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# MEASURING LOCAL HOUSE PRICE MOVEMENTS IN ISRAEL AND ESTIMATING PRICE ELASTICITY

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Abstract

This paper studies price movements over the past decade in the Israeli housing market at the regional level and analyzes the variables that affect housing prices and the estimation of their elasticity. The price indices were calculated based on the hedonic methodology, using the CPIM technique (tracking a representative house). The selected model was adapted to the Israeli market after conducting numerous simulations to optimize the structure of the function and the number and type of explanatory variables.

The basic research assumption posits that the housing market does not consist of a single market, but of several submarkets having mixed price trends that differ in their intensity. The existence of varying price trends in different geographical areas stems from differential levels of regional demand deriving from a range of parameters, such as the local unemployment rate, regional disposable household income, regional balance of migration and so forth. On the supply side, regional parameters affecting the housing market include the unsold inventory level, the number of housing starts, etc.

The measurement was carried out over the years 1999-2009 in nine geographical submarkets in Israel encompassing 64 urban communities, using a least-squares multivariable hedonic regression analysis, and it explains, on average, more than 70% of the variance in prices of houses by means of eight explanatory variables. The majority of the explanatory variables included in the study were found to have a level of significance of 5% or less.

**Key words:** hedonic price, price index, quality adjustment, hedonic regression, utility function, measurement by the least-squares method.

## 1. INTRODUCTION

The real estate market in general and the residential real estate market in particular reflect the wealth and health of the national economy. In a developed market, increases in housing prices usually reflect expectations for economic growth, a high level of job security and so

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forth, whereas price decreases reflect expectations for economic recession and a low level of job security.

The real estate sector is of such central importance to the national economy that it is customary to attribute reciprocal influences to the two. Thus, the housing market is impacted by the state of the economy and the macroeconomic climate (interest rates, unemployment, inflation, average wage, exchange rates, tax rates, etc.), but at the same time exerts a considerable influence on the economy.

The real estate sector, which is considered the "engine of the economy," pulls after it professionals from a wide range of fields, such as entrepreneurs, bankers, architects, appraisers, surveyors, lawyers, insurers, brokers, electricians, floor layers, carpenters, glaziers, plumbers, transporters and other professionals from the different fields of construction. A flourishing real estate sector can be a catalyst for national economic growth and generate a chain reaction, with an increase in employment in the related sectors as well as higher government revenues from land taxes which percolate into other sectors.

The official information on housing prices in Israel, published by the Central Bureau of Statistics, includes a nationwide price index and average quarterly prices by geographical area. These data do not provide all the knowledge needed to gain familiarity with the Israeli housing market and for analyzing the influences and implications of public reforms and macroeconomic changes. Furthermore, the lack of regional information based on empirical data and on accepted scientific methodologies causes interested parties to publish data that serve their interests and sometimes mislead the public.

This paper studies movements in housing prices over the past decade and analyzes the effects of house characteristics on housing prices. The research relies on a broad database including more than 700,000 observations spread over the years 1999-2009.

In addition, the study for the first time measures empirically the regional variation in prices of houses. The measurement was carried out in nine geographical submarkets in Israel encompassing 64 urban communities,

The motivation for a differential regional estimation is the fact that the housing market consists of submarkets that are differentiated from each other by their geographical location. This differentiation in the submarkets is evidenced by the price gaps between the geographical areas arising from the variation in demand for housing between the different areas and the impossibility of relocating houses. The existence of differential price trends is examined in this study on an empirical basis by regional estimation.

Besides measuring the movements in house prices, the study also analyzes the factors affecting house prices and estimates price elasticity taking into account house characteristics.

The characteristics affecting housing prices are divided in the study into two categories:

**i) Environmental characteristics** – Variables characterizing the environmental quality of the house, including the socioeconomic level of the area's residents, the proximity to employment centers and the level of community services, represented by the use of the peripherality index- accessibility component, and the degree of the security risk in communities on the Lebanese border and near the Gaza Strip, which are referred to as confrontation line communities.

**ii) House quality characteristics** – Variables characterizing the quality of the house, including number of rooms, net house size, house type and house age.

The factors affecting housing prices were analyzed using the hedonic regression method which enables estimating the effect of each unit of a characteristic on the price.

## 2. DIFFICULTIES AND METHODS OF ESTIMATING HOUSE PRICE MOVEMENTS

### a. Difficulty in Measuring House Price Movements

The accepted method for measuring price movements is by building a price index. Price indices provide a numerical expression for changes in the price of a good or a service over time, enabling a comparison between price levels in different periods.

The purpose of building a housing price index is to create a continuous time series of changes in the prices of houses (new and secondhand) over time.

The measurement relied on actual completed transactions between a willing seller and a willing buyer. The main reason for using actual completed transactions is the fact that there is no price for a house prior to its actual sale.

The price for a house requested by the seller cannot serve as the information for a database measuring price movements, since it is merely a theoretical price requested by the seller. Furthermore, the gap between the price requested by the seller and the price at which the house is actually sold changes from one period to another and between geographical areas (according to demand) and also depends on personal characteristics of the seller, which are irrelevant to the present study.

#### Difficulty in measuring house prices

The difficulty in measuring house prices stems from two factors:

1. The great heterogeneity in house characteristics.
2. Timing differences between houses of equal quality.

Both the above differences are strongly reflected in the database available to the researcher.

To illustrate the difficulty in measuring the movement in house prices, a comparison was made between the structure of the database for a consumer good sold in retail stores and the structure of the database for housing prices.

#### Database for consumer goods

The database for consumer goods includes prices from observations in retail stores that are collected at fixed time intervals. Since the prices are determined by the supply side (the individual consumers are too insignificant to affect the price), they can be collected from the retail stores at fixed time intervals.

The observations collected represent a sample of the goods existing in the market and include information on the good's characteristics, such as the manufacturer's name, the type of product, the product's weight or content, etc.

The database for such a consumer good appears as a matrix of the collecting periods, the types of products and their prices.

**Table 1**
**Database for Consumer Goods**

| Type of Product | Period | | | | |
|---|---|---|---|---|---|
| | t = 1 | t = 2 | t = 3 | t = 4 | t = 5 |
| A | $P_A^1$ | $P_A^2$ | $P_A^3$ | $P_A^4$ | $P_A^5$ |
| B | $P_B^1$ | $P_B^2$ | $P_B^3$ | $P_B^4$ | $P_B^5$ |
| C | $P_C^1$ | $P_C^2$ | $P_C^3$ | $P_C^4$ | $P_C^5$ |
| D | $P_D^1$ | $P_D^2$ | $P_D^3$ | $P_D^4$ | $P_D^5$ |
| E | $P_E^1$ | $P_E^2$ | $P_E^3$ | $P_E^4$ | $P_E^5$ |

### Database of houses

As noted, the database of houses depends on actually completed sales, and therefore there can be no fixed time intervals for collecting prices of houses of equal quality. Furthermore, the combinations of house characteristics are so varied that it is virtually impossible to find apartments of equal quality.

The database of houses is illustrated in the following table:

**Table 2**
**Database of Houses**

| Types of Houses | Period | | | | |
|---|---|---|---|---|---|
| | t = 1 | t = 2 | t = 3 | t = 4 | t = 5 |
| A | | $P_A^2$ | | | |
| B | $P_B^1$ | | | | |
| C | | | $P_C^3$ | | |
| D | | | | | $P_D^5$ |
| … ∞ | | | | $P_\infty^4$ | |

The database described above requires special methodologies to enable a price comparison. In other words, in order to estimate the movement in prices for different quality houses, one must first reduce the houses sold in each period to an equal standard of quality. The process of standardizing house quality characteristics to obtain a quality constant, enabling a price comparison, is termed in the professional jargon "quality adjustment."

### b. Quality Adjustment Methods in the Housing Market

The purpose of price indices is to reflect changes in the price of a product or group of products, with quality held constant. Failure to make adjustments to eliminate the effect of changes in price that arise from change in the quality of the product will cause the index to be biased.

A consensus has prevailed among economists for dozens of years that changes in quality are a prime source of error in price indices. One reason for a decline in the quality of price indices could be their failure to reflect the full extent of such changes.

The problem of bias due to quality changes was addressed by three American committees: the Stigler Committee (1961), the Boskin Committee (1996) and the Committee on National Statistics (Schultz Report, 2002), each of which found flaws in the differentiation between changes resulting from quality versus price changes.

The housing market, which is characterized by great heterogeneity of the characteristics affecting prices, does not allow for the measurement of price trends based on a **comparison of average prices** of houses sold. This is because a difference between periods in the quality mix of houses could affect the results of the measurement and produce a biased index. The use of a median price is also not helpful, as there is no guarantee that the quality of the median house will remain constant over time. Moreover, the use of a median price does not reflect changes in the prices of houses above and below the median. An increase in the price of luxury houses or of houses in exclusive or high-demand locations will usually not be reflected in the median price, which is based on a single price. On the other hand, an increase in the relative number of houses sold, for example, in the peripheral regions will bring down the median price, irrespective of the actual price trend.

The professional literature suggests several methods for dealing with changes in quality. Below are the three most widely accepted methods of adjustment for quality changes in the housing market.

*(i) Equivalent-Quality Clusters (Stratification Method)*

This method uses a matrix consisting of clusters of houses of equivalent quality. The division into clusters is performed on the basis of such criteria as region, house type, number of rooms, year of construction, etc.

Changes in house prices are measured by multiplying the mean price in each cluster by its relative weight and comparing the result to the previous period.

$$R^{t} = \frac{\sum \overline{P}_{j}^{t} * W_{j}}{\sum \overline{P}_{j}^{t-1} * W_{j}}$$

Where:

$R^t$ = Average change in prices in period *t* compared to period *t-1*

$W_j$ = Weight of cluster *j*, where $\sum W_j = 1$

$\overline{P}_j$ = Mean price for cluster *j*

**Limitations of the method:**

The main limitation of this method lies in the practical aspect. The heterogeneity in regional and house characteristics is so great that virtually every house differs from the next. This would necessitate the use of a vast number of clusters (that is, multiple combinations of different sets of values of the characteristics), to the extent that it would be impossible to estimate a mean house price for each cluster.

To overcome this practical difficulty, the number of characteristics included in each cluster has to be reduced; however, this impairs the homogeneity of each cluster in terms of quality.

*(ii) Repeat Sales Method*

The repeat sales method estimates the change in prices using a database consisting of houses that were sold at least twice.

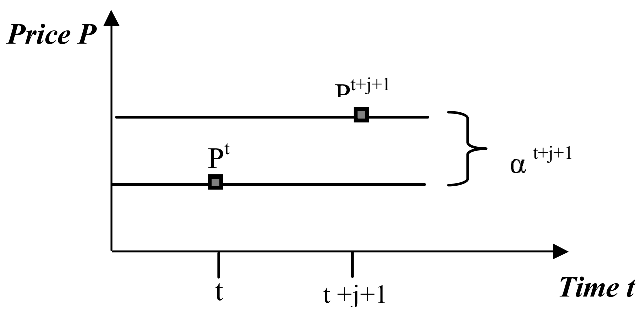
The model assumes that if $P^t$ is the price of the house in period *t*, then the price in period *t+1* is $P^t(1+\alpha^t)$, where $\alpha^t$ is the rate of change between the periods *t* and *t+1*.

In period *t+2* the rate of change will be $(1+\alpha^t)(1+\alpha^{t+1})$ and so forth.

If a house was sold once in period *t* at a price of $P^t$ and once in period *t+j* at a price of $P^{t+j}$, then the rate of change in the price between *t* and *t+j+1* will be:

$$\frac{p^{t+j+1}}{p^t} = \alpha^{t+j+1}$$

**Graph 1**
**Measurement of Change in House Prices by the Repeat Sales Method**



Since there is generally a large time interval between two points of sale in the house market, the following algorithmic formula is used:

$$\log(\frac{p^{t+j+1}}{p^{t}}) = \sum_{i=t}^{t+j} \log(1+\alpha^{i}) = \sum_{i=1}^{t} \delta_i D_i$$

Where $\delta = log(1+\alpha)$ and $D$ is a dummy variable equal to 1 for the periods between $t$ and $t+j+1$ and 0 for other periods.

**Advantages of the method:**

1. Overcoming almost completely the problem of a change in quality (since the price comparison is performed for the same house in different periods).
2. There is no need to use data regarding the characteristics of the house or data of the geographical area.

**Drawbacks of the method:**

1. The assumption that the house's characteristics do not change over time does not take into account circumstances such as aging/renovation of the house, improvement and deterioration in the residential area, etc.
2. The assumption that the subsample of resold houses represents the overall change in prices does not take into account the fact that the duration of ownership of less expensive houses is shorter, which makes their influence on the result greater than their relative proportion.
3. The method does not enable the measurement of new houses (since they were not previously sold).
4. The method presents the change in house prices over time and does not provide information on price levels.
5. There is a difficulty in the single-value identification of the house.
6. The method necessitates a large quantity of repeat sales of houses in every month.

*(iii) Hedonic Price Method*

The hedonic price method uses a multivariable regression to estimate the effects of quality variables on price and enables the isolation of these effects. The hedonic hypothesis states that "heterogeneous goods are aggregations of characteristics" (Triplett, 1988, p. 630).

The ability to control the effects of house characteristics enables estimating the change in house prices over time according to the periods in which the houses were sold.

Since the beginning of the 1990s, use of the hedonic method for measuring changes in house prices has increased, and has become the standard method for handling the problem of heterogeneity in house characteristics.

**Advantages of the method:**

1. It enables measuring changes in prices of houses of varying quality in a range of characteristics and in all combinations.
2. Identification of the characteristics influencing house prices and estimation of the shadow price (in the additive model) or the elasticities (in the logarithmic model).
3. Estimation of the consumer's willingness to pay for each characteristic (Willingness to Pay – WTP).
4. Ability to broadly analyze the macroeconomic factors influencing house prices.

**Drawbacks of the method:**

1. Since the house characteristics and geographical area characteristics, which determine the quality and price of the house, are sold together with the house, there is a certain difficulty in isolating the marginal addition to the price due to one or another characteristic.
2. A hedonic price index could be biased when some of the house characteristics are not observed.

The problem can stem from a lack of data on the characteristics of a house that affect its price. This may result in the performance of incomplete quality adjustment. The problem with the hedonic method was noted by Court (1939), Griliches (1961) and Triplett (1969), but has remained unsolved.

One possible way of minimizing the problem is by combining the repeat sales method with the hedonic method.[1]

## 3. THE HEDONIC MODEL

### a. The Hedonic Model – Literature Review

Hedonic price models are a widespread economic tool for investigating consumer preference of a product's characteristics estimating the influence of the product's characteristics on its price. The word "hedonic" derives from the Greek word "Hedonikos," which means pleasure. In the economic context, the word "hedonic" refers to the benefit the individual derives from consuming the product's characteristics.

The method was first applied in the 1920s by Haas (1922), who used hedonic prices in his research towards his Master's thesis. Haas estimated the prices of agricultural land in Minnesota (USA) during 1916-1919 according to the characteristics of the land (proximity to the market, depreciated cost of the buildings on the land, fertility of the land, etc.), using a multivariable regression.

Waugh (1928) developed the fundamentals of the hedonic methodology. In his study Waugh estimated by a linear regression the correlation between the prices of vegetables

[1] For elaboration see: *Shepperd, S. (1999)*.

(asparagus) and their characteristics, determining the factors that affect these prices and the extent of this effect.

Court (1939) was the first economist to coin the term "hedonic price." *Court*, an economist at General Motors, sought for a model to compare the prices of cars manufactured at different times. In his study he posited that car size, engine power, etc., change from year to year, and therefore it was necessary to "keep" these variables constant, in order to determine the "pure" price change. Court was the first to develop the concept of estimating the effects of car characteristics on price for building a quality-adjusted temporal price index. Court also was the first to develop the Time Dummy method.

Stone (1956) and Griliches (1961) used the Time Dummy method in a number of areas. Their work "breathed new life" into the hedonic price theory, after this approach failed to gain traction during many years. In the wake of their study, the Time Dummy method became the most prevalent for building indexes during the 1960s and 1970s. Griliches (1961 and 1971) was the first to use other methods not based on the Time Dummy method. He discussed the advantages of alternative methods for building hedonic indexes and was named the father of hedonic modeling in the modern era.

In his paper from 1971, Griliches was the first to describe the Characteristics Price Index method.

Lancaster (1966) attempted for the first time to formulate a mathematical model for a consumer who consumes one unit or one composition of a product that links the benefit to the consumer to the product's price and characteristics, assuming a linear relationship.

Muellbauer (1974) presented a model describing optimal behavior for maximizing the benefit, representing the consumers' "hidden" preferences. In this paper *Muellbauer* notes that the model ignores another side of the market, namely, the manufacturer.

Rosen (1974) elaborated on the theory, stressing the importance of hedonic analysis for manufacturers as well, in view of their interest in manufacturing products with characteristics that satisfy consumer desires. Rosen developed a hedonic price model for the estimation of characteristics as a function of supply and demand.

**b. The Hedonic Pricing Model – Theoretical Basis**

The hedonic pricing model relates to a product as a "bundle" of characteristics, in which the price of a product is composed of the value of its constituent characteristics – in terms of the benefit to the user or in terms of the cost, or in terms of both together.

$$P(z) = \sum_{i=1}^{N} p_i z_i$$

Where:

P(z) – The price of the product

$Z_i$ – The characteristics vector of the product

$P_i$ – The hedonic prices of the characteristics

The hedonic model is based on the economic theory of maximization of the utility for the consumer deriving from a product's characteristics, which was developed by Lancaster in an article published in JPE 1966. This article presents for the first time consumer utility as a direct function of a product's characteristics ($Z_i$), i.e.: $U=u(z_1,\ldots,z_N)$.

**The Housing Market**

Housing characteristics are considered desirable if they increase the level of consumer utility, and undesirable if they impair the level of consumer utility. According to the theory, the price of one house relative to another will differ due to the different number of desirable or undesirable unit characteristics existing in each house.
Each house can be described by means of quality characteristics. For example:

| | | | | |
|---|---|---|---|---|
| | Area of the house in sq.m. | x | Hedonic price per sq.m. in a particular area | |
| + | (Garden size in sq.m. | x | Hedonic price per sq.m. of garden | ) |
| + | (Number of car parking spaces | x | Hedonic price per parking space | ) |
| + | (Elevator (yes/no) | x | Hedonic price per elevator | ) |
| + | Other characteristics[2] | | | |
| | **House price (= aggregated price of the characteristics)** | | | |

The derivative (slope) according to any characteristic calculated at the consumer's optimum point is equal to the "price" the consumer is willing to pay for a change in a unit of the characteristic.

In order to estimate the shadow prices (the change in the house price after the addition of a unit characteristic $Z_i$, when the rest of the characteristics remain unchanged) of the house characteristics, an additive function must be used.

Use of the following basic model will give us the added price for each additional room:

*(House Price)* $= \beta_0 + \beta_1$*(Rooms) + (others factors)*

Estimation of the coefficients in a multiplier function will yield the price elasticity relative to the house characteristics.

**c. Hedonic Indices**

The professional literature on hedonic price indices discusses two main techniques:

*(i) "Time-Dummy Method" (TDM)*

This method is based on an estimation of hedonic price equations in which the time appears directly as a dummy variable. The method is also referred to as the "direct method."

[2] In many cases there is importance to the interaction between the explanatory variables – for example, when using an interaction between the floor and the "elevator" dummy variable: the hedonic price for a house without an elevator that is located on an upper floor differs from the shadow price for a house that is located on a lower floor.

The TDM methodology is based on pooled data, which are cross-sectional data over a number of periods. Estimation of the effect coefficients of the geographical area characteristics and the house characteristics is done by regressing the price over several periods.

The house price is explained as a function of several explanatory variables that describe the effect of the house quality on the price (the "hedonic" variables), and time variables (dummy variables) that describe the change in prices over time.

In this method, the coefficients of the quality variables are kept constant in every regression that is run, and the "pure" change in prices is expressed by means of the time variable coefficients.

The function model[3]:

$$\ln(P_i^t) = \beta_0 + \sum_{k=1}^{K} \beta_k Z_{i,k} + \sum_{t=1}^{T} \delta^t D^t + \varepsilon_i$$

Where:

$\ln(P_i^t)$ – The natural log of the *i* house price.

$\beta_k$ – The *k* quality characteristic.

$Z_{i,k}$ – The *k* quality characteristic of the *i* house.

$\delta^t$ – The change in the price log between two periods, when all the quality coefficients are kept constant,

$D^t$ – Time dummy variable vector

$$D^t = \begin{cases} 1 & \text{If the house price is observed in period } t \\ 0 & \text{If the house price is observed in another period} \end{cases}$$

Estimation of coefficient vectors $\beta_k$ $\beta_1$, $\beta_2$, $\beta_3$,….. enables a price comparison of houses that differ from each other in the $Z_K$ characteristics. We assume that the house characteristics differ from one house to another, but the effect of each characteristic ($\beta_1$, $\beta_2$, $\beta_3$,… $\beta_k$ ) remains constant during the estimation period.

Since the expression $\sum_{k=1}^{K} \beta_k Z_{ik}$ subsumes the changes in house quality in monetary terms, the change in the house price is reflected in the time variable coefficients $\sum_{t=1}^{T} \delta^t D^t$ . The rationale of the method is clear. If we compare the house prices between period *t* and period *t-1*, for any given quality specification, *z,* then the ratio is equal to the time coefficient log exponential $\Delta P = \exp(\delta^t)$ (Melser 2004).

[3] The use of a semi-logarithmic function is solely for the purpose of demonstrating the calculation methods.

*(ii) Characteristics Price Index Method (CPIM)*

In this method, the hedonic price index is calculated using a fixed "bundle" of house characteristics in all the estimation periods. One can use the "bundle" of characteristics from the previous period (Laspeyres) or from the current period (Paasche). A change in prices between the two periods, estimated by means of those periods but with different coefficients (the hedonic prices in each period), reflects the pure price changes.

As noted, according to the hedonic assumption, "heterogeneous goods are aggregations of characteristics." Hence, in order to compare prices between two periods it is necessary to use a fixed "bundle" of characteristics from the previous period or from the current period.

**The central idea:** Comparing the price of the product between two different time periods when the product's characteristics are "kept" constant (constant quality).

**The assumption:** The coefficients of the quality characteristics vary over time, that is, the variance in house prices between two periods stems from changes in the hedonic prices of the houses.

**Definition of the model:**

Estimation of the characteristic coefficients for period *t* and period *t+1*.

$$\ln(P^{t}) = \beta_0^{t} + \sum_{k=1}^{K} \beta_k^{t} Z_k^{t} + \varepsilon_i^{t}$$

$$\ln(P^{t+1}) = \beta_0^{t+1} + \sum_{k=1}^{K} \beta_k^{t+1} Z_k^{t+1} + \varepsilon_i^{t+1}$$

Where:

$Z_k^t$ - The values of the house characteristics in period *t.*

$\beta_k^t$ - The hedonic prices of the house characteristics.

Calculation of hedonic index according to characteristics by the Laspeyres method:

$$\Delta \text{P}_{\text{Laspeyres}} = \frac{\sum_{i=1}^{K^0} \beta_i^1 \overline{z}_i^0}{\sum_{i=1}^{K^0} \beta_i^0 \overline{z}_i^0}$$

In other words, in the Laspeyres index the change in house prices from period *t* to period *t-1* is the ratio between the expected prices in period *t* (based on the mean characteristics in period *t-1* and the hedonic prices from period *t*) and the actual prices in period *t-1*.

Similarly, one can build an alternative index based on a "representative" house in the current period that is analogous to the Paasche method[4].

Calculation of hedonic index according to characteristics by the Paasche method:

$$\Delta P_{\text{Paasche}} = \frac{\sum_{i=1}^{K^1} \beta_i^1 \bar{z}_i^1}{\sum_{i=1}^{K^1} \beta_i^0 \bar{z}_i^1}$$

The Laspeyres index does not take into account the fact that when the prices for certain products/ characteristics rise, the consumer substitutes the products/characteristics with cheaper products/characteristics.

This problem can be overcome by means of a superlative index[5].

$$\Delta P_{\text{Fisher}} = \left( \frac{\sum_{i=1}^{K^1} \beta_i^1 \bar{z}_i^1}{\sum_{i=1}^{K^1} \beta_i^0 \bar{z}_i^1} * \frac{\sum_{i=1}^{K^0} \beta_i^1 \bar{z}_i^0}{\sum_{i=1}^{K^0} \beta_i^0 \bar{z}_i^0} \right)^{1/2}$$

The Fisher index[6] is based on a geometric average between Laspeyres (the left member) and Paasche (the right member).

**d. Comparing the Methods**

The TDM technique has been criticized, beginning already in the 1970s by *Griliches*. There are several aspects on which the critics base their preference for the CPIM technique:

1. **Noncompliance with price index axioms**

There are several axioms that form the basis for any price index. The first is the *Monotonocity in Current Prices Axiom*, meaning:

$$\mathbf{I}(P^t_x, P^{t-1}, Z^t, Z^{t-1}) > \mathbf{I}(P^t, P^{t-1}, Z^t, Z^{t-1}), \qquad \text{if } P^t_x > P^t$$

In other words, if the price of one of the products in the current period increases while the rest of the prices remain unchanged, the index must also increase. The TDM does not necessarily comply with this axiom.[7]

[4] The method is consistent with the way in which a consumer/manufacturer price index is estimated—determining a basket of products in the base period and estimating the variance in the product prices that were defined in the base period. The only difference is that instead of determining a "representative" basket of products, a representative "bundle" of characteristics is estimated.

[5] There are three superlative indices: Tornqvist, Fisher and Walsh.

[6] Since data exist on the number of transactions performed in the current period, the Paasche index can be used.

[7] For elaboration see: Melser Daniel (2005).

2. **Index formula** – The index formula in the CPIM technique completely separates between the structure of the hedonic function and the structure of the index function. This is desirable both theoretically and practically. The method enables building a superlative index without forcing a superlative structure on the hedonic function (Diewert, 1976).

3. **Theoretical justification** – Estimating the hedonic price changes (characteristic coefficients) between the periods is essential for estimating the price variance using the CPIM technique. Estimation by the TDM technique paradoxically forces the hedonic prices to remain constant throughout the periods. This forcing of the hedonic prices to remain constant has been the object of strong criticism by many economists.

Pakes (2003) estimated by a hedonic regression the variance in mobile computer prices for the years 1995-1999. He rejected the assumption of constant coefficients between the periods and recommended not using the TDM technique: "…since hedonic coefficients vary across periods it [the T.D Method] has no theoretical justification."

4. **Gaps in results** – Dulberger (1989) measured several hedonic indices for mainframe computers. The results in a comparison between the TDM technique and the CPIM technique amounted to approximately 2 percent per annum. Other studies (Okamoto & Sato, 2001) also showed differences in the results of the two methods. As noted, the gaps stem from forcing the hedonic prices to be the same in the several periods[8].

### E. Structure of the Hedonic Function

The structure of the function determines the definition and meaning of the hedonic price. The accepted functions for hedonic measurement are linear functions, semi-logarithmic functions and double log functions.

The professional literature does not indicate a preference for a particular structure of the hedonic function. Nevertheless, there is agreement that in the case of the housing market the double log function and the semi-logarithmic function are to be preferred to the linear function. This preference is based on empirical studies but also relies to a considerable degree on theoretical explanations.

Below are the arguments for preferring the double log or semi-logarithmic function structure in the housing market:

1. Hedonic estimation using a linear function estimates a constant shadow price. In other words, the coefficients describe the addition to the price (in NIS) for an additional unit characteristic irrespective of any other characteristics in the house.

The double log and semi-logarithmic model measures the elasticity of each characteristic and is affected by the general house value.

To illustrate the hedonic price result, differentiation was performed according to the characteristics of the function in each of the accepted forms. One can see that only in the double log differentiation does the general price remain within the hedonic price.

[8] For elaboration see: Okamoto & Sato (2001); Triplett (2001).

**Table 3**
**Structure of the Hedonic Functions**

| Type of Function | Function Structure | Hedonic Price |
|---|---|---|
| Linear function | $P = \beta_0 + \sum_{k=1}^{K} \beta_k Z_k$ | $\frac{\partial P}{\partial Z_K} = \beta_K$ |
| Semi-logarithmic function | $P = \beta_0 + \sum_{k=1}^{K} \beta_k \ln Z_k$ | $\frac{\partial P}{\partial Z_K} = \frac{\beta_K}{Z_k}$ |
| Double log function (exponential) | $P = \beta_0 \prod_{k=1}^{K} Z_K^{\beta_k}$ After logarithmic transformation: $\ln P = \ln \beta_0 + \sum_{k=1}^{K} \beta_K \ln Z_K$ | $\frac{\partial P}{\partial Z_k} = \frac{\beta_k}{Z_k} P$ |

There is no importance to using a hedonic price that includes the product's general value, for example, in a computer, in which the price of the burner or the screen is not affected by the computer's other characteristics or by its overall price. By contrast, decisive importance attaches to this factor in the housing market.

For example: In the linear model, the shadow price (in NIS) for an additional square meter will be fixed for a new house in an upscale neighborhood and for an old house in a poor neighborhood. In reality this is unreasonable, because the additional price for a square meter in a new house in an upscale neighborhood will be higher than in an old house in a poor neighborhood. The logarithmic model provides a solution to the problem, since it uses a percentage of the house value and therefore will reflect a higher price for an additional square meter in a new house located in an upscale neighborhood.

2. Another argument posits that in the majority of explanatory variables in the housing market model, the willingness to pay for an additional unit characteristic is not fixed but rather decreases. Therefore, the relationship of these variables is logarithmic. For instance, the willingness to pay for an additional square meter in a 40 square meter apartment is greater than in a 150 square meter apartment. In variables in which the marginal willingness does not decrease, a linear relationship can be used – for example, the variable of socioeconomic level or degree of peripherality.

## 4. STUDY DESCRIPTION

### a. Description of the Database

The main database used in the study consists of the real estate database system (the CARMAN system) maintained by the Israel Tax Authority. Information on the purchase of houses is collected on a regular basis by the betterment tax offices throughout Israel by means of the CARMAN system. The national file is produced by the Automated Processing

Service (SHAAM) – a computer unit of the Israel Tax Authority that provides computing services to government tax departments and to external customers – and contains information on new and secondhand house purchases. The CARMAN data are intended for statistical reporting and therefore include extensive information on every house that is sold. This information is based on the details provided in the appreciation tax form which is submitted by the lawyer in every real estate transaction within 50 days from when the transaction is completed. The data in the form are entered manually into the CARMAN system.

**b. Study Population**

Geographically, the CARMAN data cover all parts of Israel. The study population includes all houses purchased by private individuals in urban communities only, since the hedonic pricing method assumes the existence of a competitive market, i.e. multiple buyers and multiple sellers.

Such a situation exists only in large urban communities, whereas in small communities or in moshavim (cooperative communities) house supply and demand is limited. The communities included in the sample are those with 5,000 houses and up.

**Table 4**
**Sample of Communities and Regional Division into Submarkets[9]**

| Area | List of Communities Included in the Submarkets | | | | |
|---|---|---|---|---|---|
| Jerusalem | 1. Jerusalem | | | | |
| Tel Aviv | 2. Tel Aviv | | | | |
| Haifa | 3. Haifa | | | | |
| Dan Metropolis | 4. Bnei Brak | 5. Bat Yam | 6. Givatayim | 7. Holon | 8. Ramat Gan |
| Center | 9. Or Yehuda | 10. Beit Shemesh | 11. Givat Shmuel | 12. Taibeh | 13. Yavne |
| | 14. Yahud | 15. Lod | 16. Mevasseret Zion | 17. Modi'in | 18. Nes Ziona |
| | 19. Petach Tikva | 20. Kiryat Ono | 21. Rosh Ha'ayin | 22. Rishon Lezion | 23. Rehovot |
| | 24. Ramle | | | | |
| South | 25. Ofakim | 26. Eilat | 27. Ashdod | 28. Ashkelon | 29. Beer Sheba |
| | 39. Dimona | 31. Arad | 32. Kiryat Malachi | 33. Kiryat Gat | 34. Netivot |
| | 35. Sderot | | | | |
| Sharon Plain | 36. Hod Hasharon | 37. Herzliya | 38. Hadera | 39. Kfar Saba | 40. Netanya |
| | 41. Ramat Hasharon | 42, Raanana | | | |
| North | 43. Um el Fahm | 44. Tiberias | 45. Tirat Hacarmel | 46. Tamra | 47. Yokne'am Illit |
| | 48. Karmiel | 49. Migdal Ha'emek | 50. Maalot | 51. Nahariya | 52. Nazareth |
| | 53. Upper Nazareth | 54. Nesher | 55. Acre | 56. Afula | 57. Pardes Hanna |
| | 58. Safed | 59. Kiryat Shmona | 60. Shfaram | | |
| Krayot | 61. Kiryat Ata | 62. Kiryat Bialik | 63. Kiryat Yam | 64. Kiryat Motzkin | |

[9] The number of houses in a city is based on the number of municipal property tax billings. Source of data: Central Bureau of Statistics, 2003.

### c. Potential Explanatory Variables

The potential number of variables affecting the house price is large and varies from one geographical area to another. Many of these characteristics are not included in the database, or else the information about them in the database is partial/blank/of low quality.

The present study examined the effect of nine explanatory variables with a theoretical potential effect on the house price.

**Table 5**
**Description of Potential Variables**

| Name of Variable | | | Description |
|---|---|---|---|
| **Environmental quality variables** | | | |
| 1 | Peripherality index – accessibility component | **PAC** | Component in the peripherality index. Indicates accessibility to employment areas and community services. |
| 2 | Socioeconomic level | **SEL** | Socioeconomic level of the population in a statistical zone. |
| 3 | Security risk – communities on the confrontation line | **CLC** | Israel's northern communities situated within a radius of up to 9 kilometers from the Lebanese border, and Gaza-belt communities situated within a radius of up to 7 kilometers from the Gaza border. |
| **House quality variables** | | | |
| 4 | House size | **SIZ** | Net house size |
| 5 | Number of rooms | **RMS** | Number of rooms in the house |
| 6 | House age | **AGE** | Difference in years between the transaction date and the construction date |
| 7 | Special houses | **SAP** | Dummy variable separating ordinary apartments in a building and special houses: semidetached houses, penthouses, villas, garden apartments, etc |
| 8 | Status: new house or secondhand house | **STA** | Dummy variable separating secondhand houses and new houses |
| 9 | Floor | **FLR** | Variable indicated the apartment floor |

*(i) Environmental Quality Characteristics*

The housing market differs from other markets in that house prices and price trends may differ from one geographical area to another. In contrast to other goods that can be moved from one area to another, the housing market is static, hence the need for using characteristics that define environmental quality.

The variables examined in the context of environmental quality characteristics (for some of the geographical areas) are:

- **Peripherality index – accessibility component (PAC)**

Important influences on house prices stem from the economies of scale of the locality and its geographical location. A large locality or a locality situated close to a large population center will benefit from employment areas and diverse and nearby community services, such as schools, kindergartens and daycare centers, community centers, commercial centers, culture centers, care centers for the elderly, game courts and sports facilities, health services, synagogues, etc., and therefore one can expect the prices of houses in large communities or in communities situated close to population centers to be higher than those of identical houses in small communities or in communities located at a distance from population centers.

In order to measure the degree of accessibility to employment areas and community services, use was made of the potential accessibility component of the peripherality index published by the Central Bureau of Statistics. The potential accessibility index weights between the local authority's proximity to all local authorities in Israel and the size of their population.

The potential accessibility formula: $$A_i = \sum_{j=1}^{252} \frac{P_j}{d_{ij}^{1.19}}$$

Where:

$A_i$ – Potential accessibility of local authority $i$ ;

$P_j$ – Population of local authority $j$ ;

$d_{ij}$ – Distance in kilometers from center of local authority $i$ to center of local authority $j$ ;

$d_{ii}$ – Self-distance of local authority $i$ which is defined as 3 kilometers for any local authority

The index is divided into 10 clusters, with cluster 1 indicating a low level of accessibility and cluster 10 indicating a high level of accessibility.

**Table 6**
**Peripherality Index – Potential Accessibility Index**[10]

| Geographical Area | Potential Accessibility Level | | | | |
|---|---|---|---|---|---|
| Jerusalem | 10 – Jerusalem | | | | |
| Tel Aviv | 10 – Tel Aviv | | | | |
| Haifa | 7 – Haifa | | | | |
| Dan Metropolis | 10 – Bnei Brak | 9 – Bat Yam | 10 – Givatayim | 9 – Holon | 10 – Ramat Gan |
| Center | 8 – Or Yehuda | 5 – Beit Shemesh | 10 – Givat Shmuel | 5 – Taibeh | 6 – Yavne |
| | 8 – Yahud | 7 – Lod | 5 – Mevasseret Zion | 5 – Modi'in | 8 – Nes Ziona |
| | 9 – Petach Tikva | 9 – Kiryat Ono | 7 – Rosh Ha'ayin | 9 – Rishon Lezion | 7 – Rehovot |
| | 7 – Ramle | | | | |
| South | 1 – Ofakim | 1 – Eilat | 6 – Ashdod | 4 – Ashkelon | 4 – Beer Sheba |
| | 1 – Dimona | 1 – Arad | 4 – Kiryat Malachi | 3 – Kiryat Gat | 2 – Netivot |
| | 2 – Sderot | | | | |
| Sharon Plain | 8 – Hod Hasharon | 8 – Herzliya | 5 – Hadera | 8 – Kfar Saba | 6 – Netanya |
| | 8 – Ramat Hasharon | 8 – Raanana | | | |
| North | 3 – Um el Fahm | 2 – Tiberias | 3 – Tirat Hacarmel | 3 – Tamra | 3 – Yokne'am Illit |
| | 3 – Karmiel | 4 – Migdal Ha'emek | 2 – Maalot | 3 – Nahariya | 5 – Nazareth |
| | 4 – Upper Nazareth | 5 – Nesher | 4 – Acre | 3 – Afula | 4 – Pardes Hanna |
| | 1 – Safed | 1 – Kiryat Shmona | 4 – Shfaram | | |
| Krayot | 5 – Kiryat Ata | 5 – Kiryat Bialik | 5 – Kiryat Yam | 5 – Kiryat Motzkin | |

[10] Source of data: Central Bureau of Statistics.

- **Security risk – confrontation line communities (CLC)**

Communities situated near the confrontation line are at a greater security risk, a factor affecting house prices.

Out of the study's population of communities, Kiryat Shmona, Maalot and Nahariya were defined as northern confrontation line communities, while Sderot was defined as a southern confrontation line community.

**Table 7**
**List of CLC Communities in the Study**[11]

| | Locality | Distance from Gaza Strip (km) | | Locality | Distance from Lebanese Border (km) |
|---|---|---|---|---|---|
| 1. | Sderot | 3.1 | 1. | Kiryat Shmona | 3.4 |
| | | | 2. | Maalot | 8.5 |
| | | | 3. | Nahariya | 8.8 |

- **Socioeconomic Level (SEL)**

An important characteristic of the geographical area of the house is the socioeconomic level of the population. The basic units are statistical zones within urban communities with 10,000 residents and up, and smaller communities, which are not subdivided. The statistical zone was chosen as a geographical basis since it is small enough to be homogeneous but large enough to enable reliable estimates of socioeconomic characteristics.[12] The socioeconomic level is a value between 1 and 20, with 20 indicating a high socioeconomic level and 1 indicating a low socioeconomic level.

Setting the socioeconomic level of the geographical unit's residents takes into account the following variables: demography; standard of living; schooling and education; employment and unemployment; pension/allowances.

*(ii) House Quality Characteristics*

The variables included in the house quality characteristics are:

- **House size – SIZ:** The relevant house size for house buyers is the net area. In cases where the gross area was indicated without the net area, the net area was imputed based on the gross area and the type of property.
- **Number of rooms – RMS:** The number of rooms in a house is defined as the number of bedrooms + living room. The standard for room size is 8 square meters; a smaller space is defined as a half room.

[11] The distance to the border is calculated from the city center. Source of data: Central Bureau of Statistics, GIS Unit.

[12] One of the problems arising from the use of the socioeconomic index is the difficulty in linking records from different databases. The link between the socioeconomic index and the houses reported in the purchase tax file was established by "anchoring" each house to a statistical zone based on the address (city, street and house number). In cases where no address was found, the house's block-parcel number was used.

- **Special apartments – SAP:** A dummy variable given a value of 0 for an apartment in a condominium and a value of 1 for special houses (semidetached, villa, duplex, penthouse, etc.).
- **House age – AGE:** The house age is the difference between the year of construction and the transaction date (rounded to years).
- **Status – STA:** A dummy variable given a value of 0 for a secondhand house and a value of 1 for a new house. New house – a house sold up to two years after the construction date.
- **Floor – FLR:** A variable indicating the floor on which a purchased apartment is located.

### d. Simulations and Selection of the Optimal Model

Choosing the optimal model involved 32 simulations which examined the level of significance of each potential variable and its appropriate form (linear of logarithmic). The simulations were run for the years 1999-2009, on a monthly basis, separately for each geographical area. The model chosen is a differential model specially adjusted for each geographical area according to the relevant variables for that area.

The need for a differential model stems from the fact that certain variables are relevant in some geographical areas but irrelevant in others. For example, the use of the peripherality index is relevant for the northern, southern, central and other regions, but irrelevant for areas consisting of a single community or areas in which the peripherality level is the same for all the communities included in the area, such as the Krayot. Various area characteristics, such as the floor number, are relevant only for Tel Aviv, which is characterized by high-rise buildings. Proximity to the Lebanese border or to the Gaza Strip is a variable relevant solely to the north and the south.

### e. Definition of the Selected Model

- **Hedonic estimation method** – An empirical analysis of the two hedonic models showed negligible differences between the two. Based on the recommendations of the professional literature, the CPIM model was chosen.
- **Calculation method** – Estimation of the coefficients was done by the ordinary least squares (OLS) method.

Function structure: Semi-logarithmic

- **Listing and description of the variables in the model** – 8 explanatory variables: 3 environmental quality variables and 5 house quality variables.

The type and number of variables vary between the geographical areas, according to the following table.

**Table 8**
**Description of Explanatory Variables in the Model According to Geographical Area**

| Geographical Areas in Which the Variables Are Included | Jerusalem | Tel Aviv | Haifa | Dan Metro | Center | South | Sharon Pl | North | Krayot | Variable Symbol |
|---|---|---|---|---|---|---|---|---|---|---|
| *House price in NIS (logarithmic)* | + | + | + | + | + | + | + | + | + | P |
| *Environmental quality characteristics* | | | | | | | | | | |
| *Socioeconomic level (linear)* | + | + | + | + | + | + | + | + | + | SEL |
| *Peripherality index – accessibility (linear)* | | | | + | + | + | + | + | | PAC |
| *Security risk – confrontation line communities (dummy)* | | | | | | + | | + | | CLC |
| *House quality characteristics* | | | | | | | | | | |
| *House size (logarithmic)* | + | + | + | + | + | + | + | + | + | SIZ |
| *Number of rooms (logarithmic)* | + | + | + | + | + | + | + | + | + | RMS |
| *House age (logarithmic)* | + | + | + | + | + | + | + | + | + | AGE |
| *Special houses (dummy)* | + | + | + | + | + | + | + | + | + | SAP |
| *Floor (linear)* | | + | | | | | | | | FLR |

**General area function equation**

$$Ln\ P_i = Ln\ \beta_0 + \beta_1 SEL_i + \beta_2 PAC_i + \beta_3 CLC_i + \beta_4 Ln\ SIZ_i + \beta_5 Ln\ RMS_i + \beta_6 Ln\ AGE_i + \beta_7\ SAP_i + \beta_8 FLR_i$$

**The price calculated for a house with average characteristics for area *j* is:**

$$\hat{p}_j^{\,t} = e^{(\beta_0^t + \beta_1^t \overline{SEL}_j^0 + \beta_2^t \overline{PAC}_j^0 + \beta_3^t \overline{CLC}_j^0 + \beta_4^t Ln\ \overline{SIZ}_j^0 + \beta_5^t Ln\ \overline{RMS}_j^0 + \beta_6^t Ln\ \overline{AGE}_j^0 + \beta_7^t\ \overline{SAP}_j^0 + \beta_8^t\ \overline{FLR}_j^0)}$$

**Area index formula:**

$$I_j^t = I_j^{t-1} \left( \frac{e^{(\beta_0^{t-1} + \beta_1^{t-1} \overline{SEL}_j^0 + \beta_2^{t-1} \overline{PAC}_j^0 + \beta_3^{t-1} \overline{CLC}_j^0 + \beta_4^{t-1} Ln\ \overline{SIZ}_j^0 + \beta_5^{t-1} Ln\ \overline{RMS}_j^0 + \beta_6^{t-1} Ln\ \overline{AGE}_j^0 + \beta_7^{t-1}\ \overline{SAP}_j^0 + \beta_8^{t-1}\ \overline{FLR}_j^0)}}{e^{(\beta_0^{t-1} + \beta_1^{t-1} \overline{SEL}_j^0 + \beta_2^{t-1} \overline{PAC}_j^0 + \beta_3^{t-1} \overline{CLC}_j^0 + \beta_4^{t-1} Ln\ \overline{SIZ}_j^0 + \beta_5^{t-1} Ln\ \overline{RMS}_j^0 + \beta_6^{t-1} Ln\ \overline{AGE}_j^0 + \beta_7^{t-1}\ \overline{SAP}_j^0 + \beta_8^{t-1}\ \overline{FLR}_j^0)}} \right.$$

**Definition of representative house by geographical area**

The CPIM technique, which is based on a representative house over time, ensures that the quality is kept unchanged over time. The calculation of the representative house for each area was determined based on the mean characteristics of houses sold in 1999. As can be seen in the following table, the calculation of the representative house for each area included the nine characteristics that were included in the simulations.

**Table 9**
**Description of Representative House by Geographical Area**

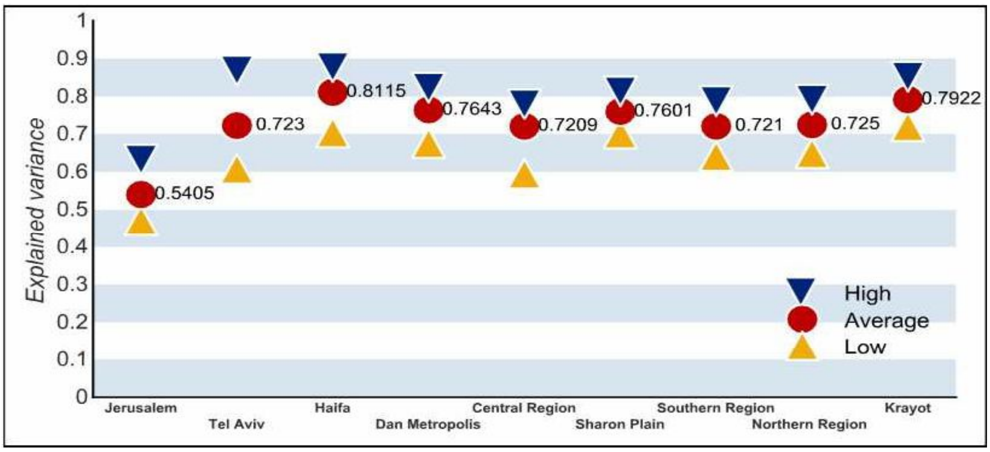
| | SIZ | RMS | AGE | SEL | PAC | FLR | SAP | CLC |
|---|---|---|---|---|---|---|---|---|
| Jerusalem | 75.9 | 3.3 | 24.2 | 12.5 | - | - | 0.002 | - |
| Tel Aviv | 71.8 | 3.0 | 30.3 | 14.4 | - | 2.9 | 0.045 | - |
| Haifa | 73.6 | 3.2 | 27.0 | 13.8 | - | - | 0.028 | - |
| Dan Metropolis | 68.4 | 3.1 | 27.3 | 12.7 | 9.5 | - | 0.021 | - |
| Center | 87.2 | 3.7 | 12.2 | 13.2 | 7.9 | - | 0.060 | - |
| South | 85.6 | 3.6 | 8.5 | 8.2 | 4.9 | - | 0.148 | 0.02 |
| Sharon Plain | 90.4 | 3.9 | 12.4 | 13.2 | 6.9 | - | 0.286 | - |
| North | 88.2 | 3.6 | 12.7 | 10.2 | 3.3 | - | 0.120 | 0.21 |
| Krayot | 78.4 | 3.4 | 20.6 | 10.8 | - | - | 0.090 | - |

## 5. RESULTS

### a. Description of Explained Variance

As expected, the explained variance is not uniform for all the geographical areas. Graph 2 shows the results of the explained variance ($R^2$) in each area. The graph for each area includes all the monthly results in the years 1999-2009.

**Graph 2**
**Description of Explained Variance by Geographical Areas**



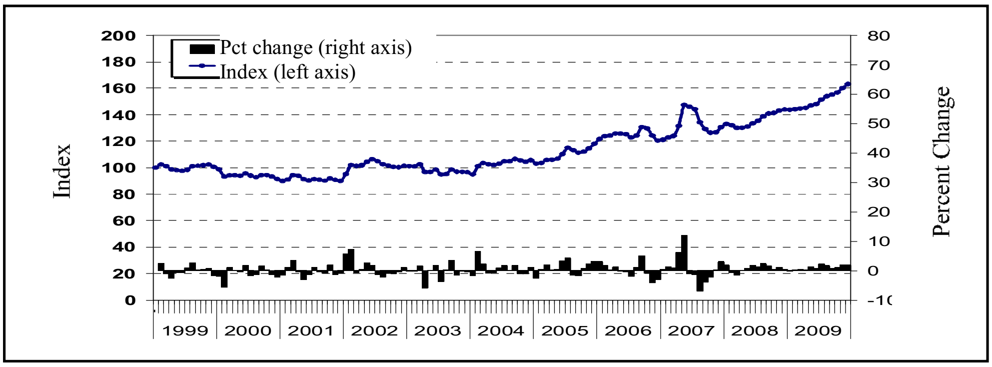

It is apparent from the graph that the explained variance in Jerusalem is significantly lower than in the other areas. It is also apparent that the distance between the minimum and maximum variance is greater in Tel Aviv.

An examination of the explained variance along the time axis does not show any trend of improvement or worsening of the explained variance.

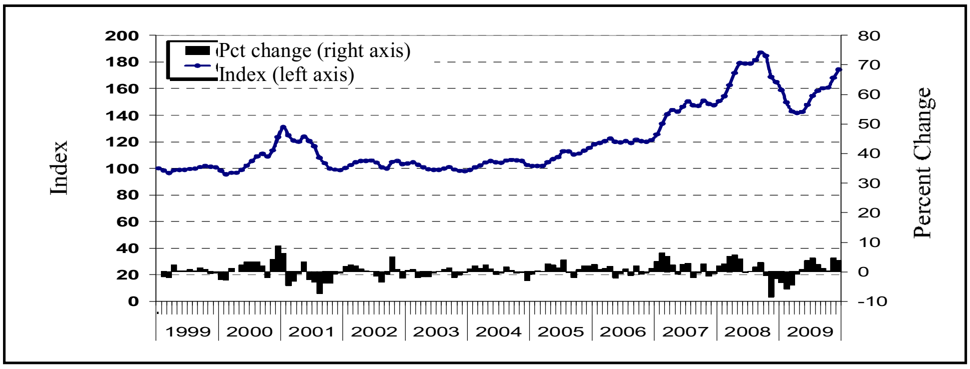
It is interesting to note that developments in Tel Aviv and Jerusalem are similar, while in Haifa the picture looks different. Perelman (2011)[13] shows that the ratio of apartments stock to households in Haifa is higher when compared to other cities. Note also that after the economic crisis the decline in Tel Aviv is remarkable when compared to other cities. A possible explanation (not explored in the paper) is the fall in investors purchases, which is consistent with the higher stock of apartments for rent in Tel Aviv as compared with Jerusalem and Haifa: 47.3 percent against 26 and 30.6, respectively (source: expenditure survey of the CBS).

**b. Regional change in house prices**

**Graph 3**
**Behavior of Jerusalem Index**

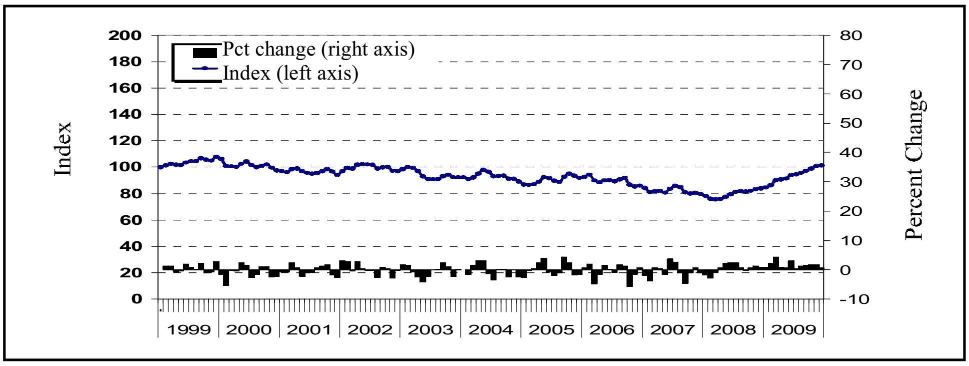



**Graph 4**
**Behavior of Tel Aviv Index**

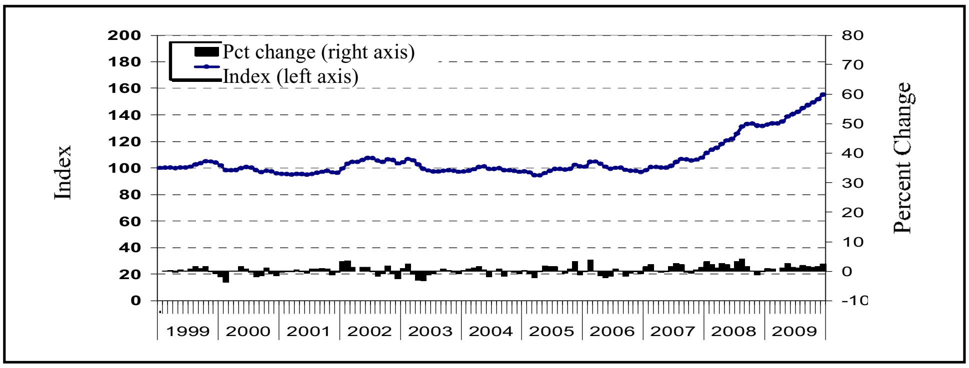



[13] Bank of Israel's site, 2011.

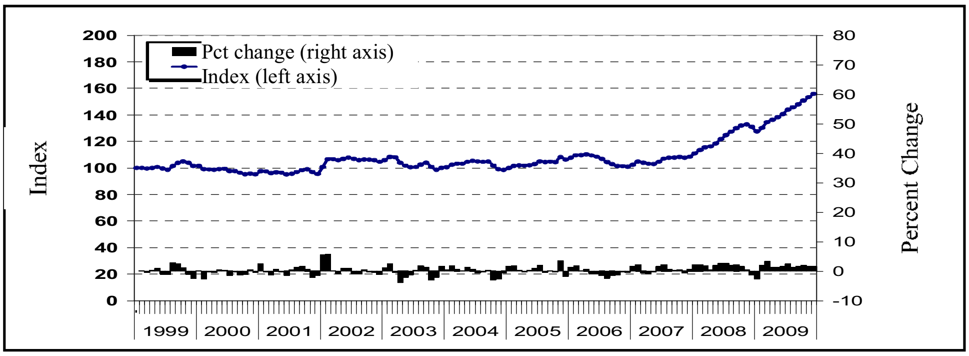
**Graph 5**
**Behavior of Haifa Index**



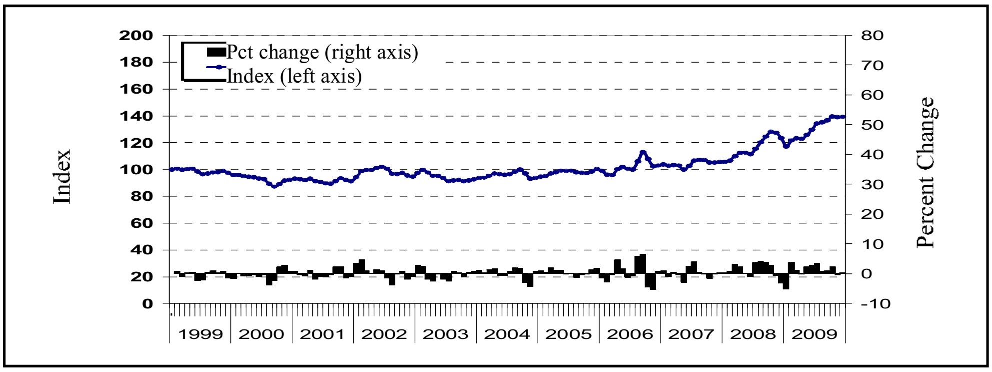

**Graph 6**
**Behavior of Dan Metropolis Index**



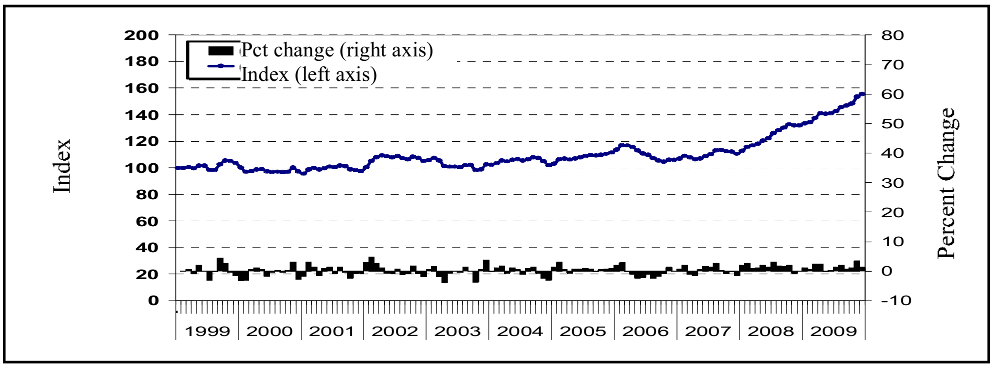

**Graph 7**
**Behavior of Central Region Index**



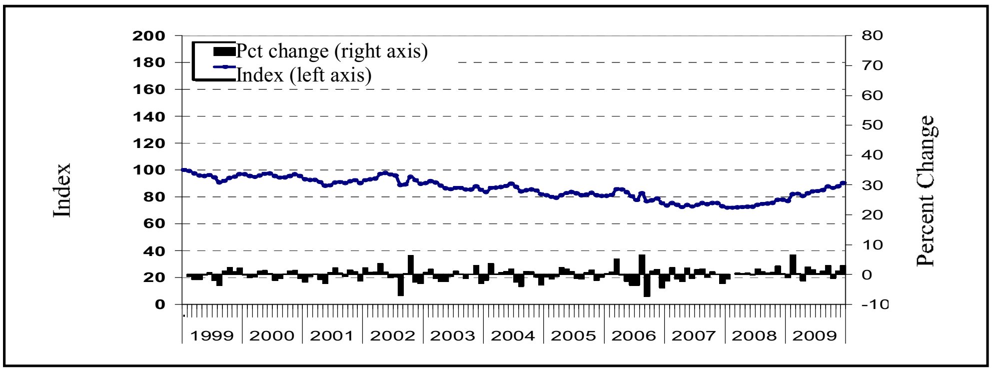
**Graph 8**
**Behavior of Southern Region Index**




**Graph 9**
**Behavior of Sharon Plain Index**




**Graph 10**
**Behavior of Northern Region Index**



**Graph 11**
**Behavior of Krayot Index**

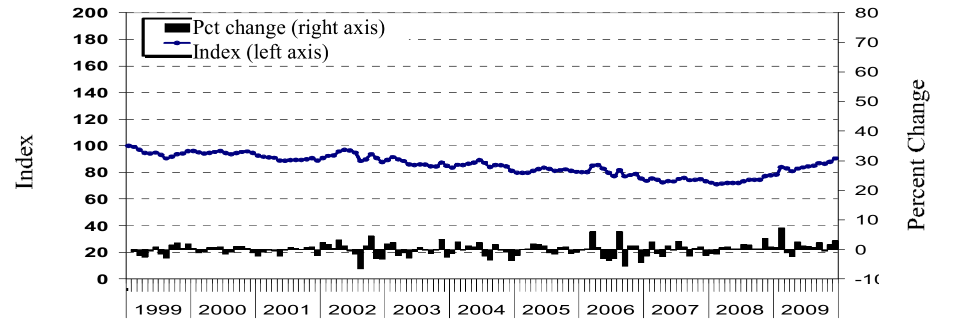



**Table 10**
**Annual Price Change – Jerusalem**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | 0.8 | -1.0 |
| 2000 | -9.2 | -9.2 |
| 2001 | -1.6 | -3.0 |
| 2002 | 12.8 | 5.9 |
| 2003 | -4.8 | -3.0 |
| 2004 | 9.5 | 8.2 |
| 2005 | 11.7 | 9.1 |
| 2006 | 2.0 | 2.1 |
| 2007 | 8.3 | 4.7 |
| 2008 | 10.3 | 6.2 |
| 2009 | 13.4 | 9.1 |
| Cum. pct. Change | 63.3 | 25.2 |
| Annual rate of change | 4.6 | 2.1 |

**Table 11**
**Annual Price Change – Tel Aviv**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | 0.7 | -1.1 |
| 2000 | 22.5 | 22.5 |
| 2001 | -20.1 | -21.2 |
| 2002 | 4.8 | -1.6 |
| 2003 | -5.2 | -3.4 |
| 2004 | 4.7 | 3.4 |
| 2005 | 12.6 | 10.0 |
| 2006 | 5.1 | 5.2 |
| 2007 | 21.6 | 17.6 |
| 2008 | 11.8 | 7.7 |
| 2009 | 5.7 | 1.7 |
| Cum. pct. change | 74.3 | 33.6 |
| Annual rate of change | 5.2 | 2.7 |

**Table 12**
**Annual Price Change – Haifa**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | 8.0 | 6.1 |
| 2000 | -9.7 | -9.7 |
| 2001 | -3.5 | -4.8 |
| 2002 | 3.0 | -3.3 |
| 2003 | -4.7 | -2.9 |
| 2004 | -3.5 | -4.6 |
| 2005 | 3.3 | 0.8 |
| 2006 | -6.5 | -6.4 |
| 2007 | -7.3 | -10.4 |
| 2008 | 5.3 | 1.4 |
| 2009 | 20.7 | 16.2 |
| Cum. pct. change | 1.3 | -22.3 |
| Annual rate of change | 0.1 | -2.3 |

**Table 13**
**Annual Price Change – Dan Metropolis**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | 4.0 | 2.1 |
| 2000 | -7.7 | -7.7 |
| 2001 | 0.4 | -1.0 |
| 2002 | 7.2 | 0.6 |
| 2003 | -6.0 | -4.2 |
| 2004 | 0.0 | -1.2 |
| 2005 | 4.1 | 1.7 |
| 2006 | -4.1 | -4.0 |
| 2007 | 11.0 | 7.4 |
| 2008 | 22.3 | 17.8 |
| 2009 | 18.0 | 13.6 |
| Cum. pct. change | 55.4 | 19.2 |
| Annual rate of change | 4.1 | 1.6 |

**Table 14**
**Annual Price Change – Central Region**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | 1.5 | -0.3 |
| 2000 | -6.1 | -6.1 |
| 2001 | 0.2 | -1.2 |
| 2002 | 9.6 | 2.9 |
| 2003 | -4.3 | -2.5 |
| 2004 | -1.7 | -2.9 |
| 2005 | 7.9 | 5.4 |
| 2006 | -5.0 | -4.9 |
| 2007 | 7.4 | 3.9 |
| 2008 | 20.7 | 16.3 |
| 2009 | 19.0 | 14.5 |
| Cum. pct. change | 55.9 | 19.5 |
| Annual rate of change | 4.1 | 1.6 |

**Table 15**
**Annual Price Change – Southern Region**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | -2.6 | -4.3 |
| 2000 | -5.3 | -5.3 |
| 2001 | -1.1 | -2.5 |
| 2002 | 3.7 | -2.6 |
| 2003 | -2.2 | -0.3 |
| 2004 | 1.2 | 0.0 |
| 2005 | 7.1 | 4.6 |
| 2006 | 2.7 | 2.8 |
| 2007 | 2.5 | -0.8 |
| 2008 | 17.0 | 12.7 |
| 2009 | 12.8 | 8.6 |
| Cum. pct. change | 39.2 | 6.7 |
| Annual rate of change | 3.1 | 0.6 |

**Table 16**
**Annual Price Change – Sharon Plain**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | 3.7 | 1.9 |
| 2000 | -6.2 | -6.2 |
| 2001 | 0.3 | -1.1 |
| 2002 | 7.9 | 1.3 |
| 2003 | -2.7 | -0.8 |
| 2004 | -0.6 | -1.8 |
| 2005 | 9.5 | 7.0 |
| 2006 | -4.9 | -4.8 |
| 2007 | 4.3 | 0.9 |
| 2008 | 19.1 | 14.9 |
| 2009 | 17.9 | 13.4 |
| Cum. pct. change | 55.6 | 19.3 |
| Annual rate of change | 4.1 | 1.6 |

**Table 17**
**Annual Price Change – Northern Region**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | -3.1 | -4.8 |
| 2000 | -1.4 | -1.4 |
| 2001 | -5.3 | -6.7 |
| 2002 | -0.9 | -6.9 |
| 2003 | -4.9 | -1.3 |
| 2004 | -3.9 | -5.0 |
| 2005 | -1.5 | -3.8 |
| 2006 | -6.7 | -6.6 |
| 2007 | -2.9 | -6.1 |
| 2008 | 6.6 | 2.7 |
| 2009 | 16.0 | 11.7 |
| Cum. pct. change | -9.6 | -30.7 |
| Annual rate of change | -0.9 | -3.3 |

**Table 18**
**Annual Price Change - Krayot**

| Years | Annual Pct. Change (Nominal) | Annual Pct Change (Real) |
|---|---|---|
| 1999 | -4.1 | -5.8 |
| 2000 | -1.3 | -1.3 |
| 2001 | -6.1 | -7.4 |
| 2002 | -1.2 | -7.3 |
| 2003 | -3.3 | -1.4 |
| 2004 | -4.2 | -5.4 |
| 2005 | -1.0 | -3.3 |
| 2006 | -6.3 | -6.2 |
| 2007 | -2.7 | -5.9 |
| 2008 | 6.1 | 2.2 |
| 2009 | 16.2 | 11.8 |
| Cum. pct. change | -9.5 | -30.6 |
| Annual rate of change | -0.9 | -3.3 |

### c. Analysis of Factors Influencing House Prices

The characteristic coefficients (βs) signify the elasticity of the price relative to the characteristics. Elasticity provides information about the extent of the effect that a change in a particular characteristic will have on the house price. Elasticity is not affected by the measurement units, and therefore it is suitable for testing the sensitivity of the house price to changes in the house characteristics.

It should be noted that elasticity of the characteristics assumes that the rest of the characteristics remain unchanged. However, changes in the house size and changes in the number of rooms usually occur together.

**Table 19**
**Elasticity of House Characteristics and Environmental Characteristics by Geographical Area**

| | $E_{SIZ,P}$ | $E_{RMS,P}$ | $E_{AGE,P}$ | $E_{SEL,P}$ | $E_{PAC,P}$ | $E_{CLC,P}$ | $E_{SAP,P}$ | $E_{FLR,P}$ |
|---|---|---|---|---|---|---|---|---|
| Jerusalem | 0.7521 | 0.1472 | -0.0024 | 0.0192 | - | - | 0.1744 | - |
| Tel Aviv | 0.7435 | 0.1744 | -0.0272 | 0.0346 | - | - | 0.2323 | 0.0131 |
| Haifa | 0.7520 | 0.2757 | -0.0356 | 0.0512 | - | - | 0.2443 | - |
| Dan Metro | 0.4544 | 0.3985 | -0.0306 | 0.0307 | 0.0603 | - | 0.2539 | - |
| Center | 0.5830 | 0.3205 | -0.0278 | 0.0363 | 0.0618 | - | 0.1982 | - |
| South | 0.6368 | 0.2734 | -0.0356 | 0.0281 | 0.0781 | -0.0649 | 0.1973 | - |
| Sharon Pl | 0.5743 | 0.2752 | -0.0290 | 0.0263 | 0.0675 | - | 0.1619 | - |
| North | 0.5992 | 0.3486 | -0.0335 | 0.0345 | 0.0821 | 0.1904 | 0.2045 | - |
| Krayot | 0.6914 | 0.2710 | -0.0364 | 0.0342 | - | - | 0.1462 | - |
| Nationwide | **0.6430** | **0.2761** | **-0.0287** | **0.0328** | **0.0700** | - | **0.2014** | **-** |

Table 19 shows that the elasticity of the characteristics relative to the price is rigid for all the characteristics ($0<|E|<1$)

- **Effect of house size relative to house price**

As expected, the house size affects house prices positively at a level of significance of 1% in all the geographical areas.

The nationwide mean elasticity of this characteristic on the house price is 0.643. The significance of this estimate is that an increase of one percent in the house size (the rest of the house characteristics remain unchanged) will raise the house price by 0.64%. In major cities, i.e., Jerusalem, Tel Aviv and Haifa, the addition to the price (as a percent) for an additional square meter is higher than in the other areas.

Note that in the Dan Area the elasticity is lower when compared to other areas, or even to cities that belong to it, like Tel Aviv. However, we show in the next table that the elasticity for rooms in this area is higher. A possible interpretation of this result is that in this area there is a higher sensitivity for rooms.

- **Elasticity of house price relative to number of rooms in the house**

Also the number of rooms affects house prices positively. The mean elasticity of this characteristic is estimated at 0.2761.

The significance: A transition from two rooms to four rooms, when the house size and the other house characteristics remain unchanged, will raise the house price by an average of 27.6 percent.

- **Elasticity of house price relative to house age**

House age is the only characteristic in the study with a negative effect on the price. The nationwide elasticity of the price relative to age is -0.0287. The effect of the house age on the house price was recorded as negative in all the geographical areas. Jerusalem is differentiated from all other cities and areas in that the effect of the house age is significantly lower than in other areas. The low devaluation of old houses is apparently due to the historical value and unique character of Jerusalem's old houses.

- **Elasticity of house price relative to socioeconomic level**

The nationwide elasticity of the price relative to the socioeconomic level is 0.0328. The effect of the socioeconomic level was found to be positive in all the geographical areas, signifying that an increase by one unit in the socioeconomic level will result in an average increase of 3.28 percent in house prices.

- **Elasticity of house price relative to degree of peripherality of the community**

The study's findings show that the nationwide elasticity of the price relative to the degree of peripherality is 0.07. The effect of the degree of peripherality was found to be positive in all the geographical areas, signifying that an increase by one unit in the degree of peripherality will result in an average increase of 7 percent in house prices.

- **Elasticity of house price relative to house type**

The study's findings show that the nationwide elasticity of the price relative to the house type is 0.2014.

The significance: A transition from a house in a multi-story apartment building to an upscale house (detached house, penthouse, villa, etc.) raises the house price by 20%.

- **Effect of floor on the house price**

The effect of the floor on the house price was examined only in Tel Aviv. The study's findings show a positive correlation between the floor and the house price, equivalent to an average increase of 1.315 percent in the house value.

- **Effect of proximity to the Lebanese border and to the Gaza Strip on the house price**

Houses located on the northern and southern confrontation lines are subject to two opposite effects:

**(1)** The security effect, which operates to lower house prices in these communities due to a higher level of risk.

**(2)** The economic effect, reflected in increased demand and higher prices due to tax concessions of up to 25%.

The study's findings show that in the northern confrontation line communities, the economic effect is stronger than the security effect, causing house prices to be an average of 19% above their economic value relative to the environmental characteristics, i.e., the degree of peripherality and the socioeconomic level.

In the southern confrontation line communities, represented by the city of Sderot, the security effect was found to be stronger than the economic effect. Thus, the value of houses in Sderot is lower by 6.5% than their economic value, in spite of the tax concessions.

## 6. SUMMARY AND CONCLUSIONS

This study joins a long series of studies around the world that support the use of hedonic prices for measuring movements in house prices and as a tool for studying the effects of house characteristics on the house price.

Apart from information on changes in house prices, the CPIM technique provides a new dimension of knowledge on house prices, namely, the monthly price level of a representative apartment.

The results of the regional house price indices provide empirical evidence of mixed trends in house prices, which differ from one geographical area to another. These empirical findings substantiate the study's central thesis, that the residential housing market consists of several regional submarkets that are characterized by different levels and price trends.

**Findings regarding changes in regional house prices:**

- During 2008 and 2009, house prices in Israel rose sharply in all the geographical areas, to rates of between 15% and 40%.
- Price rises in all regions presents a new phenomenon compared to the mixed regional price trends that characterized Israel's real estate market in all the other periods of the study.

- The areas leading the increase in prices during this period are the Dan Metropolis, the Central Region and the Sharon Plain.
- In Haifa, the north of the country and the Krayot (Haifa bayside suburbs), the price rises in the past two years are an adjustment to the extended price decreases during the nine years preceding the rise. Therefore, the fear of a real estate bubble does not apply to these areas.
- Prices behaved similarly in the Dan Metropolis, the Central Region and the Sharon Region. During the period of the study, price increases of more than 50% were recorded, about three-quarters of the increase occurring during 2008-2009.
- Tel Aviv and Jerusalem recorded the sharpest increases during the period of the study. In Tel Aviv house prices rose at a rate of 75%, and in Jerusalem at a rate of 65%. The likelihood of a real estate bubble in these cities is much greater than in other areas of the country.
- Excluding Tel Aviv, the house market in most areas of Israel does not react immediately to specific occurrences or economic events. In Tel Aviv, on the other hand, events such as the crisis in the high-tech industry at the end of the year 2000 and the global economic crisis at the end of 2008 were reflected in house prices, which reacted immediately and sharply. It may be presumed that the high percentage of investors in the city (based on the percentage of rented houses) and the percentage of luxury apartments in the city render Tel Aviv highly sensitive to economic events.
- The price gaps among the representative houses in the different geographical areas widened sharply during the period of the study, due to price increases in areas characterized by high price levels (Haifa, Tel Aviv and the Sharon), versus price decreases in areas characterized by low price levels (the north and the Krayot). Thus for example, the ratio of prices between representative houses in Tel Aviv and in the north, which was less than two times in 1999, rose to more than three times in 2009.
- In the northern and southern regions, which were characterized by similar price levels in 1999, price levels gradually but systematically began to part ways, with the gap in representative house prices standing at the end of 2009 at 30%.
- Despite the proximity of Tel Aviv to the Dan Metropolis which envelopes it, there are behavioral differences in prices. The sharp rise in house prices in Tel Aviv indicates that from the standpoint of house buyers (owners and investors), the Dan Metropolis is not a substitute for the city of Tel Aviv.
- A similarity in the behavior of prices, indicating, from the house buyers' standpoint, a high level of substitutability, was observed in the following areas: 1. the Dan Metropolis and the Central Region; 2. the Krayot and the northern region.

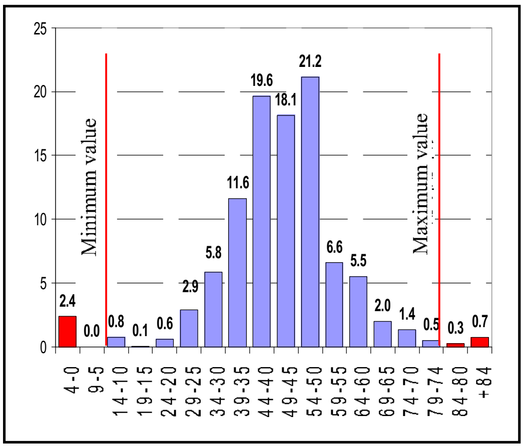
**Additional findings of the study:**

- The price elasticity of the "house size" characteristic is the most significant among the characteristics examined in this study. The price elasticity relative to this characteristic is also the highest.

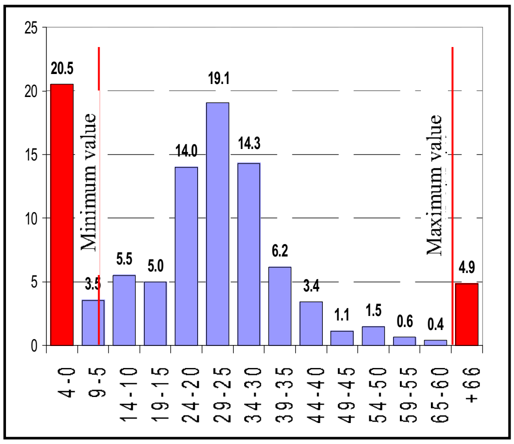
- Most physical characteristics of the houses, among them: house size, number of rooms and house age, are characterized by a nonlinear relationship, signifying that the marginal willingness to pay for an additional unit characteristic decreases.
- The majority of the environmental characteristics among them: the peripherality index and the socioeconomic level (together with the floor characteristic) are characterized by a linear relationship, that is, a relationship in which the willingness to pay for an additional unit characteristic does not decrease.
- The characteristic with the greatest elasticity after house size is "number of rooms."
- The explained variance in Jerusalem is lower than in all other measured geographical areas, due to the existence of other price influences of variables that are not observable in the database.

**Appendix A – Breakdown of House Area by Number of Rooms (1999-2009)**

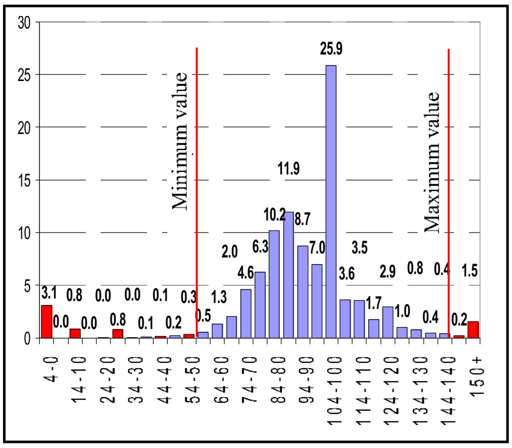
**One-room apartment (8-65 sqm)**



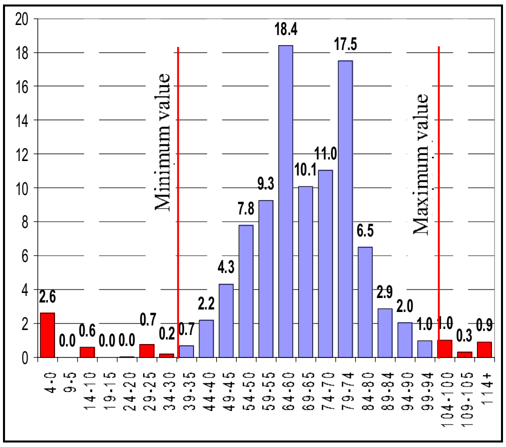

**1.5-2 room apartment (10-77 sqm)**



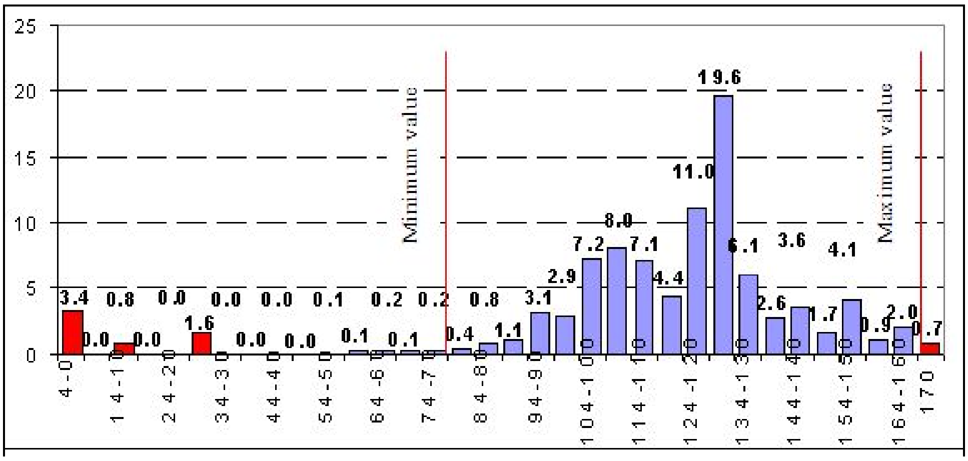

**2.5-3 room apartment (37-100 sqm)**




**3.5-4 room apartment (55-142 sqm)**



**4.5-5 room apartment (37-100 sqm)**



## Appendix B – Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables

| Jerusalem | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Intercept** | *** 12.36763<br>(0.15762) | *** 9.82099<br>(0.26596) | *** 9.51253<br>(0.26879) | *** 9.69894<br>(0.28426) | *** 9.51072<br>(0.29412) |
| **Size** | *** 0.01027<br>(0.0011) | | | | |
| **Ln Size** | | *** 0.71395<br>(0.07856) | *** 0.81969<br>(0.08137) | *** 0.77319<br>(0.08256) | *** 0.79582<br>(0.08351) |
| **Rooms** | ** 0.07406<br>(0.02969) | ** 0.09313<br>(0.02869) | | | |
| **Ln Rooms** | | | ** 0.14865<br>(0.09237) | ** 0.1574<br>(0.09386) | ** 0.14166<br>(0.09506) |
| **Age** | -0.00394<br>(0.00091) | -0.00418<br>(0.00093) | -0.00427<br>(0.00093) | | |
| **Ln Age** | | | | -0.00095<br>(0.01843) | -0.00406<br>(0.01868) |
| **Socioeconomic Level** | ** 0.01992<br>(0.00332) | ** 0.01933<br>(0.00334) | ** 0.01894<br>(0.00336) | ** 0.01883<br>(0.00341) | |
| **Ln Socioeconomic Level** | | | | | ** 0.13647<br>(0.03463) |
| **Potential Accessibility**[2] | | | | | |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | -0.01300<br>(0.00912) | -0.01436<br>(0.00736) | -0.01471<br>(0.00756) | -0.01567<br>(0.00438) | -0.01616<br>(0.00766) |
| **Ln Floor** | | | | | |
| **Special Apartments** | ** 0.11078<br>(0.02616) | ** 0.13394<br>(0.10764) | ** 0.15026<br>(0.10835) | ** 0.16837<br>(0.10954) | ** 0.1652<br>(0.11108) |
| **Status** | 0.24304<br>(0.01777) | 0.22188<br>(0.07546) | 0.22002<br>(0.07621) | 0.39782<br>(0.14885) | 0.41119<br>(0.15109) |
| **R Square** | 0.57677 | 0.56860 | 0.56755 | 0.55487 | 0.54206 |
| **Adjusted R Square** | 0.57145 | 0.56827 | 0.56199 | 0.54905 | 0.53668 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Appendix B – Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Jerusalem (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 9.51072<br>(0.29412) | *** 9.48188<br>(0.2937) | *** 9.75229<br>(0.27747) | *** 9.71173<br>(0.27644) | *** 9.51253<br>(0.28107) |
| **Size** | | | | | |
| **Ln Size** | *** 0.79582<br>(0.08351) | *** 0.79613<br>(0.08367) | *** 0.76514<br>(0.08333) | *** 0.77554<br>(0.08313) | *** 0.78576<br>(0.08326) |
| **Rooms** | | | | | |
| **Ln Rooms** | ** 0.14166<br>(0.09506) | ** 0.13925<br>(0.09515) | ** 0.14907<br>(0.09567) | ** 0.14726<br>(0.09574) | ** 0.13552<br>(0.09553) |
| **Age** | | | | | |
| **Ln Age** | -0.00406<br>(0.01868) | -0.00440<br>(0.01872) | -0.00117<br>(0.00919) | -0.00186<br>(0.00918) | -0.00137<br>(0.00857) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | ** 0.13647<br>(0.03463) | ** 0.13708<br>(0.03468) | ** 0.13382<br>(0.03484) | ** 0.13336<br>(0.03489) | ** 0.13268<br>(0.03498) |
| **Potential Accessibility[2]** | | | | | |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | -0.01616<br>(0.00766) | | | | |
| **Ln Floor** | | -0.0185<br>(0.00943) | -0.01804<br>(0.00949) | -0.01907<br>(0.00942) | |
| **Special Apartments** | ** 0.1652<br>(0.11108) | ** 0.15557<br>(0.1121) | ** 0.15577<br>(0.11279) | | |
| **Status** | 0.41119<br>(0.15109) | 0.40773<br>(0.15136) | | | |
| **R Square** | 0.54206 | 0.54109 | 0.53347 | 0.53128 | 0.53060 |
| **Adjusted R Square** | 0.53668 | 0.53571 | 0.53145 | 0.52696 | 0.52599 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Tel Aviv | (1) | | (2) | | (3) | | (4) | | (5) | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intercept** | *** | 12.6287<br>(0.0905) | *** | 10.074<br>(0.21826) | *** | 9.93823<br>(0.22884) | *** | 10.0448<br>(0.23111) | *** | 9.53048<br>(0.25084) |
| **Size** | ** | 0.00997<br>(0.0021) | | | | | | | | |
| **Ln Size** | | | ** | 0.70521<br>(0.06569) | ** | 0.75169<br>(0.06919) | ** | 0.73676<br>(0.06896) | ** | 0.76008<br>(0.0708) |
| **Rooms** | ** | 0.08111<br>(0.02742) | ** | 0.08002<br>(0.02552) | | | | | | |
| **Ln Rooms** | | | | | ** | 0.16465<br>(0.07554) | ** | 0.17611<br>(0.07463) | ** | 0.16973<br>(0.07647) |
| **Age** | * | -0.0013<br>(0.00074) | * | -0.0012<br>(0.00074) | * | -0.00137<br>(0.00073) | | | | |
| **Ln Age** | | | | | | | * | -0.03576<br>(0.01215) | * | -0.03536<br>(0.06896) |
| **Socioeconomic Level** | *** | 0.03259<br>(0.00332) | *** | 0.03213<br>(0.0033) | *** | 0.03275<br>(0.00325) | *** | 0.03367<br>(0.00322) | | |
| **Ln Socioeconomic Level** | | | | | | | | | *** | 0.34736<br>(0.0395) |
| **Potential Accessibility[2]** | | | | | | | | | | |
| **Ln Potential Accessibility** | | | | | | | | | | |
| **Floor** | * | 0.00948<br>(0.00646) | * | 0.01286<br>(0.00449) | * | 0.01332<br>(0.00445) | * | 0.01279<br>(0.0044) | * | 0.01306<br>(0.00451) |
| **Ln Floor** | | | | | | | | | | |
| **Special Apartments** | ** | 0.11078<br>(0.12616) | ** | 0.13394<br>(0.10764) | ** | 0.15026<br>(0.10835) | ** | 0.16837<br>(0.10954) | ** | 0.1652<br>(0.11108) |
| **Status** | * | 0.24304<br>(0.01777) | * | 0.22188<br>(0.07546) | * | 0.22002<br>(0.07621) | * | 0.39782<br>(0.14885) | * | 0.41119<br>(0.15109) |
| **R Square** | | 0.71863 | | 0.72842 | | 0.72891 | | 0.72792 | | 0.71745 |
| **Adjusted R Square** | | 0.71543 | | 0.72793 | | 0.72806 | | 0.72637 | | 0.71405 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Tel Aviv (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 9.53048 | *** 9.51036 | *** 9.75229 | *** 9.71173 | *** 9.51253 |
| | (0.25084) | (0.25309) | (0.27747) | (0.27644) | (0.28107) |
| **Size** | | | | | |
| **Ln Size** | ** 0.76008 | ** 0.77719 | ** 0.78222 | ** 0.81208 | ** 0.80559 |
| | (0.0708) | (0.07094) | (0.07103) | (0.07214) | (0.07213) |
| **Rooms** | | | | | |
| **Ln Rooms** | ** 0.16973 | ** 0.1666 | ** 0.17105 | ** 0.16601 | ** 0.16491 |
| | (0.07647) | (0.07723) | (0.07734) | (0.07896) | (0.07869) |
| **Age** | | | | | |
| **Ln Age** | * -0.03536 | * -0.0407 | * -0.0293 | * -0.02915 | * -0.0319 |
| | (0.06896) | (0.01241) | (0.00557) | (0.00568) | (0.00783) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | *** 0.34736 | *** 0.34849 | *** 0.34471 | *** 0.33874 | *** 0.34093 |
| | (0.0395) | (0.03991) | (0.03977) | (0.04053) | (0.04033) |
| **Potential Accessibility**[2] | | | | | |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | * 0.01306 | | | | |
| | (0.00451) | | | | |
| **Ln Floor** | | * 0.00549 | * 0.00591 | * 0.00254 | |
| | | (0.00654) | (0.00654) | (0.00649) | |
| **Special Apartments** | ** 0.1652 | ** 0.15557 | ** 0.23621 | | |
| | (0.11108) | (0.1121) | (0.06069) | | |
| **Status** | * 0.41119 | * 0.40773 | | | |
| | (0.15109) | (0.15136) | | | |
| **R Square** | | 0.71295 | 0.71003 | 0.69997 | 0.70147 |
| **Adjusted R Square** | 0.71405 | 0.70951 | 0.70723 | 0.69662 | 0.69857 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Haifa | | (1) | | (2) | | (3) | | (4) | | (5) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intercept** | *** | 11.74196<br>(0.12396) | *** | 9.17140<br>(0.24559) | *** | 9.14743<br>(0.24568) | *** | 9.25248<br>(0.25304) | *** | 8.54861<br>(0.28181) |
| **Size** | *** | 0.00886<br>(0.00104) | | | | | | | | |
| **Ln Size** | | | *** | 0.73127<br>(0.07133) | *** | 0.74067<br>(0.07193) | *** | 0.73083<br>(0.0721) | *** | 0.79205<br>(0.07735) |
| **Rooms** | *** | 0.11355<br>(0.02759) | *** | 0.08978<br>(0.02626) | | | | | | |
| **Ln Rooms** | | | | | *** | 0.24534<br>(0.07824) | *** | 0.26909<br>(0.07769) | *** | 0.25055<br>(0.08413) |
| **Age** | *** | -0.00371<br>(0.00092) | *** | -0.0036<br>(0.0009) | *** | -0.00374<br>(0.0009) | | | | |
| **Ln Age** | | | | | | | *** | -0.07027<br>(0.01586) | *** | -0.04472<br>(0.01709) |
| **Socioeconomic Level** | *** | 0.04898<br>(0.00372) | *** | 0.04819<br>(0.00367) | *** | 0.04841<br>(0.00361) | *** | 0.04941<br>(0.00358) | | |
| **Ln Socioeconomic Level** | | | | | | | | | *** | 0.45439<br>(0.04196) |
| **Potential Accessibility**[2] | | | | | | | | | | |
| **Ln Potential Accessibility** | | | | | | | | | | |
| **Floor** | | -0.00359<br>(0.00587) | | -0.00343<br>(0.00442) | | -0.00369<br>(0.00442) | | -0.00305<br>(0.00438) | | -0.0045<br>(0.00473) |
| **Ln Floor** | | | | | | | | | | |
| **Special Apartments** | * | 0.13728<br>(0.02173) | * | 0.21544<br>(0.08259) | * | 0.23951<br>(0.08239) | * | 0.24299<br>(0.08218) | * | 0.28807<br>(0.08931) |
| **Status** | | 0.12557<br>(0.02574) | | 0.11058<br>(0.05085) | | 0.12865<br>(0.11093) | | 0.28667<br>(0.11847) | | 0.3288<br>(0.12754) |
| **R Square** | | 0.80469 | | 0.81401 | | 0.81737 | | 0.81796 | | 0.78739 |
| **Adjusted R Square** | | 0.80092 | | 0.81318 | | 0.81319 | | 0.81355 | | 0.78318 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Haifa (cont.) | | (6) | | (7) | | (8) | | (9) | | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intercept** | *** | 8.54861<br>(0.28181) | *** | 8.54254<br>(0.28083) | *** | 8.32727<br>(0.27747) | *** | 8.24198<br>(0.27229) | *** | 8.32734<br>(0.2756) |
| **Size** | | | | | | | | | | |
| **Ln Size** | *** | 0.79205<br>(0.07735) | *** | 0.78992<br>(0.07723) | *** | 0.80845<br>(0.07755) | *** | 0.84245<br>(0.07811) | *** | 0.82647<br>(0.07801) |
| **Rooms** | | | | | | | | | | |
| **Ln Rooms** | *** | 0.25055<br>(0.08413) | *** | 0.25323<br>(0.08412) | *** | 0.26349<br>(0.08468) | *** | 0.25730<br>(0.08593) | *** | 0.25198<br>(0.08536) |
| **Age** | | | | | | | | | | |
| **Ln Age** | *** | -0.04472<br>(0.01709) | *** | -0.04344<br>(0.01688) | *** | -0.0346<br>(0.00645) | *** | -0.03418<br>(0.00654) | *** | -0.04888<br>(0.0104) |
| **Socioeconomic Level** | | | | | | | | | | |
| **Ln Socioeconomic Level** | *** | 0.45439<br>(0.04196) | *** | 0.45253<br>(0.04184) | *** | 0.44975<br>(0.04212) | *** | 0.43210<br>(0.04219) | *** | 0.44660<br>(0.04224) |
| **Potential Accessibility**[2] | | | | | | | | | | |
| **Ln Potential Accessibility** | | | | | | | | | | |
| **Floor** | | -0.0045<br>(0.00473) | | | | | | | | |
| **Ln Floor** | | | | -0.0079<br>(0.00613) | | -0.00714<br>(0.00617) | | -0.00898<br>(0.00623) | | |
| **Special Apartments** | * | 0.28807<br>(0.08931) | * | 0.28347<br>(0.08940) | * | 0.29367<br>(0.08992) | | | | |
| **Status** | | 0.3288<br>(0.12754) | | 0.32383<br>(0.12687) | | | | | | |
| **R Square** | | 0.78739 | | 0.78811 | | 0.78361 | | 0.77525 | | 0.77751 |
| **Adjusted R Square** | | 0.78318 | | 0.7839 | | 0.77987 | | 0.77218 | | 0.77446 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Dan Metropolis | | (1) | | (2) | | (3) | | (4) | | (5) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intercept** | *** | 12.3841<br>(0.08164) | *** | 8.7603<br>(0.19714) | *** | 8.6537<br>(0.19441) | *** | 8.76501<br>(0.19742) | *** | 8.15086<br>(0.20097) |
| **Size** | *** | 0.00582<br>(0.00074) | | | | | | | | |
| **Ln Size** | | | *** | 0.40517<br>(0.04632) | *** | 0.43813<br>(0.04625) | *** | 0.43047<br>(0.04611) | *** | 0.43651<br>(0.04651) |
| **Rooms** | ** | 0.13802<br>(0.01837) | ** | 0.14839<br>(0.01674) | | | | | | |
| **Ln Rooms** | | | | | ** | 0.3919<br>(0.0488) | ** | 0.40163<br>(0.04816) | ** | 0.40208<br>(0.04861) |
| **Age** | ** | -0.0018<br>(0.00066) | ** | -0.0019<br>(0.0006) | ** | -0.00212<br>(0.00059) | | | | |
| **Ln Age** | | | | | | | ** | -0.04043<br>(0.00865) | ** | -0.04091<br>(0.00872) |
| **Socioeconomic Level** | *** | 0.03794<br>(0.00238) | *** | 0.02998<br>(0.00222) | *** | 0.03021<br>(0.00219) | *** | 0.02972<br>(0.00217) | | |
| **Ln Socioeconomic Level** | | | | | | | | | *** | 0.30428<br>(0.02379) |
| **Potential Accessibility** | * | 0.07894<br>(0.00076) | * | 0.07054<br>(0.01427) | * | 0.06085<br>(0.01409) | * | 0.06883<br>(0.01401) | * | 0.05007<br>(0.01388) |
| **Ln Potential Accessibility** | | | | | | | | | | |
| **Floor** | | 0.00071<br>(0.00583) | | 0.00881<br>(0.00255) | | 0.00921<br>(0.00251) | | 0.0089<br>(0.0025) | | 0.00904<br>(0.00252) |
| **Ln Floor** | | | | | | | | | | |
| **Special Apartments** | ** | 0.15254<br>(0.01341) | ** | 0.25003<br>(0.04476) | ** | 0.27974<br>(0.0442) | ** | 0.27923<br>(0.04387) | ** | 0.28234<br>(0.04424) |
| **Status** | | 0.03528<br>(0.00746) | | 0.11837<br>(0.02677) | | 0.13182<br>(0.02645) | | 0.10155<br>(0.06432) | | 0.1052<br>(0.06482) |
| **R Square** | | 0.71262 | | 0.77205 | | 0.77078 | | 0.77305 | | 0.76736 |
| **Adjusted R Square** | | 0.70903 | | 0.77164 | | 0.76779 | | 0.76953 | | 0.76534 |

***,**,*Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Dan Metropolis (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 5.33571<br>(0.32462) | *** 5.35796<br>(0.32751) | *** 5.27952<br>(0.32678) | *** 5.14306<br>(0.33156) | *** 5.21385<br>(0.33101) |
| **Size** | | | | | |
| **Ln Size** | *** 0.42125<br>(0.04667) | *** 0.45101<br>(0.04675) | *** 0.45926<br>(0.04682) | *** 0.48906<br>(0.04738) | *** 0.47839<br>(0.04728) |
| **Rooms** | | | | | |
| **Ln Rooms** | ** 0.40103<br>(0.04857) | ** 0.39943<br>(0.04912) | ** 0.40403<br>(0.04923) | ** 0.39868<br>(0.05008) | ** 0.39246<br>(0.04972) |
| **Age** | | | | | |
| **Ln Age** | ** -0.04167<br>(0.00874) | ** -0.04622<br>(0.00871) | ** -0.0315<br>(0.00296) | ** -0.03092<br>(0.00301) | ** -0.03661<br>(0.00506) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | *** 0.30467<br>(0.02365) | *** 0.31134<br>(0.02393) | *** 0.31151<br>(0.02402) | *** 0.31841<br>(0.02442) | *** 0.31407<br>(0.0243) |
| **Potential Accessibility** | | | | | |
| **Ln Potential Accessibility** | * 2.2648<br>(0.13094) | * 2.24014<br>(0.13194) | * 2.23524<br>(0.13237) | * 2.24055<br>(0.13467) | * 2.24197<br>(0.13393) |
| **Floor** | 0.00954<br>(0.00235) | | | | |
| **Ln Floor** | | 0.0014<br>(0.00534) | -0.0007<br>(0.00536) | -0.0101<br>(0.00517) | |
| **Special Apartments** | ** 0.28234<br>(0.04416) | ** 0.27009<br>(0.0466) | ** 0.26839<br>(0.04674) | | |
| **Status** | 0.10394<br>(0.06466) | 0.12152<br>(0.065) | | | |
| **R Square** | 0.76713 | 0.76377 | 0.76159 | 0.75235 | 0.75455 |
| **Adjusted R Square** | 0.76508 | 0.76156 | 0.75954 | 0.75084 | 0.75302 |

***,**,*Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Center | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Intercept** | *** 12.33373 (0.05362) | *** 9.48304 (0.22041) | *** 9.90622 (0.14855) | *** 9.80521 (0.14547) | *** 9.18631 (0.2235) |
| **Size** | *** 0.00336 (0.00055) | | | | |
| **Ln Size** | | *** 0.55839 (0.06060) | *** 0.48514 (0.04275) | *** 0.51959 (0.04179) | *** 0.55545 (0.06291) |
| **Rooms** | ** 0.15614 (0.01474) | ** 0.10191 (0.02078) | | | |
| **Ln Rooms** | | | ** 0.34958 (0.04750) | ** 0.34899 (0.04710) | ** 0.35881 (0.07655) |
| **Age** | ** -0.00539 (0.00058) | ** -0.00527 (0.00072) | ** -0.00583 (0.00054) | | |
| **Ln Age** | | | | ** -0.05892 (0.00565) | ** -0.05787 (0.01027) |
| **Socioeconomic Level** | ** 0.03614 (0.00193) | ** 0.03641 (0.00814) | ** 0.03595 (0.00177) | ** 0.03545 (0.00176) | |
| **Ln Socioeconomic Level** | | | | | ** 0.36695 (0.03578) |
| **Potential Accessibility** | *** 0.05209 (0.00019) | *** 0.07142 (0.01131) | *** 0.06418 (0.00376) | *** 0.06229 (0.00375) | *** 0.08645 (0.01129) |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | 0.00778 (0.00335) | 0.00659 (0.00480) | 0.00341 (0.00224) | 0.00411 (0.00222) | 0.00456 (0.00482) |
| **Ln Floor** | | | | | |
| **Special Apartments** | ** 0.14822 (0.00748) | ** 0.20166 (0.02262) | ** 0.22841 (0.02353) | ** 0.21831 (0.02334) | ** 0.22099 (0.0234) |
| **Status** | 0.07844 (0.00491) | 0.05227 (0.02692) | 0.06876 (0.01630) | 0.06714 (0.03854) | 0.06158 (0.02667) |
| **R Square** | 0.67891 | 0.73073 | 0.73916 | 0.73799 | 0.72905 |
| **Adjusted R Square** | 0.67738 | 0.72628 | 0.73777 | 0.73660 | 0.72455 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Center (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 8.98134 (0.15886) | *** 8.92949 (0.15730) | *** 8.41254 (0.15579) | *** 8.48759 (0.15577) | *** 8.64614 (0.15793) |
| **Size** | | | | | |
| **Ln Size** | *** 0.51779 (0.04246) | *** 0.51730 (0.04198) | *** 0.53962 (0.04213) | *** 0.60201 (0.04247) | *** 0.58205 (0.0426) |
| **Rooms** | | | | | |
| **Ln Rooms** | ** 0.35122 (0.04796) | ** 0.35379 (0.04734) | ** 0.32539 (0.04796) | ** 0.34250 (0.04887) | ** 0.34530 (0.04873) |
| **Age** | | | | | |
| **Ln Age** | ** -0.05874 (0.00572) | ** -0.04125 (0.00564) | ** -0.03913 (0.00214) | ** -0.02873 (0.00218) | ** -0.02981 (0.00245) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | ** 0.39135 (0.01903) | ** 0.38857 (0.01876) | ** 0.39161 (0.01924) | ** 0.38939 (0.01957) | ** 0.38672 (0.01948) |
| **Potential Accessibility** | | | | | |
| **Ln Potential Accessibility** | *** 0.38893 (0.02553) | *** 0.41513 (0.02814) | *** 0.41633 (0.02570) | *** 0.43081 (0.02607) | *** 0.41362 (0.02561) |
| **Floor** | 0.00454 (0.00226) | | | | |
| **Ln Floor** | | 0.00726 (0.00318) | -0.01607 (0.00322) | -0.01561 (0.00304) | |
| **Special Apartments** | ** 0.21704 (0.02376) | ** 0.18625 (0.02484) | ** 0.18329 (0.02521) | | |
| **Status** | 0.06993 (0.03898) | 0.06375 (0.03858) | | | |
| **R Square** | 0.73432 | 0.73501 | 0.70243 | 0.71742 | 0.71914 |
| **Adjusted R Square** | 0.73289 | 0.73360 | 0.70120 | 0.71629 | 0.71804 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| South | | (1) | | (2) | | (3) | | (4) | | (5) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intercept** | *** | 12.0532<br>(0.15762) | *** | 9.61215<br>(0.26596) | *** | 9.50524<br>(0.18113) | *** | 9.59435<br>(0.18383) | *** | 9.44285<br>(0.18686) |
| **Size** | *** | 0.00980<br>(0.00107) | | | | | | | | |
| **Ln Size** | | | *** | 0.5711<br>(0.0550) | *** | 0.58698<br>(0.05654) | *** | 0.58213<br>(0.05636) | *** | 0.58812<br>(0.05645) |
| **Rooms** | *** | 0.09386<br>(0.02087) | *** | 0.09400<br>(0.01888) | | | | | | |
| **Ln Rooms** | | | | | *** | 0.29750<br>(0.06630) | *** | 0.30370<br>(0.06606) | *** | 0.30156<br>(0.06626) |
| **Age** | ** | -0.0053<br>(0.00064) | ** | -0.00470<br>(0.0005) | ** | -0.00464<br>(0.00057) | | | | |
| **Ln Age** | | | | | | | ** | -0.05782<br>(0.0079) | ** | -0.05771<br>(0.00794) |
| **Socioeconomic Level** | ** | 0.02372<br>(0.00321) | ** | 0.03361<br>(0.03098) | ** | 0.02986<br>(0.03076) | ** | 0.04354<br>(0.0306) | | |
| **Ln Socioeconomic Level** | | | | | | | | | ** | 0.14955<br>(0.02399) |
| **Potential Accessibility** | *** | 0.05082<br>(0.00508) | *** | 0.07092<br>(0.00633) | *** | 0.07175<br>(0.00634) | *** | 0.07257<br>(0.00635) | *** | 0.07262<br>(0.00635) |
| **Ln Potential Accessibility** | | | | | | | | | | |
| **Floor** | | 0.01267<br>(0.00366) | | 0.00497<br>(0.00316) | | 0.00491<br>(0.00313) | | 0.00499<br>(0.00311) | | 0.00495<br>(0.00312) |
| **Ln Floor** | | | | | | | | | | |
| **Special Apartments** | ** | 0.12209<br>(0.03769) | ** | 0.15003<br>(0.04476) | ** | 0.15026<br>(0.10835) | ** | 0.16837<br>(0.10954) | ** | 0.1658<br>(0.11108) |
| **Status** | | 0.02489<br>(0.00582) | | 0.00102<br>(0.00046) | | 0.00109<br>(0.0004) | | 0.0009<br>(0.00045) | | 0.00089<br>(0.00045) |
| **Confrontation Line Cities** | * | -0.04415<br>(0.08342) | * | -0.03303<br>(0.08286) | * | -0.05052<br>(0.08305) | * | -0.05750<br>(0.08175) | * | -0.06560<br>(0.08209) |
| **R Square** | | 0.67888 | | 0.73381 | | 0.73260 | | 0.73403 | | 0.72909 |
| **Adjusted R Square** | | 0.67578 | | 0.73019 | | 0.72897 | | 0.73043 | | 0.73271 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| South (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 9.46591 (0.19092) | *** 9.47700 (0.19080) | *** 9.25310 (0.18540) | *** 9.13085 (0.18672) | *** 9.26250 (0.19120) |
| **Size** | | | | | |
| **Ln Size** | *** 0.61390 (0.05742) | *** 0.61701 (0.05724) | *** 0.65178 (0.05737) | *** 0.67797 (0.05802) | *** 0.64133 (0.05857) |
| **Rooms** | | | | | |
| **Ln Rooms** | *** 0.28226 (0.06761) | *** 0.28120 (0.06754) | *** 0.26520 (0.06829) | *** 0.28741 (0.06927) | *** 0.30106 (0.06935) |
| **Age** | | | | | |
| **Ln Age** | ** -0.04803 (0.00820) | ** -0.04875 (0.00813) | ** -0.03833 (0.00355) | ** -0.03709 (0.00359) | ** -0.03909 (0.00550) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | ** 0.14415 (0.02453 | ** 0.14424 0.02459) | ** 0.15026 (0.02487) | ** 0.15109 (0.0253) | ** 0.16577 (0.02409) |
| **Potential Accessibility** | | | | | |
| **Ln Potential Accessibility** | *** 0.16735 (0.01811) | *** 0.16422 (0.01830) | *** 0.15462 (0.01874) | *** 0.15573 (0.01854) | *** 0.15717 (0.01824) |
| **Floor** | 0.00748 (0.00318) | | | | |
| **Ln Floor** | | 0.00092 (0.00053) | 0.00094 (0.0005) | 0.00067 (0.00942) | |
| **Special Apartments** | ** 0.1652 (0.11108) | ** 0.65057 (0.1121) | ** 0.16027 (0.11012) | | |
| **Status** | 0.00082 (0.00047) | 0.00101 (0.00048) | | | |
| **Confrontation Line Cities** | * -0.08189 (0.08420) | * -0.08424 (0.08482) | * -0.07708 (0.08582) | * -0.07882 (0.08720) | * -0.06537 (0.04888) |
| **R Square** | 0.71963 | 0.72126 | 0.71268 | 0.70079 | 0.69915 |
| **Adjusted R Square** | 0.71588 | 0.71750 | 0.70916 | 0.69750 | 0.69621 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Sharon | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Intercept** | *** 12.09814 (0.07320) | *** 10.26666 (0.25151) | *** 9.37299 0.20813) | *** 9.37179 (0.20504) | *** 8.94360 (0.20332) |
| **Size** | *** 0.00336 (0.00072) | | | | |
| **Ln Size** | | *** 0.49910 (0.0668) | *** 0.51811 (0.05902) | *** 0.52656 (0.05838) | *** 0.54232 (0.05877) |
| **Rooms** | *** 0.14736 (0.02035) | *** 0.14046 (0.02169) | | | |
| **Ln Rooms** | | | *** 0.27207 (0.06760) | *** 0.28234 (0.06734) | *** 0.27239 (0.06788) |
| **Age** | ** -0.00463 (0.0009) | ** -0.00313 (0.0011) | ** -0.00362 (0.00081) | | |
| **Ln Age** | | | | ** -0.04620 (0.00895) | ** -0.04575 (0.00902) |
| **Socioeconomic Level** | ** 0.05041 (0.00274) | ** 0.03945 (0.00450) | ** 0.02683 (0.00332) | ** 0.02216 (0.00331) | |
| **Ln Socioeconomic Level** | | | | | ** 0.25589 (0.03579) |
| **Potential Accessibility** | * 0.01313 (0.00061) | * 0.06221 (0.0122) | * 0.06623 (0.00991) | * 0.06603 (0.00988) | * 0.07744 (0.00950) |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | 0.01433 (0.00427) | 0.00211 (0.00386) | 0.01214 (0.00316) | 0.01205 (0.00315) | 0.01175 (0.00318) |
| **Ln Floor** | | | | | |
| **Special Apartments** | ** 0.13843 (0.03967) | ** 0.12739 (0.04120) | ** 0.19943 (0.03016) | ** 0.19238 (0.02994) | ** 0.18970 (0.03020) |
| **Status** | 0.03349 (0.00730) | 0.06763 (0.02912) | 0.11645 (0.02430) | 0.13808 (0.06336) | ** 0.13477 (0.06392) |
| **R Square** | 0.69581 | 0.75108 | 0.76724 | 0.76845 | 0.76436 |
| **Adjusted R Square** | 0.69315 | 0.75719 | 0.76493 | 0.76614 | 0.76202 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Sharon (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 7.84408 | *** 7.87913 | *** 7.75826 | *** 7.51334 | *** 7.67601 |
| | (0.21791) | (0.21908) | (0.21418) | (0.21429) | (0.21867) |
| **Size** | | | | | |
| **Ln Size** | *** 0.55181 | *** 0.56396 | *** 0.58144 | *** 0.63438 | *** 0.59781 |
| | (0.05791) | (0.05793) | (0.05791) | (0.05821) | (0.05874) |
| **Rooms** | | | | | |
| **Ln Rooms** | *** 0.26166 | *** 0.25642 | *** 0.25717 | *** 0.26175 | *** 0.28024 |
| | (0.06689) | (0.06704) | (0.06741) | (0.06845) | (0.06835) |
| **Age** | | | | | |
| **Ln Age** | ** -0.03651 | ** -0.03874 | ** -0.02954 | ** -0.02722 | ** -0.03384 |
| | (0.00888) | (0.00887) | (0.00284) | (0.00286) | (0.00493) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | ** 0.25613 | ** 0.26050 | ** 0.25674 | ** 0.25804 | ** 0.26170 |
| | (0.03472) | (0.03476) | (0.03489) | (0.03553) | (0.03553) |
| **Potential Accessibility** | | | | | |
| **Ln Potential Accessibility** | * 1.20027 | * 1.17062 | * 1.17035 | * 1.17821 | * 1.16674 |
| | (0.06099) | (0.06188) | (0.06223) | (0.06314) | (0.06253) |
| **Floor** | 0.01086 | | | | |
| | (0.00313) | | | | |
| **Ln Floor** | | 0.00439 | 0.00438 | 0.00454 | |
| | | (0.00381) | (0.00383) | (0.00355) | |
| **Special Apartments** | ** 0.19582 | ** 0.18027 | ** 0.17821 | | |
| | (0.02975) | (0.03148) | (0.03164) | | |
| **Status** | ** 0.14040 | ** 0.14466 | | | |
| | (0.06291) | (0.06299) | | | |
| **R Square** | 0.76156 | 0.77046 | 0.76716 | 0.75562 | 0.75594 |
| **Adjusted R Square** | 0.75928 | 0.76819 | 0.76514 | 0.75384 | 0.75424 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| North | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Intercept** | *** 11.90868 (0.15762) | *** 9.48304 (0.22041) | *** 9.40410 (0.21605) | *** 9.50345 (0.21643) | *** 9.18631 (0.22350) |
| **Size** | *** 0.00551 (0.00082) | | | | |
| **Ln Size** | | *** 0.55839 (0.06060) | *** 0.55991 (0.06313) | *** 0.55312 (0.06241) | *** 0.55545 (0.06291) |
| **Rooms** | ** 0.12000 (0.02359) | ** 0.10191 (0.02078) | | | |
| **Ln Rooms** | | | ** 0.35005 (0.07644) | ** 0.35915 (0.07598) | ** 0.35881 (0.07655) |
| **Age** | * -0.00388 (0.00078) | * -0.00337 (0.00072) | ** -0.00330 (0.00072) | | |
| **Ln Age** | | | | ** -0.05736 (0.01020) | ** -0.05787 (0.01027) |
| **Socioeconomic Level** | ** 0.03183 (0.00412) | ** 0.04641 (0.00814) | ** 0.05496 (0.05929) | ** 0.05882 (0.00801) | |
| **Ln Socioeconomic Level** | | | | | ** 0.26695 (0.03578) |
| **Potential Accessibility** | ** 0.02146 (0.00018) | ** 0.08142 (0.01131) | ** 0.08095 (0.01134) | ** 0.08048 (0.01128) | ** 0.08645 (0.01129) |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | 0.00591 (0.00453) | -0.00059 (0.00480) | -0.00088 (0.00481) | -0.00122 (0.00479) | -0.00056 (0.00482) |
| **Ln Floor** | | | | | |
| **Special Apartments** | ** 0.13526 (0.10764) | ** 0.13394 (0.10764) | ** 0.15026 (0.10835) | ** 0.16837 (0.10954) | ** 0.1652 (0.11108) |
| **Status** | 0.03334 (0.00717) | 0.15227 (0.02692) | 0.16585 (0.02667) | 0.16276 (0.02648) | 0.16158 (0.02667) |
| **Confrontation Line Cities** | *** 0.20363 (0.02646) | *** 0.20065 (0.02921) | *** 0.19982 (0.02928) | *** 0.19484 (0.02914) | *** 0.20605 (0.02913) |
| **R Square** | 0.68190 | 0.72073 | 0.72955 | 0.73301 | 0.72905 |
| **Adjusted R Square** | 0.67796 | 0.71628 | 0.72508 | 0.72859 | 0.72455 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| North (cont.) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|
| **Intercept** | *** 9.21592<br>(0.22151) | *** 9.24566<br>(0.22181) | *** 9.04883<br>(0.21153) | *** 8.87820<br>(0.21438) | *** 9.01614<br>(0.22057) |
| **Size** | | | | | |
| **Ln Size** | *** 0.55318<br>(0.06265) | *** 0.54893<br>(0.06284) | *** 0.57920<br>(0.06251) | *** 0.61511<br>(0.06364) | *** 0.58573<br>(0.06412) |
| **Rooms** | | | | | |
| **Ln Rooms** | ** 0.35888<br>(0.07628) | ** 0.35906<br>(0.07645) | ** 0.34698<br>(0.07694) | ** 0.37942<br>(0.07857) | ** 0.37842<br>(0.07877) |
| **Age** | | | | | |
| **Ln Age** | ** -0.05788<br>(0.01027) | ** -0.04699<br>(0.01027) | ** -0.03242<br>(0.00381) | ** -0.03132<br>(0.00390) | ** -0.04443<br>(0.00669) |
| **Socioeconomic Level** | | | | | |
| **Ln Socioeconomic Level** | ** 0.27254<br>(0.03556) | ** 0.26718<br>(0.03569) | ** 0.27356<br>(0.03588) | ** 0.26860<br>(0.03678) | ** 0.29223<br>(0.03605) |
| **Potential Accessibility** | | | | | |
| **Ln Potential Accessibility** | ** 0.22200<br>(0.02882) | ** 0.22230<br>(0.02918) | ** 0.22142<br>(0.02935) | ** 0.22368<br>(0.03002) | ** 0.20372<br>(0.02862) |
| **Floor** | -0.00048<br>(0.00475) | | | | |
| **Ln Floor** | | -0.0185<br>(0.00943) | -0.00221<br>(0.00424) | -0.00817<br>(0.00419) | |
| **Special Apartments** | ** 0.16382<br>(0.11108) | ** 0.15836<br>(0.1121) | ** 0.15569<br>(0.02699) | | |
| **Status** | 0.16347<br>(0.02655) | 0.15773<br>(0.02679) | | | |
| **Confrontation Line Cities** | *** 0.19391<br>(0.02841) | *** 0.19394<br>(0.02873) | *** 0.19027<br>(0.02889) | *** 0.18644<br>(0.02956) | *** 0.16115<br>(0.01837) |
| **R Square** | 0.73006 | 0.73040 | 0.72507 | 0.70871 | 0.70685 |
| **Adjusted R Square** | 0.72565 | 0.72594 | 0.72097 | 0.70487 | 0.70334 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Krayot | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| **Intercept** | *** 11.88097<br>(0.12482) | *** 9.48449<br>(0.30016) | *** 9.53137<br>(0.30164) | *** 9.61970<br>(0.29803) | *** 9.20566<br>(0.31672) |
| **Size** | *** 0.00692<br>(0.00114) | | | | |
| **Ln Size** | | *** 0.66297<br>(0.08434) | *** 0.63860<br>(0.08808) | *** 0.63209<br>(0.08663) | *** 0.63128<br>(0.08686) |
| **Rooms** | ** 0.11175<br>(0.03073) | ** 0.07653<br>(0.02954) | | | |
| **Ln Rooms** | | | ** 0.26786<br>(0.09850) | ** 0.29023<br>(0.09782) | ** 0.29097<br>(0.09808) |
| **Age** | * -0.00459<br>(0.00123) | * -0.00365<br>(0.00120) | ** -0.00369<br>(0.00119) | | |
| **Ln Age** | | | | ** -0.04034<br>(0.01527) | ** -0.04945<br>(0.01530) |
| **Socioeconomic Level** | ** 0.03500<br>(0.00595) | ** 0.03370<br>(0.00572) | ** 0.03394<br>(0.00569) | ** 0.03360<br>(0.00564) | |
| **Ln Socioeconomic Level** | | | | | ** 0.33116<br>(0.05709) |
| **Potential Accessibility[2]** | | | | | |
| **Ln Potential Accessibility** | | | | | |
| **Floor** | -0.00320<br>(0.00688) | -0.00009<br>(0.00543) | -0.00033<br>(0.00540) | -0.00005<br>(0.00533) | -0.00011<br>(0.00534) |
| **Ln Floor** | | | | | |
| **Special Apartments** | ** 0.12491<br>(0.01759) | ** 0.13514<br>(0.06128) | ** 0.15459<br>(0.06065) | ** 0.14785<br>(0.06007) | ** 0.14636<br>(0.06021) |
| **Status** | 0.13372<br>(0.01203) | 0.14241<br>(0.04237) | 0.15024<br>(0.04226) | 0.19249<br>(0.10811) | 0.18689<br>(0.10832) |
| **R Square** | 0.77631 | 0.79289 | 0.79446 | 0.79739 | 0.79624 |
| **Adjusted R Square** | 0.76977 | 0.78683 | 0.78845 | 0.79146 | 0.79028 |

*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Simulations for Sensitivity Analysis and Examination of Nonlinear Relationships of the Explanatory Variables**

| Krayot (cont.) | | (6) | | (7) | | (8) | | (9) | | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intercept** | *** | 9.20566<br>(0.31672) | *** | 9.21117<br>(0.31585) | *** | 9.01657<br>(0.30153) | *** | 8.92331<br>(0.30153) | *** | 9.04270<br>(0.30802) |
| **Size** | | | | | | | | | | |
| **Ln Size** | *** | 0.63128<br>(0.08686) | *** | 0.63048<br>(0.08649) | *** | 0.66303<br>(0.08575) | *** | 0.69006<br>(0.08570) | *** | 0.66933<br>(0.08611) |
| **Rooms** | | | | | | | | | | |
| **Ln Rooms** | ** | 0.29097<br>(0.09808) | ** | 0.29300<br>(0.09793) | *** | 0.28317<br>(0.09858) | *** | 0.28135<br>(0.09951) | *** | 0.28202<br>(0.09897) |
| **Age** | | | | | | | | | | |
| **Ln Age** | ** | -0.04945<br>(0.01530) | ** | -0.03101<br>(0.01515) | ** | -0.03528<br>(0.00515) | ** | -0.03461<br>(0.05766) | ** | -0.04925<br>(0.00895) |
| **Socioeconomic Level** | | | | | | | | | | |
| **Ln Socioeconomic Level** | ** | 0.33116<br>(0.05709) | ** | 0.33139<br>(0.05696) | ** | 0.32625<br>(0.05730) | ** | 0.31977<br>(0.05766) | ** | 0.32510<br>(0.05739) |
| **Potential Accessibility[2]** | | | | | | | | | | |
| **Ln Potential Accessibility** | | | | | | | | | | |
| **Floor** | | -0.00011<br>(0.00534) | | | | | | | | |
| **Ln Floor** | | | | -0.00725<br>(0.00660) | ** | -0.00628<br>(0.00662) | ** | -0.00988<br>(0.00642) | | |
| **Special Apartments** | ** | 0.14636<br>(0.06021) | ** | 0.13065<br>(0.06105) | ** | 0.12933<br>(0.06144) | | | | |
| **Status** | | 0.18689<br>(0.10832) | | 0.19819<br>(0.10744) | | | | | | |
| **R Square** | | 0.79624 | | 0.79737 | | 0.79290 | | 0.78697 | | 0.78810 |
| **Adjusted R Square** | | 0.79028 | | 0.79144 | | 0.78774 | | 0.78254 | | 0.78388 |

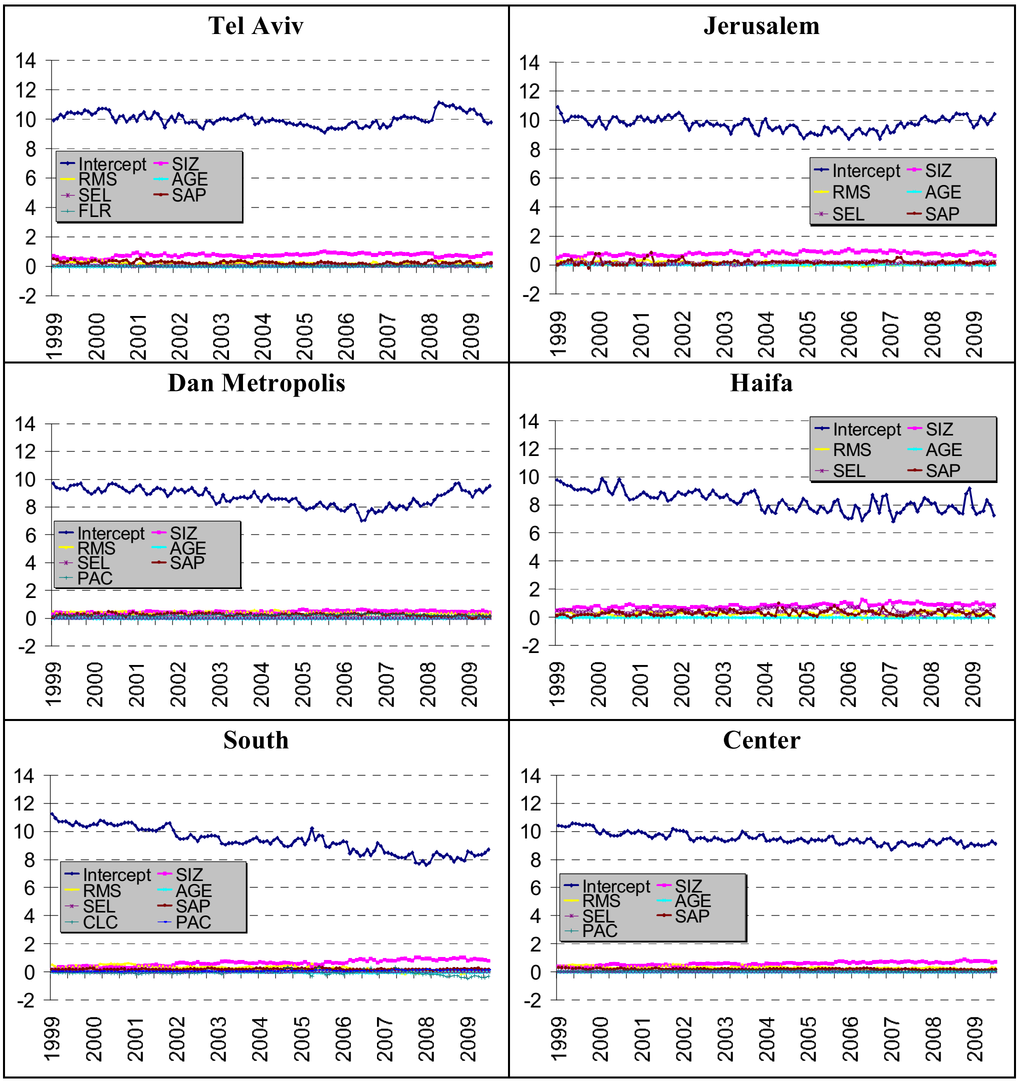
*,**,*** Represents the statistical significance at a level of 10%, 5% and 1%, respectively. A variable is considered significant at a certain level if at least 80% of the cases were below the indicated level.

[2] Potential accessibility is calculated at the level of the community and not at the level of the neighborhood, thus it is not included in the simulations for geographical areas containing one city.

**Appendix C – Examination of Stability and Time Trends of Regional Coefficients in the Model (1999-2009)**

**Graph 15**

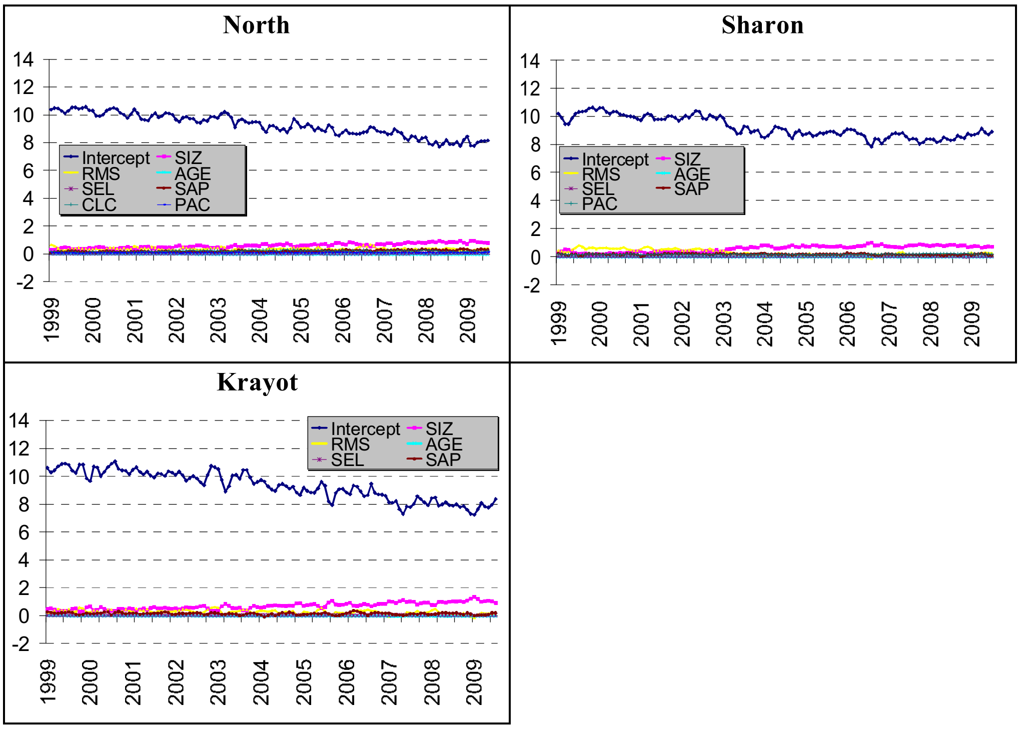
**Change in Coefficients over Time**



**Appendix C (cont.) – Examination of Stability and Time Trends of Regional Coefficients in the Model (1999-2009)**

## Graph 15

**Change in Coefficients over Time**



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