results of the model are evaluated in detail under the next section.

4.5.3. Evaluation of the Results of Model 1

Estimation results of Model 1 presented in Table 4 show that all the variables have the expected signs as hypothesized in section 4.4. In order to evaluate the coefficients of the qualitative variables-namely the dummies, their adjusted coefficients were calculated through the Kennedy adjustment process.[44] The adjusted-coefficients indicate the relative effect on the mean value of RENT of the presence of the factor represented by the dummy variable (see section D.2 in Appendix D). The adjusted coefficients computed for the dummy variables in Model 1[45] are given in Table 7.

Table 7 presents that locational characteristics have the greatest effect on office rents in Ankara. The location dummies were specified for the 4 sub-areas, namely Gaziosmanpaşa, Ayrancı, Ulus, and Yıldız. Among them, offices in Gaziosmanpaşa have the highest rent premium. That they are located in Gaziosmanpaşa District increases the rental prices of the offices by about 88 %. Office buildings in Ayrancı and Yıldız have 55 % and 59 % rent premiums, respectively, over the buildings located in the central core. SUBAREA3 is the only variable that has a negative coefficient among the four location variables. It represents the sub-area, Ulus, and its coefficient equals to -0.38. The negative sign indicates that buildings located in Ulus District generate lower rents compared with the buildings located in the central core. This is not an unexpected result considering the present situation of Ulus: Being located in the northern part of the city, Ulus is the old city center comprising historical buildings. Ulus lost its importance since the main shopping center shifted from Ulus to Kızılay. Thereafter, Ulus cannot benefit from the linkage advantages provided by the existing CBD and confront with the undesirable neighborhood influences prevailing since then. Due to the negative externalities and linkage disadvantages, it is rational to expect that the offices in Ulus District generate lower rents

[44] In the log-linear models-in our case it is the model specified in equation (4.2), the coefficient of the quantitative variable gives the elasticity of rental price with respect to the increase in the attribute. However, the same evaluation cannot be made for the qualitative variables-namely the dummies. The methods for the interpretation of dummy variables in semi-logarithmic equations are proposed by Halvorsen and Palmquist (1980), and Kennedy (1981). The details of the interpretation of dummy variables in logarithmic models are given in section D.2 in Appendix D.

[45] Three diagnostic tests were applied to the model. The results (see Table C.1 in Appendix C) indicate that the null hypothesis of no specification error in the functional form is rejected at 5% significance level. The other diagnostic tests applied to Model 1 give appropriate results.

compared with the offices in the central core. The negative sign on SUBAREA3 confirms this fact.

The coefficients of DESIGN1 and DESIGN2 verify the hypothesis that convergence to ideal design will increase functional efficiency and as a result, increase productivity. Their positive coefficients indicate that increase in the demand for the office buildings which are relatively more efficient will result in higher rental prices. Indeed, buildings designed as an office space and buildings totally transformed from residence to office use have 28 % and 39 % rent premiums, respectively, over the buildings which are both used as an office and a residence. The positive coefficient on DESIGN2 verifies that buildings totally transferred from residence to office use command higher rents compared with the buildings that are used for both housing and office activities. This implies that the

Table 7. Adjusted Coefficients Computed for Model 1 for the Qualitative Variables with the Significance Level of 10 % or Less

Variables	Unstandardized Coefficients		Standard Error	t (Significance Level)
	B	**Adjusted Coefficients***		
(Constant)	15.686	**-**	.178	88.308(.000)
SUBAREA1	.636	**.875**	.120	5.311(.000)
SUBAREA2	.451	**.557**	.130	3.469(.001)
SUBAREA3	-.484	**-.387**	.111	-4.381(.000)
SUBAREA4	.475	**.589**	.156	3.041(.003)
LEASE	.089	**.092**	.053	1.667(.097)
DESIGN1	.255	**.287**	.069	3.695(.000)
DESİGN2	.336	**.395**	.078	4.305(.000)
lnOFAREA	-.183	**-**	.034	-5.322(.000)
OFFLOOR1	-.363	**-.321**	.218	-1.666(.097)
OFFLOOR2	.228	**.250**	.095	2.383(.018)
GENER	.259	**.287**	.117	2.209(.028)
SECUR	.269	**.306**	.068	3.963(.000)
INTDESGN	.226	**.248**	.094	2.416(.016)

* See section D. 2 in Appendix D for the explanation of adjusted coefficients.

mixed usage of the residential buildings causes a loss of prestige and decreases the properties ability to command higher rents. Besides the functional efficiency, being accessible is also an important factor for the users of the office units. The positive coefficient on OFFLOOR2 implies that the offices in the ground floor are valued at higher rental prices compared with those in upper floors. It is observed that most of the office buildings do not have an elevator and even if there is an elevator, it is either useless or insecure. The staircase in these buildings is either narrow or not well-kept. These drawbacks cause difficulties in the accessibility of the office units in the upper floors. Considering these drawbacks, the current users value the office units in the ground floor at higher rental rates as indicated by the positive coefficient on OFFLOOR2. The basement floors are also not preferred by the tenants in the sense that being located in the basement floor has a negative effect on the prestige of the office unit. This is verified by the negative sign of the variable OFFLOOR1.

SECUR, GENER, and INTDESIGN have the expected positive signs implying that the existence of such internal services add value to the property. However, among them, SECUR affects the rental prices the most: The existence of a security system either in the building or in the office unit causes approximately a 30 percent increase in the rental prices, holding other variables constant. Besides the magnitude of the coefficient on SECUR, the coefficients of GENER and INTDESIGN are reasonably high. These results imply that the provision of such internal services must be a proxy for the other characteristics of the office property not included in the regression, rather than a highly desirable attribute of their own. For instance, it is observed that the buildings, which have security system and/or generator, are mostly high quality buildings and therefore, the variables, SECUR and GENER, may also represent these buildings which were constructed with high quality construction elements. Not only the costs of providing a generator and security system but also the costs of the high quality construction materials affect the construction costs of these buildings. Furthermore, high quality buildings are short in supply and are highly valued by the users of the office space. Considering high construction costs and supply shortage, both price and rental price are higher in these buildings. Given that the variables, GENER and SECUR, represent the high quality buildings providing the services, generator and security system, the magnitudes of their coefficients are reasonable. Similarly, it can be suggested that the office units, which have high quality wall covering and/or floor covering are either designed with high quality interior construction elements or located in high quality buildings. Therefore, rental prices of these types of offices are also high and this is reflected in the magnitude of the coefficient on INTDESIGN.

Among the lease characteristics of the office property, only the variable, LEASE, is significant in the final equation. The coefficient of LEASE has an expected positive sign indicating that landlords are likely to raise rents when their properties are occupied by new tenants rather than occupied by stable tenants. This result verifies the hypothesis that both landlords and tenants prefer longer to shorter leases as both of them try to escape from transaction costs. Therefore, it can be stated that both landlords and tenants are willing to accept lower unit rents in the case of an increase in the lease term.

The coefficient of the variable OFAREA is negative and gives the elasticity of rental price with respect to the increase in the size of the office unit. As it is indicated in Table 7, its elasticity coefficient is -0.18, implying that for a 1 percent increase in the size of the office unit, rental price of the unit decreases by about 0.18 percent. The coefficient on OFAREA reflects the market conditions in the area: The negative sign indicates that the increase in the size of the unit which is subject to a rental transaction will result in lower unit rents. This verifies the hypothesis developed by Brennan, Cannaday and Colwell (1984):

> The larger the size of the office unit the lower the unit rents the landlords would be willing to accept and the tenants would be willing to offer, holding other factors constant (Brennan, Cannaday and Colwell, 1984: 251).

From another point of view, it can be stated that the floor area of the office unit that is subject to the rental transaction is smaller in the buildings which are situated in central locations compared with those situated in distant locations. Because of the high land prices and a consequent rise in production costs, investors prefer capital intensive property investments to land intensive investments in the central locations. This is resulted in the construction of higher office buildings with small office units in more central locations where location rent is greater. With regard to these explanations, small office units in the buildings that are centrally located are expected to command higher unit rents in comparison with larger office units located in less preferable sites. Because few locational characteristics could be included in the model, the variable OFAREA probably represents both the location of the building and the size of the unit in that building. Therefore, the result obtained for OFAREA is reasonable as it indicates that increase in the size of the office unit results in lower unit rents. In other words, this result implies that larger office units in less preferable locations command lower unit rents in compared to those in preferable locations.

In considering the market for office space in Ankara, the estimation results confirm that there is spatial variation in the rental prices of the office property. This variation is mainly related to two factors: The first factor is related to the locational preference of more affluent firms whose willingness to pay is higher compared with the other firms. Their preference affects both the price and the rental price of the property as the existence of prestigious buildings adds value to the selected sites. In addition to this, the office buildings in those sites are in short supply since the supply of land is fixed at each location. Therefore, the increase in demand for these offices will result in both higher prices and rental prices. The second factor is related to the existence of geographical submarkets. The existence of submarkets causes rental price differentiations due to the fact that each submarket has specific supply and demand conditions, as well as specific locational and environmental characteristics. Also, the quality differences of the office property in each sub-area will cause rental price variations across different locations.

In the present study, hedonic methodology is applied for explaining the rental price variations of the office property. As mentioned earlier, the technique assumes a general equilibrium throughout the entire property market. In other words, the estimated hedonic prices are assumed to be the same across different submarkets and different properties. Therefore, it is not possible to identify the rental variations of each property by means of hedonic models. Despite its limitations, hedonic technique has an extensive usage in explaining the price variations in the property markets.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This study aimed to analyze the office rent determinants and their effects on rent variations in Ankara. The analysis is confined to office buildings which provide professional, financial and business services; other commercial properties are out of the scope of the study. The office property data referring to the period July 2002 to October 2002 was utilized in the study.

The study involves three main parts: In the first part, a theoretical framework is constructed for analyzing the rental price variations of the office property. At first, principal determinants of office rents are identified. Rental value of the office property is related to three factors: These are physical characteristics, locational characteristics and transfer (lease) characteristics. Following the explanations on the determinants of value, the theories on quality variations are discussed. In this section, the theories developed by Court (1941), Houthekker (1952), Muth (1966), Lancester (1966) and Rosen (1974) were explained briefly. Among these theories, Rosen's hedonic theory is the most important one, since he considers both consumer and producer behavior in the model constructed for differentiated products.

In the second part, empirical studies on hedonic price models are presented. The studies on hedonic analysis of office rents are from the World literature. These studies are classified into two groups: The first group examined the hedonic prices by employing the data on asking rents and the second group dealt with actual rent and lease data in order to construct the hedonic price function. The studies of Clapp (1980), Hough and Kratz (1983), Frew and Jud (1988), Vandell and Lane

(1989), Glascock, Jahanian and Sirmans (1990), Mills (1992), Sivitanidou (1995), Dunse and Jones (1998) were included in the first group. The second group involves fewer studies compared with the first group. The studies performed by Brennan, Cannaday and Colwell (1984), Wheaton and Torto (1994), and Webb and Fisher (1996) were examined under the second group. In contrast to the studies from the World literature, the two studies selected from the Turkish literature focused on the residential property markets. As there is no study concerning the commercial property in Turkey, the examples were selected from the empirical studies related to residential real estate. Therefore, in this section, the studies of Türel (1981) and Hasekioğlu (1997) which examined 'the determinants of housing prices in Turkey' were presented. At last, all the studies both in the World and in Turkish literature are summarized and evaluated.

In the third part, hedonic model is constructed in order to identify the significant determinants of rental value for the office property in Ankara. The hedonic analysis is carried out with the data obtained from a detailed questionnaire. Through the questionnaire, the data on location, physical characteristics and transfer (lease) characteristics of the office property were collected from the 16 neighborhoods in Ankara. These neighborhoods constitute the most important areas which are densely populated by office buildings. Therefore, rental price variations in the office market of Ankara could be explained to a large extent.

The present model is similar to the model constructed by Brennan, Cannaday and Colwell (1984). Hedonic price function is specified for the demand-side attributes of the office property and net actual transacted rents are used as the dependent variable. Since individual office space is the unit of observation, dependent variable is specified as 'net actual rent of the office unit per square meter'.

The hedonic equation is specified in the log-linear functional form. Demand side attributes of the office property, which is identified as location, physical characteristics and lease characteristics are represented by 20 variables. By utilizing the OLS estimation method, hedonic equation is estimated for two different models by using these variables: The models have in common a set of physical characteristics and a set of lease (transfer) characteristics. However, the first model differs from the second model in including the locational characteristics. These models were constructed in order to compare the effect of the use of locational characteristics with the use of their proxies.

The initial estimation results indicate that there are some common variables which are found to be insignificant in both models. These are the variables related to the lease characteristics of the property (deposit, CPI escalation, and new tenancy) and the physical characteristics related to internal services (shopping center, parking facilities, and air-conditioning), internal accessibility (basement floor) and physical depreciation (age of the building). Also, the results show that the two variables related to the height and construction quality of the building are not significant in Model 1 but they are found to be significant in Model 2. Because locational characteristics were not included in Model 2, this result implies that total number of floors in the building and construction quality of the building act as proxies for the locational characteristics of the building.

The two models were re-estimated for the significant variables again by using the OLS estimation method in order to identify the significant determinants of the rental value and compare the effect of the use of locational characteristics with the use of their proxies. The magnitudes of the location variables in Model 1 (see Table 4) imply that locational characteristics are important in explaining the rental price variations. In order to verify this fact, Model 1 is tested against Model 2 and vice versa based on alternative tests for non-nested models. Based on the results of non-nested tests, it is finally concluded that Model 1 which incorporates the location variables is preferred to Model 2. Therefore, the results obtained for Model 1 became the focus of interest.

Estimation results of Model 1 presented that rental value of the office property can be explained as a function of thirteen explanatory variables. Among the variables which represent internal services, three variables including generator, security system and high quality interior design of the office unit were found to be significant. The existence of these internal services has positive effects on the rental prices.

The design variables which relate to functional efficiency were found to be positively related with rent. It is concluded that the buildings either designed as an office space or totally transferred from residence to office use command higher rents compared with the buildings which are used for both residential and office activities. The accessibility of the office unit is also important and is positively valued by the current users of the rental office space. It can be seen from Table 7 that office units located in the ground floor generate higher rents compared with the offices in the upper floors. In contrast, offices in the basement generate lower rents as indicated by the negative sign on OFFLOOR1.

The size variable-size of the office unit- relates to the capacity of the office unit. Its negative coefficient indicates that the increase in the size of the office space results in lower unit rents. This result is the same as the one obtained by Brennan, Cannaday and Colwell (1984) for the office property in Chicago CBD.

Among the few variables related to lease characteristics, only the variable which represents new tenancies is found to be significant. Its positive coefficient verifies the hypothesis that landlords charge higher rents from new tenants compared with stable tenants. This coincides with the result obtained from Türel's (1981) model. However, Türel's study is based on hedonic analysis of the residential property and there is no study performed for commercial property in Turkey that we can compare our results.

As it can be observed from Table 7, three location variables associated with the three sub-areas, namely Gaziosmanpaşa, Ayrancı and Yıldız are positively related with rent. Among these sub-areas, offices in Gaziosmanpaşa have the highest rent premium. In contrast, offices situated in Ulus generate the lowest rents. This result is related to the undesirable neighborhood influences and the linkage disadvantages of Ulus. The magnitudes of these location variables show that locational characteristics are responsible for most of the rental price variations of the office property. Considering this result, it is finally concluded that locational characteristics explain the spatial rent variations of the office market in Ankara to a large extent.

This study is probably the first one which examines the rental price variations of the office property in Turkey. By employing the cross sectional data, hedonic price indices were constructed for the demand-side attributes of the office property. Despite the difficulties in the accessibility of the lease data, actual transacted rents and some of the lease characteristics of the office property were included in the hedonic analysis. As the analysis is performed for the areas which, serve as important centers for the office activities, this study is important in explaining the rental price variations of the office market in Ankara.

Previous studies indicated that hedonic analyses are not confined to cross sectional studies which focus on the demand side of the office market. There are hedonic analyses dealing with the supply side of the office market, studies on rent adjustment models, estimates of effective rents and analyses examining the relationship between rent levels and office vacancy rates. Therefore, future research should be directed toward these analyses in order to examine the different aspects of the office markets in Turkey.

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APPENDIX A

A QUESTIONAIRE BASED ON THE OFFICE RENT DETERMINANTS IN ANKARA

This questionnaire is prepared for constructing a model to identify the office rent determinants in Ankara. There are three main factors which determine the office rents: Location, physical characteristics and lease characteristics. These questions were prepared under these three headings.

The reliability of your answers to these questions is important in the sense that the results of this study be trustworthy.

Thank you for your attention and cooperation.

1. Address:
2. Building was
   ( ) constructed as an office space
   ( ) transformed from residence to office use
   ( ) Some part of the building is being used as a residence
3. Building contains a shopping center in the ground/basement floor
   ( ) Yes
   ( ) No
4. Building's entrance seems
   ( ) Luxury
   ( ) Good
   ( ) Not well-kept

5. Total number of floors in the building

( ) Ground floor and up:.....

( ) Basement floors:.....

6. Building has an elevator/elevators

( ) Yes ⇨ continue with the 7th question

( ) No ⇨ continue with the 8th question

7. Elevator is

( ) Secure and large

( ) Secure and small

( ) Insecure and large

( ) Insecure and small

8. Staircase is

( ) Wide

( ) Narrow

( ) Well-kept

( ) Not well-kept

9. Building's construction quality

( ) Construction material is luxury

( ) Construction material is high quality

( ) Construction material is low quality

( ) Construction material is worn-out

10. Tenant uses the total space in the building

( ) Yes ⇨ answer 11 and then continue with 14th question

( ) No ⇨ continue with the 12th question

11. Size of the building (m^2):

12. Size of the office unit (m^2):

13. Unit's vertical location in the building:

14. Age of the building:

15. Heating system

( ) Building has central heating system

( ) Office unit has its own heating system

( ) None

16. Kitchen/lavatory is

( ) in the common area

( ) in the office unit

( ) None

17. Wall covering of the office unit

( ) Plaster/paint

( ) Wall paper

( ) Wainscot

( ) Laminant

( ) Other....

18. Floor covering of the office unit

( ) Wooden parquet

( ) Carpet

( ) Laminant

( ) Other....

16. Building has open and/or covered parking

( ) Yes

( ) No

20. Building has fire escape and/or fire extinguishing system

( ) Yes

( ) No

21. Air-conditioning

( ) Building has air-conditioner

( ) Office unit has air-conditioner

( ) None

22. Security system

( ) Building has security system

( ) Office unit has security system

( ) None

23. Building and/or office unit has a generator

( ) Yes

( ) No

24. Office unit is used by

( ) a single firm

( ) two or more firms ⇨ The percentage of rent that the subject tenant is responsible to pay for........

25. Monthly paid rent → Property tax is excluded:.........
→ Property tax is included:..........

26. Commencement date of the lease:

27. Rent escalation is determined as a

( ) Percentage of increases in the Consumer/Wholesale Price Index ⇨ Continue with the 29th question

( ) Specified percentage increase in the lease

( ) Other...

28. The percentage of rent escalation:

29. The date and the percentage of previous rent escalation:

30. Tenant paid deposit

( ) Yes

( ) No

31. The amount of money paid for electricity+water+heating+other charges per month:

32. How many office units are there in the building and how many are vacant?

Thank you…

APPENDIX B

SAMPLE AND VARIABLES

(See Table B.1 and Table B.2 on the next pages)

Table B.1. Distribution of the Sample Among Selected Neighborhoods[a]

Neighborhoods	Number of Office Units (OU_i)	(OU_i) / (96)[c] i = 1,…, 16	Distribution of the Sample	Distribution of the Actual Sample[d]
1.AZİZİYE	683	683/96 = 7.11	7	6
2.ÇANKAYA	2344	2344/96 = 24.41	24	20
3.FEVZİPAŞA	1485	1485/96 = 15.46	16	14
4.GOP[b]	1818	1818/96 = 18.93	19	14
5.GÜVEN	863	863/96 = 8.98	9	8
6.GÜZELTEPE	354	354/96 = 3.68	4	4
7.KAVAKLIDERE	3221	3221/96 = 33.55	34	28
8.KAZIM ÖZALP	280	280/96 = 2.91	3	3
9.KIZILAY	11324	11324/96 =117.95	118	91
10.KORKUT REİS	1802	1802/96 = 18.77	19	18
11.KÜÇÜKESAT	966	966/96 = 10.06	10	4
12.KÜLTÜR	512	512/96 = 5.33	5	5
13.MALTEPE	1791	1791/96 = 18.65	19	19
14.NECATİBEY	180	180/96 = 1.87	2	2
15.OĞUZLAR	280	280/96 = 2.91	3[e]	-
16.YILDIZ	802	802/96 = 8.35	8	8
TOTAL	28705		300	244

[a] The neighborhoods which include office units less than 100 were not included in the analysis, since the size of the sample obtained from those neighborhoods is inadequate.

[b] Gaziosmanpaşa

[c] It is found from the operation:
(Total Number of Office Units)/(Expected Sample Size) = 28705/300 = 95.68 ≅ 96; meaning that 1 office unit will be taken as a sample from each of the 96 office units.

[d] Samples were selected from each neighborhood homogeneously: The number of the sample taken from the areas that are densely populated by offices is large compared with the areas which include small number of offices. Questionnaire was applied to the current users of the rental offices who gave response to the survey. Therefore, sample from each neighborhood is selected randomly, however it is important to note that the sample selected from each neighborhood is distributed homogeneously. The offices situated in each neighborhood are illustrated in the map of Ankara which is given in Appendix E.

[e] Oğuzlar District-namely Balgat- was chosen to be a sub-area. Because the sample size of 3 was small to get precise results, Balgat was excluded from the analysis.

Table B.2. Description of Variables

VARIABLE CODE:	TYPE:	DESCRIPTION:
RENT	Numeric	Monthly net actual rent of the office unit per square meter
DEPOSIT	Dummy	a 0-1 dummy equal to one if the tenant paid deposit
CPI	Dummy	a 0-1 dummy equal to one if the rent is subject to a Consumer/Wholesale Price Index escalation
LEASE	Dummy	a 0-1 dummy equal to one if the subject tenancy is up to 3 years
SUBAREA1	Dummy	GOP- Gaziosmanpaşa District, Kazım Özalp District
SUBAREA2	Dummy	AYRANCI- Güzeltepe District, Aziziye District, Güven District
SUBAREA3	Dummy	ULUS- Fevzipaşa District, Necatibey District
SUBAREA4	Dummy	YILDIZ- Yıldız District
	Base Category	CENTRAL CORE- Kızılay District, Kültür District, Maltepe District, Korkut Reis District Kavaklıdere District, Küçükesat District, Çankaya District
DESIGN1	Dummy	Building was designed as an office space
DESIGN2	Dummy	Building was completely transformed from residence to office use
	Base Category	Some part of the building is being used as a residence
SHOPP	Dummy	a 0-1 dummy equal to one if the building has a shopping center in the ground/ basement floor
QCONST	Dummy	a 0-1 dummy equal to one if the construction material is luxury/high quality
OFAREA	Numeric	Area of the office unit in square meter
OFFLOOR1	Dummy	Office unit is in the basement floor
OFFLOOR2	Dummy	Office unit is in the ground floor
	Base Category	Office unit is in the upper floor

Table B.2 (cont.)

VARIABLE CODE:	TYPE:	DESCRIPTION:
TOTFLOOR	Numeric	Total number of floors in the building
AGE	Numeric	Age of the building
PARK	Dummy	a 0-1 dummy equal to one if the building has open/covered parking
AIRCOND	Dummy	a 0-1 dummy equal to one if the building/ office unit has air-conditioner
SECUR	Dummy	a 0-1 dummy equal to one if the building/ office unit has security system
GENER	Dummy	a 0-1 dummy equal to one if the building/ office unit has a generator
INTDESIGN	Dummy	a 0-1 dummy equal to one if the office wall and/or floor is covered by high quality materials such as laminant, wainscot, granite etc.

APPENDIX C

RESULTS OF DIAGNOSTIC TESTS APPLIED TO MODEL 1

Table C.1. Descriptive Statistics and Diagnostic Tests[a] for Model 1

Model	MODEL 1[b]
Dependent Variable	lnRENT
R	.662
R-Squared	.438
R-Bar-Squared	.406
Standard Error of the Regression	.399
F-Statistic	13.737 [.000] ~ F(13, 230)
Ramsey's RESET Test of Functional Form	9.531 [.002] ~ F(1, 229)
Jarque-Bera Test of Normality of Regression Residuals	2.9298 [.231] ~ X^2 (2)
Test of Heteroscedasticity	3.931 [.050] ~ F(1, 242)
N-Sample Size	244

[a] Diagnostic tests are explained in section D.4 in Appendix D.

[b]Predictors:(constant), SUBAREA1, SUBAREA2, SUBAREA3, SUBAREA4, LEASE, DESIGN1, DESIGN2, lnOFAREA, OFFLOOR1, OFFLOOR2, GENER, SECUR, INTDESIGN.

APPENDIX D

TECHNICAL APPENDIX

D.1. Multicollinearity Problem and Collinearity Statistics

Multicollinearity is defined as "the existence of perfect or less than perfect correlation among some or all explanatory variables of a regression model" (Gujarati, 1995: 320). Few significant t ratios and a higher R^2, the overall measure of goodness of fit, are the main indicators of the problem. Although BLUE, the OLS estimators have large variances and covariances causing difficulties in estimating the regression coefficients precisely.

The problem of multicollinearity is common in most of the hedonic price analyses in real estate literature. The reason is that hedonic price function incorporates large number of explanatory variables most of which are correlated with each other in some degree.

Variance inflation factor and tolerance are the two statistics used for detecting multicollinearity. Variance inflation factor (VIF) can be identified in the formula written for the variance of a particular regression coefficient for the k variable regression model (intercept and k-1 explanatory variables):

$$\operatorname{var}(\hat{\beta}_i) = \frac{\sigma^2}{\sum x_i^2}\left(\frac{1}{1-R_i^2}\right),$$

$$\text{var}(\hat{\beta}_i) = \frac{\sigma^2}{\sum x_i^2} VIF_i$$

Where $\hat{\beta}_i$ is the estimated coefficient of the regressor x_i, σ^2 is standard error of the estimate, R_i^2 is the multiple coefficient of determination in the regression of x_i on the remaining k-2 regressors and VIF_i is the variance inflation factor. R_i^2 measures the collinearity of x_i with the other regressors. If it increases, VIF also increases and in the limit it can be infinite indicating a more serious problem of multicollinearity.

Tolerance is the other statistic used as an indicator of multicollinearity. It is given by the formula:

$$TOL_i = \left(1 - R_i^2\right) = \left(1 / VIF_i\right)$$

Therefore, tolerance is the percentage of variance in a given regressor that cannot be explained by the other regressors. If the tolerances are close to zero, there will be high multicollinearity and both the variance and standard error of the regression coefficients will be inflated.

D.2. Interpretation of Dummy Variables in Logarithmic Models

The problem of the misinterpretation of the dummies in logarithmic models is stressed by Halvorsen and Palmquist (1980) for the first time and then, Kennedy (1981) contributed to the method for the interpretation of dummy variables in semi-logarithmic equations offered by Halvorsen and Palmquist.

The method suggested by Halvorsen and Palmquist will be explained first. They stated that in a semi-logarithmic model;

$$\ln Y = c + \sum_i \alpha_i X_i + \sum_j \beta_j D_j \ , \tag{D.1}$$

Where X_i are the quantitative variables and D_j are the qualitative variables specified as 0-1 dummies, the coefficient of a quantitative variable is equal to relative change in Y for a given absolute change in the value of the regressor (X):

$$\alpha_i = \frac{\partial \ln Y}{\partial X_i} = \frac{1}{Y}\frac{\partial Y}{\partial X_i}$$

However, the same evaluation cannot be made for the dummy variables since the derivative of the dependent variable with respect to the dummy variable does not exist. The coefficient of a dummy variable, in equation (D.1), gives the relative change in the mean value of the regressand (lnY) for the presence of an attribute represented by the dummy variable. In order to find the effect on Y of the presence of the factor represented by the dummy variable, equation (D.1) is written as;

$$Y = \exp\left(c + \sum_i \alpha_i X_i + \beta D \right), \tag{D.2}$$

For simplicity, it is assumed that there is only one dummy variable represented by D. The relative effect on Y of the presence of the factor represented by the dummy variable is:

$$g = \frac{(Y_1 - Y_0)}{Y_0}$$

Where Y_1 and Y_0 are the values of the regressand, Y, in the case where the dummy variable equals to one and zero, respectively. g is computed below for equation (D.2):

$$g = \frac{\exp\left(c + \sum_i \alpha_i X_i + \beta\right) - \exp\left(c + \sum_i \alpha_i X_i\right)}{\exp\left(c + \sum_i \alpha_i X_i\right)}$$

$$g = \exp(\beta) - 1, \qquad \text{(D.3)}$$

(see Halvorsen and Palmquist, 1980: 474)

Therefore, equation (D.2) can be re-written as;

$$Y = (1+g)^D \exp\left(c + \sum_i \alpha_i X_i\right), \qquad \text{(D.4)}$$

(see Halvorsen and Palmquist, 1980: 474)

The model used in the present study is given below

lnRENT$_i$ (Z, D) = $\alpha_0 + \sum_{k=1}^{n} \alpha_k \ln Z_{ki} + \sum_{j=1}^{m} \beta_j D_{ji} + \varepsilon_i$, i = 1,…, N

(see equation 4.2)

Equation (4.2) can be re-written as;

$$RENT_i = (1+g)^{D_i} \exp\left(\alpha_0 + \sum_{k=1}^{n} \alpha_k \ln Z_{ki}\right), \qquad \text{(D.5)}$$

Again, for simplicity, equation (D.5) is computed for only one dummy variable denoted by D_i. Similar to equation (D.3), g is equal to

$g = \exp(\beta) - 1$, (see equation D.3)

and gives the relative effect on RENT of the presence of the attribute represented by the dummy variable, D_i.

Kennedy (1981) pointed out that the estimated value of g, $\hat{g} = \exp(\hat{\beta}) - 1$, is a biased estimator. He proposed to use

$$g^* = \exp\left(\hat{\beta} - \frac{1}{2}\hat{V}(\hat{\beta})\right) - 1, \qquad \text{(D.6)}$$

(see Kennedy, 1981: 801)

by indicating that $\exp(\beta)$ should be estimated by $\exp\left(\hat{\beta} - \frac{1}{2}\hat{V}(\hat{\beta})\right)$ where $\hat{V}(\hat{\beta})$ is the estimated value of the variance of β. He also stated that g* is biased but, has less bias than $\hat{g}$. Therefore, in the present study, g*, instead of $\hat{g}$, is computed in order to interpret the coefficients of the dummy variables.

D.3. Alternative Tests for Non-Nested Hypotheses

Suppose we wish to choose between the following models/hypotheses:

M_1: $y = X\beta_1 + u$, $\quad u \sim N(0, \sigma^2 I_n)$

M_2: $y = Z\beta_2 + v$, $\quad v \sim N(0, w^2 I_n)$

Where y is $n \times 1$ vector of observations on the dependent variable; X and Z are $n \times k_1$ and $n \times k_2$ observation matrices for the independent variables of the models M_1 and M_2, respectively; β and α are the coefficient vectors; and u and v are the $n \times 1$ disturbance vectors.

The two models, M_1 and M_2, are non-nested because it is not possible to obtain the specification of one from the other by the imposition of appropriate restrictions. In order to test M_1 against M_2 and vice versa, four alternative test statistics, NT-test, W-test, J-test and encompassing test, were computed by utilizing the Microfit 4.0 program. The program also computes two choice criteria including, Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). These test statistics are given below:

1. The NT-Test:

This is the adjusted Cox test specified for the test of M_1 against M_2:

$$\widetilde{N}_1 = \widetilde{T}_1 / \left\{ \widetilde{V}_1(\widetilde{T}_1) \right\}^{1/2} \tag{D.7}$$

(see Pesaran and Pesaran, 1997: 360)

Where

$$\widetilde{T}_1 = \frac{1}{2}(n-k_2)\log(\widetilde{w}^2 / \widetilde{w}_*^2)$$

$$\widetilde{w}^2 = e'_2\, e_2 /(n-k_2)\,;\ \widetilde{\sigma}^2 = e'_1\, e_1 /(n-k_1)$$

$$\widetilde{w}_*^2 = \left\{ \widetilde{\sigma}^2 Tr(M_1 M_2) + \hat{\beta}'_1\, X' M_2 X \hat{\beta}_1 \right\} /(n-k_2)$$

$$\hat{\beta}_1 = (X'X)^{-1} X' y\,;\ M_1 = I_n - X(X'X)^{-1} X'\,;\ M_2 = I_n - Z(Z'Z)^{-1} Z'$$

$$\widetilde{V}_1(\widetilde{T}_1) = (\widetilde{\sigma}^2 / \widetilde{w}_*^4) \left\{ \hat{\beta}'_1\, X' M_2 M_1 M_2 X \hat{\beta}_1 + (1/2)\widetilde{\sigma}^2 Tr(B^2) \right\}$$

$$Tr(B^2) = k_2 - Tr(A_1 A_2)^2 - \left\{ \left\{ k_2 - Tr(A_1 A_2) \right\}^2 \big/ (n-k_1) \right\}$$

$$A_1 = X(X'X)^{-1} X\,;\ A_2 = Z(Z'Z)^{-1} Z$$

The NT-test statistic can also be computed for the test of M_2 against M_1.

2. The W-Test:

The W-test is a Wald type test and can be specified for the test of M_1 against M_2 as:

$$W_1 = \frac{(n-k_2)(\widetilde{w}^2 - \widetilde{w}_*^2)}{\left\{ 2\widetilde{\sigma}^4 Tr(B^2) + 4\widetilde{\sigma}^2 \hat{\beta}'_1\, X' M_2 M_1 M_2 X \hat{\beta}_1 \right\}^{1/2}} \tag{D.8}$$

(see Pesaran and Pesaran, 1997: 360)

All the notations in equation (D.8) are as described above. Similarly the same statistic can be computed to test M_2 against M_1.

3. The J-Test:

This test is based on the artificial regression:

$$y = X\beta_1 + \lambda(Z\hat{\beta}_2) + u_1 \tag{D.9}$$

(see Pesaran and Pesaran, 1997: 360)

Where $\hat{\beta}_1 = (X'X)^{-1}X'y$; and $\hat{\beta}_2 = (Z'Z)^{-1}Z'y$. Testing $\lambda = 0$ implies testing of M_1 against M_2. Similarly, M_2 is tested against M_1 based on the t ratio of μ in the artificial regression:

$$y = Z\beta_2 + \mu(X\hat{\beta}_1) + u_2 \tag{D.10}$$

(see Pesaran and Pesaran, 1997: 360)

A modification of the J-test known as JA-test is also computed by the program. However, it is indicated in Godfrey and Pesaran (1983) that "the JA-test should only be used if both models being tested have the same number of non-overlapping variables" (Godfrey and Pesaran, 1983: 152). Because the models in the present study have different numbers of non-overlapping variables, JA-test statistic is not preferred.

4. The Encompassing Test:

This test statistic is based on the F statistic for testing $\delta = 0$ in the following OLS regression:

$$y = X\alpha_0 + Z^*\delta + u_1 \tag{D.11}$$

(see Pesaran and Pesaran, 1997: 361)

Where Z^* represents explanatory variables in M_2 that cannot be expressed as exact linear combinations of the regressors of M_1. Similarly, M_2 is tested against M_1 based on testing $\varphi = 0$ in the regression:

$$y = Z\alpha_1 + X^*\varphi + u_2 \tag{D.12}$$

Where X^* represents the regressors in M_1 that cannot be expressed as exact linear combinations of the regressors of M_2.

5. Choice Criteria:

The program computes two choice criteria for the choice between the models. Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) are computed as:

$$AIC(M_1 : M_2) = LL_1 - LL_2 - (k_1 - k_2) \tag{D.13}$$

$$SBC(M_1 : M_2) = LL_1 - LL_2 - (1/2)(k_1 - k_2)\log(n) \tag{D.14}$$

Where LL_1 and LL_2 are the maximized log-likelihood functions of M_1 and M_2, respectively. According to the AIC, M_1 is preferred to M_2 if AIC (M_1: M_2)>0; M_2 is preferred otherwise. Similarly, according to the SBC, M_1 is preferred to M_2 if SBC (M_1: M_2)>0; M_2 is preferred otherwise.

In Godfrey and Pesaran (1983), it is demonstrated that “in experimental designs for the non-nested models with non-normal errors, different number of regressors or a lagged dependent variable both NT-test and W-test perform better than the J-test” (Godfrey and Pesaran, 1983). Considering the encompassing test, Pesaran (1982) claimed that “this test is asymptotically equivalent to the other non-nested tests under the null hypothesis, but in general it is less powerful than these for a large class of alternative non-nested models” (Pesaran and Pesaran, 1997: 361).

D.4. Diagnostic Tests

1. Test of Functional Form:

Ramsey's RESET test statistic is used to detect the choice of an inappropriate functional form. If the functional form is not consistent with the data, it is expected that explanatory power of the model will improve when square or some higher powers of one or more explanatory variables are included into the model. RESET test suggests using the powers of $\hat{Y}_t$, the predicted value of the dependent variable. Ramsey's RESET test is carried out by the regression:

$$y = X\beta + Z\gamma + \text{error}; \; z_t' = (\hat{Y}_t^{\,2}); \qquad \text{(D.15)}$$

By applying the RESET test, $LM_{RESET} = nR^2 \sim X^2_1$ (R^2 is obtained from equation (D.15)), we test the null hypothesis that the functional form is consistent with the data versus the alternative hypothesis that there is specification error in the functional form. F version of the test statistic which is distributed with 1 and n-(k-1)-1 degrees of freedom is reported.

2. Heteroscedasticity:

The null hypothesis of equal variance is tested against the alternative that the variance of the dependent variable changes from one observation to another. The heteroscedasticity test is calculated from the squared residuals on squared fitted values and tests whether the squared fitted values are significant. Therefore, heteroscedasticity test is based on the auxiliary regression:

$$e_t^2 = \text{constant} + \alpha\, \hat{y}_t^{\,2} + \text{error}; \qquad \text{(D.16)}$$

The test statistic of $LM = nR^2 \sim X^2_1$ (R^2 is obtained from equation (D.16)) is used to test the null hypothesis $\alpha = 0$, against the alternative $\alpha \neq 0$. F version of the LM test is also available and is preferred in the present analysis. If LM-test value or F-test value is greater than the significance level, null hypothesis of no heteroscedasticity is rejected.

3. <u>Normality:</u>

Jarque-Bera test of normality is a Lagrange Multiplier (LM) test. The test computes the skewness and kurtosis measures of OLS residuals. The (LM) test statistic is computed as:

$$JB = n\left[\frac{S}{6} + \frac{(K-3)^2}{24}\right] \sim X_2^2 \tag{D.17}$$

Where

$$S = Skewness = \frac{\left[E(X-\mu)^3\right]^2}{\left[E(X-\mu)^2\right]^3}$$

$$K = Kurtosis = \frac{E(X-\mu)^4}{\left[E(X-\mu)^2\right]^2}$$

For normal distributions: S = 0 and K = 3. We test the null hypothesis: H_0: S = 0, K = 3; against the alternative. Rejecting H_0, rejects normality of the disturbances.

APPENDIX E

MAP OF ANKARA

(See Figure E.1 on the next page)