DEMAND AND SUPPLY OF REAL ESTATE MARKET IN TURKEY:

A COINTEGRATION ANALYSIS

A Master's Thesis

by

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Bilkent University

Ankara

January 2009

To My Husband and My Family

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A COINTEGRATION ANALYSIS

The Institute of Economics and Social Sciences
of
Bilkent University

by

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

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Since in a country the housing market is a leading indicator for the whole economy, the determinants, that are affecting aggregate housing supply and demand, are widely searched. In this study, we try to find the variables which are affecting the demand and supply of real estate market in Turkey between the years 1970 to 2007. We can not specialize on the housing market and rather study the real estate market in the aggregate---number of dwellings is our quantity measure---due to data limitations. We chose Topel and Rosen's (1988) demand and supply models that are basically based on different short- and long-run elasticity. As demand side independent variables, interest rate, value variable, income and population are chosen and as supply side independent variables, value, interest rate and costs are chosen.

Value is used as a proxy since the market price data does not exist in Turkey. Value is a kind of cost that is taken from the builder without interested in what the materials are and how much the labor costs to the builder. Also, the annual data is used because of the data limitations. Due to the fact that all these variables are I(1), Johansen Cointegration and VECM are preferred. According to the empirical findings, the signs of all the variables are as expected and are significant in the long-run. However, in the short-run, only interest rate and cost variables are significant in 90% confidence level. Furthermore, the price elasticity of supply is 1.5 in the long-run while it is 0.13 in the short-run. This shows us that the adjustment costs for a change in Turkey is significantly high. Moreover, the long-run price elasticity of demand is -4.97.

Keywords: Housing supply, housing demand, cointegration, vector error correction

ÖZET

TÜRKİYE'DE GAYRİMENKUL PİYASASI ARZ VE TALEP DENGESİ:
EŞBÜTÜNLEŞME ANALİZİ

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Bir ülkede konut piyasası, genel ekonomi açısından gösterge niteliği taşıdığından dolayı, konut piyasası toplam arz ve talep bileşenleri yaygın bir şekilde araştırılmıştır. Bu çalışmada, 1970 ve 2007 yılları arasında Türkiye gayrimenkul piyasası toplam arz ve talebi oluşturan değişkenler bulunmaya çalışılmıştır. Veri eksikliğinden dolayı, özel olarak konut piyasası incelenememişti. Birbirinden farklı uzun ve kısa dönem fiyat elastikiyetleri esasına dayalı olan Topel ve Rosen (1988) konut arz ve talep modeli tercih edilmiştir. Konut piyasası yazınında sıkça kullanılan talep/arz değişkenleri esas alınarak, bu çalışmada telep değişkenleri olarak, nüfus, faiz oranı, gelir ve değer değişkenleri; arz denge değişkenleri olarak, değer, faiz oranı ve maliyet endeksi değişkenleri kullanılmıştır. Değer datası, Türkiye'de evlerin piyasa fiyatları bulunmadığından dolayı, fiyat değişkenine vekil olarak kullanılmıştır. Ayrıca, bina sayısı verisi yıllık olarak toplanmasından dolayı, bu çalışma yıllık veri ile gerçekleştirilmiştir. Bütün değişkenlerin birinci farkları durağan olduğundan dolayı, Johansen Eşbütünleme ve Hata Düzeltme Modeli tercih edilmiştir. Bu çalışmanın ampirik sonuçlarına gore, uzun dönemde söz konusu arz/talep değişkenleri anlamlı çıkmıştır ve beklenen işaretler görülmüştür. Buna karşın, kısa dönemde faiz oranları ve maliyet değişkenleri dışında bütün değişkenler %90 güven seviyesinde anlamsız çıkmıştır. Ayrıca, uzun dönem arz fiyat esnekliği 1.50 olarak çıkarken, kısa dönem arz fiyat esnekliği 0.13 olarak çıkmıştır. Söz konusu esneklik sayıları bize, konut piyasasında olan bir değişikliğin kısa dönemde gerçekleşme maliyetinin çok yüksek olduğunu göstermektedir. Ayrıca, uzun dönem talep fiyat esnekliği -4.97 olarak çıkmıştır.

Anahtar kelimeler: Konut Talebi, konut arzı, Eşbütünleşme, Vektör Hata Düzeltme

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CHAPTER 1

INTRODUCTION

The housing market is different from most of the other markets' goods and services. One reason for this is the dual function; it is both a commodity by yielding a flow of consumer services and also an investment asset by being a large portion of household net worth. So, all the analysis of the housing market includes both properties. Due to not only including these properties but also having different other features, the analysis of the housing is further complicated. According to Palmquist (1983), the housing market is a kind of differentiated product due to the heterogeneous structure, i.e. it has a structure based on the characteristics of houses like the structures of house or the location. Also, according to Quigley (1992), there are four basic features that differentiate housing from other goods and services. These are, high cost of supply -because it takes long time to build-, durability, heterogeneity- no two houses are identical in every respect- and location fixity. These features of housing, in particular its durability, heterogeneity and location fixity together imply that the housing market is a collection of connected but segmented markets.

According to the real estate financiers and economists, because of the relation between the macroeconomic variables and housing -such as, the relation between employment and housing construction- housing investment, made by both the builders and the consumers in order to increase their worth, is a leading indicator of economic activity (Smith and Tesarek 1991; Wheeler and Chowdhury 1993). Holly and Jones (1997) also agree with this opinion; due to the fact that housing is an element of personal wealth, its operation may be significantly linked to economic conditions of that country. The increased in demand in real estate market results in capital gain in investment for real estate. In this environment, households observe two effects depending on whether they are the owners of real estate or planning to acquire one. In the former group, the rise in asset prices along with the decline in the interest rates as a result of continuing good economic environment lead to the so called “wealth effect”. A positive shock to households’ total wealth leads to an increase in their current and future consumption. In the latter group, where households are on the buyer side of the market, the decline in interest rates generates an income effect that motivates households to purchase houses whereas the increase in house prices leads them to substitute away. The resultant impact depends on whichever force is greater. (Binay and Salman, 2008) These types of effects bring about the housing market to be too important and interesting.

In addition, government policy can have a profound impact on the operation of the housing market. The vouchers or subsidies to homeowners in the form of the mortgage interest deduction increase demand for housing services. The long-run impact on price depends on the supply response determined by the price elasticity of supply. Government policy has also impacted the supply side of the market directly through the construction of public housing and tax policy designed to encourage the private construction of new housing. These interventions raise an important policy question concerning the extent to which these policies result in net additions to the housing stock or simply crowd out private activity.

Economists have used the fact that the housing price is a natural outcome of the demand for housing, equating with its supply. So, the demand and supply for housing interact to determine the price of housing relative to other goods and services. Based on this fact, which basically depends on the idea that the price is formed by supply and demand market makers simultaneously, I try to estimate the supply and demand equations for the housing market activity. In the first part of this study, I will give some information about the literature about housing market studies. In the second part, I will introduce Topel and Rosen housing investment theory that is consistent with my empirical research and with the structure of the Turkish housing market. Then, I will briefly explain the housing market structure in Turkey and the studies about Turkish housing market. In the fourth part of my study, I will explain my method selection for the estimation as well as the data and theory underlying the estimation method with the econometric model. In the last part, the estimation results will be displayed.

CHAPTER 2

LITERATURE REVIEW

In the literature, while modeling housing market, various methods are used. Poterba (1984) takes an asset market approach to modeling the housing market. His model of the housing market examines the impact of a shock to the steady state, mapping out the adjustment process to a new steady state. A shock such as a decline in user cost results initially in an increase in real housing price since the housing stock is fixed. The market then adjusts with growth in the housing stock and a decline in real price to a new steady state.

Urban spatial theory, which provides equilibrium models in which the stock of housing always equals the urban population, is another way of modeling housing market. In these models, there is no supply theory dealing with construction flows since new construction or the flow of housing simply equals the growth in population. Dipasquale and Wheaton (1994) use this theory effectively in order to disprove one of the assumptions about the housing market which tells housing market clears quickly. They question this by using stock-flow approach and show the housing market's inability to rapidly clear, and also show the inefficiency of housing market. In order to get rid of the problem of slow market clearing, they use price adjustment mechanism and annex it to demand-supply equations. They estimate their models by using two quite different approaches in the way of forming consumers' expectations about future house prices, and they find that the gradual price adjustment statistically holds strongly both when consumers develop expectations by looking backward at historic price movements and when housing demand is based upon rational forward looking forecasts. Moreover, they use land factor, which depends on the stock of housing not the level of building activity, in defining the supply equation of the housing market.

Some researchers such as Palmquist (1983) think that housing is a good example for a differentiated product. So, Palmquist estimates the demand for the characteristic of housing by using hedonic demand theory. He chooses this because previous studies about hedonic regression could not find any weakness of this theory and also nonlinear hedonic equation with the data of seven standard metropolitan areas provides elimination of identification and endogeonity of marginal prices problems. In his paper, he assumed there is no market segmentation within an urban area since there is mobility among housing types and locations and little evidence of price discrimination. Also he assumes that differences in consumers within and between cities are measurable and can be controlled.

Unlike Palmquist (1983), Reichert (1990) thinks that there are big differences in housing demand or supply between regions within a country. So his research is based on effects of some macroeconomic variables upon regional housing prices by constructing a region-specific housing supply and demand function of United States.

Topel and Rosen (1988) examine the extent to which housing investment decisions are determined by comparing current asset prices with current marginal costs of production. They argue that current asset prices are sufficient statistics for housing investment if short-run and long-run investment supplies are the same. If changes in the level of construction activity impact the cost of production, then supply is less elastic in the short run than the long run. This divergence between short-term and long-term elasticity indicates that current asset prices are not sufficient and builders must form expectations about future prices in order to make investment decisions.

Besides these theoretical studies about housing market, there is a huge literature based on empirical analysis of housing market in the country-level in the light of these above theories.

Since the housing market of United States is the most advanced one in the world, there is so much empirical analysis about housing market about the whole country as well as about within the country.

The housing supply and housing demand studies will be presented in later sections.

Other than focusing the supply and demand analysis, the interaction between the income and price is widely searched. Joshua Gallin (2006) searches whether there is a long run relationship between house prices and income by using 95 United States metropolitan areas for 23 years. Many housing market observers have become concerned that house prices have grown too quickly and are now too high relative to per capita incomes. Gallin admits that under the idea that there is a long-run relationship between prices and income, prices will likely stagnate or fall until they are better aligned by income. However, he finds that with the standard tests, there is little evidence for the cointegration of housing prices and income in 95 United States metropolitan areas for 23 years.

Unlike Gallin, Malpezzi (1999) finds that house price changes are not random walks and are at least partly predictable. In his work, by constructing a simple model that tests whether prices tend to revert to some equilibrium ratio of house price to income. Furthermore, he investigates how supply conditions affect both the equilibrium price and the time path of adjustment to equilibrium in 133 United States metropolitan areas from 1979 through 1996. According to his results, the stringency of the regulatory environment was a particularly powerful determinant of the equilibrium house price to income ratio. Also, faster rates of population growth and of income growth were associated with higher conditional price changes, suggesting a less than perfectly elastic short-run housing supply.

CHAPTER 3

HOUSING INVESTMENT THEORY

Housing stock depends on depreciated number of dwellings and number of housing completions as in perpetual inventory.

It is a common assumption that housing supply is inelastic in the short-run than in the long run, since housing completions is relatively smaller than housing stock.(Kenny, 1998) Also Topel and Rosen (1988) explained the reason of this assumption by the high costs of construction activity when rapid changes occur. So, in the short-run, the demand for housing driven by the exogenous factors will determine the price of housing relative to other goods and services.

Figure 1. Short-run equilibrium

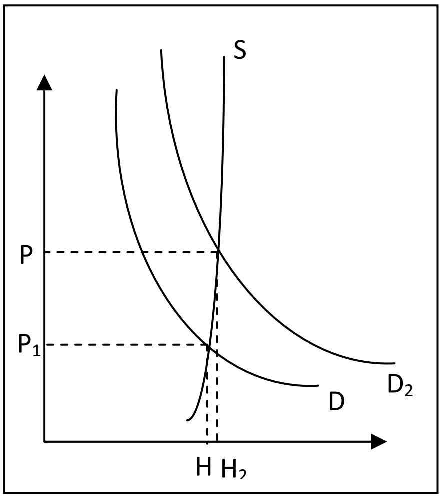
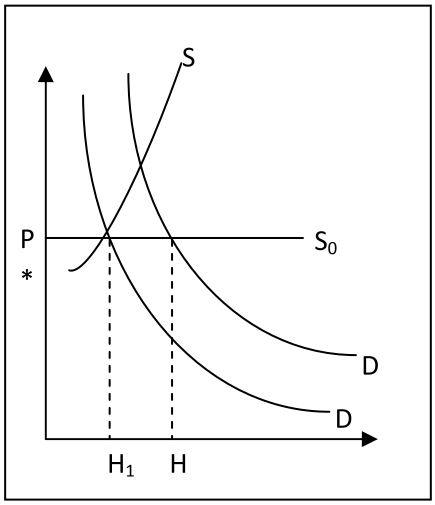


Figure 2. Long-run equilibrium



In Figure 1, for any level of house prices below P_1, there is an excess demand for housing and for any level of house prices above P_1, there is an excess supply for housing. From the graph, it is quite clear that under conditions of short-run equilibrium, any stimulus to housing demand will result in a rise more in house prices relative to other goods and services than house dwellings as mentioned in Kenny (1998). Hence, the microeconomic studies of house market predict a very strong relationship between the arguments of housing demand function and the real price of housing in the short-run.

However, in the long-run, a sudden increase in demand results again rise in house prices, this time construction firms will find it profitable to supply more housing units to the market which makes the supply curve more elastic.

3.1. Housing Supply

Much of the literature has focused on the determinants of new housing supply, particularly the supply of single family detached homes, and the renovation and repair decisions of homeowners. It has focused on aggregate data because there is so little information where the unit of observation is the builder, investor, or landlord. In addition, since housing is a durable good, housing supply is determined not only by the production decisions of builders of new units but also by the decisions made by owners of housing (and their agents) concerning conversion of the existing stock of housing. (Dipasquale, 1999)

While modeling supply side of the market, Poterba (1984) assumes that the home-building industry is composed of competitive firms and that the industry's aggregate supply depends on its input prices and the real market price of housing. Assuming there are limits to supply of any factor of production (such as lumber), increases in demand for construction increase the equilibrium price of structures. Poterba defines supply as net investment in structures, ignoring land prices; he acknowledges the importance of land but omits land in his empirical studies because of the data issues for his empirical work.

A disadvantage of a cost structure based on rising supply price alone is that it does not make the Marshallian distinction, in which the longer the period, the fewer things that you are holding constant while you analyze the response of a market to an external shock, between short-run and long-run supply responses: the industry supply curve is fixed, and has no time-dimension. This assumption gives an industry version of the adjustment cost theory of investment, but is unlikely to be valid, because supply is likely to be more inelastic in the short-run.

Therefore, the nature of the short and long-run supply conditions of factors of production to the industry is specified. Thus, for example, labor does not move costless in and out of the industry. Neither does capital. Short-run factor supplies are less elastic than long-run supplies. To go in this direction, it requires introducing additional state variables into the analysis, which increases the complexity of the model, especially for empirical work. Instead Topel and Rosen (1988) adopt a more tractable alternative where supply conditions of factors are approximately incorporated into an expanded cost function which includes the rate of change of industry output. Short-run output supply inelasticity is implied by cost penalties to rapid changes in the level of construction activity.

A complete model of the dynamics of new housing supply requires detailed specification of supply dynamics for all factors of production to the industry. By allowing marginal cost to vary with both the level of output and its rate of change, Topel and Rosen (1988) cut through the immense complications.

In housing literature, there is a large literature on modeling the housing supply of new homes. While Topel and Rosen (1988) model the housing investment under the assumption of perfect foresight, they focus on housing supply. On the supply side of the market, the representative building firms maximizes discounted profits over an infinite horizon. Since the market is perfectly competitive, profits are defined as

$$\int_0^\infty [P(t)I(t) - C(I(t), \dot{I}(t), y(t))]\ \mathrm{e}^{-\mathrm{rt}}\mathrm{dt} \qquad (3.1.1)$$

where P(t) is the price for one unit of housing stock at time t, $I(t)$ is gross investment in housing at time t, C(t)represents the costs at time t and r is a positive constant representing the interest rate. Furthermore, the industry's capital evolution equation is

$$I = \dot{K} + \delta K \qquad (3.1.2)$$

The cost function is specified as

$$C = C(I, \dot{I}, y), \qquad (3.1.3)$$

Total cost C at time t is a function of the level of production, the change in production and a number of cost function shifters represented by a factor y. Note that the inclusion of the change of the gross investment level is the difference between the cost function in Poterba (1984), who includes only the level of investment, and Topel and Rosen (1988), who include both the level and the change in gross investment. Third change in the gross investment level denotes the adjustment cost that the firm faces when changing its output level.

They impose that C is twice continuously differentiable and that marginal costs are positive and increasing in the level of gross investment I and that the adjustment costs are increasing.

$$C_1 = \frac{\partial C}{\partial I} > 0, C_{11} = \frac{\partial^2 C}{\partial I^2} > 0$$

$$C_2 = \partial C / \partial \dot{I} \geq 0, C_{22} = \partial^2 C / \partial \dot{I}^2 \geq 0$$

Furthermore, the nonnegative constraints for the derivative cost function (C_2 and C_{22}) prevent the infinite production since as the rate of change of investment increases, the cost also increases.

Given these assumptions, we can solve the maximization problem of the representative building firm by constructing the Hamiltonian equation and taking the first derivatives with respect to I, $\dot{I}$ and $\dot{K}$. The necessary condition for the optimal path is given by Euler equation.

$$P(t) - \frac{\partial C}{\partial I} = r\left(\frac{\partial C}{\partial \dot{I}}\right) - \frac{d(\partial C/\partial \dot{I})}{dt} \qquad (3.1.4)$$

If $\frac{\partial C}{\partial \dot{I}} = 0$, in other words there is no adjustment cost, firms should choose I such that the price equals to the marginal cost. In such a situation, the right hand side of above equation (3.1.4) reduces to zero and current prices become sufficient in order to determine production.

When the change in $\dot{I}$ appears as an argument in the cost function, there becomes a difference between price and marginal cost that consists of the right hand side of equation (3.1.4). By the linearization of euler equation, we can derive,

$$(1 + r\beta D - \beta D^2)I(t) = \frac{\beta}{c_{22}}P(t) - \left(\frac{\beta}{c_{22}}\right)[c_1 + rc_2 + c_{13}y(t)] \qquad (3.1.5)$$

where the terms in $c_i$and c_{ij} are derivatives of the cost function evaluated at stationary point, $\beta = c_{22}/(c_{11} + rc_{21})$ and $DZ = dZ/dt$.

If the crucial parameter c_{22} is zero then the above equation (3.1.5) tells us that the investment is a function of exogenous cost shifters and the price.

By rewriting the equation (3.1.5) slightly different, we can have the following expression,

$$(1 + r\beta_1 D - \beta_1 D^2)I(t) = \beta_0 + \beta_2 P(t) + y(t) \qquad (16)$$

where the β_i's can be obtained from the equation (3.1.5). In the model without adjustment costs β_1= 0, that is, changes in exogenous cost shifters are immediately reflected in the level of investment. In the case where there are adjustment costs ($\beta_1 \neq 0$), there is a lag before the new level of investment is reached.

In the literature, Topel and Rosen model is used for different purposes. Kenny (1999) has considered the potential effects of asymmetric adjustment costs on the dynamics of housing supply by utilizing from the Topel and Rosen (1988) supply model with the flexible adjustment costs function advocated in Pfann (1996). His empirical results suggest Irish housing supply is unit elastic in equilibrium in the long-run and also in the Irish housing market, adjustment costs associated with an expansion in housing output are greater than the adjustment costs associated with a contraction.

Furthermore, Kenny (1998) summarizes the housing market in Ireland where his estimations about housing supply and demand is based on Topel and Rosen (1988) housing models. He also examines the monetary policy developments about Irish housing market by looking deeply the banking channels and also the inflation policy effects on housing prices.

Topel and Rosen's (1988) ideas such as the supply restrictions on construction activity are not only used in estimations of supply models but also used in setting up an equilibrium asset pricing model between house prices and rents (Ayuso and Restoy, 2006). They apply their own constructed model to Spain, UK and US. And they conclude that sharp increases in house prices lead to price to rent ratios above equilibrium by mid-2003 in those countries.

Hakfoort and Matsyiak (1997) examine the determinants of unsubsidized housing starts in Netherlands by estimating the supply-side of the Poterba (1984) model and the supply-side of the Topel and Rosen (1988) model. The former model yields a supply elasticity of the order 1.6 while the latter yields a short- run elasticity of 2.3 and a long-run elasticity of 6.

3.2. Housing Demand

Most of the literature for the demand side of the housing market is based on the estimation of price elasticity of demand. As mentioned before, Palmquist (1983) estimates the demand for the characteristic of housing by using the hedonic demand theory. He estimates the price elasticity of demand for living space which comes out unitary while the other characteristics are more inelastic. The cross-price effects are significant while the expenditure and income elasticities are found to be inelastic.

The empirical research for demand differ either in variables used for the estimation or in the method chosen for the estimation. James R. Follain, Jr. (1979) examines the effect of an increase in demand on long-run price of housing by finding the price elasticity of the long-run supply of new housing construction in period 1947-1975. He shows that demand function depends on long-run price of a unit of housing, permanent income of households, interest rate and the price of other goods. Follain uses real value of private residential construction as a quantity in supply function by applying OLS and TSLS methods.

Dipasquale and Wheaton (1994) estimates demand equation which is composed of stock of single family units as a function of rent index, age expected homeownership rate, permanent income per household, price index of single family housing, annual user cost of homeownership, and total households. They compare two econometric models for actual households as for tenure choice and age expected households as for both tenure choice and household formation. They find that all elasticities are higher when age expected households are used than when actual households are used. The regional differences within a country are seen not only for the supply side of the housing but also for the demand side of it. Alan K. Reichert (1990) searches effects of some macroeconomic variables upon regional housing prices by constructing region-specific housing equations. He derives demand function in the way of assuming utility maximization on the part of homeowners and wealth maximization on the part of investors. The demand equation is composed of the quantity of new housing sold as a left-hand side variable and real housing prices index of new housing quality, resident income, average employment rate, average loan to value ratio, real mortgage interest rate, the measure of acceleration in regional housing prices and seasonal dummy variables for each specific region.

In housing economics literature, the demand for housing is normally derived in multi-period model where consumers maximize utility subject to an inter-temporal budget constraint. These models incorporate various features of housing market including the large cost of housing relative to the current disposable income and hence the dependence of housing demands the savings in earlier periods and also the price. (Kenny, 1998)

Consider a simple demand function which ignores the frictions generated by the heterogeneity of units and the matching of buyers and sellers. (Topel and Rosen, 1988) Under the assumption of perfect capital market, the inverse demand equation of Topel and Rosen (1988) model becomes;

$$R = \alpha K + x \qquad (3.2.1)$$

where R is the rental price of a housing unit, $x(t)$ is a vector of exogenous demand shifters, $K(t)$ be the stock of housing capital and α < 0.

There is a perfect foresight deterministic model assumption and taxes are ignored. Then, the rental price of a house is its amortized stock of depreciated price including the interest and capital gains which can be expresses as in the following way;

$$R = (r + \delta)P - \dot{P} \qquad (3.2.2)$$

where r is the interest rate and δ is the depreciation rate. For explaining this equation in detail, think it as we are in a discrete time. For example, when a household buys a house, the price of a house is the sum of all its rental prices.

$$P_t = R_t + R_{t+1} + R_{t+2} + \cdots + R_{t+k} \quad (3.2.3)$$

where k is the life of a building.

In the next period, the price of a house is still sum of the rental prices but there is a depreciation since you did not sell the house in the previous period. Also, you have a depreciated income and income that are exposing to the interest gain.

$$P_t = R_t + R_{t+1} + R_{t+2} + \cdots + R_{t+k} + \delta P_t + rP_t \quad (3.2.4)$$

$$P_{t+1} = P_t - R_t + \delta P_t + rP_t \quad (3.2.5)$$

Equation (3.2.5) is the same with the equation (3.2.2), just written in discrete time. Furthermore, the value of housing stock must be bounded so that the discounted future price of capital converges:

$$\lim_{t\to\infty} P(t)\, e^{-(r+\delta)t} = 0 \quad (3.2.6)$$

By taking the integral of equation (3.2.2) with respect to t under the boundary condition, we can write;

$$P(t) = \int_t^{\infty} R(s)\, e^{-(r+\delta)(s-t)} ds \quad (3.2.7)$$

Above equation (3.2.7) tells us that the price of a house is the accumulation of all discounted rental income through its life.

Hence, the complete market dynamics of stocks and prices are described by two linear differential equations:

$$(1 + r\beta_1 D - \beta_1 D^2)I(t) = \beta_0 + \beta_2 P(t) + y(t) \tag{3.2.8}$$

$$(r + \delta)P(t) - \dot{P}(t) = \alpha K(t) + x(t) \tag{3.2.9}$$

Given the initial conditions $I(0)$ and $K(0)$ with the boundary condition (3.2.6), by differentiating (3.2.9) with respect to t and substituting from (3.1.2) yields

$$(1 + rBD - BD^2)P(t) = \alpha BI(t) + B(D + \delta)x(t) \tag{3.2.10}$$

where $B = [\delta(\delta + r)]^{-1}$.

This demand model (Topel and Rosen, 1988) has its origins in the work of Walras (1954) and much later by Friedman (1963) and Tobin (1969). They deal with a linear structure for analytical tractability and present a deterministic (perfect foresight) formulation to illustrate the key ideas. To avoid expository distractions, which are well treated in the literature, they also ignore the special and peculiar income tax provisions of home ownership.

This demand part of the Topel and Rosen (1988) model completes the housing supply model since the market should be thought simultaneously.

3.3 Implications of Theory

Topel and Rosen (1988) housing investment theory provides a framework to analyze the possible determinants of the housing supply as well as the allowance of short-run and long-run analysis in my empirical work. In addition, Topel and Rosen model also contains the expected present value theory of asset pricing which supports my empirical analysis and becomes suitable for the Turkish housing market in the way of houses, not being only consumption good but also a part of a household wealth. Therefore their model is a kind of an extended version of Poterba's (1984) model.

As in this model, by not omitting the long-run relations, short-run relations can be found and be interpreted in my study with the help of Vector Error Correction econometric methodology which provides us to study on short-run dynamics by restricting the variables to converge to their cointegrating long-run relations. (Known as Restricted Vector Auto-Regression).

In my empirical framework, the cost index behaves like one of the element of the cost function in Topel and Rosen (1988) model, which is denoted as y(t). Because, the cost index has the construction material prices and in the Topel and Rosen (1988) model the cost shifter is defined as the factor prices that are supplied to the industry, the cost index can be used as a cost shifter. The other dynamics, represented as gross investment level is composed of the quantity of dwellings, constructed for the defined period, because the investment level depends on the change of capital stock with the depreciated capital, equation (3.1.2). Lastly, the rate of change of the investment is added to the model because of the slow adjustment mechanism of the market in the short-run, so it is used in the short-run empirical analysis. In my empirical framework, the long-run errors that can be found by Johansen Cointegration econometric methodology and used in the restricted vector auto-regression model, and also the first differences of the variables are the representatives of the rate of change of gross investment level in the short-run analysis.

According to the equilibrium equation (3.2.10), when demand side shifter, $x(t)$, increases under the assumption that the other variables stay the same, the investment level, $I(t)$, increases since $B = [\delta(\delta + r)]^{-1}$ is positive and α is negative. Moreover, as $I(t)$ increases, the capital stock $K(t)$ increases. In my empirical study, the demand side shifters are population and income. So as population increases, the need for houses increases so quantity demanded increases and as income increases, the demand of houses increases. On the other hand, when the supply side shifter, $y(t)$ increases, the price of the investment, $P(t)$, increases then $I(t)$decreases since again $B = [\delta(\delta + r)]^{-1}$ is positive and α is negative. In my empirical framework, the supply side shifter is the cost index since it includes factor prices affecting the supply and as cost index increases, the desire for building will decrease due to less profit. Hence, as cost index increases, the level of investment and so the capital stock will decrease. Furthermore, the interest rate, $r(t)$ in the equation (3.2.10) affects both the supply side and the demand side. The interest rate has a negative relationship since

α is negative. In this study, the interest rate has also a negative effect on the quantity of dwellings for both sides of the market. The other variable, affecting both the demand and the supply, is the price of the investment, $P(t)$. The effect of price to the demand side and to the supply side is different. According to the supply equation (3.2.8), as price increases, the level of investment increases since β_2 is positive and so the capital stock increases. However, according to the equation (3.2.9), as the price of investment increases, the capital stock directly decreases due to the fact that $(r + \delta)$is positive and α is negative. The value, which is used as a proxy for the price, has a negative effect on quantity demanded since as prices increases, less people can buy houses. However, the value has a positive effect on the supply of houses since building a house may become more profitable than before.

CHAPTER 4

HOUSING MARKET IN TURKEY

Housing was not ranked among the most important socio-economic issues in Turkey until the early 1960s. The main reasons for this lack of interest may be summarized as follows. First, the migration from rural to urban areas was relatively slow and there was no marked deficit in the housing supply at least quantitatively until that era. Second, the slow pace of industrialization did not make the workers' housing question an important source of discontent before the early 1960's. Finally until the beginning of the planned development period, housing had not been taken up within the broader context of its position relative to the whole of the economy. Therefore, its effect to the economy was largely neglected. (Keles, 1990)

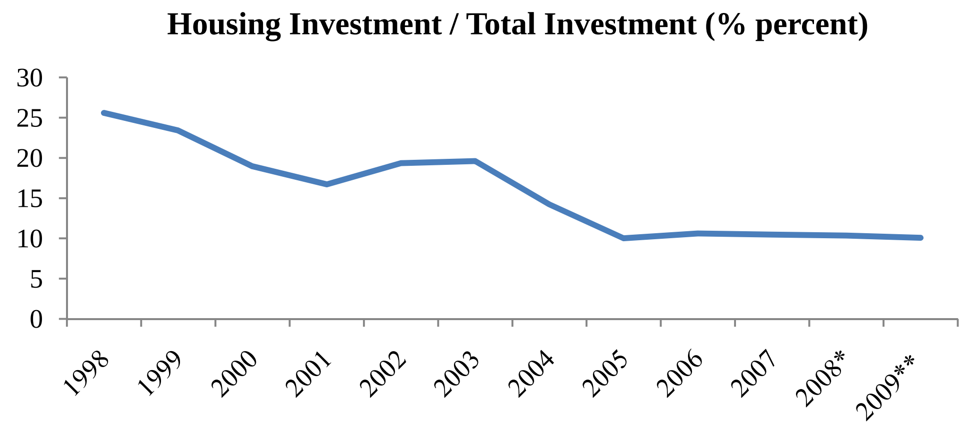
After 1960's, transition from the traditional family to nucleus family and rapid rising of population increases the demand for houses, especially the housing type called apartments which have smaller gardens and more than one floor. Due to Turkey's problems about economics such as low level of Gross National Product per capita, chronical high inflation and high interest rates, enough savings for house building and buying can not be formed. The implemented policies about housing is not efficient enough to solve the problems of Turkey housing market. In the past, land is allowed to build but the infrastructure is not constructed for a living place, this reduces the investment desire of the investors. Also, the unavailability of mortgage credits causes more people not to be able to buy houses for long periods. So, building shanty houses (gecekondu) and unhealthy, unplanned urbanization spread widely. The promises before each election and frequently accepted construction forgiveness cause to raise the problem exponentially. (Gurbuz, 2002)

In addition, deficient municipal income is not enough to construct infrastructure services to the new streets and new counties where there are already lots of shanty houses. Furthermore, deficiency in communication between the municipalities who construct infrastructure and the utility units who provide electricity and water causes wasteful expenditure.

Increasing investment to the infrastructure services with the renovation in housing policy in 1980's maintains the construction sector to rally. Collective housing fund, housing aid fund to the employees and especially the Turkey Emlak Bank had assumed the role of the leader for the construction sector. With the guidance of these funds, house supplies and cooperatives, which are supported by the mortgage credits, increase rapidly. Housing Development Administration of Turkey starts to build houses for the low income families with facilities in payment. This helps reducing the inequality between demand and supply in Turkey.

There was seen a significant decline in housing investments in the middle of the 1970's and also in the beginning of the 1980's with the effect of the crisis seen in during 1970's. Since housing investment is one of the most important expenditure of a household and it has a high portion in the expenditure of a household, this investment is an important source for the other investments other than the infrastructure and utility investments. (Malpezzi, 1990) In the 1980s, the housing investment increases, especially with the help of government investment, and then starts to decline in the last years of twentieth century and in the beginning of twenty first century. By observing the figure 3, we can easily notice that after 1998, the ratio of housing fixed investment to the gross fixed investment is rapidly declining.

Figure 3: The share of housing investment in gross fixed investments- 1998 current prices



*****Expectation ****** Target of the government

Source: DPT, State Planning Organization, www.dpt.gov.tr

With this decrease investment in housing, Turkey housing investments is lower than the investment ratios of developed countries, whereas in 1988's this ratio is near to the developed countries (Eraydin et al., 1996)

The literature about housing in Turkey is widely based on the inefficiency of the housing policies; little empirical analysis is done due to the deficiency of data. However, as the housing sector importance is understood, various data collection increases and more studies are done. For example one of the latest studies is done by Sari, Ewing and Aydin (2007). They investigate the relation between housing starts and macroeconomic variables in Turkey from 1961 to 2000. They use generalized variance decomposition approach for examining the relations between housing market activity and prices, interest rates, output, money stock and employment. Their results indicate that the effect of the housing market on output is not necessarily reflected in labor market. Moreover, the shocks to interest rates, output and prices have notable effects on housing activity in Turkey.

The provision of housing finance in developing countries is often problematic, because of the volatile macroeconomic environment and the lack of legal and regulatory framework that supports collateralized lending. Erol and Patel (2004) evaluate Turkish government's housing policy for financing the public sector housing and discuss the appropriate type of mortgages from the lender's perspective. According to their results, wage-indexed payment mortgages (WIPM) are found to be desirable mortgage instruments in periods of persistent high inflation from the lender's perspective. The reason behind this finding is that WIPM eliminate the real interest rate risk, credit risk of adjustable rate mortgages and the wealth risk of the fixed rate mortgages.

Another research paper on the Turkish real estate market is based on the idea that the housing is both an income decrease for the tenants and an income provider for the landlords. So housing has some kind of wealth effect for the households that can affect the whole economy. Binay and Salman (2008) discuss the extent of wealth effects, affordability, financial deepening and credit market risks in Turkish real estate market. They use price- rent ratio to test whether there is a real estate price bubble in Turkey or not. As a result, they do not find enough evidence supporting that there is a real estate bubble in Turkey, contradicting what many believe.

Therefore, there is no direct and collective study which is based on formulating both the supply and the demand side of the Turkish housing market. So, this study aims to determine the factors affecting the housing supply and demand in Turkey.

CHAPTER 5

ECONOMETRIC METHODOLOGY AND DATA

In this chapter, econometric methodology that is found suitable to use in this study is introduced with the data descriptions. Furthermore, econometric model is briefly explained.

5.1 Methodology

This chapter presents and discusses a brief review of the empirical methodology employed. In section 5.1.1, we briefly present Phillips Perron Unit Root Tests. In 5.1.2, Johansen Cointegration Test and Vector Error Correction Methods are presented.

5.1.1 Phillips-Perron Unit Root Test

A stationary time series has a constant long-run mean, a finite variance (time-invariant) and a theoretical correlogram that diminishes as lag length increases. On the other hand, for a non-stationary series, there exists no long-run mean and its variance is time dependent. Therefore, under the condition of non-stationarity, to use classical statistical methods such as ordinary least squares (OLS), usual t-tests and F-tests, are inappropriate. However, in order to decide the presence of unit roots which can be defined as a tendency for changes in a system to persist, in other words non-stationarity in a system, only looking at the sample correlogram is unreliable. A formal test to detect the possible presence of unit roots is developed by Phillips and Perron (1988)

The distribution theory supporting the Dickey-Fuller tests assumes that the errors are statistically independent and have a constant variance. In using this methodology, care must be taken to ensure that the error terms are uncorrelated and have constant variance. Phillips and Peron (1988) developed a generalization of the Dickey-

Fuller procedure that allows for fairly mild assumptions concerning the distribution of the errors.

The Phillips-Peron test is explained in Enders (1995) as follows:

Suppose that we observe observations 1,2,...,T of the $\{y_t\}$ sequence and estimate the regression equation:

$$y_t = \tilde{a}_0 + \tilde{a}_1 y_{t-1} + \tilde{a}_2 \left(t - \frac{T}{2}\right) + u_t$$

Fortunately, the changes are minor; simply replace $\tilde{a}_0$ with $u, \tilde{a}_1$ with α, and $\tilde{a}_2$ with β. Thus, suppose we have estimated the regression:

$$y_t = u + \beta \left(t - \frac{T}{2}\right) + \alpha y_{t-1} + u_t$$

where u, β, and α are the conventional least squares regression coefficients.

Phillips-Perron derive test statistics for the regression coefficients under the null hypotheses that the data are generated by

$$y_t = y_{t-1} + u_t$$

where the disturbance term u_t is such that $Eu_t = 0$.

There is no requirement that the disturbance term be serially uncorrelated or homogenous. Instead, the Phillips-Perron test allows the disturbances to be weakly dependent and heterogeneously distributed.

The Phillips-Perron statistics modify the Dickey-Fuller t-statistics by allowing for an adjustment to account for heterogeneity in the error process.

The appropriate critical values are given in MacKinnon (1991) same with the Dickey- Fuller test critical values.

5.1.2. Johansen Cointegration Test

The sequences $\{y_t\}$ and $\{z_t\}$ are cointegrated, if they are integrated of the same order, let us say d, or I(d), and their residual sequence is stationary. It is a known fact that OLS estimation procedure can be applied if the variables involved in the model are I(0). The violation of this assumption causes us to obtain spurious correlation (Granger and Newbold,1974). While dealing this problem, Davidson et al. (1978) state that fitting the regression by using the first differences of the variables would result in a loss of valuable information about the long-run. Therefore, they propose an error correction mechanism (ECM) by combining the first differences of the short-run and undifferenced values of the long-run dynamics. However, Engle and Granger (1987) prove that this method developed by Davidson et al. (1978) is true if the variables in the model are cointegrated.

A theoretically more satisfying approach is developed by Johansen (1988) to consider the cointegration relationship when there are more than two variables. This procedure is explained in Watson and Teelucksingh (2002) as follows; x_t is composed of (n,1) vector of I(1) variables whose vector autoregressive (VAR) representation is given as,

$$x_t = \Pi_1 x_{t-1} + \Pi_2 x_{t-2} + \cdots + \Pi_p x_{t-p} + \varepsilon_t \quad (5.1.2.1)$$

where Π_s are (n,n) matrices. It can also be written as,

$$\Delta x_t = \Gamma_1 \Delta x_{t-1} + \Gamma_2 \Delta x_{t-2} + \cdots + \Gamma_{p-1} \Delta x_{t-p+1} + \Gamma x_{t-1} + \varepsilon_t \quad (5.1.2.2)$$

where

$$\Gamma_i = -(\Pi_{i+1} + \Pi_{i+1} + \cdots + \Pi_p)$$

and

$$\Gamma = (-I + \Pi_1 + \Pi_2 + \cdots + \Pi_p)$$

The purpose of the Johansen procedure can be stated as follows;

1. To determine the maximum number of cointegrating vectors

2. To obtain the maximum likelihood estimators of the cointegrating matrix (β) and adjustment parameters (α) for a given value of r.

The rank of the matrix Γ, r, is equal to the number of independent cointegrating vectors. There can be at most n-1 cointegrating vectors and if r=0, it is a known fact that the variables are not cointegrated and equation (5.1.2.2) is VAR model in first differences. If r=n, the vector process is stationary. For 0<r<n, the Γ matrix can be represented as

$$\Gamma = \alpha\beta' \qquad (5.1.2.3)$$

where α and β are full column rank matrices with size (n,r),

$$\alpha = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \cdots & \alpha_{1r} \\ \alpha_{21} & \alpha_{22} & \cdots & \alpha_{2r} \\ \vdots & \vdots & \vdots & \vdots \\ \alpha_{n1} & \alpha_{n2} & \cdots & \alpha_{nr} \end{bmatrix}, and\ \beta = \begin{bmatrix} \beta_{11} & \beta_{12} & \cdots & \beta_{1r} \\ \beta_{21} & \beta_{22} & \cdots & \beta_{2r} \\ \vdots & \vdots & \vdots & \vdots \\ \beta_{n1} & \beta_{n2} & \cdots & \beta_{nr} \end{bmatrix}$$

Equation (5.1.2.2) is denoted as a vector error correction model (VECM). When there are r cointegrating vectors, r error correction terms appear in each of the n equations. For instance, in the first equation (explaining Δx_{1t}), $\alpha\beta' x_{t-1}$ consists of terms,

$$\alpha_{11}(\beta_1' x_{t-1}) + \alpha_{12}(\beta_2' x_{t-1}) + .. + \alpha_{1r}(\beta_r' x_{t-1})$$

It is known that the number of cointegrating vectors is equal to the number of significant characteristics roots of the matrix Γ. Suppose the ordered characteristic roots of the matrix Γ are; $\lambda_1 > \lambda_2 > \cdots > \lambda_n$. To obtain the number of characteristic roots that are different from zero, Johansen proposes the following tests, that are based on trace and maximum eigenvalue statistics, respectively,

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln 1 - \hat{\lambda}_i \qquad (5.1.2.4)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (5.1.2.5)$$

where $\hat{\lambda}_i$ is the estimated values of characteristic roots (eigenvalues) of the estmated Γ matrix and T is the number of usable observations.

The trace statistic tests whether the number of cointegrating vectors is less than or equal to r against a general alternative while the alternative hypothesis for maximum eigenvalue statistic is r+1. The critical values for these statistics are calculated by Johansen and Juselius (1990) with the help of simulation.

5.1.3 Vector Error Correction Model (VECM)

A vector error correction model (VECM) is a restricted VAR designed for use with nonstationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

Formally, the (nx1) vector $x_t = (x_{1t}, x_{2t}, \dots, x_{nt})'$ has no error-correction representation if it can be expressed in the form:

$$\Delta x_t = \pi_0 + \pi x_{t-1} + \pi_1 \Delta x_{t-1} + \pi_2 \Delta x_{t-2} + \cdots + \pi_p \Delta x_{t-p} + \epsilon_t \qquad (5.1.2.6)$$

where,

π_0 = an (n x 1) vector of intercept terms with elements π_{i0}

π_i = (n x n) coefficient matrices with elements $\pi_{jk}(i)$

π = is a matrix with elements π_{jk} such that one or more of the $\pi_{jk} \neq 0$

ϵ_t= an (n x 1) vector with elements ϵ_{it}

Note that the disturbance terms are such that ϵ_{it} may be correlated with ϵ_{jt^*}

The key feature in (5.1.2.6) is the presence of the matrix π. There are two important points to note:

1. If all elements of π equal zero, (5.1.2.6) is a traditional VAR in first differences. In such circumstances, there is no error-correction representation since Δx_t does not respond to the previous period's deviation from long-run equilibrium.

2. If one or more of the π_{jk} differs from zero, Δx_t responds to the previous period's deviation from long-run equilibrium. Hence, estimating x_t as a VAR in first differences is inappropriate if x_t has an error-correction representation. The omission of the expression πx_{t-1} entails a misspecification error if x_t has an error-correction representation as in (5.1.2.6)

5.2. Data

All the data are obtained from the Turkish Statistical Institute (Turk Stat) over the period 1970- 2007 (annually).

First variable is the quantity of dwellings (q) which is the number of buildings including apartment houses, houses, other buildings (commercial, industrial, medical and social, cultural, religious, administrative and other). It is taken as completed or partially completed new buildings and additions by use of building according to occupancy permits from Turk Stat. This variable represents the quantity demanded and quantity supplied in the equilibrium. Also, the Occupancy permit is preferred in this study since it is a certificate which must be given to building owners by municipalities to be constructed in boundaries of municipalities and it must be given to building owners by governorships if the construction is out of boundaries of municipalities.

The second variable is the interest rate which directly affects both the supply side and the demand side. The Central Bank of the Republic of Turkey (CBRT) nominal discount interest rates are used as a proxy for all other interest rates, since the aim of CBRT for this discount interest rate is being a benchmark for the other interest rates, such as deposit or loan rates. Under the assumption that the inflation expectations are equal to the actual inflation, it is transformed to real values by using the Fisher's Rule which is;

$$(1+i) = (1+r)(1+\pi_e)$$

where, i is the nominal interest rate

r is the real interest rate

π_e is the expected inflation.

The third variable is Gross Domestic Product at constant prices (1987), calculated by Turk Stat. It is used as a proxy for real income.

The other variable is the value of dwellings, which is taken from Turk Stat. The description of the data is as follows:

> "Unit price of m^2 are calculated four times at a year by province for reinforced concrete and bearing wall construction, for building that their use of buildings include apartment houses, houses, other buildings (commercial, industrial, medical and social, cultural, religious, administrative and other) by province. Value is multiplication of floor areas indicated in Occupancy Permits. The cost of land is excluded."

This value m^2 is turned into real terms with the base year 1970 by using the Fisher method. This real value is used as a proxy for real housing prices.

Another variable is Buildings Construction Cost Index, which is calculated by Turk Stat. Since the aim of forming a building construction price index is to determine the quantities of inputs used in building construction and to show the yearly cost changes of these quantities of inputs, this index can be used as cost in the supply side of the market. This study began in 1989 and and results were published first in November 1992. 1991 was determined as the base year and a weighted Laspeyres index formula was used in this calculation.

The index is constructed as below;

> "Out of a total of 295 items in the buildings construction cost index, 20 encompass workmanship, 7 are machinery, 146 are construction materials and 122 are installation materials. Price of these items are gathered from 24 provinces (for every item prices are collected from 3 separate establishments) These prices are collected on the 15th of the last month of every quarter from 1292 establishments which are producers, wholesalers or retailers who do business with construction firms and contractors."

The Turkey Building Cost Index starts from 1991 till 2007 but Istanbul Construction Cost Index starts from 1970 to 2007. So by using Istanbul Construction Cost Index as a leading variable, Turkey Building Cost Index can be generated for the years before 1991. The detailed calculation is in the appendix. This index is also turned into real terms to the base year 1970 by using Fisher method. In addition, another study is established by using the Istanbul Construction Cost Index since this index is highly correlated with Turkey Building Cost Index and Istanbul Construction Cost Index starts from 1970 to 2007. This index is transformed into real terms by using Fisher’s Rule and Istanbul actual inflation.

In Building Cost Index, preset materials and labor are calculated within the preset weights. The weights and the materials are not changed during the years. In addition, these prices are taken from the producers. On the other hand, in value each buildings cost are taken from the builder without interested in what the materials are and how much the labor costs to the builder. So the materials and the weights probably change over time. Another difference is that value is taken and calculated for each city while building cost index is taken from preset four regions.

The last variable is the population. Mid year population (population on July 1) estimate is taken from Turk Stat. This covers data related to the results obtained in General Population.

5.3. Econometric Model

The credit restrictions have a crucial impact on the sign of the effect of various variables on housing demand. Under the assumption of perfect capital markets, i.e. no credit restrictions, both the current and future income and the expected increase in real house prices have a positive effect on housing demand due to the fact that when the current and future income of a household increase; he wants to buy new homes in order to increase his monthly income by taking rent from each additional home if the benefit from consumption or the return from alternative investments are less than the housing investment; or he wants to buy a new home in order to raise his standard of living. Also, a household who wants to maximize his profit from a house buys new homes when house prices are expected to increase. Since as population rises, the need for the houses increase, there is a positive relationship between housing demand and population. Conversely, the demand for housing is negatively related with the interest rate because higher interest rates increase the cost of borrowing as well as the cost of housing services.

As the credit restrictions increase, the effect of the variables on housing demand may vary. For example, a fall in future income has an immediate effect on future consumption. Since the households want to smooth their consumption, from now on they start to save. Since there is a shortage of alternative savings (other than housing market) because of the credit restrictions, current demand for housing increases when future income falls.

In this study, it is assumed that the quantity demanded (q_d) is a function of real value (p), real income (y), real interest rate (c) and population (n)

$$Q_d = f(P, Y, R, N) \tag{6.2.1}$$

where Q_d = quantity of dwellings

P = real value

Y = GDP at 1987 prices

R = real CBRT discount rate

N = population

The impacts of these variables are basically based on the consumer behaviors. However, the changes of exogenous factors on the equilibrium level of value will also depend on how the supply of housing adjusts both to the changes in demand and to the other exogenous factors.

In the supply side of the housing market, there is a builder who wants to maximize his profit. So the more the construction cost, the less the builder wants to continue building, which means there is a negative relative relation between housing supply and construction cost like the relation between supply and interest rate. If the interest rate increases, the cost of building new houses increases, because they have to accept to pay more interest for having enough capital for building a house. On the other hand, increase in both the current and the future house prices will increase current supply of housing due to the fact that selling houses may be more profitable than the other investments. The population and the income of a household have not a direct effect on supply of housing but an indirect effect through the housing demand.

In this study, it is assumed that the quantity supplied (q_s) is a function of real value (p), real interest rate (r) and real cost (c)

$$Q_s = f(P, R, C) \quad (6.2.2)$$

where Q_s = quantity of dwellings

P = real value

R = real CBRT discount rate

C = real construction cost index

So, in my analysis the instrumental variables are population and income for the supply side of the market and construction cost for the demand side of the market. These variables help me to estimate supply and demand. The expected signs of the variables are as in the Table 1.

Table1. Expected Signs in Demand and Supply

Variables	Expected Signs in Demand	Expected Signs in Supply
Real House Prices	-	+
Real Income	+	No Direct Effect
Population	+	No Direct Effect
Real Interest Rate	-	-
Construction Cost	No Direct Effect	-

CHAPTER 6

ESTIMATION RESULTS

The descriptive statistics of the levels and logarithmic forms of all the variables investigated in this study are given in the appendix 2. The times series plots of the levels of the variables purport to be non-stationary processes. However, to obtain the exact integration levels of the variables, only considering the plots is not reliable. Therefore, the Philips Perron Unit Root tests are applied. The results of these tests are given in Table 2 in Appendix C.

According to the Phillips Perron test results (Table 2), all the variables are of integrated of order 1, I (1) at the 0.1 significance level. Therefore, the results of Phillips Perron unit root tests can be interpreted not to preclude the validity of employing the Johansen Cointegration procedure for our sample.

The logarithmic forms of the variables are also checked by Philips-Perron unit root test and we observe the results that can be seen from Table 3 in Appendix C

According to Table 3 results, all the variables are of integrated of order 1, that is, the first difference of all the variables are stationary at 90% confidence level. Since all the variables are in the same order, we can use Johansen Cointegration procedure.

6.1 Empirical Results of Housing Supply And Demand

In this section the empirical analysis is employed for two different econometric models. In the first model, all the variables are in the level forms while in the second model, in order to observe the elasticity the variables are in logarithmic forms. Inside the first model, there exist also two different analysis based on different cost indexes, Turkey Building Construction Cost Index or Istanbul Construction Cost Index.

6.1.1. Level Data Analysis

In this part, we employ the Johansen (1988) cointegration procedure to investigate the presence of a long-run relationship between the variables of housing market by using Turkey Cost Index. Considering the results that all the variables are of integrated of order 1, I (1), we consider all the variables simultaneously. We test the null of no cointegration by using both the Johansen maximum eigenvalue (λ_{max}) and trace (λ_{trace}) statistics for a VAR model with a constant and without trend.

In table 4 (Appendix C), eigenvalues (λ_i), the maximum eigenvalue (λ_{max}) and trace eigenvalue (λ_{trace}) statistics are reported. The appropriate lag lengths for the VAR model are selected according to the sequential modified likelihood ratio (LR) test, final prediction error (FPE) and Akaike Information Criterion (AIC).

From Table 4, it is seen that there are two co-integrated vectors in order to explain the long-run relation between the housing variables at the 0.05 significance level. This result is consistent with our expectations since the housing market consists of supply and demand sides.

The economic assumptions tell us that in supply side of the market, the income and population does not affect the quantity while in the demand side of the housing market, the instrumental variable should be the cost. In order to test whether these restrictions are significant in the model or not, the chi- square (χ^2) is estimated and interpreted. The Table 5 in Appendix C shows these statistics for some specified restrictions.

CE1 stands for the demand side, CE2 stands for the supply side. In the first restriction, I only impose the restrictions that are consistent with the economic theory during analysis which tells cost has not a direct effect on demand and income and population do not affect the supply directly. By looking at the results of Table 5, at the 30% level, the first restrictions are appropriate. In the second restriction, in addition to the first restriction, I restrict the coefficient of quantity supplied to take the value of 1, in order not to normalize the supply model. According to the results, the second restriction is appropriate at the 99% conficence level In the third restriction, the restrictions that are used in the second restriction is still valid and also the coefficient of quantity demanded is restricted to the value 1. At the 99% confidence level, third restriction is found significant. Therefore, since p value of the second restriction is the highest, which means the restrictions are the most appropriate among these three restrictions, the second one should be used during the analysis.

By using the second type of restrictions and normalize the demand side, we will get the results which can be seen in Table 6 (Appendix C)

These results (Table 6) provide us to analyze the market in the long-run. So, according to these results, all the variables forming the supply and demand sides are significant in 99% confidence level in the long-run. In the demand side of the housing market, as prices increase, the quantity demanded of buildings decrease. In addition, as income rises, the quantity demanded increases since the households have more money to buy houses. Population also affects the quantity demanded positively in the long run, due to the fact that as people increases the need for houses increases. Also the interest rate effect is negative, meaning, as interest rate increases the households are less willing to buy a house. These signs are consistent with our expectations as well as the economic theory.

In the supply side of the housing market, all the signs are also as expected. As prices increase, the quantity supplied rises; on the other hand costs and interest rates are negatively related.

The coefficients of the variables may not be in the same scale that we face in reality, due to the fact that these variables are real, not nominal. On the other hand, if we observe the coefficient meanings by transforming the variables into nominal terms, we can interpret the coefficients as follows;

Firstly the demand side of the market is analyzed. The real value at 2007 is 0.0006, if we decide to increase the value 0.0025%, in other words $1.5x10^{-8}$, then the quantity of dwelling will decrease by 1. By applying the Fisher' formula with the actual inflation of 2007, we can have the nominal values. The results tell us that when the mean of dwelling values increase by 9,495 YTL in Turkey, the demand for the dwellings decrease by 1. The same procedure is applied to the real interest rate. When the nominal interest rate increases by 1 point, 100 base points, the demand to the dwellings decreases by 64 units. The population and income can directly be interpreted. When the population increases by 1,000 people then the demand increases by 6.44 numbers of dwellings. Also, when the GDP increases $1.63x10^8$ to $1.64x10^8$, 1,000 dwellings are demanded.

Secondly, when we look at the supply side, we can see that the response of builder is less sensitive than the response of a household to the changes of values. The same procedure that is applied above is also done for the supply side. So, if the mean of dwellings values increase by 35,140 YTL, builders want to build one more dwelling. Furthermore, when the nominal interest rate increases by 1 point, 100 base points, 44 less dwellings are supplied. When we observe the effect of real cost which is 141.2 in 2007, by applying the same procedure we have the following result: when the nominal cost index increases by 1,044, which is the 2 percent of nominal cost index in 2007, the quantity supplied decreases by 840 units.

When we look at the vector-error correction model results from Table 7 (Appendix C) which provide us to observe the market in the short-run simply by differencing the data, we can see that most of the variables are not significant in the short-run. In the vector error correction model, the sequence is important in order to understand the path of the speed of adjustment which can be decreasing or increasing, in other words whether the short-run dynamics converge to the long-run dynamics by following an increasing path or a decreasing path. In my analysis, the quantity of dwellings is written first and then the other variables follow the quantity. The coefficient of the error terms shows the speed of adjustment, so according to the resulting table, the short-run dynamics follows an increasing path in order to converge to the long-run equilibrium. In addition, the error correction terms are significant at 99% confidence level. Other than the error correction terms, the real cost index and the real interest rate come out significant at 85% confidence level. Despite the insignificance in the value, we can notice in the short run the value of the response (coefficient is $9.4 x 10^5$) is less than in the long-run. This supports the ideas of the model of Topel and Rosen (1988) since in their model; the short-run price elasticity is less elastic, in other words smaller coefficient, than the long-run price elasticity. This shows that the adjustment costs for a change in the housing market are significant in Turkey.

In the demand side of Topel and Rosen (1988) model, demand side shifters are population and income which come out significant at 99% confidence level in the long-run; however in the short-run they are insignificant. Furthermore, price and common variable, interest rate, are all significant in the long-run and behave in the same manner as it does in the model in the way of coefficients.

Now, the same analysis is applied by only changing the variable, Turkey Construction Cost Index to Istanbul Construction Cost Index.[1] Firstly, we test the null of no cointegration by using both the Johansen maximum eigenvalue (λ_{max}) and trace (λ_{trace}) statistics for a VAR model with a constant and without trend.

From Table 8 in Appendix C, it is seen that there are two co-integrated vectors in order to explain the long-run relation between the housing variables at the 0.05 significance level.

[1] This analysis can be interpreted as roboustness check.

The restrictions are the same with Table 5 where CE1 stands for the demand side and CE2 stands for the supply side. By looking at the results of Table 9 in Appendix C, the first restrictions are not appropriate for this analysis; at the 99% confidence level, the second restriction is appropriate and third restriction is significant at 75% confidence level. Therefore, since p value of the second restriction is the highest, the second one is used during this analysis.

By using the second type of restrictions and normalize it, the associated results are found, shown in Table 10 (Appendix C).

These results provide us to analyze the market in the long-run by using Istanbul Construction Cost Index. So, according to these results, all the variables forming the supply and demand sides are significant in 99% confidence level in the long-run. In the demand side of the housing market, value and interest rate have a negative relationship with the quantity demanded. On the other hand population and income have a positive relationship with the quantity demanded. These signs are consistent with our expectations as well as the economic theory.

In the supply side of the housing market, all the signs are also as expected. As prices increase, the quantity supplied rises; on the other hand costs and interest rates are negatively related.

When we look at the vector-error correction model results (Table 11- Appendix C) which provide us to observe the market in the short-run, we can see that most of the variables are not significant in the short-run. Error correction term that is coming from demand equation, the lag of quantity dwellings and lag of population are significant at 90% confidence level. Despite the insignificance, we can notice in the short run the price of the response (coefficient is $5.4x10^6$) is less than in the long-run when Istanbul Construction Cost Index is used. This also supports the ideas of the model of Topel and Rosen (1988). This shows again that the adjustment costs for a change in the housing market are significant in Turkey.

The difference between the analysis, made by using Turkey Cost Index, and the analysis, made by using Istanbul Cost Index can be seen in the short-run results. In the former one, all error terms with real interest rate and the real cost are significant while in the latter analysis, the error term coming from demand equation and the lag of quantity and lag of population are significant. On the other hand, the long-run analysis

6.1.2 Logarithmic Form Analysis

In this section, all the variables are transformed into logarithmic terms then the same analysis with section 7.1.1 is applied. Since all the variables are in the same order, we can test whether there is a cointegration relation between the variables by using both the Johansen maximum eigenvalue (λ_{max}) and trace (λ_{trace}) statistics for a VAR model with a constant and a trend.

According to the Table 11 in Appendix C, at the 0.05 significance level, two cointegrated relationship between these variables are found out in the long-run.

The restrictions are as described in 7.1.1., where CE1 stands for the demand side, CE2 stands for the supply side. In Table 12 (Appendix C), the first and second restrictions are significant at 1% confidence level. However, the second restriction is appropriate at 99% confidence level.

By using the second type of restrictions and normalize it, we can find the results presented in Table 13 (Appendix C).

These results (Table 13) provide us to analyze the market in the long-run elasticities. So, according to these results, all the variables forming the supply and demand sides are significant in 99% confidence level in the long-run. The price elasticity of demand is -4.97 while the price elasticity of supply is 1.5 in the long-run. These coefficients mean that when the prices increase by 1%, the demand to the buildings decrease by 4.97% on the other hand the supply of the buildings increase by 1.5%. Furthermore, the income elasticity of demand is 10.28, that is, when the income of a household increase by 1%, the demand of buildings increase by 10.28%. This high coefficient shows us that when the income of a household increases, the buying a house is widely preferred in Turkey.

When we look at the vector-error correction model results in Table 14 (Appendix C) which provide us to observe the market in the short-run, we can see that the logarithmic forms of real price, real interest rate, real cost and real income are insignificant. Conversely the error correction terms that are coming from demand and supply equations, the lag of quantity dwellings and lag of population with the constant term are significant at 99% confidence level. Despite the insignificance, we can notice the price elasticity is 0.13, meaning when the price of a dwelling increases by 1%, the quantity supplied increases by 0.13% in the short run. This shows that there are high adjustment costs for a change in the short-run in Turkey since for instance in USA the short-run price elasticity of supply is 1.0 (Topel and Rosen, 1988) while it is 3 in the long-run during the period 1963 to 1983 with quarterly data. These results are all consistent with the model of Topel and Rosen (1988).

According to Hakfoort and Matsiyak (1997), in Netherlands the short-run price elasticity of supply is 2.3 while the long-run price elasticity of supply is 6 over the period 1977 to 1994 with quarterly data. On the other hand, Follain (1979) finds the long-run price elasticity of supply for United States as 1.48 over the period 1947 to 1975. In addition Dipasquale and Wheaton (1992) finds the price elasticity of supply for the long-run as at least 1.2 by using their constructed model.

In most of the developing countries, housing market data does not exist completely, however for United States and within United States; data about housing market data is one of the most available. Hence there is a huge literature about finding the price elasticities for United States. According to Palmquist (1983), in the short-run the price elasticity of demand is approximately unitary while the income elasticity is inelastic for United States. Reichert (1990) finds the income elasticity of demand is 3.78 in United States over the period 1975 to 1987, with quarterly data. He examines the price elasticity of demand for the specific regions in United States and finds that the price elasticity of demand changes between 0.13 and 0.22 within the country.

Green et. al. (1999) estimate the elasticity of housing supply based upon contemporaneous price change for 44 United States metropolitan areas over the period 1979 to 1996. According to his findings, the price elasticities are in the range of 38.6 to 0.6

6.2. Limitations of Results

This is the first study that attempts to analyze the demand and supply relationships in the real estate market of Turkey using a structural model. However there are serious limitations to this study due to lack of appropriate data. For instance, since the real market housing price does not exist for Turkey, value per each dwelling is used as a proxy for the price. The value is a kind of cost that is taken from the builder without interested in what the materials are and how much the labor costs to the builder. So, the value per each dwelling has a high correlation with the cost index; however they are not the same. They have slight differences which are discussed in detail in Section 6.1.

Another limitation of this study is that in order to use the value data, number of all the buildings, such as residential, commercial, social cultural buildings, are taken as the quantity of buildings. As a result of this restriction, we can not focus on the dynamics of housing market. Furthermore, the number of buildings data is constituted annually, which means for a long period, 1970 to 2007, only 38 data exists. In fact the number of dwellings starts from 1961 but the interest rate does not exist before the years 1970.

In my empirical framework, all the variables are transformed into real terms by using the Fisher's rule. Fisher's rule is based on the real interest rate, nominal interest rate and inflation expectations. However, in Turkey the expectation survey data starts in 2001 in Turkey. So, in this study it is assumed that inflation expectations are equal to the actual inflation.

CHAPTER 7

CONCLUSION:

This study has attempted to model the demand and supply sides of the Turkish real estate market using a structural model and an econometric framework which clearly distinguishes the long- and short-run information among a relevant set of economic variables.

In this study Topel and Rosen's (1988) housing demand and supply models are used due to the fact that in these models short and long-run elasticities are different; short-run price elasticity is more inelastic which fits the Turkish real estate market structure since the adjustment cost for short-run equilibrium is high.

In addition, since all the variables used in this study are of integrated of order 1 (I(1)), in order not to lose information by differencing data, cointegration analysis is found appropriate to be used. Johansen Cointegration test is preferred because there has not been found a significant weakness on this test so far. In addition the Vector Error Correction Model (VECM) is used to find the short-run relations by imposing some restrictions on VAR model. Furthermore, VECM takes into account the long-run relations while finding short-run relations, which is consistent with the Topel and Rosen (1988) housing investment theory.

In this study since the market price of a house does not exist in Turkey, the value is used as a proxy for price. In addition, the value of buildings is not divided into the use of building types, so we can not observe the dynamics of the residential buildings but the dynamics of real estate market in the aggregate. Furthermore, because the number of buildings data is formed annually, annual data is used for the period 1970 to 2007

All the variables, which are taken from Turkish Statistical Institute, are transformed into real forms by using Fisher's rule under the assumption of actual inflation is equal to the inflation expectations. The empirical study is divided into two groups, level data analysis and logarithmic form analysis. According to the both of the analysis, interest rate, value, income and population are found to be significant in explaining the quantity demanded of dwellings in the long-run with the expected signs and for the supply side, value, cost and interest rate are found to be significant in explaining the quantity supplied in the short-run with the expected signs. On the other hand, in the short-run, the variables, those are significant, are different for the two analyses.

According to the results of the logarithmic form analysis, the long-run price elasticity of supply is 1.5 while the short-run price elasticity of supply is 0.13. This shows that there are high adjustment costs for a change in the short-run in Turkey. These results are all consistent with the model of Topel and Rosen (1988). Furthermore, the long-run price elasticity is -4.97 which is more elastic comparing with the long-run price supply elasticity, that is, consumers are more sensitive that the builders.

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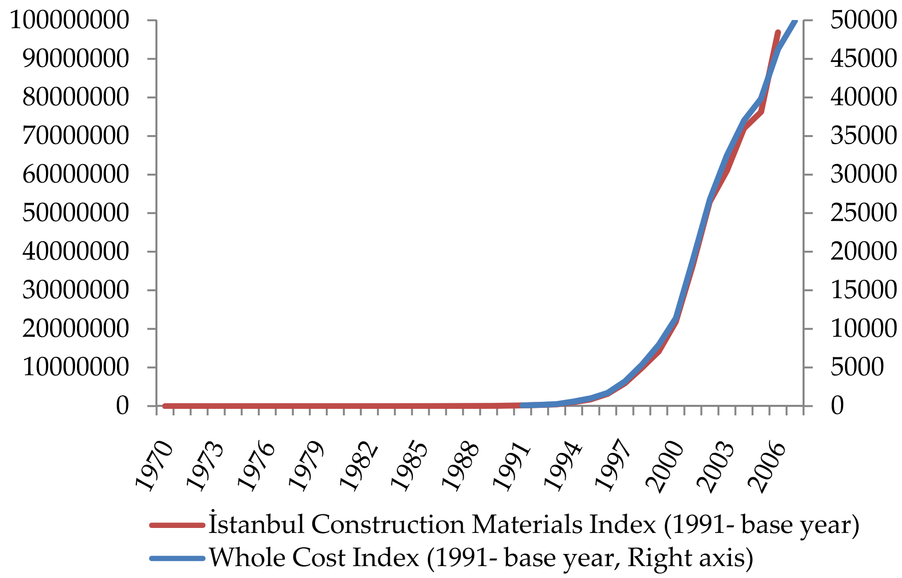
APPENDICES

APPENDIX A

TURKEY BUILDING COST INDEX

Figure 4. Whole Building Cost Index (1991 – 2007) and Istanbul Construction Materials Index (1970- 2007)



The Turkey Building Cost Index starts from 1991 till 2007 but Istanbul Construction Cost Index starts from 1970 to 2007. So by using

Istanbul Construction Cost Index as a leading variable, Turkey Building Cost Index can be generated for the years before 1991.

In this data generating process, polynomial interpolation is firstly chosen. When the polynomial interpolation is implemented, a sixth degree polynomial comes out and gives negative values for the years before 1991. Due to the fact that the cost index can not take negative values, polynomial interpolation can not be used.

By looking at the Figure 1, it can be concluded that exponential regression is suitable for this data generating process. Then we get;

Table 2. Exponential Regression Result

	X_t	**$\ln Y_{t-1}$**	**Constant**
$\ln Y_t$	$-4.72x10^{-9}$ $(1.79x10^{-9})$	0.99 (0.03)	0.64 (0.19
	R^2 =0.997	Durbin Watson=2.1	F Statistics = 2199

*Standard errors are in parenthesis ( ).

X_t is Istanbul Construction Cost Index

Y_t is Building Cost Index

By using these exponential regression data generating process, Turkey Building Cost Index is extended through the year 1970.

APPENDIX B

DESCRIPTIVE STATISTICS

Table 3. Descriptive statistics of real level data

	Mean	Median	Maximum	Minimum	Std.Dev.
q	69953.7	60664.5	106406	40792	21691.3
p	0.0006	0.0006	0.0008	0.0003	0.0001
r	0.007	-0.19	3.06	-0.81	0.71
c	0.49	0.44	1.08	0.06	0.39
c_2	141.84	145.74	269.75	70.11	37.77
y	82518092	76402302	1.63×10^8	33765132	35990683
n	54396.3	54304.5	73875	35321	12010

Table 4. Descriptive statistics of logaritmic data

	Mean	Median	Maximum	Minimum	Std.Dev.
Log(q)	11.11	11.01	11.57	10.62	0.31
Log(p)	-7.48	-7.41	-7.11	-8.20	0.28
Log(r)	-7.68	-6.39	-2.41	-15.36	4.28
Log(c)	-1.49	-1.99	0.86	-2.81	2.30
Log(y)	18.13	18.15	18.91	17.33	0.45
Log(n)	10.88	10.90	11.21	10.47	0.23

APPENDIX C

TABLES OF ESTIMATION RESULTS

Table5. Phillips Perron Unit Root Test Statistic Results 1

Series	Adj. t values of levels	Adj. t values of first differences
Quantity of dwellings (q)	-1.71 (0.42)	-4.88 (0.00)*
Real value (p)	-2.30 (0.18)	-5.56 (0.00)*
Real Income (y)	2.29 (0.99)	-5.98 (0.00)*
Real Cost (c)	-0.99 (0.75)	-6.04 (0.00)*
Real Istanbul Cost (c_2)	-0.51 (0.49)	-10.01 (0.00)*
Population (n)	0.47 (0.98)	-1.63 (0.10)**

*Statistics that is significant at the level 1% level.
** Statistics that is significant at the level 10% level
(p values are in parenthesis)

Table 6: Results of Philips Perron Unit Root Test Statistics 2

Series	Adj. t values of levels	Adj. t values of first differences
Log (q)	-1.90 (0.33)	-4.84 (0.00)*
Log (p)	-1.44 (0.14)	-5.82 (0.00)*
Log (y)	-0.44 (0.89)	-6.60 (0.00)*
Log (c)	-2.15 (0.23)	-3.06 (0.04)*
Log (n)	12.35 (1.00)	-1.65 (0.09)**

*Statistics that is significant at the level 1% level.
** Statistics that is significant at the level 10% level
(p values are in parenthesis)

Table 7. Tests of the Cointegration Rank for Turkey Cost Index

Ho: r	*(λ_{max})*	*Max.- Eigen Statistic*	*Prob.**	*(λ_{trace})*	*Trace Statistic*	*Prob.**
0	0.89	78.66	0.00**	0.89	154.85	0.00**
1	0.65	38.15	0.0***	0.65	76.19	0.01**
2	0.43	20.20	0.33	0.43	38.04	0.30
3	0.26	10.85	0.66	0.26	17.84	0.58
4	0.18	6.97	0.49	0.18	6.99	0.58
5	0.00	0.02	0.88	0.00	0.02	0.88

*MacKinnon-Haug-Michelis (1999) p-values
** denotes the rejection of the hypothesis at the 0.05 level

Table 8. Chi- square (χ^2) statistics for the restrictions under Ho: restrictions are appropriate-Turkey Cost Index

	CE 1	*CE2*	*CE1*	*CE2*	*CE1*	*CE2*
Q	-	-	-	1	1	1
P	-	-	-	-	-	-
C	0	-	0	-	0	-
I	-	-	-	-	-	-
Y	-	0	-	0	-	0
N	-	0	-	0	-	0
(χ^2)	$\chi^2_{(1)}$ 0.14		$\chi^2_{(9)}$ 0.14		$\chi^2_{(3)}$ 4.24	
P value	0.71		1.00		0.99	

Table9.Long-Run Equilibrium Results 1

Variables	Demand Side	Supply Side*
Price	– 66.7x 10^6 (-2.93)**	17.8x10^6 (4.98)**
Income	0.001 (3.63)**	-
Interest Rate	- 48x10^4 (-14.24)**	– 32.7x10^4 (-17.22)**
Population	6.44 (7.03)**	-
Cost	-	– 59.6x10^4, (-6.04)**
Constant	-1.5x10^5 (-9.09)**	-8.9x10^4 (-2.85)**

*t-statistics are in ( )
**Significant in 99% confidence level

Table10: Vector Error Correction Results 1

Error Correction	D[3](quantity)
Cointeq1[1]	$2.41x10^{13}$ (2.3)*
Cointeq2[2]	0.93 (2.0)*
D(quantity(-1))	0.09 (0.33)
D(rprice(-1))	$9.4x10^{5}$ (0.27)
D(rinterest(-1))	$5.4x10^{3}$ (1.29)
D(rcost(-1))	$4.9x10^{4}$ (1.16)
D(population(-1)	-0.72 (-0.05)
D(rincome(-1))	$0.2x10^{-4}$ (0.39)
constant	$1.5x10^{3}$ (0.09)

[1]Error term of the long-run demand equation
[2]Error term of the long-run supply equation
[3]D stands for the first difference of the data
*Significant at 99% confidence level
**Significant at 85% confidence level

Table11. Tests of the Cointegration Rank 2

Ho: r	*(λ_{max})*	*Max.- Eigen Statistic*	*Prob.**	*(λ_{trace})*	*Trace Statistic*	*Prob.**
0	0.82	61.45	0.00**	0.82	148.13	0.00**
1	0.66	39.34	0.01**	0.66	86.68	0.00**
2	0.52	26.37	0.10	0.52	47.34	0.10
3	0.30	12.93	0.46	0.30	20.96	0.36
4	0.19	7.81	0.40	0.19	8.04	0.46
5	0.01	0.23	0.63	0.01	0.23	0.63

*MacKinnon-Haug-Michelis (1999) p-values
** denotes the rejection of the hypothesis at the 0.05 level

Table12. Chi- square (χ^2) statistics for the restrictions under Ho: restrictions are appropriate 2

	CE 1	*CE2*	*CE1*	*CE2*	*CE1*	*CE2*
Q	-	-	-	1	1	1
P	-	-	-	-	-	-
C	0	-	0	-	0	-
I	-	-	-	-	-	-
Y	-	0	-	0	-	0
N	-	0	-	0	-	0
(χ^2)	$\chi^2_{(1)}$ 6.25		$\chi^2_{(9)}$ 1.87		$\chi^2_{(4)}$ 1.87	
P value	0.01		0.99		0.76	

Table13.Long-run Equilibrium Results 2

Variables	Demand Side	Supply Side
Price	– 46.1×10^{6} (-2.03)*	17.8×10^{7} (5.13)*
Income	0.002 (3.71)*	-
Interest Rate	- 47×10^{4} (-11.03)*	– 27×10^{4} (-13.65)*
Population	7.19 (7.82)*	-
Cost	-	-38.1×10^{2} (-2.96)*
Constant	1.7×10^{5} (10.02)*	2.5×10^{4} (3.10)*

t-statistics are in ( )

**Significant in 99% confidence level

Table14: Vector Error Correction Results 2

Error Correction	D[3](quantity)
Cointeq1[1]	$1.55x10^{15}$ (1.40)*
Cointeq2[2]	-0.65 (-0.89)
D(quantity(-1))	-0.65 (-1.37)*
D(rprice(-1))	$5.4x10^{6}$ (1.00)
D(rinterest(-1))	$-2.4x10^{3}$ (-0.32)
D(rcost(-1))	24.98 (0.33)
D(population(-1)	46.9 (1.54)*
D(rincome(-1))	$-6x10^{-4}$ (-1.04)
constant	$1.5x10^{3}$ (0.09)

[1]Error term of the long-run demand equation
[2]Error term of the long-run supply equation
[3]D stands for the first difference of the data
*Significant at 90% confidence level

Table15. Tests of the Cointegration Rank 3

Ho: r	*(λ_{max})*	*Max.- Eigen Statistic*	*Prob.**	*(λ_{trace})*	*Trace Statistic*	*Prob.**
0	0.79	53.10	0.00**	0.80	143.753	0.00**
1	0.64	42.82	0.00**	0.65	100.64	0.00**
2	0.50	31.04	0.10	0.48	57.82	0.10
3	0.44	18.63	0.26	0.27	42.78	0.38
4	0.29	15.96	0.40	0.19	24.15	0.56
5	0.11	8.19	0.68	0.08	8.19	0.73

*MacKinnon-Haug-Michelis (1999) p-values
** denotes the rejection of the hypothesis at the 0.05 level

Table16. Chi- square (χ^2) statistics for the restrictions under Ho: restrictions are appropriate 3

	CE 1	*CE2*	*CE1*	*CE2*	*CE1*	*CE2*
Q	-	-	-	1	1	1
P	-	-	-	-	-	-
C	0	-	0	-	0	-
I	-	-	-	-	-	-
Y	-	0	-	0	-	0
N	-	0	-	0	-	0
(χ^2)	$\chi^2_{(1)}$ 3.12		$\chi^2_{(16)}$ 3.13		$\chi^2_{(1)}$ 3.15	
P value	0.07		0.99		0.08	

Table17. Long-run Equilibrium 3

Variables	Demand Side	Supply Side
log(price)	-4.97 (-5.07)*	1.50 (7.64)*
log(income)	10.28 (4.40)*	-
log(interest rate)	0.24 (2.25)*	- 0.28 (-6.21)*
log(population)	54.18 (4.38)*	-
log(Cost)	-	–0.28 (-2.48)*
Trend	-1.36 (-4.77)	-0.14 (-5.34)
Constant	-773.57 (-2.01)*	22.53 (2.55)*

t-statistics are in ( )

**Significant in 99% confidence level

Table18: Vector Error Correction Results 3

Error Correction	D^3(quantity)
Cointeq1[1]	-0.19 (-4.04)*
Cointeq2[2]	-0.92 (-5.39)*
D(log(quantity(-1)))	0.57 (3.59)*
D(log(price(-1)))	0.13 (0.59)
D(log(interest(-1)))	-0.07 (-0.66)
D(log(cost(-1)))	-0.01 (-0.04)
D(log(population(-1))	21.49 (2.30)*
D(log(income(-1)))	-0.23 (-0.36)
constant	-0.45 (-2.23)*

[1]Error term of the long-run demand equation
[2]Error term of the long-run supply equation
[3]D stands for the first difference of the data
*Significant at 99% confidence level